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AIMS OF THE PROJECT

RATIONALE OF THE PROJECT

The major cause of pain and disability in Australians is arthritis (Access Economics, 2005), affecting more than 3.4 million people (17% of the population) at a total cost to the community of \$11.2 billion per year. The prevalence of osteoarthritis, one of the many forms of arthritis, was 8% in 2004, but this figure has been projected to increase to 10% in 2020 (Access Economics, 2005). Considering that 60% of all people with arthritis are of working age, the personal and socioeconomic costs are enormous. Since the incidence of osteoarthritis increases with age (Armstrong, Hunter & Davis 1994, Haara et al. 2004) and the Australian population is rapidly aging, it is likely that the demand on health care and community resources for people with osteoarthritis will increase dramatically over the coming decades.

The effect of osteoarthritis can be analysed according to the International Classification of Functioning, Disability and Health, known as ICF (World Health Organisation, 2005). This classification provides a structure to consider the interactions between impairments, limitations to activity and restrictions to participation (Figure 1.1). In applying this classification to the population of people with trapeziometacarpal osteoarthritis, impairments will be considered to include factors such as pain, weakness and loss of mobility of the thumb. These impairments result in limitations to activity, ie, difficulty performing specific tasks. Further, these limitations result in restrictions to participation or involvement in life situations, such as work duties, hobbies and sports.

Figure 1.1 *Schematic representation of the International Classification of Functioning, Disability and Health (ICF) applied to trapeziometacarpal joint osteoarthritis*

The studies reported in this project explore the trapeziometacarpal joint in two different populations, first musculoskeletal physiotherapists, and second, the people attending hand clinics for management of their thumb pain. Musculoskeletal physiotherapists subject their thumbs to a unique weight-bearing situation while performing various manual therapy techniques. They often report pain at the trapeziometacarpal joint which is aggravated by these techniques. In contrast, people attending hand clinics for management of their thumb pain consist largely of post-menopausal women, who present with pain, weakness, and in more advanced stages, fixed deformity. This thesis will explore approaches to both conservative and surgical management of this condition in these populations.

OSTEOARTHRITIS OF THE TRAPEZIOMETACARPAL JOINT

Prevalence

Trapeziometacarpal osteoarthritis is particularly common in post-menopausal women in the fifth to seventh decades of life (Swigart et al. 1999). In a radiographic review of nearly 4000 people (>30 years), the prevalence of trapeziometacarpal osteoarthritis was found to be 15% for women (Haara et al. 2004). In another radiographic review, this time of 143 post-menopausal women (>45 years) with acute distal radius fracture, the prevalence was 33% (Armstrong, Hunter & Davis 1994). While it is clear that the prevalence of radiological osteoarthritis increases with age, it must be remembered that only 30% of those with radiological osteoarthritis reported basal thumb pain. This is consistent with the clinical observation that the severity of symptoms does not necessarily correlate with the severity of radiological findings, and suggests that interventions should not be based on radiological signs alone.

Impairments

The most common and disabling impairment for people with trapeziometacarpal osteoarthritis is pain. They report pain localised to either the palmar surface of the joint or the dorsum of the web space, between the first and second metacarpals (Flatt 1995). While some people report a dull-aching pain at rest, most complain of a sudden, intense pain aggravated by performing certain tasks and activities. Rest and the application of superficial heat can provide symptomatic relief; however, these people find their symptoms return when they resume normal use of their hands.

With progression of joint degeneration with advancing osteoarthritis, impairments worsen to include thumb weakness and contracture, which cause considerable interference to overall function of the hand (Menon 1995).

Activity Limitations

The pain of trapeziometacarpal joint osteoarthritis limits many activities requiring manipulation of objects in the hand. Such activities include, but are not limited to: opening jars and bottles, pouring liquids, turning keys, fastening buttons, lifting heavy objects, hand-writing, and driving.

Participation restrictions

These activity limitations can subsequently restrict participation in a variety of domestic, work, leisure and recreational activities which require use of the hand. Occupations which may be affected include process work, retail, and musculoskeletal physiotherapy, while affected leisure and recreational activities include gardening, china painting, yoga, bowls, and handcrafts. Participation in these activities can be restricted due to the impairments of pain, weakness and loss of mobility.

Environmental and personal factors

Both environmental and personal factors combine to contribute to the activity limitation and participation restriction of trapeziometacarpal osteoarthritis. Perhaps the most significant personal factor is gender. Females are known to have significantly smaller trapeziums than males, resulting in less joint congruency and smaller contact areas (Ateshian, Rosenwasser & Mow 1992, Kovler et al. 2004). Under similar loading conditions, the female trapeziometacarpal joint would be subject to greater stresses than the male joint. Other predisposing personal factors include age (March 1997), obesity (Haara et al. 2004), hysterectomy (Spector et al. 1991), ethnicity, genetics, history of inflammatory joint disease, and metabolic, congenital and developmental defects (Martou, Veltri & Thoma 2004).

Environmental factors which contribute to trapeziometacarpal osteoarthritis include previous trauma (Martou, Veltri & Thoma 2004) and repetitive use (March 1997). Certain occupations or hobbies predispose people to developing pain at the trapeziometacarpal joint, particularly when the specific task requires sustained loading through the thumb. For example, musculoskeletal physiotherapists apply a sustained load through the thumb as they perform their manual therapy techniques and they are an example of an occupational group particularly prone to developing pain at the trapeziometacarpal joint. In fact, Cromie et al (2000) found an increased risk of thumb pain in manual physiotherapists compared to general physiotherapists, with the severity of pain being related to the number of hours physiotherapists used mobilisation techniques.

Classification

The severity of trapeziometacarpal osteoarthritis can be graded according to the following commonly-used staging system, which has been modified from the original description by Eaton and Glickel (1987) (Table 1.1).

Table 1.1 Staging of osteoarthritis at the trapeziometacarpal joint

Stage	I	II	III	IV
Articular contours	Normal	Normal	Irregular	Degenerated
Joint space	Slight widening	Slight narrowing	Markedly narrowed	Complete deterioration
Sclerotic change	Nil	Mild	Marked	Marked
Articular debris	Nil	<2mm	>2mm	>2mm
Dorsal Subluxation	Nil	<1/3	1/3-2/3	>2/3
Scaphotrapezial joint	Normal	Normal	Normal	Sclerotic

This system provides a structure for staging the radiological stage of trapeziometacarpal osteoarthritis. While the radiological stage does not always correlate with the severity of clinical symptoms, it can be helpful in determining appropriate management. For example, people with Stage IV trapeziometacarpal joint osteoarthritis will require removal of the trapezium to relieve the symptoms of osteoarthritis. This staging system will be used throughout this project when referring to the stage of osteoarthritis at the trapeziometacarpal joint.

MECHANISMS UNDERLYING DEVELOPMENT OF TRAPEZIOMETACARPAL OSTEOARTHRITIS

Changes to stabilising structures

The trapeziometacarpal joint depends on its articular configuration, ligament tension, and muscular activity for stability (Miura, Ohe & Masuko 2004). Subtle changes to these stabilising structures will predispose the joint to hypermobility and progressive joint degeneration (Jonsson et al. 1996).

Articular configuration

The articular configuration of the trapeziometacarpal joint allows great mobility at the expense of stability. It is a bi-concave saddle joint (Imaeda, An & Cooney 1992). The trapezium has a bony ridge running obliquely from proximal to distal, which faces ulnarly (Humes et al 2004) and divides the trapezium surface into two slightly concave surfaces, volar and dorsal (Kauer 1987, Kuczynski 1974). The corresponding concave groove on the metacarpal surface approximately matches the ridge of the trapezium, but the subtle differences in the curvature of the surfaces results in there being no position in which the surfaces fit together well (Kauer 1987). This inherent incongruity of the articular surfaces allows the joint to sublux during pinch and grasp (Imaeda, An & Cooney 1992) unless adequately restrained by the surrounding soft tissue structures (Moulton et al. 2001). Insufficiency of these structures results in narrowing of the joint space, subchondral sclerosis, articular debris and osteophyte formation, increasing dorsal subluxation of the metacarpal base off the trapezium, and in the more severe cases, scaphotrapezium joint involvement.

Ligamentous tension

Trapeziometacarpal joint stability relies on strong supporting ligamentous structures. Laxity of these structures has been proposed as a mechanism for the development of osteoarthritis at the trapeziometacarpal joint (Jonsson et al. 1996). Imaeda et al (1992) suggest that trapeziometacarpal joint stability is provided by the *volar oblique* ligament, combined with secondary support from the *intermetacarpal* and *ulnar collateral* ligaments. The importance of the *volar oblique ligament* (referred to as the *palmar beak* ligament by Pellegrini in 1991(b) (Najima et al. 1997)) was confirmed in an anatomic study of 47 elderly cadaver thumbs. Normal articular surfaces were only found in the presence of complete integrity of the capsuloligamentous structures about the joint, whereas degeneration of the *volar oblique* ligament predicted severe articular disease (Pellegrini 1991b). While the *volar oblique* ligament has more recently been shown to be relatively weak and compliant compared to the *intermetacarpal* and *dorsoradial* ligaments (Bettinger et al. 2000), it is still considered to be integral for a normal thumb trapeziometacarpal joint (Doerschuk et al. 1999). These studies support the mechanism of ligament laxity as one of the key factors underlying the development of trapeziometacarpal osteoarthritis. They suggest that ligament laxity allows excessive shear forces at the joint, altering contact wear patterns, and predisposing people to the development of osteoarthritis.

Muscular activity

Strong intrinsic and extrinsic muscles assist the ligamentous structures in maintaining stability of the thumb (Cooney & Chao 1977). These muscles work in a balanced fashion to contribute to stabilisation of the thumb (Chao et al. 1989),

resisting external forces, positioning the thumb in functional positions, and producing force during pinch and grasp tasks (Bourbannais et al. 1993, Cooney & Chao 1977).

The advanced stages of trapeziometacarpal osteoarthritis are characterised by the thumb assuming a fixed collapse deformity. With incompetence of the *volar oblique* ligament, dorsal subluxation of the base of the metacarpal progresses unchecked, and the thumb assumes a collapsed deformity of flexion at the trapeziometacarpal joint, hyperextension at the metacarpophalangeal joint, and reciprocal flexion at the interphalangeal joint (Tubiana, Thomine & Mackin 1996). Two thenar muscles which have the potential to counter the tendency toward the collapse deformity and stabilise the volar aspect of the trapeziometacarpal joint are *abductor pollicis brevis* and *opponens pollicis*. *Abductor pollicis brevis* produces palmar abduction but can also extend the interphalangeal (IP) joint, via its attachment into the extensor expansion when the metacarpophalangeal (MP) joint is flexed (Fahrer 1994). *Opponens pollicis* is the only thenar muscle to act solely on the trapeziometacarpal joint, and has an important role in rotating the thumb into pronation (Brand 1985, Tubiana 1984). When considering the combined action of these muscles, it becomes evident that they contribute to supporting the base of the metacarpal in normal alignment, as well as causing palmar abduction, flexion of the MP and extension of the IP joints. Strength in these muscles is essential in order to avoid the typical collapse deformity of trapeziometacarpal osteoarthritis.

Changes to contact wear patterns

Insufficiency of the stabilising structures predisposes the trapeziometacarpal joint to progressive joint degeneration, characterised by alteration of the joint contact wear patterns. Early work by Pellegrini et al (1993) determined that the volar compartment is the major area of joint contact during lateral pinch in the normal joint. However, laxity or experimental division of the volar oblique ligament resulted in the base of the metacarpal subluxing dorsally on the trapezium, causing the contact area to migrate dorsally and permitting excessive metacarpal pronation, in turn causing joint impingement.

Altered contact wear patterns have also been associated with metacarpophalangeal joint position (Moulton et al. 2001). Dynamic testing of 20 cadaveric forearm specimens using a lateral pinch model revealed that positioning the metacarpophalangeal joint in 30° flexion unloaded the most severely-involved volar compartment of the joint, moving the centre of contact pressure dorsally. This and previous studies suggest that limiting the amount of joint subluxation, metacarpal pronation, and/or metacarpophalangeal hyperextension will alter the joint contact wear patterns, and may have a role in delaying the development of trapeziometacarpal osteoarthritis.

CURRENT CONSERVATIVE MANAGEMENT OF OSTEOARTHRITIS OF THE TRAPEZIOMETACARPAL JOINT

Conservative management of trapeziometacarpal osteoarthritis aims to decrease pain, weakness and contracture, and improve hand function. Interventions have traditionally included splinting to reduce pain (Colditz 2000) and preserve the web space (Poole & Pellegrini 2000), exercise regimens to strengthen the thenar musculature and restore stability (Taylor 2000), and activity modification (Wolock, Moore & Weiland 1989).

Splinting

Splinting aims to enhance pain-free use of the thumb, and allow people to perform previously aggravating activities without pain. In general, people with frequent or constant pain are more comfortable wearing their splints full-time, whereas, those with intermittent symptoms find they can manage with only wearing the splint during performance of a specific aggravating activity.

Many splinting options are available, both prefabricated and custom-made. The splint may be fabricated from either a rigid thermoplastic material or a flexible neoprene fabric. A variety of thermoplastic splinting options exist; from a small splint which only supports the trapeziometacarpal joint, to a much larger splint which includes both the metacarpophalangeal joint and the wrist. Traditionally, a short opponens splint which includes the metacarpophalangeal joint (Poole & Pellegrini 2000) has been considered appropriate for this condition, however others describe success with a long opponens splint, which also includes the wrist (Swigart et al.

1999). Still others describe variations of the above splints, attempting to maintain the thumb in a stable position and enhance hand function (Galindo & Lim 2002).

While clinical experience suggests that people can perform activities of daily living with less pain while wearing their splints, they will be inclined to remove the splint if the activities become too difficult or awkward with it on. Colditz (2000) agrees that poor compliance with splint wearing may be related to the immobilisation of unnecessary joints, and has described a splint that neither includes the wrist nor the metacarpophalangeal joint. In a comparison of outcomes in 25 people with Stage I-II trapeziometacarpal osteoarthritis, after one week of wearing either the short opponens splint (excluding the metacarpophalangeal joint) or a prefabricated neoprene support (including the wrist and metacarpophalangeal joint), Weiss et al. (2004) found pain and hand function were improved but no difference between the groups.

Exercise

Exercise is routinely prescribed for people with osteoarthritis of the knee and hip. There is evidence that well-conditioned muscles provide joint stability, attenuate impact loads, and improve independence (Felson et al. 2000). In a systematic review of randomised controlled trials of exercise for osteoarthritis of the hip or knee, van Baar et al. (1999) found beneficial effects of exercise therapy on pain, activity limitation measures and patient's global assessment.

Although there is no evidence of any direct benefit of exercise alone in the treatment of trapeziometacarpal osteoarthritis, Taylor (2000) has proposed that specific thenar muscle strengthening exercises may have the potential to delay or ultimately reduce the need for surgical intervention in people with early trapeziometacarpal joint osteoarthritis. Appropriate exercises include specific thenar muscle strengthening and/or pain-free resisted pinching of a soft sponge.

Adaptations

Another strategy in the conservative management of people with trapeziometacarpal osteoarthritis is education. Education about techniques of joint protection may include use of assistive devices (eg, tap turners), use of splints (eg, thermoplastic thumb splint), or instruction in ways to change their technique for performance of specific tasks (eg, lifting with two hands). These adaptations can assist the person with trapeziometacarpal osteoarthritis to control their symptoms and delay the need for surgical intervention (Conolly & Wajon 2003, Wolock, Moore & Weiland 1989).

CURRENT SURGICAL MANAGEMENT OF OSTEOARTHRITIS OF THE TRAPEZIOMETACARPAL JOINT

Some people who complain of persistent pain and dysfunction at the base of the thumb, despite a trial of conservative management, will consider surgery. Surgery aims to provide a stable, mobile, pain-free thumb (Kuhns, Emerson & Meals 2003). Many surgical procedures have been described for this condition, with the procedure of choice determined by a combination of factors, including the surgeon's experience

and preference, the radiographic stage of disease, the patient's age and specific requirements for domestic, work, leisure and recreational activities.

Ligament reconstruction

Volar ligament reconstruction (Eaton et al. 1984) has traditionally been the procedure chosen for the painful hypermobile pre-arthritis trapeziometacarpal joint (Freedman, Eaton & Glickel 2000) (Stage I). It aims to relieve pain, maintain a functional range of motion and improve stability. The procedure involves reconstructing a strong volar ligament and reinforcing the dorsal joint capsule (Eaton et al. 1984). Such surgically stabilised joints are considered to be less likely to develop degenerative changes because they are not subject to shear forces (Freedman, Eaton & Glickel 2000). In a review of 38 cases at a mean of 7 years follow-up, 89% of patients with Stage I and II osteoarthritis were pain free (Eaton, et al. 1984). However in a more recent review of 24 thumbs at a mean of 15 years follow-up, 71% reported mild but persistent pain.

Metacarpal osteotomy

Metacarpal osteotomy has been recommended for people with Stage II-III osteoarthritis who have persistent pain which interferes with daily activities, despite conservative management (Hobby, Lyall & Meggitt 1998). The procedure aims to redistribute trapeziometacarpal contact area and load away from the compromised volar joint surface to the normal dorsal surface (Hobby, Lyall & Meggitt 1998). It involves removing a radially-based wedge of 20-30° from the metaphyseal bone of

the first metacarpal, followed by four weeks of fixation with Kirschner wires.

Metacarpal osteotomy has been found to be an effective biomechanical alternative to ligament reconstruction in people with Eaton Stage I osteoarthritis (Tomaino 2000).

In a review of 41 thumbs at a mean of seven years, Hobby et al (1998) found that 80% had achieved good or excellent pain relief.

Arthrodesis

Trapeziometacarpal arthrodesis has traditionally been the procedure chosen for younger, active people because of the stability and increased strength achieved (Fulton & Stern 2001). It is indicated for people with Stage II-III osteoarthritis, ie, those people without any scaphotrapezial joint involvement. While it provides stability, strength and pain relief, it does so at the expense of mobility. The procedure involves resection of the articular surfaces of the metacarpal and trapezium, bone grafting and internal fixation (Bamberger et al. 1992, Carroll 1987, Ferlic, Turner & Clayton 1983). Plate and screw fixation has been used as one method of fixation. However Forseth & Stern (2003) found that the hardware frequently needed removal (27%) and that patient satisfaction was lower than when Kirschner wires were used. The thumb is fused in a functional position of mid palmar / radial abduction, with the thumb tip resting on the middle phalanx of the index finger (Bamberger et al. 1992). Despite the significant loss of motion at the base of the thumb, and the inability to flatten the hand (Chamay & Piaget-Morerod 1994), minimal functional deficit has been reported (Bamberger et al. 1992, Chamay & Piaget-Morerod 1994). In a review of 52 thumbs, 85% were pain free at a mean follow-up of four years (Lisanti et al. 1997).

Trapeziectomy

Trapeziectomy has traditionally been the procedure chosen for the less active elderly patient with more advanced disease (Davis, Brady & Dias 2004). However in recent years, this procedure has become less popular because it cannot prevent proximal migration of the first metacarpal, resulting in impingement between the metacarpal and scaphoid with loss of thumb length (Davis, Brady & Dias 2004, Hobby, Lyall & Meggitt 1998). In an assessment of 34 simple trapezium excisions at 5 year follow-up, Varley et al (1994) reported only 47% were completely pain-free.

Arthroplasty

Arthroplasty has traditionally been the procedure chosen for Stage III-IV osteoarthritis, and is the preferred technique of the majority of hand surgeons in New South Wales (NSW Hand Surgery Association Annual Meeting, personal communication, October 24, 2004). In an effort to maintain the length of the thumb and enhance strength and stability after trapeziectomy, Burton and Pellegrini described the soft-tissue interposition and reconstruction with a stabilising tendon sling (ligament reconstruction and tendon interposition (LRTI)) (1986). This was found to improve strength and restore web space. However, the potential for recession of the metacarpal and instability at the pseudoarthrosis site remained (Kuschner & Lane 1996). Alternative interpositional arthroplasties include procedures which excise either all or part of the trapezium, and interpose the space with materials such as silicon (O'Leary, ST et al. 2002), allograft (Trumble et al.

2000, Schmidt, CC et al. 2000), or polypropylene (Marlex) (Muermans & Coenen 1998).

Joint replacement

Trapeziometacarpal joint replacements have traditionally been the procedure chosen for people with Eaton Stage II-IV osteoarthritis. Examples of prosthetic designs include the ball-and-socket type arthroplasty (Hannula & Nahigian 1999) and the Avanta joint resurfacing type arthroplasty (<http://www.avanta.org/hand.htm>), both of which can be either cemented (eg, de la Caffinière) or non-cemented (eg, Ledoux) (Wachtl, Guggenheim & Sennwald 1998) prostheses. Replacement of the degenerative articular joint surface with a prosthesis has the potential to reproduce normal kinematics and stability at the joint in the presence of intact ligaments (Uchiyama et al. 1999), but unfortunately these prostheses have also been reported to subside, loosen, dislocate and break (Linscheid 2000).

While many procedures have been described for this condition, there remains uncertainty regarding which procedure is likely to achieve the best outcomes for any given stage of trapeziometacarpal OA (Hartigan, Stern & Kiefhaber 2001).

AIMS OF THE PROJECT

This project explores factors that are associated with, and efficacy of intervention for, osteoarthritis at the trapeziometacarpal joint in two populations. First, the musculoskeletal physiotherapy population which report pain aggravated by

performing manual therapy techniques was studied. Second, the general patient population was studied. The efficacy of conservative and surgical intervention for the management of trapeziometacarpal osteoarthritis was investigated for this group.

The aims of the project were as follows:

1. Identify the technique most likely to aggravate pain at the base of the thumb in musculoskeletal physiotherapists.

Clinical experience has demonstrated that pain at the base of the thumb is very common in physiotherapists. In particular, these physiotherapists report aggravation of symptoms whilst performing manual therapy techniques. In an effort to quantify the problem, a survey was sent to members of Musculoskeletal Physiotherapy Australia, asking about their work history and pain presentation. The results of this survey are presented in Chapter 2.

2. Determine whether the alignment of the joints of the thumb during performance of the aggravating manual therapy technique is associated with thumb pain.

The survey revealed that physiotherapists regularly performing manual therapy were able to identify one manual therapy technique as the most aggravating. This technique involves the transfer of body weight through the joints of the thumb to the patient's spine. It was understood that positioning the metacarpophalangeal and interphalangeal joints in extension during the application of pressure would be likely to minimise any deforming force to the

thumb. However, hypermobile therapists have difficulty maintaining this position and often collapse into hyperextension or flexion at either or both joints. The alignment of the metacarpophalangeal and interphalangeal joints of the thumb during the application of a PA glide was analysed to determine whether there was an association with thumb pain. The results of this analysis are presented in Chapter 3.

3. Design a new thumb strap splint used for the management of trapeziometacarpal osteoarthritis.

Limitations in existing splints led the author to design a new splint for people with trapeziometacarpal osteoarthritis. In particular, the thumb strap splint was designed to maintain the web space, restrict dorsal subluxation of the base of the first metacarpal, and prevent metacarpophalangeal hyperextension. The design of the splint and its clinical application is presented in Chapter 4.

4. Examine the efficacy of the thumb strap splint with specific thenar strengthening exercises for the management of trapeziometacarpal osteoarthritis.

A randomised controlled trial was conducted to compare the outcomes of the thumb strap splint with specific thenar strengthening exercises with the traditional choice of a short opponens splint and strengthening exercises. The results of the trial are presented in Chapter 5.

5. Conduct a systematic review of the literature to determine whether any one surgical procedure for trapeziometacarpal osteoarthritis is superior to another.

For some, relief with conservative management is inadequate or short-lived, and they begin to consider their surgical options. While there is a wealth of literature describing results of various surgical procedures, few papers report their results for a given stage of osteoarthritis. Rather, they report results of one procedure performed over a range of stages. It was the intention of this review to determine whether there was any superiority in outcomes of one procedure over another for a given stage of osteoarthritis. In the absence of any papers which analysed results by stage of osteoarthritis, the secondary intention was to determine whether there was any superiority in outcomes of one procedure over another for any stage of osteoarthritis. The results of this systematic review are presented in Chapter 6.

Pain and dysfunction at the base of the thumb is the most common condition seen in clinical practice by this author. Not only is it common in the general population, but also in the physiotherapy population. Many physiotherapists express concern regarding their ability to continue to work in manual therapy, and others regret the years spent performing heavy mobilisations which they feel contributed to their early retirement. The two studies on the physiotherapy population are important because they can assist in the formulation of guidelines for the safe performance of manual therapy techniques.

The development of the thumb strap splint has provided a valuable clinical alternative for the conservative management of people with trapeziometacarpal osteoarthritis. While some people find they can manage their symptoms with conservative approaches, others will decide to proceed with surgery to control persistent pain and dysfunction. The two studies on the general population are important because their findings assist in the decision-making process in relation to the conservative and surgical management of patients with trapeziometacarpal osteoarthritis.

CHAPTER 2

PREVALENCE OF THUMB PAIN IN MUSCULOSKELETAL PHYSIOTHERAPISTS

INTRODUCTION

METHODS

Design

Participants

Survey

Presentation of pain

Factors affecting presence of pain

Factors affecting severity of pain

Intervention strategies used to deal with the pain

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RESULTS

Demographics

Presentation of pain

Factors affecting presence of pain

Factors affecting severity of pain

Intervention strategies used to deal with the pain

Intervention strategies used to deal with more severe pain (VAS>5)

DISCUSSION

This work presented in this chapter has been published (Appendix A.1) as:

Wajon A, Ada L (2003): Prevalence of thumb pain in physical therapists

practicing spinal manipulative therapy. *Journal of Hand Therapy* 16:237-244.

INTRODUCTION

The aim of this study was to determine the prevalence of pain in the thumbs of Australian musculoskeletal physiotherapists. Physiotherapists are susceptible to a variety of occupational musculoskeletal injuries with annual prevalence highest in the low back (45%), followed by the wrists and hands (29.6%), upper back (28.7%), neck (24.7%), and shoulders, knees, ankles/feet, elbows and hips/thighs (each less than 20%) (Bork et al. 1996). In a systematic survey of 1 in 4 Australian physiotherapists on a state register, Cromie et al (2000) found an increased risk of pain in the thumbs of manual physiotherapists, with 33.6% of their 536 respondents complaining of pain in the thumb lasting more than three days, with a severity score on a 10cm VAS of three or greater. They found that the severity of thumb symptoms were related to the number of hours per week physiotherapists used manipulation or mobilisation techniques. This finding was supported by West and Gardner (2001) who similarly found that treating an excessive number of patients each day caused an aggravation of pain in the thumbs of musculoskeletal physiotherapists.

In an effort to begin to quantify the extent of the problem, a pilot survey was sent to 16 musculoskeletal physiotherapy practices in NSW. Demographic data was collected, along with information about aggravating techniques. Eighteen responses were obtained with 72% of the respondents reporting episodes of pain in their thumb during the preceding year. Pain was localised mostly to the metacarpophalangeal and trapeziometacarpal joints. Ninety-two percent of respondents reported that PA glides using thumb tips was the most aggravating techniques. Other factors associated with aggravation of symptoms include the number of repetitions and/or grade of mobilisations, the hours worked per day, and the number of patients with

similar conditions treated each day. Over 50% of physiotherapists who reported episodes of pain in their thumbs had modified their techniques, with 30% reducing hours of patient contact, and 38% considering a career change in an effort to alleviate symptoms. It was concluded that pain in the thumb is a significant problem for musculoskeletal physiotherapists (Wajon & Ada 2001). Surveying a larger sample was deemed necessary to determine whether these results were representative of the population as a whole.

The aim of this study was to determine the location, severity, frequency and duration of painful episodes in the thumbs of musculoskeletal physiotherapists in the year 2000. In particular, the research questions were:

- i. Which particular spinal manipulative therapy technique is most likely to be responsible for the aggravation of thumb pain?
- ii. Is there any relation between prevalence of pain and age, sex, or work patterns?
- iii. What are the common intervention strategies employed by musculoskeletal physiotherapists to control their thumb pain?

METHODS

Design

A loose-leaf survey was sent to all 1444 members of Musculoskeletal Physiotherapy Australia (MPA) with MPA News, their quarterly publication. This publication has a large readership by musculoskeletal physiotherapists who were the target group for

the survey. The newsletter was sent to 1444 members of the MPA. The MPA uses a three-tiered Professional Development framework for membership:

- Level 1: Non-titled members with an interest in musculoskeletal health*
- Level 2: Titled members who have completed postgraduate education in manipulative physiotherapy*
- Level 3: Specialist members*

To encourage readers to complete the survey, the findings of the pilot study were described in the newsletter (Wajon & Ada 2001). The study was approved by the Ethics Committee of the University of Sydney (Appendix A.2). Return of the survey to the researchers was taken as evidence of consent to participate.

Participants

The participants of this study were the Level 2 and 3 members who responded to the survey. It was assumed that Level 2 and 3 members would spend more time performing spinal manipulative therapy techniques, and would therefore be more representative of the musculoskeletal physiotherapy population. Of the 698 Level 2 and 3 members who received the survey, 155 (22.2%) replied. This low response rate was disappointing. Nevertheless, 83% of the respondents complained of pain in their thumbs, aggravated by performing spinal manipulative therapy, with the majority complaining of their pain being aggravated by two similar techniques. As analysis of specific aggravating techniques had not been performed previously, it was deemed worthwhile to continue with this study, even with the low response rate.

Survey

The survey consisted of a series of questions regarding demographics, work practices, and the presentation of pain (Appendix A.3). Specific questions about the presentation of pain included the severity of pain, which was measured using a 10 cm visual analogue scale (VAS), with 0 representing no pain and 10 the worst pain imaginable. Other details about the presentation of pain included the location, frequency and duration of painful episodes experienced during the year 2000. The survey was designed to provide the answer to the following questions.

Presentation of pain

- Did performing manual therapy techniques aggravate pain in the thumb?
- Where was the pain most commonly located?
- How severe was the pain, measured on a VAS?
- How many episodes of pain were experienced in the thumb during the year 2000?
- How long did each painful episode last?

Factors affecting presence of pain

- Is there any correlation between age and presence of pain in the thumb?
- Was there any change in the location of pain with increasing age?
- Were females more susceptible to pain in the thumb?
- Were symptoms more prevalent on the dominant hand?
- Were physiotherapists who have worked in manual therapy for more than 10 years more likely to have pain in their thumb?

- Were physiotherapists who trained in any particular state more likely to have pain in their thumb?

Further questions regarding performance of specific manual therapy techniques aimed to determine the most aggravating techniques. The techniques included central postero-anterior (PA) glides (Figure 2.1a), unilateral PA glides (Figure 2.1b) and transverse glides (Figure 2.1c), all using thumb pressures. Other techniques included the PA glide using a pisiform (C) grip, the lumbrical grip and soft tissue massage. Specific questions were designed to investigate the following:

- Did performing central PA glides (thumb pressures) regularly aggravate symptoms?
- Did performing unilateral PA glides (thumb pressures) regularly aggravate symptoms?
- Did performing transverse glides (thumb pressures) regularly aggravate symptoms?
- Did performing central PA glides (pisiform) regularly aggravate symptoms?
- Did performing lumbrical grip mobilisations regularly aggravate symptoms?
- Did performing soft tissue massage regularly aggravate symptoms?
- Did working longer hours each day aggravate pain in the thumb?
- Did using a stronger grade of pressure aggravate pain in the thumb?
- Did performing an increasing number of repetitions aggravate pain in the thumb?
- Did treating a number of patients with similar conditions aggravate pain in the thumb?

a)



b)



c)



Figure 2.1 *Spinal manipulative therapy techniques of a) central PA glides using thumb pressures, b) unilateral PA glides using thumb pressures, and c) transverse glides using thumb pressures*

Factors affecting severity of pain

- Was there any correlation between age and severity of pain in the thumb?
- Was there any correlation between working more hours per week (>30) and severity of pain?
- Did performing central PA glides (thumb pressures) regularly aggravate severe symptoms (VAS>5)?
- Did performing unilateral PA glides (thumb pressures) regularly aggravate severe symptoms (VAS>5)?
- Did performing transverse glides (thumb pressures) regularly aggravate severe symptoms (VAS>5)?
- Did performing central PA glides (pisiform grip) regularly aggravate severe symptoms (VAS>5)?
- Did performing lumbrical grip glides regularly aggravate severe symptoms (VAS>5)?
- Did performing soft tissue massage regularly aggravate severe symptoms (VAS>5)?

Intervention strategies used to deal with the pain

- Were the symptoms severe enough to seek intervention from a physiotherapist?
- Were the symptoms severe enough to seek intervention from a medical specialist?
- Were the symptoms severe enough to change treatment techniques?
- Were the symptoms severe enough to use splints or taping?
- Were the symptoms severe enough to reduce hours of patient contact?
- Were symptoms severe enough to consider a change in career?

Therefore, the survey consisted of a series of questions about the presentation of pain, including location, severity, frequency and duration, experienced during the year 2000. Further questions about work habits and specific manual therapy techniques aimed to determine which factors aggravated pain. Subsequent intervention strategies chosen by the physiotherapist were also examined. See Appendix A.3 for the survey.

Statistical analysis

Descriptive data of each variable are summarised as percentages of the total group (n=155), with severity of pain (10 cm VAS) reported as mean \pm SD. Spearman rank correlation coefficient (r_s) was used to determine whether there was a trend in one variable as another variable changed (Glantz 1997). Chi square analysis was used to determine whether there was any correlation between severity of symptoms and particular mobilisation techniques.

RESULTS

Demographics

The characteristics of the participants (n=155) are summarised in Table 2.1. The majority of respondents were female (59%), aged from 41-50 (48%), and had worked in musculoskeletal physiotherapy for 16 years or more (53%). More than half of the respondents (61%) spent greater than 31 hours per week treating patients.

Table 2.1 Characteristics of participants (n=155)

Age	21-30 16 (10%)	31-40 55 (35%)	41-50 74 (48%)	51-60 10 (6%)		
Gender	Male 63 (41%)	Female 92 (59%)				
Years of work	0-5 12 (8%)	6-10 19 (12%)	11-15 44 (26%)	16-20 39 (25%)	>20 44 (28%)	
State trained	NSW 55 (35%)	QLD 22 (14%)	VIC 29 (19%)	SA 18 (12%)	WA 28 (18%)	Overseas 3 (2%)
Hours work / wk	<15 10 (7%)	16-30 50 (33%)	31-45 68 (45%)	>45 24 (16%)		
Pain	Yes 129 (83%)	No 26 (17%)				

Presentation of pain

Eighty-three percent of respondents (n=129) complained of pain in their thumb aggravated by performing spinal manual therapy techniques, with 62% of this group reporting pain in both thumbs. The mean score for severity of pain was 3.75 (SD 1.9) on the VAS. Of the respondents with pain, 68% reported more than four episodes during the year, and 62% complained of symptoms lasting less than one week. The pain was most commonly located at the first metacarpophalangeal joint alone (43%), followed by the metacarpophalangeal and trapeziometacarpal joints together (23%), and the trapeziometacarpal joint alone (18%). The presence of pain at the interphalangeal joint or other joints combined was negligible (Table 2.2).

Table 2.2 Presentation of pain over a 12month period (n=129)

VAS	Mean	SD			
	3.8	1.9			
Painful side	Right	Left	Both		
	37(29%)	12(9%)	80(62%)		
Number of episodes	1-3	4-6	>7		
	41(32%)	31(24%)	56(44%)		
Duration of each episode	0-1 wk	1-2 wks	2-4 wks	>4 wks	
	79(62%)	25(20%)	10(8%)	14(11%)	
Location of pain	MP	MP & TM	TM	IP	IP,MP & TM
	55(43%)	30(23%)	23(18%)	8(6%)	7(5%)

MP= metacarpophalangeal joint, TM= trapeziometacarpal joint, IP= interphalangeal joint

Factors affecting presence of pain

There was no correlation between increasing prevalence of thumb pain (n=155) with age ($r_s=0.04$, $p=0.67$). However, with increasing age the location of pain tended to change, moving from the metacarpophalangeal to the trapeziometacarpal joint. The youngest age group had the highest percentage of respondents with pain at the metacarpophalangeal joint (69%) whereas the older age group had the highest percentage of pain at the trapeziometacarpal joint (30%) (Table 2.3, Figure 2.2).

Table 2.3 Distribution of pain in the thumb over different age groups

Age	n	MP	MP/TM	TM
21-30	16	11(69%)	4(25%)	0
31-40	43	19(44%)	7(16%)	10(23%)
41-50	59	23(39%)	17(29%)	10(17%)
51-60	10	2(20%)	2(20%)	3(30%)

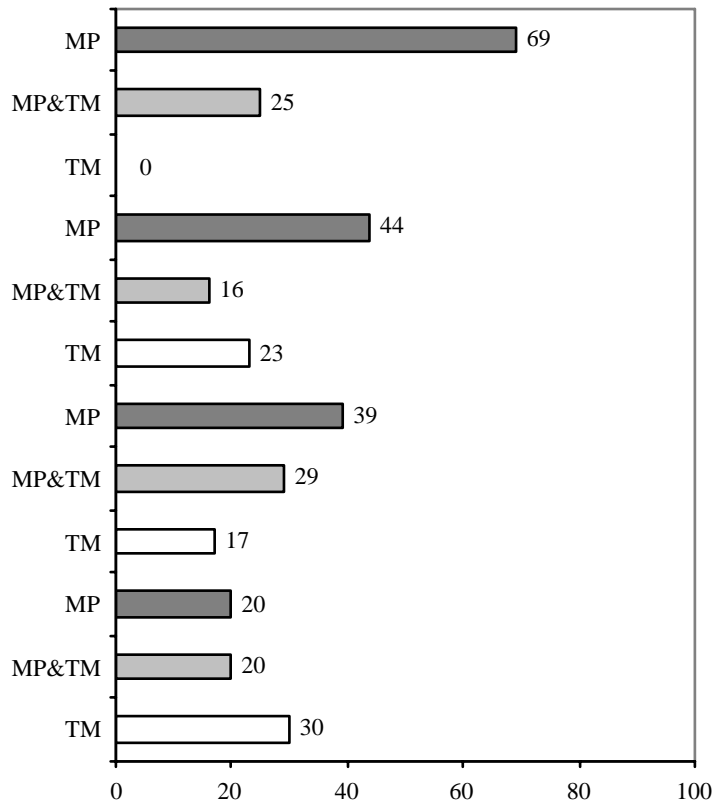


Figure 2.2 *Percentage of respondents in each age group reporting pain in the metacarpophalangeal (MP) joint, both metacarpophalangeal and trapeziometacarpal (MP & TM) joints, and trapeziometacarpal joint alone*

Females were no more susceptible to pain in the thumb than males ($n=155$, $r_s=0.05$, $p=0.53$) and symptoms no more prevalent on the dominant hand ($n=129$, $r_s=0.13$, $p=0.15$). When analysing the data of the subjects with pain, 80% had worked in the field of manual therapy for more than 10 years, the remaining 20% for 10 years or less.

Physiotherapists who trained in any one particular state were no more likely to have pain in their thumb than those who trained elsewhere. Of all the respondents, the percentage of participants who had trained in each state was similar to the percentage

of participants with pain from each state (Table 2.4). This confirms that the location of musculoskeletal physiotherapy training does not influence the prevalence of pain.

Table 2.4 Comparison of the percentage of participants who trained in each state with the percentage of participants reporting pain who trained in each state

	% Participants (N=155)	% Participants with pain (N=129)
NSW	35	36
Qld	14	14
Vic	19	20
SA	12	10
WA	18	19
Overseas	2	2

When specifically reviewing mobilisation techniques, physiotherapists were asked whether they regularly performed a specific technique and whether performance of that technique aggravated symptoms. Of the physiotherapists who regularly perform the technique, PA glides using thumb tips was the most common cause of increased thumb pain. Unilateral glides increased pain in 87% while 85% complained of pain with central PA glides. Transverse vertebral mobilisations aggravated pain in 75%, with 69% aggravated by soft tissue massage techniques. Lumbrical grip techniques increased pain in 43% of respondents, compared with only 29% who complained of pain in the thumb using central PA glides with the pisiform grip (Figure 2.3).

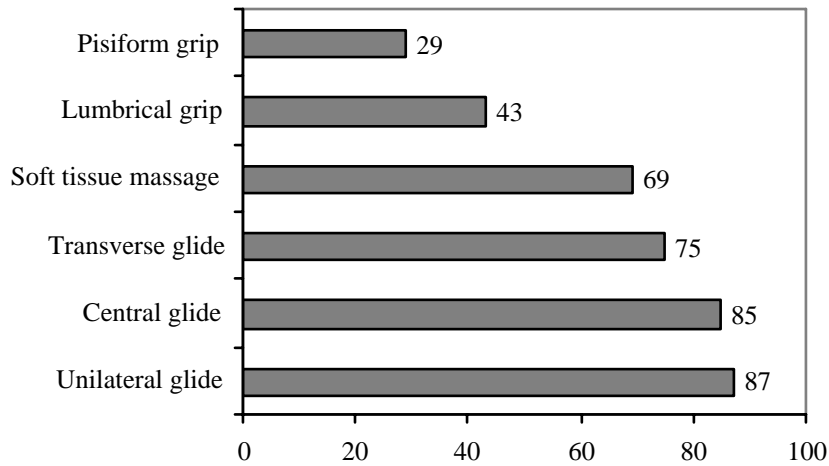


Figure 2.3 *Percentage of musculoskeletal physiotherapists who complained of an aggravation of thumb pain associated with certain spinal manipulative therapy techniques*

Pain in the thumb was aggravated by increased grades of pressure during mobilisation in 83% of subjects, while 78% complained that treating a large number of patients with similar diagnoses aggravated their symptoms. Increased repetitions aggravated symptoms in 62%, and 61% complained of pain in the thumb aggravated by working longer hours each day (Figure 2.4).

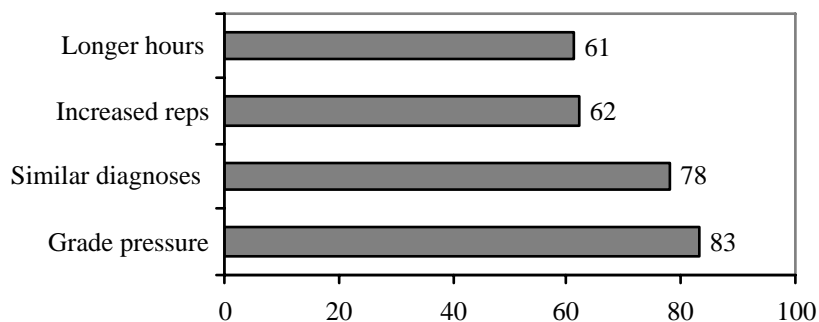


Figure 2.4 *Percentage of musculoskeletal physiotherapists who complained of an aggravation of thumb pain associated with work practices*

Factors affecting severity of pain

There was no correlation between severity of pain and age ($n=127$, $r_s=0.06$, $p=0.51$), or between severity of pain and working more than 30 hours per week ($x^2 = 0.01$, $p=0.9$). Chi square analysis was performed to determine whether severity of pain was associated with any specific technique. Table 2.5 shows that transverse glides most commonly aggravated symptoms with a VAS of >5 .

Table 2.5 Results of Chi Square analysis of techniques aggravating pain with VAS >5 .

Technique	x^2	p	Significance
Transverse glides	3.9	0.04	S
Unilateral PA glides	1.85	0.2	NS
Soft tissue massage	0.6	0.4	NS
Central PA glides (pisiform)	0.5	0.5	NS
Lumbrical grip	0.3	0.6	NS
Central PA glides (thumb tips)	0.009	0.9	NS

Intervention strategies used to deal with the pain

Musculoskeletal physiotherapists were asked whether their symptoms were severe enough for them to seek intervention, use splints or taping, or change their choice of treatment technique. By far the majority of the painful respondents chose to alleviate symptoms by changing their choice of treatment technique (74%). Less than one-third used splints or taping (29%), reconsidered their career (27%), and/or reduced their hours of patient contact (25%). Only a small minority (6%) sought intervention from either a physiotherapist or medical specialist (Figure 2.5).

Figure 2.5 *Percentage of physiotherapists that chose each management strategy to alleviate symptoms*

Intervention strategies used to deal with more severe pain (VAS>5)

Therapists with more severe pain (VAS>5) were likely to change their choice of treatment technique ($\chi^2=8.4, p=.004$), seek medical intervention ($\chi^2=6.2, p=.01$) or consider a change in career ($\chi^2=6.2, p=.01$). They also reduced their hours of patient contact ($\chi^2=4.5, p=.03$), but were unlikely to consider consulting a physiotherapist ($\chi^2=1.2, p=.27$) or using a splint ($\chi^2=0.3, p=.87$).

DISCUSSION

This study found that 83% of respondents complained of an aggravation of thumb pain due to the performance of spinal manipulative therapy techniques, with 85-87% of the painful respondents complaining of thumb pain aggravated by PA glides (unilateral and central). While the low response rate (22.2%) is a concern, if it was assumed that only those musculoskeletal physiotherapists with thumb pain responded to the survey, then it could be extrapolated that the prevalence of pain was 18.4% of the population of musculoskeletal physiotherapists during the year 2000. This percentage, the most conservative interpretation, remains a large sample of the musculoskeletal physiotherapy population, confirming that certain mobilisation techniques are a risk for the development of work-related injuries. This finding is consistent with the findings of Cromie et al (2000) and West and Gardner (2001), who reported a prevalence of 19% and 20% respectively for pain in the thumbs and wrists of general physiotherapists. This study does not attempt to address the cause

of thumb pain in general physiotherapists, however the results suggest that those physiotherapists who complain of pain in their thumbs during performance of spinal manipulative therapy techniques, are likely to be aggravating their symptoms with continued performance of these techniques

The pain was most commonly of mild intensity and located at the metacarpophalangeal and/or the trapeziometacarpal joint (84%). Of the painful respondents, over 60% reported more than four episodes during the year 2000, with most reporting the symptoms lasting less than one week (62%). This pattern of pain presentation (intensity, location, frequency and duration) is consistent with that observed clinically in patients with early stages of osteoarthritis at the trapeziometacarpal joint. Symptoms tend to be mild, and settle with modification of activities of daily living and avoidance of aggravating activities. However, they return when aggravating activities are resumed. It is assumed that physiotherapists change their techniques and avoid aggravating manoeuvres while their thumbs are painful, but once symptoms settled, return to old techniques. This would be consistent with the finding of numerous short-lived episodes of pain.

The location of pain in the thumb moved proximally with increasing age. Sixty-nine percent of those under 30 reported pain at the metacarpophalangeal joint, presumably associated with applying a force through a hypermobile thumb. Hypermobility of the metacarpophalangeal joint encourages dorsal subluxation at the trapeziometacarpal joint and has been observed clinically in static positions of lateral pinch and adduction, even in the normal joint (Najima et al. 1997). Persistent trapeziometacarpal joint subluxation causes insufficiency of the palmar ligamentous

structures, which allows abnormal translation of the metacarpal on the trapezium and causes excessive shear forces at the palmar trapeziometacarpal joint surfaces (Moulton et al. 2001, Pellegrini, Smith & Ku 1994). This accelerates the process of cartilage degeneration (Pellegrini 1991b, Pellegrini 1991a), and corresponds to the contact areas associated with the production of arthritic surface lesions at the trapeziometacarpal joint (Pellegrini 1991a). This explain why with increasing age, and years of performing spinal manipulative therapy techniques performed through a hypermobile metacarpophalangeal joint, the pain is likely to move toward the trapeziometacarpal joint.

The survey identified that the most aggravating techniques involved unilateral (87%) and central (85%) PA glides. This finding is similar to that of West and Gardner (2001) who reported that 82% of respondents with thumb pain complained of an aggravation of pain when performing manual therapy techniques. The most common strategy to reduce pain involved changing treatment techniques (74%). Cromie et al (2000) also found that 73% of physiotherapists changed or modified their technique in response to an aggravation of pain with manual therapy techniques. It is not possible to determine how the technique was changed in this group; however, it would be reasonable to suggest that those musculoskeletal physiotherapists with pain in their thumb aggravated by PA glides consider using physiological techniques, exercise, or advice, in an effort to reduce the amount of force applied through the tips of their thumbs.

Alternative management strategies included using splints or taping (29%), and seeking physiotherapy or medical treatment (6%). This contrasts with the findings of

West and Gardner (2001) who reported that 55% of their hand injured respondents had used braces, splints or other orthoses, with the majority also seeking physiotherapy treatment. It may be assumed that musculoskeletal physiotherapists were able to control their symptoms sufficiently by changing techniques, without the need for additional intervention.

Emerging evidence provides support for manual therapy in the management of spinal pain (van-Tulder, Koes & Bouter 1997), and whilst this study suggests that unilateral and central PA glides are a cause of pain in the thumbs of musculoskeletal physiotherapists, it is important not to discard them. For this reason, every effort must be made to determine how they may be performed safely.

First, the alignment of each of the thumb joints should be considered during performance of spinal manual therapy techniques. Those physiotherapists with a hypermobile metacarpophalangeal joint should attempt to avoid secondary subluxation of the trapeziometacarpal joint. The palmar beak ligament is the primary stabiliser of the trapeziometacarpal joint, resisting dorsal subluxation and excessive shear forces (Pellegrini, Smith & Ku 1994). Avoiding hyperextension of the metacarpophalangeal joint during performance of PA glides should control the tendency to dorsal subluxation at the trapeziometacarpal joint. Theoretically, avoiding metacarpophalangeal hyperextension would reduce strain to the palmar ligamentous structures and enhance stability at the trapeziometacarpal joint.

Those musculoskeletal physiotherapists who have pain at the base of the thumb and difficulty preventing metacarpophalangeal hyperextension, may be fitted with a

small thermoplastic splint to prevent metacarpophalangeal joint hyperextension (Moulton et al. 2001, Wajon 2000). Moulton et al (2001) suggests that such an approach may minimise both symptoms and progression of joint degeneration. The splint would be custom fitted and worn during performance of spinal manual therapy techniques.

Alternatively, tools may be used for the performance of PA glides to reduce aggravation of thumb pain. While it is essential that a tool should not impair the operator's ability to sense biomechanical parameters of resistance, active recoil, and resistance-free range (Maher, Latimer & Starkey 2002), it should also enable the operator to use it without pain. The Superthumb and Kneeshaw device have been compared with the pisiform grip in a sample of six physiotherapists who have experienced thumb and/or hand pain attributable to performance of spinal manual therapy. Unfortunately neither device was as comfortable as the pisiform grip for either the patient or the physiotherapist (Maher, Latimer & Starkey 2002). The pisiform grip is widely used on the lumbar spine whereas PA glides using thumb pressures are more frequently used on the cervical spine. While the pisiform grip was the least likely technique to cause pain in the thumbs of respondents, it would be interesting to know whether these devices could be used on the cervical spine, and how they might compare with PA glides using thumb pressures, in aggravating thumb pain.

Thumb pain is common in musculoskeletal physiotherapists, and is aggravated by performing spinal manipulative therapy. Techniques requiring the application of longitudinal pressure through the thumb tips, such as unilateral and central PA

glides, were most likely to cause thumb pain in respondents while the pisiform grip was the least likely to cause thumb pain. Considering the need for physiotherapists to perform these techniques when treating people with cervical spine dysfunction, it was considered appropriate to analyse the alignment of the joints of the thumb during performance of PA glides, to determine whether there is any association between the alignment of the joints of the thumb and work-related thumb pain.

CHAPTER 3

ALIGNMENT OF THE THUMB DURING PERFORMANCE OF POSTERO-ANTERIOR MOBILISATIONS TO THE CERVICAL SPINE

INTRODUCTION

METHODS

Design

Participants

Outcome measures

Measurement of work-related thumb pain

Measurement of thumb alignment during performance of PA glides

Statistical analysis

RESULTS

Demographics

Description of work-related thumb pain

Description of thumb alignment during performance of PA glides

Association between work-related thumb pain and thumb alignment during performance of PA glides

DISCUSSION

This work presented in this chapter is currently in press as:

Wajon A, Ada L, Refshauge K (in press): Work-related thumb pain in
physiotherapists is associated with thumb alignment during performance of PA
glides. *Manual Therapy* Accepted 11/8/05

INTRODUCTION

Thumb pain is common in the thumbs of Australian physiotherapists and is aggravated by performing postero-anterior (PA) glides (Chapter 2). The spinal manipulative therapy technique of PA vertebral glides produce rhythmical, oscillatory, passive accessory movement of the patient's spine (Watson & Burnett 1990). The vertebral movement is produced by the physiotherapist applying an anteriorly directed force to the spinous process of the prone patient (Maher & Adams 1995) using both thumb tips. The force is transmitted through the treating physiotherapist's interphalangeal, metacarpophalangeal, and trapeziometacarpal joints of the thumb, and subsequently through the wrist, elbow and shoulder. It is recommended that the thumbs be in contact with each other and that the pressure be applied by the arms combined with the trunk (Maitland 1986). One would assume that positioning the MP and IP joints in extension (0°) during the application of force would permit the direct transfer of pressure to more proximal joints, reducing the tendency for a zigzag collapse of the polyarticular chain (Nordin & Frankel 1989) with associated joint subluxation and pain. Given that the ideal alignment of the metacarpophalangeal and interphalangeal joints during performance of central PA glides has not previously been reported, it was considered appropriate to attempt to determine which combination of joint alignments would be associated with less thumb pain in musculoskeletal physiotherapists.

The aim of this study was to investigate the alignment of the thumbs of musculoskeletal physiotherapists during performance of a central PA glide, and determine whether there is a difference in this alignment in participants with and

without pain. In particular, the research questions in relation to physiotherapists performing PA glides were:

- i Is there an association between the alignment of the metacarpophalangeal and interphalangeal joints during performance of PA glides and thumb pain?
- ii Are musculoskeletal physiotherapists who are able to maintain the metacarpophalangeal and interphalangeal joints in extension during performance of PA glides less likely to report thumb pain than those who cannot?

METHODS

Design

This trial involved performing an observational study of a cross-section of the population of musculoskeletal physiotherapists. Participants were asked to provide information about their work practices and history of work-related thumb pain. They were then asked to perform a 'PA glide' on a force plate.

Participants

Participants were recruited from registrants attending the Musculoskeletal Physiotherapy Australia (MPA) 13th Biennial Conference (2003). The study was conducted from the Surgical Synergies stand in the Trade Hall of the Convention Centre during the conference breaks for morning tea, lunch and afternoon tea. All physiotherapists were included, with no limit on age, sex, or years of clinical

experience. Any conference registrant who was not a physiotherapist was excluded from the study.

Ethics approval was granted by the Human Ethics Committee, University of Sydney (approval no. 7084, Appendix B.1). The Participant Information Statement (See Appendix B.2) was discussed with the participant and they were given the opportunity to ask any questions. If the participant was willing to be involved in the study, they signed a consent form (Appendix B.3).

Outcome measures

Measurement of work-related thumb pain

Following completion of the consent form, participants were asked for demographic information, including details of their age, sex, dominance, years of experience in manual therapy, and number of hours spent treating patients per week (Appendix B.4). Participants who reported aggravation of thumb pain by performing manual therapy to the cervical spine in the last 12 months were asked for a detailed history of their pain presentation, including the location, severity (0-10 scale), frequency and duration of their symptoms, and their most aggravating technique.

Measurement of thumb alignment during performance of PA glides

Participants were asked to perform a central PA glide while being photographed. In order to standardise the procedure, they were asked to press on a dense foam pad (3.2mm) adhered to a wooden block (height 5cm, width 10cm), which was in turn

resting on a force plate. The participant was asked to attempt to mimic the technique that they would normally use on the cervical spine.

To determine the average amount of force used when performing Grade III - IV PA glides to the cervical spine, a pilot study was conducted using an instrumented couch (Chiradejnant, Maher & Latimer 2001). After calibration with a weight of 97.7N, one female subject, asymptomatic for neck pain, was asked to lie prone on the couch. The subject's body weight was eliminated by using the zero function of the software. Two musculoskeletal physiotherapists consecutively performed three sets of Grade III and Grade IV mobilisations to C6. The range of manually-applied forces in a vertical direction for the two physiotherapists is shown in Table 3.1.

Table 3.1 Range of manually-applied forces during central PA mobilisation to the cervical spine, measured in Newtons

	Physiotherapist 1	Physiotherapist 2
Grade III	10-30	20-35
Grade IV	20-40	35-45

It was determined that performing a PA glide at a force of 40N would mimic the clinical situation of performing a central PA glide on the cervical spine. The size and awkwardness of the instrumented couch prohibited its use during the Conference and so the compact Biometrics Force Plate was used to measure the amount of force applied. It is a component of the E-Link Computerized Rehabilitation & Clinical Testing System (<http://www.biometricsltd.com/exercise.htm>) and is able to connect to a computer to measure the amount of force applied through it. The computer was set to the 'Hit Balls' exercise module, whereby application of a force of 40 N to the

Force Plate would cause a ball to bounce from one wall to another on the screen. If the applied force was less than 40N, the ball would not move far enough to hit the opposite wall. The set-up is shown in Figure 3.1.

Figure 3.1 *The Surgical Synergies stand at the MPA conference. The advertisement, force plate and computer monitor are shown.*

The participant was given the opportunity to perform repeated ‘mobilisations’ on the block until they were confident that their alignment mimicked their clinical technique. A digital camera was fixed on a tripod and used to photograph the lateral aspect of the thumbs during application of a PA glide. This has been shown to be a valid technique to determine the alignment of the hand in a non-invasive way (Vergara, Sancho-Bru & Perez-Gonzalez 2003). The digital photographs were

downloaded to a computer and the alignment of the joints of the thumb determined. To eliminate bias, the position of the joints of the thumb was determined by a measurer blinded to thumb pain status of participants. The metacarpophalangeal and interphalangeal joints were categorised as hyperextended, extended or flexed, resulting in nine possible combinations of positions (Table 3.2). Test-retest reliability was examined several months later, with 95% exact agreement.

Table 3.2 Possible combinations of joint positions and corresponding codes according to the positions of the metacarpophalangeal (MP) and interphalangeal (IP) joints during performance of PA glides

Thumb Alignment	MP joint position	IP joint position	Code
1	Hyperextension	Hyperextension	HH
2	Hyperextension	Extension	HE
3	Hyperextension	Flexion	HF
4	Extension	Hyperextension	EH
5	Extension	Extension	EE
6	Extension	Flexion	EF
7	Flexion	Hyperextension	FH
8	Flexion	Extension	FE
9	Flexion	Flexion	FF

Statistical analysis

There was no pattern of similarity between the alignment of right and left thumbs, confirmed by the absence of any correlation between them ($r=0.25$), and so they were considered independent of each other. Uncommon thumb alignments (those used by <5% of participants) were excluded from analysis. Chi square was then calculated to determine whether there was an association between the presence of work-related thumb pain and thumb alignment during performance of PA glides.

RESULTS

Demographics

The characteristics of the participants (n=129) are summarised in Table 3.3. The majority (64%) were female, right-hand dominant (94%), with a mean age of 42 (SD 7.9) years. The mean number of hours worked per week was 29 (SD 16.6) and participants had a mean of 17.3 (SD 7.3) years of experience in musculoskeletal physiotherapy. Eighty-two (64%) participants complained of having pain in either or both thumbs at some time in the preceding 12 months, aggravated by performing spinal manipulative therapy techniques.

Table 3.3 Characteristics of participants (n=129)

	Gender	Age	Handed-ness	Hours worked/week	Years manual therapy	Presence of pain
	<i>M:F</i>	<i>Years</i>	<i>R/L</i>	<i>Hrs</i>	<i>Years</i>	<i>Y:N</i>
%	36:64		94:6			64:36
Mean (SD)		41.6 (7.9)		29(16.6)	17.3(7.3)	
Number	46:83		121:8			82:47

Description of work-related thumb pain

In total, 123 of the 258 (48%) thumbs were reported to be aggravated by performance of PA glides to the cervical spine in the preceding 12 month period. Of the 82 participants with thumb pain, 75 (91%) reported pain in their right thumb and 48 (59%) pain in their left. Forty-one (50%) participants with thumb pain had pain in both thumbs. The mean score for severity of pain in the thumb, aggravated by

performing manual therapy techniques, was 4.2/10 (SD 1.9). The majority (67%) reported pain less frequently than once per month, but 21% of thumbs were painful more than once per day. The mean duration of each episode of pain was 3.2 days (SD 9.6) per thumb. Fifty-eight (47%) thumbs were painful at the MP joint, 45 (37%) thumbs were painful at the trapeziometacarpal joint, 7 (6%) thumbs were painful at both the trapeziometacarpal and MP joints, and 13 (11%) thumbs were painful at the IP joint. Of the respondents who reported thumb pain, 43% reported the unilateral PA pressure to be the most aggravating technique.

Description of thumb alignment during performance of PA glides

There were nine possible combinations of joint alignment at the metacarpophalangeal and interphalangeal joints. Table 3.4 shows the combinations of joint hyperextension, extension and flexion at each joint, and the percentage of participants whose thumbs were aligned in those combinations.

Table 3.4 Number of right and left thumbs which were categorised into each alignment according to the positions of the metacarpophalangeal and interphalangeal joints

Thumb alignment	Metacarpophalangeal joint alignment	Interphalangeal joint alignment	Right	Left	Total
1	Hyperextension	Hyperextension	0	2	2
2	Hyperextension	Extension	2	2	4
3	Hyperextension	Flexion	26	33	59
4	Extension	Hyperextension	7	4	11
5	Extension	Extension	8	12	20
6	Extension	Flexion	10	10	20
7	Flexion	Hyperextension	29	28	57
8	Flexion	Extension	38	31	69
9	Flexion	Flexion	9	7	16

It can be seen from Table 3.4 that the most common thumb alignments were Alignment 3 (Figure 3.2a), Alignment 7 (Figure 3.2b), and Alignment 8 (Figure 3.2c). With no correlation between the alignment of each pair of right and left thumbs ($r=0.25$), they were considered to be independent of each other. The sides were therefore combined to allow analysis of data on 258 thumbs.

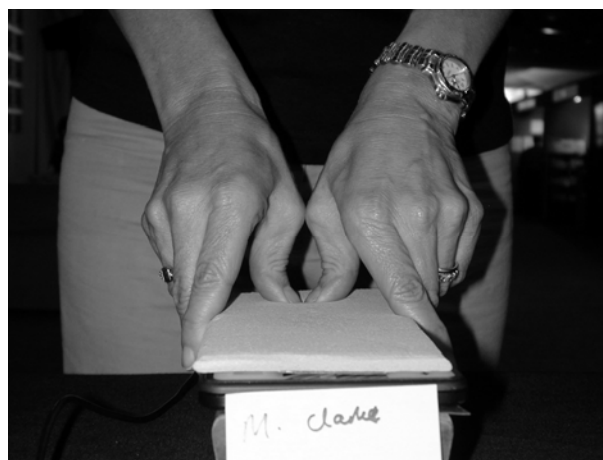
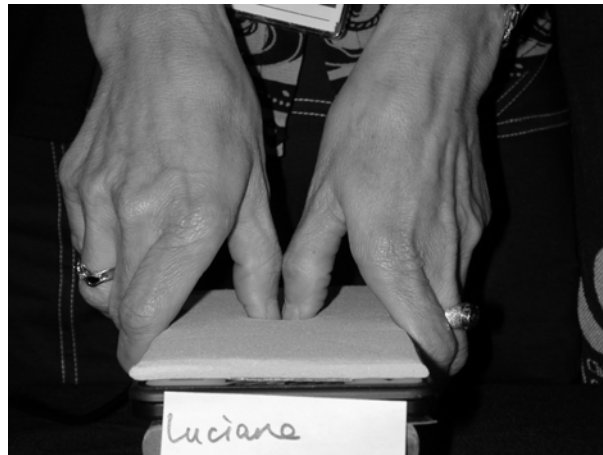


Figure 3.2 The common joint alignments of (a) metacarpophalangeal hyperextension and interphalangeal flexion, (b) metacarpophalangeal flexion and interphalangeal hyperextension, and (c) metacarpophalangeal flexion and interphalangeal extension.

Association between work-related thumb pain and thumb alignment during performance of PA glides

The number of participants performing Alignments 1, 2 and 4 were negligible. They consisted of less than 5% of the total group and so their results were removed from the statistical analysis. Table 3.5 shows the 6 x 2 table of frequencies relating thumb pain to alignment, comparing the number of participants with and without pain to the number of participants expected to be with and without pain for each alignment. The relative contribution of the deviation of observed from expected pain presentation at each alignment to the total Chi square is shown in Table 3.6.

Table 3.5 Table of frequencies relating thumb pain to alignment

Alignment	Code	No pain		Pain		Total
		Observed	Expected	Observed	Expected	
3	HF	34	31.1	25	27.91	59
5	EE	16	10.54	4	9.46	20
6	EF	11	10.54	9	9.46	20
7	FH	24	30.04	33	26.96	57
8	FE	31	36.36	38	32.64	69
9	FF	11	8.43	5	7.57	16
Total		127	127	114	114	241

Table 3.6 Relative contribution of the deviation of observed from expected pain at each alignment to the total Chi square

Alignment	Code	No pain	Pain	Total
3	HF	0.27	0.30	0.57
5	EE	2.83	3.15	5.98
6	EF	0.02	0.02	0.04
7	FH	1.21	1.35	2.56
8	FE	0.79	0.88	1.67
9	FF	0.78	0.87	1.65
Total		5.90	6.58	12.48

There was a significant association between the presence of work-related thumb pain and thumb alignment during performance of PA glides ($X^2=12.48$, $df= 5$, $p=0.03$). Referring to the matrix (Table 3.6), it can be seen that the main source of deviation from the overall presence of pain probability was Alignment 5 (EE). There was a much smaller contribution from Alignment 7 and to an even lesser extent, Alignments 8 and 9. The relative contribution of the common thumb alignments to the total Chi square is clearly demonstrated in Figure 3.3.

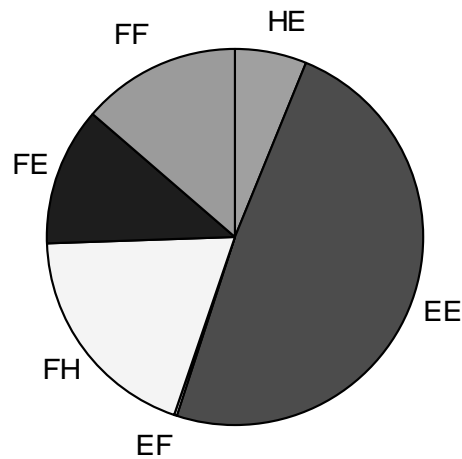


Figure 3.3 *The relative contribution of the common thumb alignments to the total Chi square.*

Figure 3.3 demonstrates that Alignment 5, with both metacarpophalangeal and interphalangeal joint extension, made the largest contribution to the total Chi square. Further analysis of Table 3.5 demonstrates that Alignment 5 made this large contribution to the Chi square because there were far fewer participants reporting pain than expected.

DISCUSSION

This is the first published study to identify the alignment of the thumb as an intrinsic factor associated with the development of work-related thumb pain in physiotherapists. Whilst many have reported the incidence of thumb pain in physiotherapists (Cromie, Robertson & Best 2000, Branton et al. 2003, Snodgrass & Rivett 2002, Wajon & Ada 2003), few have identified factors associated with its onset. In their case-control study of 44 physiotherapists, Snodgrass et al (2003) categorised photographs of physiotherapists performing a standard PA glide. They rated the hand positions according to whether the thumb was supported by the index finger, by the other thumb at the metacarpophalangeal joint, or whether the thumb pads overlapped, but did not report the alignment of the metacarpophalangeal and interphalangeal joints during the performance of PA glides. This is the first paper to identify an association between the alignment of the thumb during performance of PA glides and work-related thumb pain in physiotherapists.

These results clearly demonstrate a 'safe' alignment, but fail to identify a detrimental one. Clinical experience suggests that physiotherapists with hypermobile thumbs can be physically unable to maintain their metacarpophalangeal and interphalangeal joints in extension. Their alignment can fluctuate from one of metacarpophalangeal hyperextension with interphalangeal flexion to one of metacarpophalangeal flexion with interphalangeal hyperextension. These 'collapse' positions (Tubiana, Thomine & Mackin 1996) are associated with joint subluxation and generally result in pain at either the metacarpophalangeal or the trapeziometacarpal joint. It is possible that

these physiotherapists move from one alignment to another in an effort to avoid symptoms. This may explain the absence of any obvious pain-provoking alignment.

The trapeziometacarpal joint is a common site of pain in the hand (Armstrong, Hunter & Davis 1994), with classic patterns of joint surface wear and arthritis resulting from compression loading and shear forces applied to the joint (Ateshian et al. 1995, Pellegrini 1991b, Pellegrini, Olcott & Hollenberg 1993, Uchiyama et al. 1999). Moulton et al (2001) associated these patterns of joint surface wear with the position of the metacarpophalangeal joint, and concluded that loading through a hyperextended metacarpophalangeal joint would encourage reciprocal flexion of the metacarpal shaft and dorsal subluxation of its base, contributing to pain in the thumb. We were therefore surprised to find that those physiotherapists who hyperextended their metacarpophalangeal joint during the application of PA glide did not demonstrate an increase in the presence of work-related thumb pain. Perhaps this is due to the force being applied longitudinally through the tips of the thumb, whereas other studies which analysed patterns of trapeziometacarpal joint contact, used lateral pinch as their model (Brand 1985, Moulton et al. 2001, Pellegrini, Olcott & Hollenberg 1993, Pellegrini et al. 1996).

Extension of the metacarpophalangeal and interphalangeal joints during performance of PA glides was least likely to be associated with thumb pain. This alignment minimises tendon and joint moment arms (Brand 1985), promoting optimal joint loading and maximising the surface area of joint contact (McConnell 1993). The compressive force is then transmitted longitudinally up the thumb to larger more

proximal joints, minimising deforming forces which could cause collapse of the polyarticular chain.

Various authors have reported the tendency for musculoskeletal physiotherapists to reduce their working hours, leave the workforce, or change their area of specialisation due to pain and instability in their thumbs (Reglar & James 1999, Snodgrass & Rivett 2002, Wajon & Ada 2003). It is proposed that positioning the metacarpophalangeal and interphalangeal joints in extension during the performance of PA glides should reduce the likelihood of the development of thumb pain in physiotherapists. Those therapists who are unable to maintain the alignment of metacarpophalangeal and interphalangeal joint extension during the application of pressure may find that positioning their relaxed thumbs against each other, and resting the index fingers against the volar aspect of the interphalangeal joint, may help. However, Snodgrass et al (2003) recently reported factors related to thumb pain in physiotherapists, and found no difference in reports of immediate pain between physiotherapists whose thumb was supported by the index finger, whose metacarpophalangeal joints were touching, or whose thumb pads were overlapping. Perhaps their small sample size limited their ability to find evidence of an immediate reduction in pain in those physiotherapists whose thumbs were touching.

It may be useful for those physiotherapists unable to change their alignment to be fitted with a thermoplastic splint to control either or both the metacarpophalangeal and interphalangeal joints (Colditz 2000, Fess et al. 2005, Poole & Pellegrini 2000, Veldhoven & Lede 2002, Wajon 2000). Careful assessment of the physiotherapist performing the technique (Figure 3.4) is necessary to determine appropriate splint

provision. Various splints are available which control either or both the metacarpophalangeal and interphalangeal joints. An example of a splint which only supports the metacarpophalangeal joint is the short opponens splint (Figure 3.5). Splints which only support the interphalangeal joint include the dorsal extension splint (Figure 3.6a) and the figure 8 splint (Figure 3.6b). An example of a splint which includes both the metacarpophalangeal and interphalangeal joint is the dorsal blocking splint (Figure 3.7).



Figure 3.4 *Observation of the alignment of the metacarpophalangeal and interphalangeal joints during the application of PA glide*



Figure 3.5 *Thermoplastic splints controlling the alignment of the metacarpophalangeal joint during the application of PA glide: short opponens splint*



a)



b)

Figure 3.6 *Thermoplastic splints controlling the alignment of the interphalangeal joint during the application of PA glide: (a) static dorsal interphalangeal extension splint and (b) figure 8 'ring' splint*



Figure 3.7 *Thermoplastic splint controlling the alignment of the metacarpophalangeal and interphalangeal joints during the application of PA glide: dorsal blocking splint*

Considering the current occupational health climate, it is essential that physiotherapists are trained to perform techniques safely. If it is known that a given technique causes pain in a group of musculoskeletal physiotherapists, then we should endeavour to determine how it may be performed safely, without causing pain and dysfunction. This study gives some insight into determining the ideal alignment of the thumb during performance of these techniques. Unfortunately many physiotherapists are unable to control the alignment of the joints of their thumb and will require the aid of supportive splints. With the majority of musculoskeletal

physiotherapists reluctant to wear tape or splints during the performance of PA glides, a new 'strap splint' was designed; one which supported the metacarpophalangeal joint but did not immobilise it. This splint will be described in Chapter 4.

CHAPTER 4

THE THUMB STRAP SPLINT DESIGNED TO ENHANCE TRAPEZIOMETACARPAL JOINT STABILITY

INTRODUCTION

THEORETICAL BACKGROUND TO THE DESIGN

Prevention of dorso-radial subluxation of the base of the first metacarpal

Prevention of metacarpophalangeal joint hyperextension

Prevention of metacarpal adduction

FABRICATION OF THE SPLINT

CLINICAL APPLICATION

This work presented in this chapter has been published (Appendix C.1) as:

Wajon A (2000): The thumb 'strap splint' for dynamic instability of the trapeziometacarpal joint. *Journal of Hand Therapy* 13:236-237.

INTRODUCTION

Conservative treatment of painful trapeziometacarpal osteoarthritis traditionally includes splinting. Various splints have been described in the literature, varying in the amount of support they provide and the number of joints they control (Swigart et al. 1999).

Alternatives include the short opponens splint (Figure 4.1) which supports the trapeziometacarpal and metacarpophalangeal joints, the long opponens splint (Figure 4.2), which additionally includes the wrist, and the hand-based short opponens splint (Figure 4.3) which neither includes the metacarpophalangeal joint or the wrist. While these splints are appropriate in particular situations, some people report difficulty performing their domestic and work duties, or leisure and recreational activities while wearing them. A smaller, more flexible splint was designed with consideration of the patterns of deformity associated with advanced trapeziometacarpal osteoarthritis.



Figure 4.1 *Short opponens splint viewed from volar aspect. The splint is moulded with some metacarpophalangeal joint flexion, and allows full motion at the interphalangeal joint and wrist*

Figure 4.2 *Long opponens splint viewed from volar aspect. The splint is moulded with metacarpophalangeal joint flexion and the wrist at 20^o extension, while allowing full motion at the interphalangeal joint*



Figure 4.3 *Thumb carpometacarpal immobilisation splint (Colditz, 2000) viewed from volar aspect. The splint allows full motion at the wrist and metacarpophalangeal joint*

This study aims to:

- i. Describe the design and techniques for fabrication of a new splint for trapeziometacarpal osteoarthritis, the thumb strap splint
- ii. Discuss the clinical application and wearing schedule of the thumb strap splint

THEORETICAL BACKGROUND TO THE DESIGN

Observation of the alignment of the first ray during activities of daily living reveals that people with trapeziometacarpal osteoarthritis have a tendency for their thumb to collapse during pinch and grasp. The first ray collapses into dorso-radial subluxation of the base of the first metacarpal, metacarpophalangeal joint hyperextension and metacarpal adduction (Flatt 1995, Freedman, Eaton & Glickel 2000, Poole & Pellegrini 2000). The thumb strap splint (Figure 4.4a and b) attempts to enhance stability at the trapeziometacarpal joint by preventing this collapse of the first ray.

a)



b)



Figure 4.4 *The thumb strap splint (Wajon 2000) viewed from a) volar and b) dorsal aspects. The strap through the web space maintains palmar abduction.*

Prevention of dorso-radial subluxation of the base of the first metacarpal

The base of the splint covers the dorso-radial aspect of the trapeziometacarpal joint. The attachment of the volar wrist strap to the proximal edge of the splint keeps the splint against the thumb (Figure 4.4a). This is designed to provide a physical block to dorso-radial subluxation, which occurs during grasp in the presence of incompetent volar ligaments.

Prevention of metacarpophalangeal joint hyperextension

Hyperextension of the metacarpophalangeal joint occurs, in an effort to increase the potential space between the digits and the thumb tip, when grasping large objects. The thumb strap splint addresses hyperextension of the metacarpophalangeal joint in two ways. Firstly, the thermoplastic splinting material is moulded under the volar aspect of the metacarpophalangeal joint, which resists forward pressure of the metacarpophalangeal joint against the splint during hyperextension. Secondly, the strap attaching to the distal component of the splint is applied under tension with the metacarpophalangeal joint slightly flexed, preventing it from collapsing into hyperextension during pinch and grasp (Figure 4.4a and b).

Prevention of metacarpal adduction

Subluxation of the base of the first metacarpal leads to reciprocal adduction of the first metacarpal, reducing web space. In the presence of pain and joint effusion, sustained loss of web space results in web space contracture, increasing further the tendency to subluxation at the base of the first metacarpal and hyperextension at the

metacarpophalangeal joint. A strap maintains the thumb in palmar abduction to maintain normal joint compliance (Herbert, 1993). It attaches to the splint at the volar aspect of the metacarpophalangeal joint and runs proximally through the web space to attach to the splint at the trapeziometacarpal joint (Figure 4.4a).

FABRICATION OF THE SPLINT

The thumb strap splint is fabricated from thermoplastic splinting material and held in place with Velcro[®] straps. The patient's hand is measured to determine the size of the splint. The height of the splinting material is the distance from the interphalangeal joint of the thumb, to the base of the first metacarpal (Figure 4.5a). The widest part of the splint is the distance from the radial aspect of the base of the first metacarpal across the dorsum of the hand to the third carpometacarpal joint. The pattern is traced on a piece of 2.4mm thermoplastic splinting material. The splinting material is cut generously with a Stanley knife into a manageable size, and then dipped in water heated to 70°F to soften. Once softened, the thermoplastic piece is cut with scissors into three horizontal strips, remaining attached to each other with a radial border of approximately 1 cm. The two more distal strips are trimmed to less than half their initial length (Figure 4.5b).

a)



b)

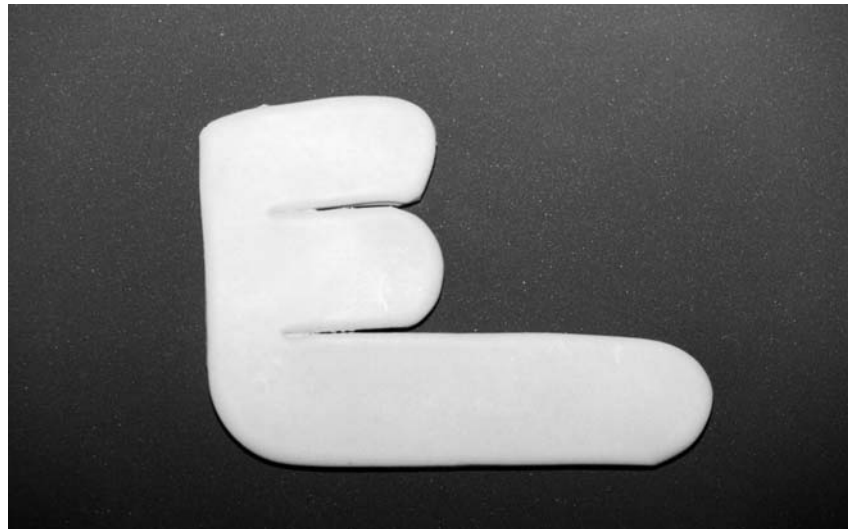


Figure 4.5 *Creating the splint pattern: a) calculation of the height of the splinting material and b) the trimmed thermoplastic splinting material used in the fabrication of the thumb strap splint*

The longer first strip of thermoplastic is positioned proximally and dorsally from the base of the first metacarpal across the dorsum of the hand to approximately the third carpometacarpal joint. It is angled proximally and ulnarly, to allow the strap which passes from the volar aspect of the wrist to attach to it. The middle strip of thermoplastic is folded back on itself to lie volar to the metacarpophalangeal joint. It is moulded well to prevent pressure areas developing during activity performance. The distal strip is positioned dorsally across the distal end of the proximal phalanx, moulded to contour to the shape of the thumb, while avoiding any restriction of interphalangeal joint motion. Careful moulding of the splint is essential, while the thumb is held in palmar abduction and metacarpophalangeal joint flexion. Once the splint is firm, adhesive hook Velcro[®] tabs are positioned along each of the three strips.

The straps are made from two lengths of 1.25 cm Velcro[®] loop (Figure 4.6). The long strap begins at the radial edge of the middle volar strip, passes through the web space proximally, to attach to the Velcro[®] tab at the radial aspect of the proximal strip of the splint. It then crosses the wrist first volarly then ulnarly, to finally attach to the dorsum of the proximal strip. The length of this strap is approximately 30 cm. This long strap acts to maintain the web space and restrict dorso-radial subluxation of the base of the first metacarpal (Figure 4.4b).

Figure 4.6 *Schematic diagram of Velcro® straps used for attachment of the thumb strap splint*

A second Velcro® strap is attached at a 45° angle to the long strap, at the point where the long strap crosses the carpal tunnel. This strap passes underneath the thumb to attach to the distal strip from the ulnar aspect of the thumb, and maintains metacarpophalangeal flexion (Figure 4.4a). Its tension should be adjusted to hold the thumb comfortably flexed, and is approximately 15 cm in length. For ease of donning and doffing, the splint may be slipped off the thumb once the ulnar wrist strap is released.

CLINICAL APPLICATION

The thumb strap splint is used to relieve pain and support the trapeziometacarpal joint for people with Stage I-III osteoarthritis. It can be used by musculoskeletal

physiotherapists to support the joint during performance of PA glides (Figure 4.7) and by the general population during any aggravating domestic or work tasks, or leisure or recreational activities.



Figure 4.7 *The thumb strap splint may be worn during performance of PA glides to control metacarpophalangeal joint hypermobility*

The ability of the patient to perform activities of daily living without the aggravation of pain should be one of the aims of physiotherapy rehabilitation. The thumb strap splint can be worn full-time until an acute episode settles, or alternatively only worn during performance of aggravating activities. It has been used successfully by this author for people with a variety of work and recreational activities, including by

musculoskeletal physiotherapists, artists, stringed-instrument players, cleaners, and typists. To examine its efficacy for the general patient population, a randomised controlled trial was conducted which compared it with the traditionally used short opponens splint.

CHAPTER 5

NO DIFFERENCE BETWEEN TWO SPLINT AND EXERCISE REGIMENS FOR PEOPLE WITH OSTEOARTHRITIS OF THE THUMB: A BLINDED, RANDOMISED, CONTROLLED TRIAL

INTRODUCTION

METHODS

Design

Participants

Outcome measures

Pain

Strength

Hand function

Intervention

Experimental group

Control group

Procedures

Week 0

Week 2

Week 4

Week 6

Statistical analysis

RESULTS

Flow of participants through the trial

Compliance

Outcomes

Pain

Strength

Hand Function

DISCUSSION

The work presented in this chapter is published (Appendix D.1) as:

Wajon A, Ada L (2005): No difference between two splint and exercise regimens for people with osteoarthritis of the thumb: a randomised controlled trial. *Australian Journal of Physiotherapy*, 51: 245-249.

INTRODUCTION

The purpose of this study was to test the efficacy of the thumb strap splint (Chapter 4). Current conservative management of Stage I-III trapeziometacarpal osteoarthritis consists of a period of splinting to allow acute pain to settle (traditionally, either a short (Poole & Pellegrini 2000) or long opponens (Swigart et al. 1999 splint)), followed by exercises for the thenar musculature (traditionally pinch exercises). A new splint (thumb strap splint) and exercise regimen (abduction exercise regimen) was developed with the intention of more specifically addressing the tendency of the thumb to collapse with advancing osteoarthritis (Flatt 1995).

In order to test the efficacy of this new splint and exercise regimen against current practice, a prospective, randomised controlled trial was conducted. It was designed to mimic clinical practice and therefore consisted of a 2-week period of splinting followed by a 4-week period incorporating the addition of an exercise regimen. The research questions were:

In participants with pain at the base of the thumb,

- i Is two weeks of splinting with a thumb strap splint more effective at decreasing pain, increasing strength and improving hand function than a short opponens splint?
- ii Is six weeks of splinting with a thumb strap splint and four weeks of an abduction exercise regimen more effective at decreasing pain, increasing strength and improving hand function than six weeks of a short opponens splint and four weeks of a pinch exercise regimen?

METHODS

Design

The study was a prospective, randomised, single blind controlled trial. Figure 5.1 summarises the design of the study. The participants were randomised into either the experimental or control group using a random numbers table at Week 0, at which time pre-test measurements were taken. Participants were fitted with one of two splints according to group allocation, and instructed to wear the splint both day and night for the first two weeks. At Week 2, Post-test 1 measurement was taken and the participant advised to continue with splint use. They were also instructed in performance of an exercise regimen according to group allocation. At Week 4, the fit of the splint and performance of exercises were checked. Post-test 2 measurements were taken at Week 6.

Week 0	Admission to study	
	Informed consent Randomised into 2 groups	
	Experimental Group	Control Group
	Pre-test measurement	Pre-test measurement
	<i>Thumb strap splint</i>	<i>Short opponens splint</i>
Week 2	Post-test 1 measurement	Post-test 1 measurement
	<i>Thumb strap splint</i> + <i>Abduction exercise regimen</i>	<i>Short opponens splint</i> + <i>Pinch exercise regimen</i>
Week 4	<i>Check splint and exercises</i>	<i>Check splint and exercises</i>
Week 6	Post-test 2 measurement	Post-test 2 measurement

Figure 5.1 Design of the randomised, controlled trial showing timing of intervention and measurement during the 6 week trial period.

Participants

Participants were recruited from those patients referred to Hand Therapy at Hornsby by rheumatologists, hand surgeons, orthopaedic surgeons, and general practitioners. They were eligible for the study if they complained of pain at the base of the thumb, and had Stage I-III trapeziometacarpal osteoarthritis. They were excluded from the study if they had:

- DeQuervains tendinitis
- Carpal tunnel syndrome
- Scapholunate instability (Wolfe, Gupta & Crisco 1997)
- Trigger thumb
- A steroid injection to the trapeziometacarpal joint in the preceding six weeks
- Any previous surgery to the trapeziometacarpal joint.

Where available, radiographs were viewed to determine the stage of osteoarthritis (Eaton & Glickel 1987). Where radiographs were not available, a clinical diagnosis was made through palpation and the grind test (Prosser & Conolly 2003). Local pain and tenderness at the scaphotrapezial joint was suggestive of Stage IV osteoarthritis, and in the absence of radiographic confirmation, these patients were excluded from the study.

Ethics approval was granted by the Human Ethics Committee, University of Sydney (ref no. 98/9/25, Appendix D.2). The participant information sheet (Appendix D.3) was discussed with the participant, stressing the importance of being available for the scheduled follow-up visits. They were given the opportunity to ask any questions,

and if it was determined that the participant was both willing and able to be involved in the study, they were asked to sign the consent form (Appendix D.4).

Forty-eight participants were assessed for eligibility. Eight thumbs were excluded from the study, six with Stage IV osteoarthritis, and two having had a steroid injection to the trapeziometacarpal joint within the previous week. Therefore, 40 participants agreed to participate in the study and gave informed consent. To ensure concealment of allocation, randomisation was performed by a person not involved in the trial. There were 19 participants in the experimental group and 21 in the control group. The experimental group was made up of 14 females and five males. The control group was made up of 17 females and four males. The characteristics of the experimental and control groups are summarised in Table 5.1, demonstrating that they were similar at baseline in terms of sex, age, handedness, affected side, duration and severity of disease. The age of the participants in the experimental group ranged from 40-78 with a mean of 59.7 (SD 9.0), which is comparable to the control group who ranged from 36-78 years with a mean of 61.1 (SD 12.5). Ninety-eight percent of all participants were right-handed; 58% of the experimental group complained of pain in the right thumb compared with 52% in the control group. The duration of symptoms ranged from one month to 20 years, with a mean of 3.7 years (SD 4.5). Where available, radiographs were viewed to determine the stage of arthritis. Of the 33 available, 19 were in the experimental group and 15 in the control group. In the experimental group, no participants had Stage I, eight (42%) had Stage II, and 11 (58%) Stage III. In the control group, four (27%) participants had Stage I, four (27%) had Stage II, and seven (46%) Stage III.

Table 5.1 Characteristics of participants

Subject <i>Number</i>	Gender <i>M / F</i>	Age <i>Years</i>	Handed- ness <i>R / L</i>	Affected side <i>R / L</i>	Duration of disease <i>Years</i>	Stage of disease <i>Stage I-III</i>
Experimental						
3	F	68	L	R	2	III
5	F	40	R	R	17	II
7	M	73	R	L	20	
9	F	57	R	R	2	II
10	F	59	R	L	5	II
14	F	62	R	L	6	III
15	F	62	R	L	.5	II
17	M	62	R	R	1	III
18	F	49	R	R	2.5	II
21	F	78	R	R	1.5	III
23	F	63	R	L	.1	III
24	F	46	R	R	.1	
27	F	64	R	R	3	II
29	F	53	R	L	.8	II
30	M	63	R	R	2	III
32	M	52	R	R	3	III
33	F	61	R	L	2	III
34	F	59	R	R	1.5	III
35	F	73	R	R	0.9	III
38	F	78	R	R	7	II
39	M	76	R	L	5	III
Mean	74%F	59.7	95%R	58%R	3.9	2.6
SD	26%M	9.0	5%L	42%L	5.2	0.5
Range		40-78			0.1-20	II-III
Control						
1	F	63	R	R	1	
2	F	63	R	L	1	III
4	M	66	R	R	10	III
6	F	54	R	L	1	
8	F	68	R	R	10	
11	F	67	R	L	8	III
12	F	54	R	L	3	III
13	F	40	R	L	.25	I
16	F	50	R	R	.5	II
19	F	78	R	R	1	
20	M	36	R	L	4	I
22	F	46	R	R	9	III
25	F	76	R	R	.2	II
26	F	47	R	L		I
28	F	57	R	L	.5	I
31	M	72	R	R	.1	II
36	M	62	R	L	5	III
37	F	59	R	R	2	II
40	F	62	R	R	3	III
Mean	81%F	61.1	100%R	52%R	3.3	2.3
SD	19%M	12.5		48%L	3.6	0.8
Range		36-78			0.1-10	I-III

Outcome measures

Three variables were measured: pain, strength and hand function. All outcome measurements were taken by an examiner blinded to group allocation. Measures of impairment included the VAS and weakness of pinch, while activity limitation was measured using the Sollerman Test of Hand Function (Sollerman & Ejeskar 1995). Pre-test measurements were completed at Week 0, with Post-test measurement 1 completed at Week 2, and Post-test 2 measurement at Week 6. The outcomes were recorded on a scoring sheet (Appendix D.5).

Pain

The primary measure of impairment was resting pain, measured on the visual analogue scale (VAS). The VAS requires participants to indicate their perception of pain intensity by placing a perpendicular mark along a 10 cm horizontal line, labelled 'no pain' at one end and 'unbearable pain' at the other (Tollison 1989). The score was taken prior to any palpation or measurement and therefore represented the participants' resting level of pain.

Strength

Participants report weakness in the thumb with trapeziometacarpal osteoarthritis. Tip pinch strength was measured using a commercially-available calibrated pinch gauge (B&L Engineering, Santa Fe Springs, CA). Tip pinch involves grasping the pinch meter between the tip of the index finger and the thumb pulp with the forearm pronated (Figure 5.2). Three trials were performed with the participant asked to perform to their maximum within the limits of pain (Nitschke et al. 1999). The best score of the three trials within each session were recorded. If the participant

complained of aggravation of symptoms and was reluctant to repeat the test for three trials, they were permitted to stop after one test, with that reading being recorded. The objective standardised testing techniques established by the American Society of Hand Therapists (Casanova 1992) were used. The instructions given as the measurer demonstrated the technique were as follows:

“I want you to hold the handle like this and squeeze as hard as you can”.

Once the participant was positioned with the dynamometer, they were instructed:

*“Are you ready? Squeeze as hard as you can. Harder! Harder! Harder!
Relax.”*



Figure 5.2 *Tip pinch strength testing using the B & L pinch gauge*

Hand function

The Sollerman Hand Function Test is a valid, standardised measure of hand function in activities of daily living, and consists of 20 test items (Sollerman & Ejeskar 1995) (Figure 5.3, Appendix D.6). Each item is scored on a four-point scale, with one point gained for:

- completion of the task;
- use of the correct hand grip;
- completion of the task in less than 20 seconds;
- absence of pain or difficulty.

A perfect score for each of the 20 test items would result in a total score of 80 points.

Figure 5.3 *The Sollerman Test of Hand Function*

Intervention

Experimental Group

From Weeks 0-2, participants in the experimental group wore the thumb strap splint (Figure 5.4a) (Wajon 2000). They were instructed to wear it full time, removing for personal hygiene only. The splint was custom made and fabricated from 3.2mm TailorSplint^ψ thermoplastic splinting material. It was moulded specifically to enhance stability at the trapeziometacarpal joint by preventing collapse of the first ray.

From Weeks 2-6, participants continued to wear the thumb strap splint and began an abduction exercise regimen (Figure 5.4b). Participants were instructed to perform the exercise against gravity in a smooth, controlled motion, avoiding any aggravation of pain. They were instructed to perform three sessions per day, increasing from 5 to 10 repetitions per session, as endurance and pain permitted. The exercise required the participant to rest the dorsum of the hand on a horizontal surface and to actively abduct the thumb perpendicular to the plane of the palm. The participant was encouraged to maintain the metacarpophalangeal joint in some flexion, with the interphalangeal joint extended, during the motion.

^ψ TailorSplint available from Surgical Synergies Pty Ltd, WI USA

a)



b)



Figure 5.4 *Intervention for the experimental group consisting of a) thumb strap splint and b) an abduction exercise regimen.*

At Week 4, the fit of the splint and correct performance of the exercises were checked, the participant being instructed in any changes to the program as necessary. In the presence of discomfort with the splint, it was remoulded and trimmed to address the participants' concerns. If they particularly complained of pain while performing their exercises, changes were made to the direction of movement, the number of repetitions performed, and/or the frequency with which the exercises were completed (Conolly & Wajon 2003).

At Week 6, participants were discharged from treatment with advice regarding joint protection (Wolfe 2000). They were encouraged to wear their splint for any persistently aggravating activities and to continue to perform their exercises.

Control group

From Weeks 0-2 participants in the control group wore a short opponens thumb splint. It was fitted at the initial visit, and fabricated from a piece of 3.2mm TailorSplint[®] thermoplastic splinting material. The splint was trimmed to cover the proximal phalanx and first metacarpal, while leaving the interphalangeal joint free (Figure 5.5a). It was secured in place with a Velcro strap attached around the ulnar border of the hand. The participant was advised to wear the splint both day and night, removing for personal hygiene only.

From Weeks 2-6, participants in the control group continued to wear the short opponens splint, and began a pinch exercise regimen (Figure 5.5b). Participants were instructed to perform five to ten repetitions of pinch strengthening exercises

with a soft foam block^Y, three times per day. The exercises were specified with respect to direction of movement, number of repetitions, and frequency. The participant was advised to reduce the repetitions or frequency if there was any aggravation of pain (Conolly & Wajon 2003).

^Y Rolyan R-lite Foam Block available from Surgical Synergies Pty Ltd, WI, USA

a)



b)



Figure 5.5 *Intervention for the control group consisting of a) short opponens splint and b) light resistive pinch exercises using soft yellow 'R lite' foam block*

At Week 4, the fit of the splint and correct performance of the exercises were checked, the participant being instructed in any changes to the program as necessary. In the presence of discomfort with the splint, it was remoulded and trimmed to address the participant's concerns. If the participant was complaining of pain while performing their exercises, changes were made to the direction of movement, the number of repetitions performed, and/or the frequency with which the exercises were completed (Conolly & Wajon 2003). At Week 6, participants were discharged from treatment with advice regarding joint protection (Wolfe 2000), splint wearing and exercise performance.

Procedures

When a patient phoned to make an appointment for physiotherapy, the secretary asked for the location of the problem. If the problem was described as being at the base of the thumb, the patient was informed that a clinical trial was being conducted within the practice on that particular condition.

Week 0 (Pre-test)

On arrival at the practice, the secretary discussed the study and asked whether the patient would like to be involved. If the patient answered no, or stated that they would be away for one of the follow-up visits, then the patient was treated as usual. Those patients who were interested in the study were asked to read the participant information statement.

Therapist 1 (recruiter and measurer) answered any questions the participants had about the study, and checked for inclusion and exclusion criteria. Those who met the criteria were asked to sign the consent form and then seen by the secretary for randomisation. A random numbers table was used to allocate participants into either the control or experimental group, while concealing the grouping from Therapist 1.

Pre-test measurements were taken by Therapist 1. Pre-test information included general demographic data, medications, previous intervention and its effect, and general history. Outcome measures for pain, strength and hand function were taken.

Therapist 2 provided the intervention in another location to prevent Therapist 1 from observing which group the participant was in. The appropriate splint was fabricated and fitted by Therapist 2, the experimental group receiving the thumb strap splint and the control group the short opponens splint. Instructions in care of the splint and its wearing schedule were outlined. General precautions regarding pressure areas and circulation were also discussed.

Participants were instructed in the importance of joint protection measures, including analysis of tasks and modification of daily activities. Patient education was felt to be an essential component of therapy, and was not varied between groups.

Week 2 (Post-test 1)

The secretary asked the participant to remove the splint on arrival in the waiting room, and conceal it in their bag or pocket. Therapist 1 repeated the outcome measures, and then Therapist 2 instructed the participant in their specific exercise

programme. Participants in the experimental group were instructed in exercises for use and control of *abductor pollicis brevis*. Participants in the control group were instructed to perform light resistive pinch exercises with a foam block. The participant was advised to reduce the repetition or frequency of exercise if there was any aggravation of symptoms.

Week 4

Therapist 2 reviewed the participant, checking both the fit and wearing schedule of the splint, and the performance of exercises. Any problems or concerns were discussed and modifications made to avoid aggravation of symptoms.

Week 6 (Post-test 2)

The secretary asked the participants to remove the splint on arrival in the waiting room, and place it in their bag or pocket. Therapist 1 repeated outcome measures and discussed the outcomes with the participant. Participants were encouraged to continue wearing their splint and performing their exercises while ever they gained relief.

Statistical analysis

Data collection yielded three variables: pain (cm), strength (kg), and hand function (score of Sollerman Test of Hand Function out of 80). The results were analysed with all subjects in the groups to which they were allocated (intention-to-treat analysis). The outcome measures yielded variables in interval data, which were summarised as mean \pm SD. There were two factors: group and time with repeated

measures on the time factor. Therefore, two-way ANOVAS with repeated measures were used to determine whether there was a greater effect of the experimental intervention than the control intervention. Individual subject data are reported in Appendix D.7.

Comparison of variables for the two groups from Pre-test to Post-test 1 (Weeks 0-2) compares the impact of the splints. One analysis conducted on data from Weeks 0-2 compared the immediate effect of the thumb strap splint with the short opponens splint, while a second analysis of the change from Weeks 0-6 compared the effect of the combined splint and exercise regimens (Table 5.2). Data are presented as means (SD) and effect sizes (95% CI). Differences were considered significant at $p < 0.05$.

Table 5.2 Analysis of interval between measurements with intervention being tested

Analysis	Interval (wks)	Intervention being tested
Pre-test to Post-test 1	0-2	Splint
Pre-test to Post-test 2	0-6	Splint (6 wk) + and exercise (4wk)

RESULTS

Flow of participants through the trial

Figure 5.6 shows the flow of participants through each stage of the trial. Nineteen participants were randomised to the experimental group and 21 to the control group. At Week 2, 19 participants were analysed in the experimental group and 20 in the control group. One participant in the control group was unable to be measured due

to unexpected overseas travel. At Week 6, 18 participants were analysed in the experimental group, 16 in the control group. Of the five participants who were unavailable for the Week 6 measurement, two were unavailable due to overseas travel, one was unable to attend due to ill health, while two others withdrew from the study due to discomfort in the splint (one in each group) and declined to attend for measurement.

Compliance

Participants were not required to keep a record of how many hours they wore their splint, or how many repetitions of their exercises they performed. However, the impression gained from the reports of participants at the Week 2 measurement was that they were wearing their splints full time. By Week 4, they had begun to leave the splint off when at rest, and were performing their exercises twice daily. By Week 6, the majority reported that they were only wearing their splint for specific aggravating activities, and were performing their exercises daily.

Figure 5.6 *Consort diagram showing flow of participants through each stage of the trial*

Outcomes

Pain

The outcome measurement for pain was the score of the visual analogue scale (VAS) taken at rest (Figure 5.7). By Week 2, after the participants had worn their splints for two weeks, there was no significant difference in the decrease in VAS scores between the groups: 0.4cm (95%CI, -0.8 to 1.6, $p=0.50$) (Appendices D.8 and D.9). By Week 6, after the participants had worn their splints for six weeks and exercised for four weeks, there was still no significant difference between the groups: 0.5 cm (95%CI, -1.1 to 2.0, $p=0.57$) (Appendices D.8 and D.9).

Figure 5.7 *Mean (SD) of resting VAS of experimental (solid line and closed circle) and control (dashed line and open circle) groups over time.*

Strength

The outcome measure for strength was tip pinch (Figure 5.8). By Week 2, there was no significant difference in the increase in strength between the groups: -0.2kg (95%CI, -0.7 to 0.3, $p=0.46$) (Appendices D.8 and D.9). By Week 6, there was still no significant difference between the groups: 0.1 kg (95%CI, -0.8 to 0.9, $p=0.86$) (Appendices D.8 and D.9).

Figure 5.8 *Mean tip pinch strength (SD) measured in kilograms for both experimental (solid line and closed circle) and control (dashed line and open circle) groups over time.*

Hand Function

The outcome measure of hand function was measured and scored by the Sollerman Test of Hand Function (Figure 5.9). By Week 2, there was no significant difference between the groups in the improvement in hand function: 2.0 points (95%CI, -0.9 to 4.9, $p=0.18$) (Appendices D.8 and D.9). By Week 6, there was still no significant difference between the groups: 0.7 points (95%CI, -3.6 to 5.0, $p=0.74$) (Appendices D.8 and D.9).

Figure 5.9 *Mean scores for Sollerman test of Hand Function (SD) for the experimental (solid line and symbol) and control (dashed line and open symbol) groups over time*

DISCUSSION

There was no greater effect of the experimental intervention on the decrease in pain, increase in strength or improvement in hand function by Week 2 or Week 6.

However, this may have been due to a lack of statistical power. If a reduction of 1.5 cm on the VAS, an increase of 1 kg tip pinch strength, and an improvement of 5 points on the Sollerman Test of Hand Function are considered the smallest clinical effects worth detecting, then the 95% CI's for the effect on these outcome measures (Figure 5.10) exclude a worthwhile effect. This suggests that we can be confident that after 6 weeks, the thumb strap splint and abduction exercise regimen provided to the experimental group was no more effective at reducing pain, increasing strength or improving hand function than the short opponens splint and pinch exercise regimen provided to the control group.

a)

b)

c)

Figure 5.10 Clinically significant size of effect (dashed vertical line) plotted against the effect size () and 95% CI for **a)** pain, **b)** strength and **c)** hand function.

Both groups in this study received a hand-based thermoplastic splint and pain-free exercise regimen which resulted in improvement. Given that there was no obvious superiority of one over another, the choice of splint can take into account other factors such as the individual's requirements, the extent of disease, and the demands placed on the trapeziometacarpal joint of the thumb by occupation, domestic tasks, hobbies and sports. For example, occupational or a-vocational demands may influence the amount of mobility required while wearing the splint. The thumb strap splint permits active flexion at the metacarpophalangeal joint and greater mobility at the trapeziometacarpal joint, essential when playing stringed instruments.

Conversely, the short opponens splint holds the metacarpophalangeal joint in a fixed position, and may be more appropriate for those patients who require stability, at the expense of mobility, with pinch and grasp. However, it is larger in size, and may be uncomfortable to wear for prolonged periods during hot weather. Ultimately, compliance with splint use will be determined by whether or not a patient perceives that a given splint relieves pain and enhances hand function (Colditz 2000).

It has been suggested that formal strengthening exercises are of no practical value for patients with trapeziometacarpal osteoarthritis (Docken 1987). On the other hand, there is a significant decrease in thumb abduction, grip and pinch strength in men and women over 60 years of age (Boatright et al 1997). This presence of weakness, combined with progressive joint laxity associated with palmar beak ligament degeneration in people with trapeziometacarpal osteoarthritis (Pellegrini 1991b), supports the need for some form of exercise to be incorporated into clinical practice. Taylor (2000) suggests that exercise of the trapeziometacarpal joint should be a component of conservative management. Given that there is no obvious superiority

of one exercise over another, the choice of exercise in clinical practice should take into account the condition of the joint and individual patients' requirements. For example, an abduction exercise regimen should be appropriate for those patients with thenar wasting who complain of difficulty while performing sustained activities, including writing and needlework. Conversely, a pinch exercise regimen should be more appropriate for patients with joints which do not sublux who have greater physical demands, such as gardeners and cleaners. A combination of these exercises may be appropriate for some patients. Ultimately, the choice of exercise regimen will be determined by whether or not it can be performed without aggravation of pain or discomfort.

Although no difference in outcomes was found between the groups, both groups improved. After 6 weeks of intervention, when both groups were considered together, pain had decreased by a mean of 2.1 cm on the VAS (95% CI, -2.8 to -1.3, $p < 0.01$) (Figure 5.11a, Appendix D.10), and strength had increased by a mean of 0.6 kg of tip pinch strength (95% CI, 0.2 to 1.0, $p < 0.01$) (Figure 5.11b, Appendix D.10). At the same time, hand function scores had improved by a mean of 6.5 points on the Sollerman Test of Hand Function (95% CI, 4.4 to 8.6, $p < 0.01$) (Figure 5.11c, Appendix D.10). It is possible that such improvements are due to the advice about joint protection given to both groups, or factors other than the intervention, such as statistical regression (Herbert et al. 2005), the placebo effect (Mackenbach 2005), or the Hawthorne effect whereby participants improved just because they were involved in the study (Verstappen et al. 2004). Nevertheless, these results suggest that patients can expect an improvement in pain, strength and hand function within six weeks of conservative intervention, regardless of the mechanism.

a)

b)

c)

Figure 5.11 Mean (SD) of **a)** VAS (cm), **b)** tip pinch strength (kg), and **c)** Sollerman Test of Hand Function scores for all subjects over time

Multiple regression analysis was performed to determine the contribution of impairment (pain and strength) to activity limitation (hand function). The independent and shared contributions of pain and strength to hand function were determined from Pre-test to Post-test 1 and Pre-test to Post-test 2. Pain made a significant independent contribution to hand function from Pre-test to Post-test 1 ($p=0.05$), and from Pre-test to Post-test 2 ($p=0.02$), implying a significant improvement in hand function could be achieved by the relief of pain with the splint (Table 5.3). At no time did strength make a significant independent contribution to hand function ($p=0.78$ and $p=0.93$ respectively). Analysis of data from Pre-test to Post-test 2 revealed that 16% of the variance in hand function ($p=0.02$) was accounted for by improvements in pain. These analyses suggest that people who persist with a home program which specifically reduces pain should enhance hand function.

Table 5.3 Results of standard multiple regression analysis used to determine the contribution of impairment (pain and strength) to activity limitation (hand function) over time.

		Pre-test to Post-test 1	Pre-test to Post-test 2
Weeks		0-2	0-6
Total variance in function accounted for by the contribution of pain and strength	r^2	0.10	0.19
	p	0.14	0.04
Variance in function accounted for by the <i>independent</i> contribution of <i>pain</i>	r^2	0.10	0.16
	p	0.05	0.02
Variance in function accounted for by the <i>independent</i> contribution of <i>strength</i>	r^2	0.0	0.0
	p	0.78	0.93
Variance in function accounted for by the shared contribution of pain and strength	r^2	0	0.03

The majority of people with Stage I-III trapeziometacarpal osteoarthritis are generally healthy and physically active, and find that the pain and dysfunction at the base of their thumb restricts their involvement in activities of daily living. Our aim should be to provide the individual with the ability to control their symptoms, either through the use of splints, exercises and/or joint protection advice. This study failed to find any additional benefit of one splint and exercise regimen over another, but identified improvements in pain, strength and hand function when all participants with trapeziometacarpal osteoarthritis were considered together. While this finding does not provide evidence of effectiveness of the intervention, it nevertheless provides useful prognostic information (Herbert et al. 2005).

Absence of any clinical improvement after six weeks of a splint and exercise regimen may be an indication for suggesting the patient consider other options, such as surgery (Wajon, Ada & Edmunds 2004). While many surgical alternatives exist, there is little evidence in the literature to demonstrate superiority of any one procedure over another. For this reason, a systematic review of the literature was undertaken (Chapter 6).

CHAPTER 6

SURGERY FOR THUMB (TRAPEZIOMETACARPAL JOINT) OSTEOARTHRITIS: A SYSTEMATIC REVIEW

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Weakness

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Hand function

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Trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy, trapeziectomy with interpositional arthroplasty, and trapeziectomy with ligament reconstruction

Pain

Weakness

Contracture

Hand function

Patient global assessment

Trapeziometacarpal joint imaging

Adverse effects

Trapeziectomy with interpositional arthroplasty versus trapeziectomy, trapeziectomy with ligament reconstruction and tendon interposition, and Swanson joint replacement

Pain

Weakness

Contracture

Trapeziometacarpal joint imaging

Adverse effects

Trapeziometacarpal joint replacement (Swanson) versus trapeziectomy with interpositional arthroplasty

Pain

Weakness

Contracture

Trapeziometacarpal joint imaging

Adverse effects

Trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Pain

Weakness

Contracture

Hand function

Patient global assessment

Trapeziometacarpal joint imaging

Adverse effects

DISCUSSION

The protocol for this review has been published as (Appendix E.1):

Wajon A, Ada L, Edmunds I (2004): Surgery for thumb (trapeziometacarpal joint) osteoarthritis [Protocol] *The Cochrane Database of Systematic Reviews*, Issue 1. Art. No.: CD004631. DOI: 10.1002/14651858.CD004631.

The work presented in this chapter has been published as:

Wajon, A, Ada, L, & Edmunds, I (2005) Surgery for thumb (trapeziometacarpal joint) osteoarthritis [Cochrane Review]: In *The Cochrane Library*, Issue 4, John Wiley & Sons, Ltd.: Chichester, UK.

INTRODUCTION

The pain and dysfunction of advanced trapeziometacarpal osteoarthritis frequently leads people to consider their surgical options, especially after failure of conservative measures. While there are many alternative surgical procedures, determining which procedure will achieve the best outcome can be difficult. The purpose of this project was to conduct a systematic review to provide the most accurate and authoritative guide to treatment (Sackett et al 1997), and determine if there was any evidence of efficacy of one procedure over another.

The main objectives of this systematic review were to assess:

- The effect of surgery in reducing the impairments of pain, contracture and weakness in people with Stage I, II, III and IV trapeziometacarpal osteoarthritis at 12 months.
- The effect of surgery in reducing activity limitations (hand function) in people with Stage I, II, III and IV trapeziometacarpal osteoarthritis at 12 months.
- The effect of surgery in reducing participation restrictions (patient global assessment) in people with Stage I, II, III and IV trapeziometacarpal osteoarthritis at 12 months.

METHODS

Criteria for considering studies for this review

Types of studies

All trials which report clinically relevant outcomes were included regardless of methodological quality. Truly randomised, quasi-randomised and controlled trials were used in the review. Allocation concealment (Schulz 1995), blinding (of participants, investigators and outcome assessment), intention-to-treat analysis (Egger, Smith & Phillips 1997) and completeness of follow-up was assessed for all trials, but not used as inclusion / exclusion criteria. Trials that compared at least two surgical procedures for trapeziometacarpal osteoarthritis were included.

Types of participants

Trials were considered which included participants of any age and gender with a clinical diagnosis of Stage I-IV trapeziometacarpal osteoarthritis. Staging of osteoarthritis was categorised according to the system of Eaton and Glickel (1987). Although it was envisaged that some trials would include participants who also underwent surgery to the metacarpophalangeal joint, no such trials were identified. If these trials had been identified, they would have formed a subgroup of the main surgical procedure performed at the trapeziometacarpal joint.

Types of interventions

Trials that compared at least two surgical procedures and evaluated the effect of surgery to the trapeziometacarpal joint were included. Various surgical procedures are recommended based on the severity of osteoarthritis. Such surgical procedures include:

- Volar ligament reconstruction
- Metacarpal osteotomy
- Trapeziometacarpal arthrodesis
- Trapeziectomy
- Trapeziectomy with ligament reconstruction and tendon interposition
- Interpositional arthroplasty
- Trapeziometacarpal joint replacement

Types of outcome measures

Outcome assessment in osteoarthritis requires reliable, valid and responsive measurement techniques (Bellamy 1999). The OMERACT III Conference in 1996 recommended a core set of outcome measures for use in trials of osteoarthritis (Bellamy et al. 1997). These included: pain, physical function, patient global assessment and joint imaging techniques for studies of one year or greater (Bellamy et al. 1997, Brooks & Hochberg 2001). Measurements of strength and range of motion were also included. For studies with greater than one year follow-up, results of joint imaging were recorded. These outcomes can be expressed according to the World Health Organisation classification as impairments: pain, weakness, contracture; activity limitations: hand function; and participation restriction: patient global assessment. Adverse effects of surgery and post-operative management were recorded where available.

Analysis of the effect of surgery on the impairment of pain was performed for continuous variables. The continuous variable of pain was measured in centimetres

on a visual analogue scale. If trials reported the presence or absence of pain, the analysis was performed for dichotomous variables.

Analysis of the effect of surgery on the impairment of weakness was performed for continuous variables. The continuous variables of lateral pinch strength were measured in kilograms or kp/cm².

Analysis of the effect of surgery on the impairment of joint contracture was performed for continuous variables. The amount of palmar abduction (web space) was measured in degrees or centimetres (Casanova 1992).

Analysis of the effect of surgery on hand function was performed for continuous variables. The continuous variable of hand function was measured using functional scales of upper limb activities which were normalised. Examples of functional scales are the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (Hunsaker et al. 2002), Sollerman Test of Hand Function (Sollerman & Ejeskar 1995), and the Jebsen Hand Function Test (Jebsen et al. 1969).

Analysis of the effect of surgery on patient global assessment was performed for dichotomous variables. The dichotomous variable of patient global assessment was measured using subjective 'Quality of Life' questionnaires. Examples of patient global assessment measures are the Buck-Gramcko scale and the Short Form-36 Health Survey (SF-36).

Analysis of the effect of surgery on trapeziometacarpal joint imaging was performed for studies of greater than one year follow-up. The continuous variable of scapho-metacarpal distance was reported in millimetres.

Analysis of any adverse effects resulting from trapeziometacarpal surgery was performed for dichotomous variables. Examples of adverse effects are the presence of Complex Regional Pain Syndrome (Type I), non-union, dislocation, wound infection, implant fracture, silicone synovitis, and nerve compression.

Search strategy for identification of studies

The detailed search strategy for this review can be found in Appendix E.2.

Methods of the review

Identification of relevant studies

One reviewer (AW) read the titles of the identified studies and eliminated obviously irrelevant studies based on titles and, where available, abstracts. Two reviewers (AW and IE) independently examined potentially relevant studies using predetermined criteria. These criteria were that: the trial was randomised, quasi-randomised or controlled; intervention was surgery (either: volar ligament reconstruction, metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy with or without ligament reconstruction and tendon interposition (LRTI), interpositional arthroplasty or joint replacement), and pain, weakness, contracture, hand function, or patient global assessment was measured as an outcome. Studies were ranked as excluded, included or uncertain using a checklist. Disagreement was resolved by discussion between the reviewers (AW and IE). Where agreement was

not reached, a third reviewer (LA) was involved to resolve disagreements. There was no exclusion on the basis of previous intervention or procedures to the metacarpophalangeal joint. There were no potentially-relevant, non-English studies requiring translation.

Assessment of methodological quality

The reviewers (AW and LA) assessed the methodological quality of included trials using the 11-item PEDro scale (Mosely et al. 2002), which is based on the Delphi List (Verhagen et al. 1998) and available at The Physiotherapy Evidence Database (PEDro) (<http://www.pedro.fhs.usyd.edu.au/FAQs/Scale/scaleitems.htm>). Items are: specification of eligibility criteria; random allocation to group; concealed allocation; groups similar at baseline; blinding of all participants, therapists and assessors; outcome measurements obtained from more than 85% of all participants; data analysed by 'intention to treat'; between-group statistical comparisons reported; reporting of point measures and measures of variability. The reviewers discussed the quality rating where disagreement occurred. There was no exclusion according to the score.

Data extraction

Two reviewers (AW and IE) extracted descriptions of the studies including methods, inclusion criteria, participant's characteristics, description of the surgical procedures, and outcome measures reported. The number of participants as well as the mean and standard deviations of outcome measures were extracted from each of the studies and recorded for analysis. The corresponding authors were contacted to provide missing information or clarify any unclear data.

Comparisons

It was the intention of this review to compare two surgical procedures for any given stage of osteoarthritis. However, there were no studies identified which reported outcomes by stage of osteoarthritis. Seven surgical procedures had been identified for trapeziometacarpal osteoarthritis. They were volar ligament reconstruction, metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy, trapeziectomy with LRTI, trapeziectomy with interpositional arthroplasty, and trapeziometacarpal joint replacement. However, there were no studies identified which reported results of volar ligament reconstruction, metacarpal osteotomy or trapeziometacarpal arthrodesis. However, studies which reported outcomes following trapeziectomy with ligament reconstruction were identified, and these studies were also included in the comparisons.

Outcomes

Comparisons were made between the five surgical procedures, for any stage of osteoarthritis, for the following outcomes:

- Pain
- Weakness
- Contracture
- Hand Function
- Patient global assessment
- Trapeziometacarpal joint imaging
- Adverse effects

Statistical analysis

Trials using similar methods of measurement for the outcomes of pain, weakness, contracture, hand function, patient global assessment, trapeziometacarpal joint imaging or adverse effects were considered for pooling. The Cochrane Collaboration's Review Manager software program (RevMan 4.2) was used for analyses. For continuous outcomes, where there was homogeneity and normality, results were analysed and the effect sizes reported as weighted mean differences (WMD) (95% confidence intervals), and a fixed effect model was used. Where the same outcome was measured with different scales (eg. weakness), or there was significant heterogeneity ($p < 0.1$ using the Q-test or chi-square test) and lack of normality, standardised mean differences (SMD) (95% CIs) were used. For dichotomous outcomes, relative risks (RR) (95% CI) were calculated.

Description of studies

Identification of relevant trials

In total, 139 studies were selected based on title and abstract. Two reviewers independently extracted details such as the type of trial, the intervention performed, and the outcome measures used. Of these, 125 studies were excluded because they: were observational studies (n=88); were descriptive studies (n=16); were reviews (n=12); had no intervention of interest (n=8) or had no outcome of interest (n=1) (Appendix E.3). Seven studies were found which met the eligibility criteria, six compared one surgical procedure with another (Belcher & Nicholl 2000, Belcher & Zic 2001, De Smet et al. 2004, Gerwin et al. 1997, Kriegs-Au et al. 2004, Tagil & Kopylov 2002), while one study compared three surgical procedures (Davis, Brady & Dias 2004). A further seven studies were identified which presented preliminary

data on the same participants as the included studies, and they were grouped with the primary study.

Included studies comparing surgical techniques for trapeziometacarpal osteoarthritis

A total of 384 participants were enrolled, and the number of participants in each study ranged from 20 to 177 (Characteristics of Included Studies, Appendix E.4). It was not possible to calculate the number of male and female participants enrolled in the studies because Gerwin et al. (1997) did not mention the sex of their participants. Three studies did not state the stage of osteoarthritis of their participants (De Smet et al. 2004, Gerwin et al. 1997, Tagil & Kopylov 2002), however there was a predominance of Stage III and IV osteoarthritis in those that did.

There were six comparisons of one surgical procedure with another across the seven studies: trapeziectomy with LRTI was compared to trapeziectomy by Belcher & Nicholl (2000), Davis, et al (2004), and De Smet et al. (2002), to trapeziectomy with interpositional arthroplasty by Davis et al (2004) (who inserted palmaris longus tendon) and to trapeziectomy with ligament reconstruction by Gerwin et al. (1997) and Kriegs-Au et al. (2004); trapeziectomy was compared to trapeziectomy with interpositional arthroplasty by Belcher and Zic (2001) (who inserted Porcine collagen) and Davis et al (2004) (who inserted palmaris longus tendon); and trapeziectomy with interpositional arthroplasty was compared to joint replacement surgery by Tagil & Kopylov (2002).

Pain was an outcome measure in Belcher and Nicholl (2000), Belcher and Zic (2001), Davis, et al (2004), De Smet et al. (2004), Kriegs-Au et al. (2004), and Tagil

& Kopylov (2002) (Appendix E.5a). Weakness was an outcome measure in all studies (Appendix E.5b), however De Smet et al. (2004) reported scores as percentage of postop / pre op scores, which prevented their inclusion in the analysis. Contracture was an outcome measure in Belcher & Nicholl (2000), Belcher & Zic (2001), Gerwin et al (1997), Kriegs-Au et al (2004), and Tagil & Kopylov (2002) (Appendix E.5c). Davis et al (2004) and De Smet et al (2004) also measured contracture but did not report group means and standard deviations, which prevented their inclusion in the analysis. Hand function was an outcome measure in Belcher and Nicholl (2000), Belcher & Zic (2001), De Smet et al (2004), Kriegs-Au et al (2004), and Tagil & Kopylov (2002) (Appendix E.5d). Patient global assessment was an outcome measure in Kriegs-Au et al (2004) (Appendix E.5e). Trapeziometacarpal joint imaging was an outcome measure in Belcher and Nicholl (2000), Belcher and Zic (2001), Gerwin et al (1997), and Tagil & Kopylov (2002) (Appendix E.5f). Adverse effects were reported by all studies except De Smet et al. (2004) and Gerwin et al (1997) (Appendix E.5g).

Methodological quality of included studies

Details of the methodological quality of included studies are reported in Table 6.1. For studies included in this review the maximum total PEDro score possible is 8 out of 10 since it is not possible to blind the participants or the surgeons to the intervention. The trials were variable in quality with one scoring 7/8 (Tagil & Kopylov 2002), three scoring 6/8 (Belcher & Nicholl 2000, Belcher & Zic 2001, Davis, et al. 2004), two scoring 5/8 (De Smet et al. 2004, Kriegs-Au et al 2004), and one scoring 3/8 (Gerwin et al 1997).

Table 6.1 Methodological quality of included studies

Study	Score	Randomisation	Concealment	Baseline compatible	Assessor blinding	Drop-outs <15%	Intention-to-treat analysis	Group comparisons	Point measures
Belcher, HJCR & Nicholl 2000	6	Yes	Yes, spin coin	Yes	No, unknown	Yes, 2%	No, unknown	Yes	Yes
Belcher, HJ & Zic 2001	6	Yes	Yes	Yes	No, unknown	Yes, 4%	No, unknown	Yes	Yes
Davis, TRC, Brady & Dias 2004	6	Yes	Yes, envelopes	Yes	No, unknown	Yes, 0%	No, unknown	Yes	Yes
De Smet et al. 2004	5	Yes	No, unknown	Yes	Yes	No, unknown	No, unknown	Yes	Yes
Gerwin et al. 1997	3	Yes	No, unknown	No, unknown	Yes	No, unknown	No	No	Yes
Kriegs-Au et al. 2004	5	Yes	Yes, independent	Yes	Yes	No, 28%	No, unknown	Yes	No
Tagil & Kopylov 2002	7	Yes	Yes, envelopes	Yes	Yes	Yes, 7%	No, unknown	Yes	Yes

RESULTS

There were no trials comparing surgical procedures for any one stage of trapeziometacarpal osteoarthritis. There were also no trials comparing volar ligament reconstruction, metacarpal osteotomy or trapeziometacarpal arthrodesis with any other procedure. Therefore, the following comparisons were made:

Trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition and trapeziectomy with interpositional arthroplasty

Trapeziectomy was compared to trapeziectomy with LRTI (*abductor pollicis longus* (APL)) by Belcher & Nicholl (2000), trapeziectomy with interpositional arthroplasty by Belcher & Zic (2001) (Porcine collagen)) and Davis, et al. (2004(b) (*palmaris longus* (PL))), and trapeziectomy with LRTI (*flexor carpi radialis* (FCR)) by De Smet et al. (2004) and Davis et al. (2004(a)). The comparison of trapeziectomy to trapeziectomy with interpositional arthroplasty by Belcher & Zic (2001) was not included in the analysis because outcomes were presented as median (range) rather than mean (SD).

Pain

There were two trials which measured pain on a continuous 100 mm VAS scale examining the effect of trapeziectomy in decreasing pain (Belcher & Nicholl 2000, De Smet et al. 2004). There was no difference in pain relief between trapeziectomy and trapeziectomy with ligament reconstruction and tendon interposition (WMD = 4.51 mm, 95%CI -5.28 to 14.30, fixed effect, p=0.37) (Figure 6.1a).

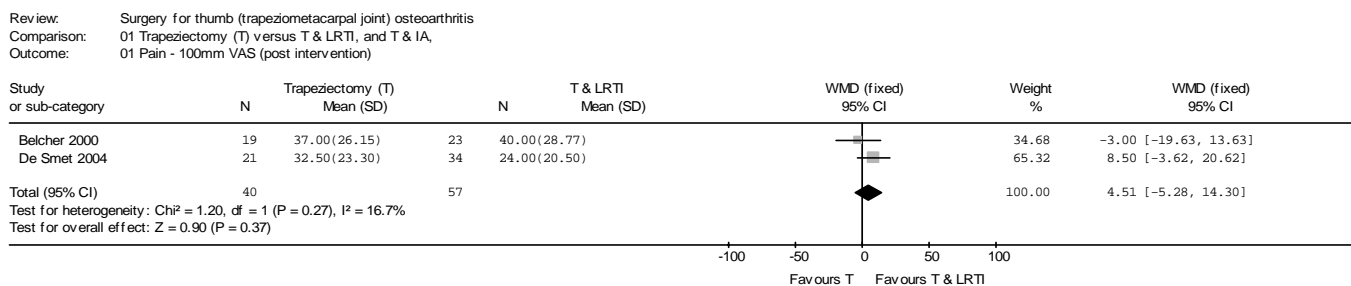


Figure 6.1a Comparison of the VAS score (mm) for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition

There were two trials which measured pain on a dichotomous scale, recording the number of participants with resting pain. There was no difference in the number of participants with resting pain between trapeziectomy and trapeziectomy with LRTI (Davis 2004 (a)) or trapeziectomy and trapeziectomy with interpositional arthroplasty (Davis 2004 (b)) (RR = 1.0 subject, 95%CI 0.38 to 2.47, $p=0.96$) (Figure 6.1b).

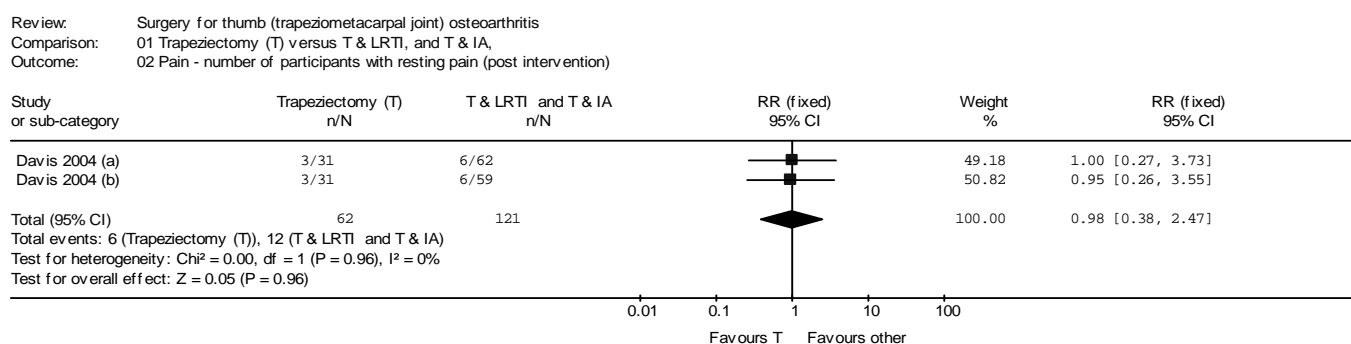


Figure 6.1b Comparison of the number of participants with resting pain for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition or trapeziectomy with interpositional arthroplasty

Weakness

There were three trials which measured lateral pinch strength in kilograms (Belcher & Nicholl 2000, Davis, et al. (2004 (a and b))). There was no difference in lateral pinch strength between trapeziectomy and trapeziectomy with ligament reconstruction or trapeziectomy with interpositional arthroplasty (WMD = 0.28 kg, 95%CI= -0.12 to 0.67, fixed effect, p=0.17) (Figure 6.1c).

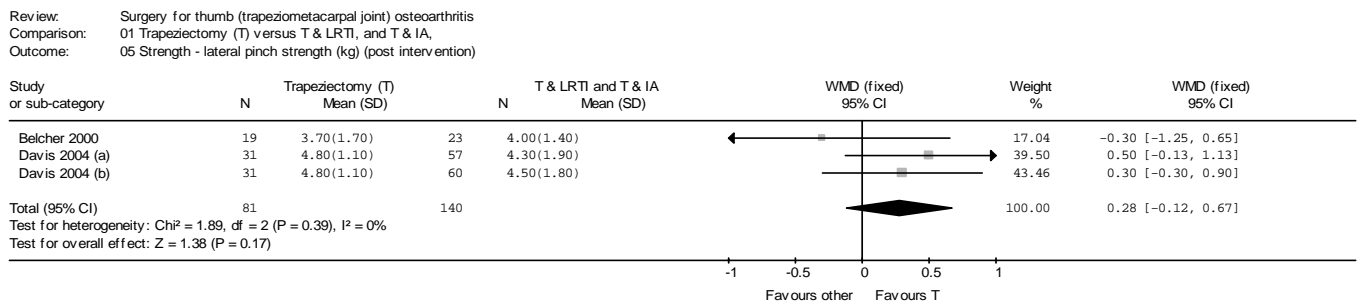


Figure 6.1c Comparison of lateral pinch strength (kg) for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition or trapeziectomy with interpositional arthroplasty

Contracture

There was one trial which measured range of palmar abduction motion in centimetres (Belcher & Nicholl 2000). There was significantly less range of motion in the trapeziectomy group compared with the trapeziectomy with ligament reconstruction and tendon interposition group (WMD = -0.3 cm, 95%CI -0.57 to -0.03, fixed effect, p=0.03) (Figure 6.1d).

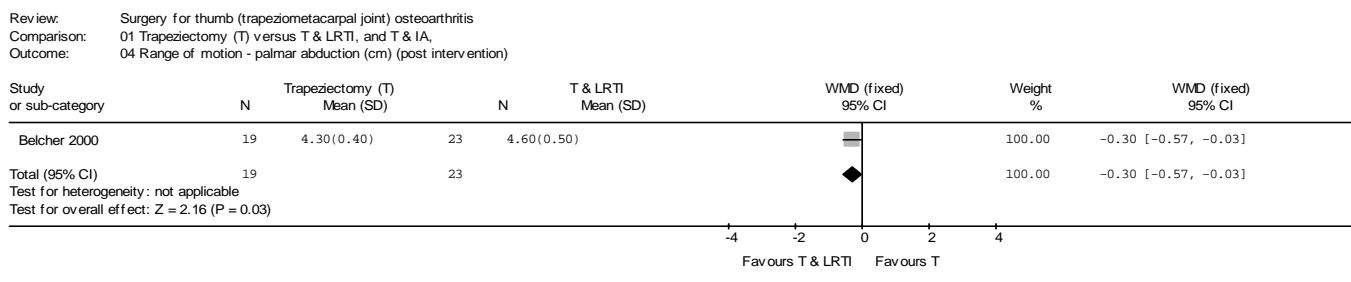


Figure 6.1d Comparison of palmar abduction range of motion (cm) for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition

Hand function

There was one trial which measured physical function on a continuous 100 mm VAS scale (Belcher & Nicholl 2000). Another study (De Smet et al. 2004) measured function on the DASH. In both scales, 0=normal function and 100=maximal disability. There was no difference in function between the trapeziectomy group and the trapeziectomy with ligament reconstruction and tendon interposition group (WMD = -1.0 mm, 95%CI -9.57 to 7.57, fixed effect, p=0.82) (Figure 6.1e).

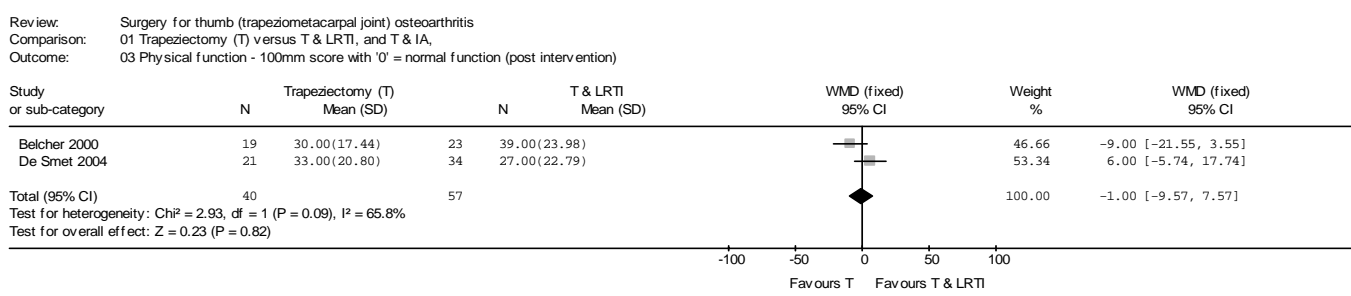


Figure 6.1e Comparison of physical function score (mm) for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition

Trapeziometacarpal joint imaging

There was one trial which measured scaphometacarpal distance in millimetres (Belcher & Nicholl 2000). There was no difference in the scaphometacarpal distance between the trapeziectomy group and the trapeziectomy with LRTI group (WMD = 0.10 mm, 95%CI -0.61 to 0.81, fixed effect, p=0.78) (Figure 6.1f).

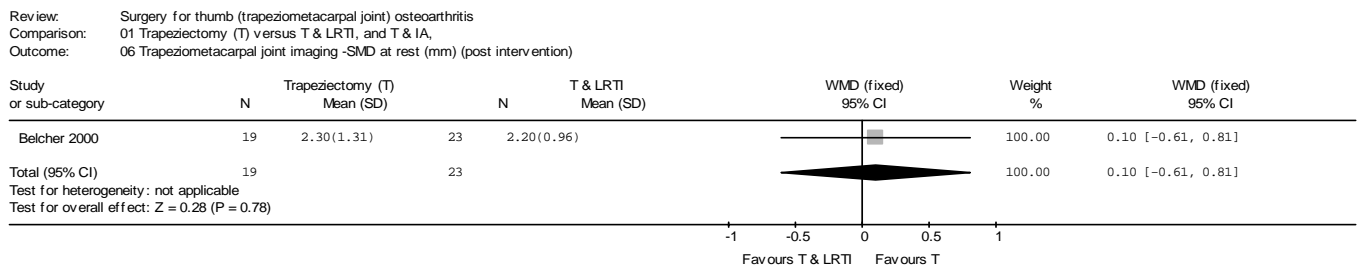


Figure 6.1f Comparison of scaphometacarpal distance (mm) for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition

Adverse effects

There were four trials which reported adverse effects (Belcher & Nicholl 2000, Belcher & Zic 2001, Davis, et al. (2004 (a and b)) (Appendix E.6a)). There were significantly less adverse effects with trapeziectomy than trapeziectomy with ligament reconstruction or tendon interposition or trapeziectomy with interpositional arthroplasty (RR = 0.48, 95%CI= 0.28 to 0.81, p=0.007) (Figure 6.1g).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 01 Trapeziectomy (T) versus T & LRTI, and T & IA,
 Outcome: 07 Adverse effects (number of participants with adverse effects post intervention)

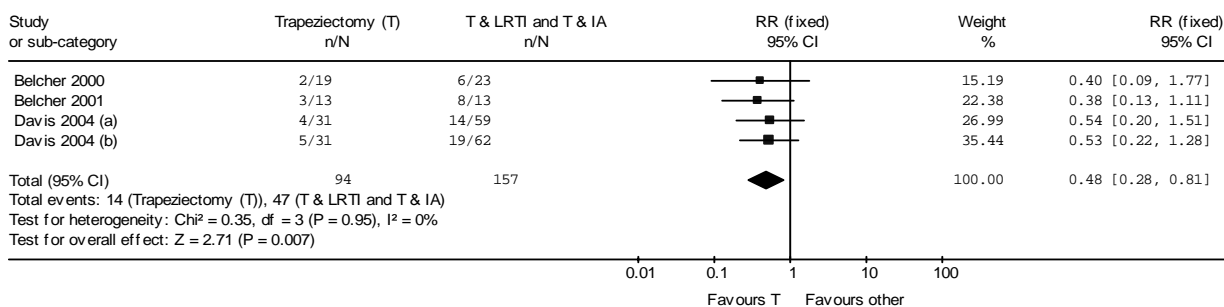


Figure 6.1g Comparison of the number of participants with adverse effects for trapeziectomy versus trapeziectomy with ligament reconstruction and tendon interposition or trapeziectomy with interpositional arthroplasty

Trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy, trapeziectomy with interpositional arthroplasty and trapeziectomy with ligament reconstruction

Trapeziectomy with LRTI was compared with trapeziectomy by Belcher and Nicholl (2000), Davis, et al. (2004 (a)), De Smet et al. (2004), trapeziectomy with interpositional arthroplasty (PL) by Davis, et al. (2004 (c)) and trapeziectomy with ligament reconstruction by Gerwin et al. (1997) and Kriegs-Au et al. (2004).

Pain

There were two trials which measured pain on a continuous 100 mm VAS scale examining the effect of trapeziectomy with LRTI in decreasing pain (Belcher & Nicholl 2000, De Smet et al. 2004). There was no difference in pain relief between trapeziectomy with LRTI and trapeziectomy (WMD = -4.51 mm, 95%CI -14.30 to 5.28, fixed effect, p=0.37) (Figure 6.2a).

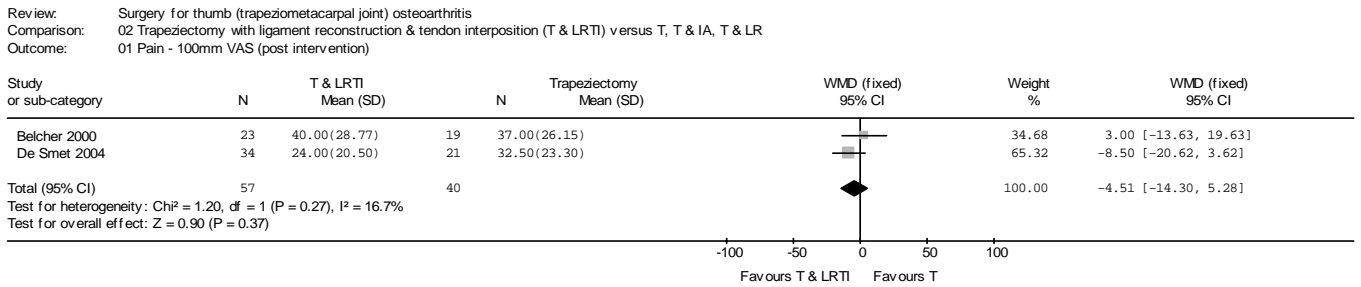


Figure 6.2a Comparison of the VAS score (mm) for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy

There were three trials which measured pain on a dichotomous scale, recording the number of participants with frequent or resting pain (Davis, et al 2004 (a and c), Kriegs-Au et al. 2004). There was no difference in the number of participants with frequent or resting pain between trapeziectomy with LRTI and trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction (RR = 1.2 subject, 95% CI 0.51 to 2.73, fixed effect, $p=0.70$) (Figure 6.2b).

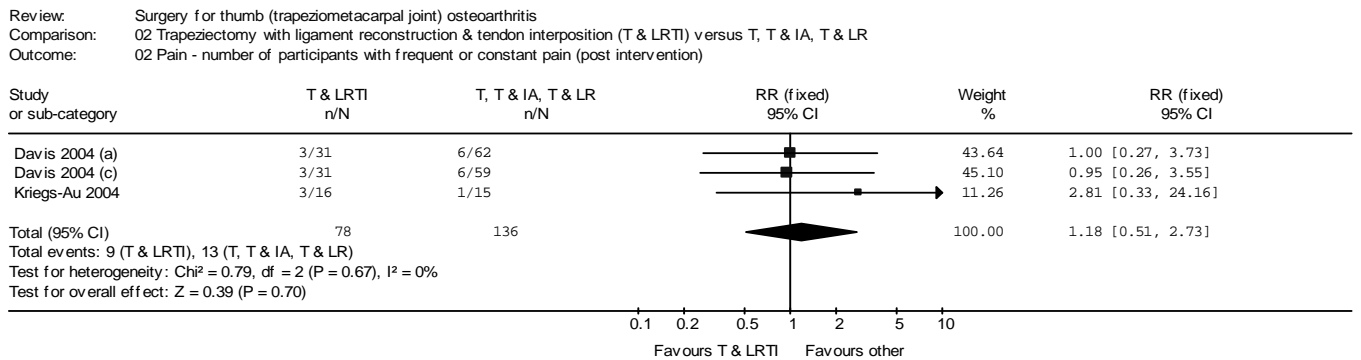


Figure 6.2b Comparison of the number of participants with frequent or constant pain for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction

Weakness

There were four trials which measured lateral pinch strength in kilograms (Belcher & Nicholl 2000, Davis, et al. 2004 (a and c), Gerwin et al. 1997). There was no difference in lateral pinch strength between trapeziectomy with LRTI and trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction (WMD = -0.06 kg, 95% CI= -0.45 to 0.33, fixed effect, p=0.77) (Figure 6.2c).

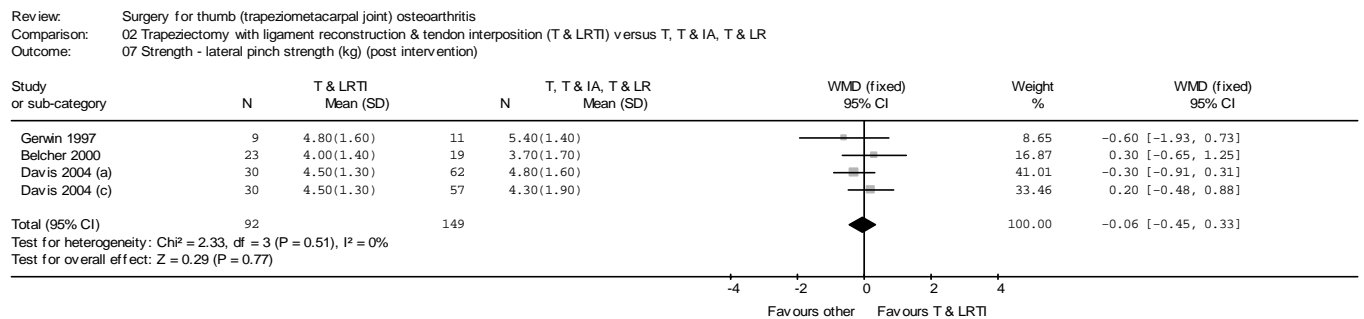


Figure 6.2c Comparison of lateral pinch strength (kg) for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction

Contracture

There were two trials which measured range of palmar abduction motion in degrees (Gerwin et al. 1997, Kriegs-Au et al. 2004). There was no difference in the range of palmar abduction between the trapeziectomy with LRTI group when compared with trapeziectomy with ligament reconstruction (WMD = -2.61 cm, 95% CI -5.35 to 0.14, fixed effect, p=0.06) (Figure 6.2d).

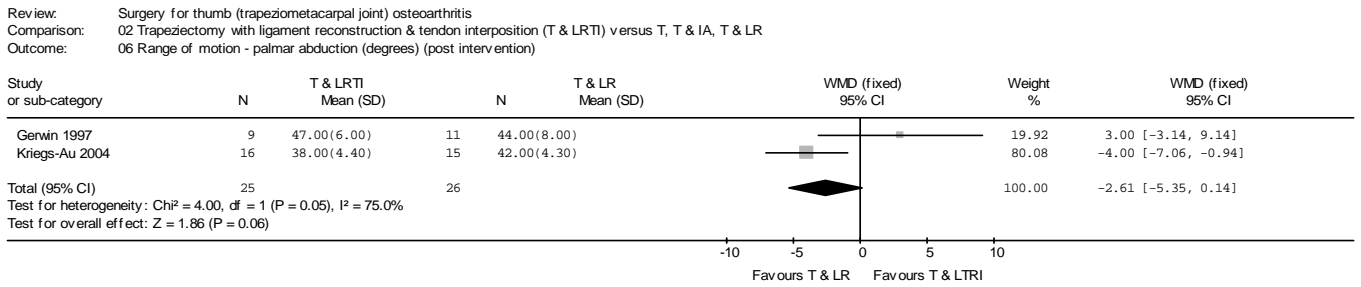


Figure 6.2d Comparison of range of palmar abduction (degrees) for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy with ligament reconstruction

Hand function

There was one trial which measured physical function on a continuous 100 mm VAS scale examining the effect of trapeziectomy with LRTI in improving function (Belcher & Nicholl 2000). Another trial measured function with the DASH score (De Smet et al 2004). There was no difference in function between trapeziectomy with LRTI and trapeziectomy (WMD = 2.73 mm, 95%CI -6.85 to 12.31, fixed effect, $p=0.58$) (Figure 6.2e).

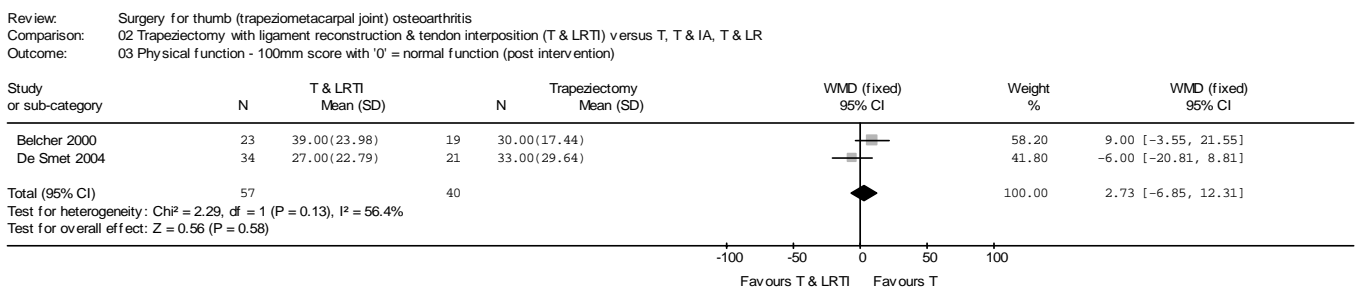


Figure 6.2e Comparison of physical function score (mm) for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy

There was no difference between the number of participants with moderate or severe difficulty with daily function (Kriegs-Au et al. 2004) in the trapeziectomy with LRTI group when compared to trapeziectomy with ligament reconstruction (RR = 2.81, 95%CI 0.33 to 24.16, fixed effect, p=0.35) (Figure 6.2f).

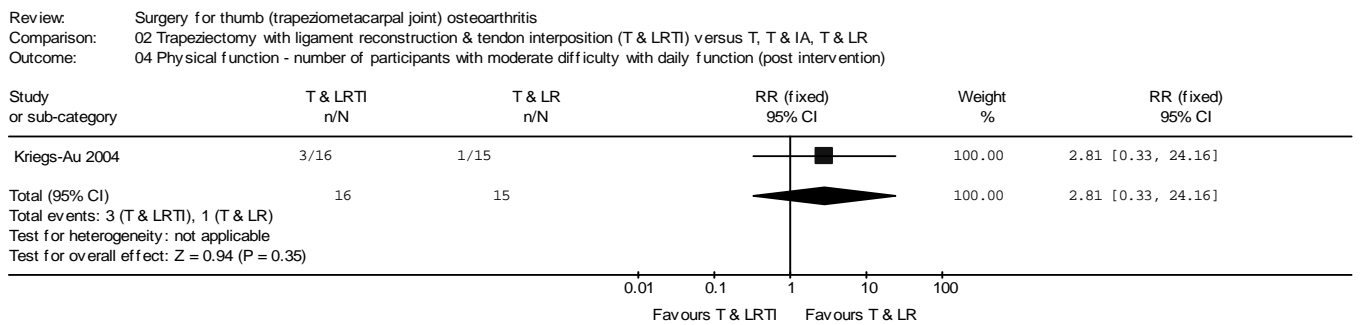


Figure 6.2f Comparison of the number of participants with moderate difficulty with daily function for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy with ligament reconstruction

Patient global assessment

There was one trial which reported patient global assessment (Kriegs-Au et al. 2004) on a dichotomous scale. The Buck-Gramcko Score reported the number of participants with good to excellent scores, ie, scores between 40-56. There was no difference between the number of participants with good to excellent scores in the trapeziectomy with LRTI group when compared to trapeziectomy with ligament reconstruction (RR = 0.81, 95%CI 0.64 to 1.03, p=0.08) (Figure 6.2g).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 02 Trapeziectomy with ligament reconstruction & tendon interposition (T & LRTI) versus T, T & IA, T & LR
 Outcome: 05 Patient global assessment - Buck Gramcko score (number of participants with good-excellent total score)

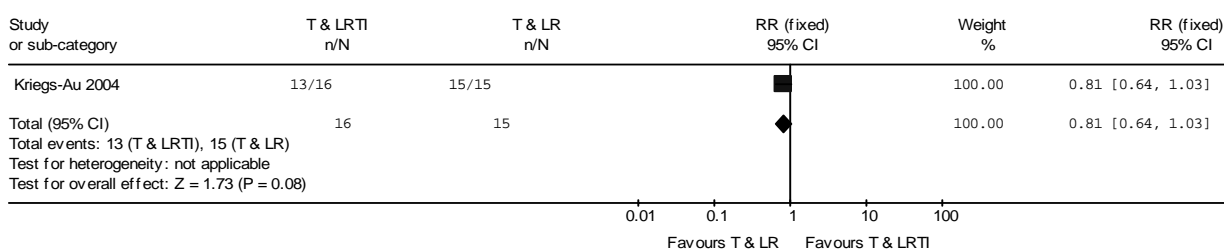


Figure 6.2g Comparison of the number of participants who scored good-excellent on the Buck-Gramcko score for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy with ligament reconstruction

Trapeziometacarpal joint imaging

There were two trials which measured scaphometacarpal distance at rest in millimetres (Belcher & Nicholl 2000, Gerwin et al. 1997). There was no difference in the scaphometacarpal distance at rest between the trapeziectomy with LRTI group and trapeziectomy or trapeziectomy with ligament reconstruction (WMD = -0.26 mm, 95%CI -0.86 to 0.35, fixed effect, p=0.41) (Figure 6.2h).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 02 Trapeziectomy with ligament reconstruction & tendon interposition (T & LRTI) versus T, T & IA, T & LR
 Outcome: 08 Trapeziometacarpal joint imaging - SMD at rest (mm) (post intervention)

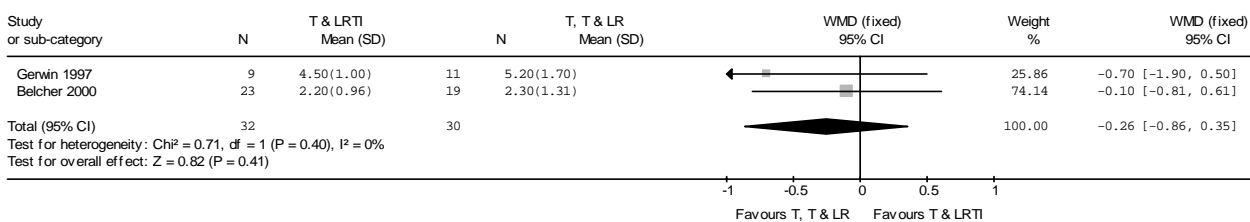


Figure 6.2h Comparison of scaphometacarpal distance (mm) for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy or trapeziectomy with ligament reconstruction

Adverse effects

There were four trials which reported adverse effects (Belcher & Nicholl 2000, Davis, et al. 2004 (a and c), Kriegs-Au et al. 2004 (Appendix E.6b). There were significantly more adverse effects following trapeziectomy with LRTI than trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction (RR = 1.68, 95% CI= 1.05 to 2.71, p=0.03) (Figure 6.2i).

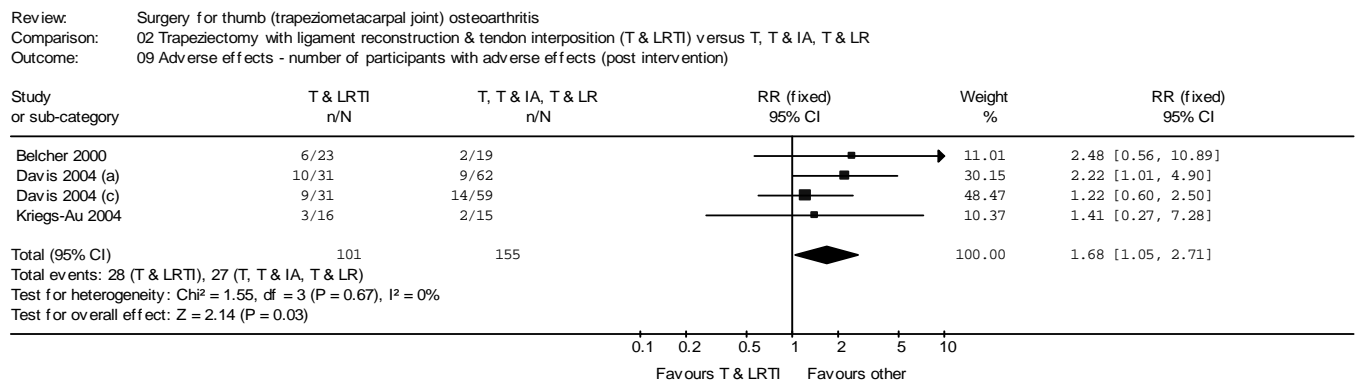


Figure 6.2i Comparison of the number of participants with adverse effects for trapeziectomy with ligament reconstruction and tendon interposition versus trapeziectomy, trapeziectomy with interpositional arthroplasty or trapeziectomy with ligament reconstruction

Trapeziectomy with interpositional arthroplasty versus trapeziectomy, trapeziectomy with ligament reconstruction and tendon interposition, and Swanson joint replacement

Trapeziectomy with interpositional arthroplasty was compared with trapeziectomy by Belcher & Zic (2001), Davis, et al (2004 (b)), trapeziectomy with LRTI by Davis, et al. (2004(c)) and Swanson joint replacement by Tagil & Kopylov (2002).

Pain

There was one trial which measured pain on a continuous 100 mm VAS scale examining the effect of trapeziectomy with interpositional arthroplasty in decreasing pain (Tagil & Kopylov 2002). There was no difference in pain relief between trapeziectomy with interpositional arthroplasty and trapeziometacarpal joint replacement (Swanson) (WMD = 5.0 mm, 95% CI -7.41 to 17.41, fixed effect, $p=0.43$) (Figure 6.3a).

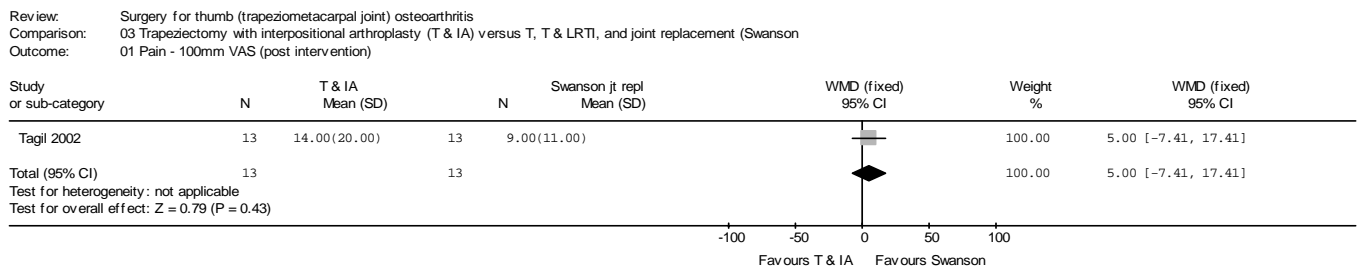


Figure 6.3a Comparison of the VAS score (mm) for trapeziectomy with interpositional arthroplasty versus trapeziometacarpal joint replacement (Swanson)

There were two trials which measured pain on a dichotomous scale, recording the number of participants with frequent or resting pain (Davis, et al 2004 (b and c)). There was no difference in the number of participants with frequent or resting pain between trapeziectomy with interpositional arthroplasty and trapeziectomy or trapeziectomy with LRTI (RR= 1.03 subject, 95% CI 0.41 to 2.62, $p=0.94$) (Figure 6.3b).

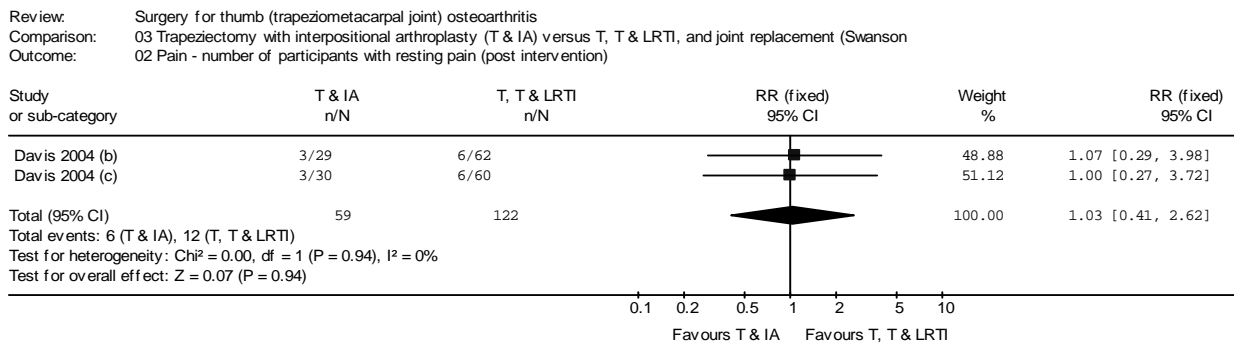


Figure 6.3b Comparison of the number of participants with resting pain for trapeziectomy with interpositional arthroplasty versus trapeziectomy or trapeziectomy with LRTI

Weakness

There were two trials which measured lateral pinch strength in kilograms (Davis, et al. 2004 (b and c)) and one which measured in kp/cm² (Tagil & Kopylov 2002). There was no difference in lateral pinch strength between trapeziectomy with interpositional arthroplasty when compared with trapeziectomy, trapeziectomy with LRTI or trapeziometacarpal joint replacement (Swanson) (SMD = -0.18, 95%CI= -0.47 to 0.12, p=0.24) (Figure 6.3c).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 03 Trapeziectomy with interpositional arthroplasty (T & IA) versus T, T & LRTI, and joint replacement (Swanson)
 Outcome: 04 Strength - lateral pinch strength (post intervention)

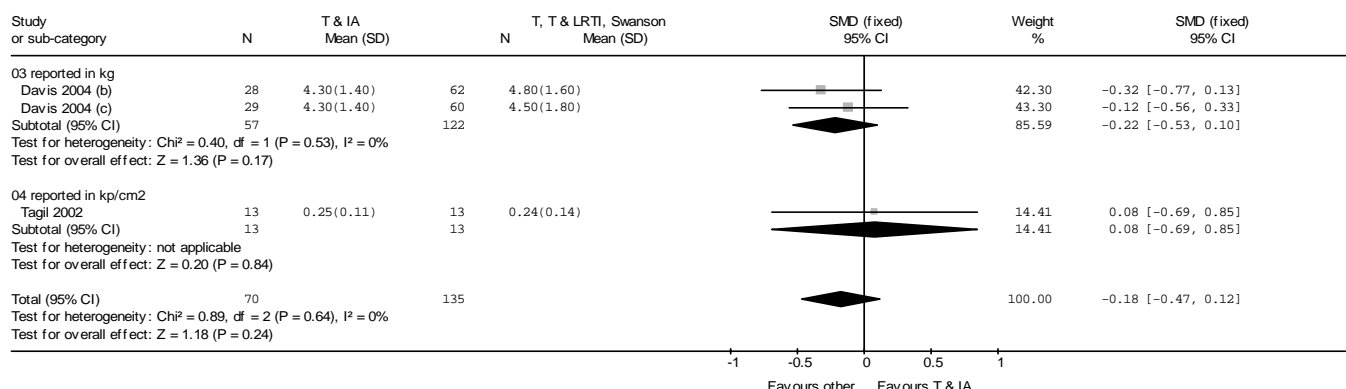


Figure 6.3c Comparison of lateral pinch strength (kg) for trapeziectomy with interpositional arthroplasty versus trapeziectomy, trapeziectomy with ligament reconstruction and tendon interposition or trapeziometacarpal joint replacement (Swanson)

Contracture

There was one trial which measured range of palmar abduction motion in degrees (Tagil & Kopylov 2002). There was no difference in the range of palmar abduction between the trapeziectomy with interpositional arthroplasty group when compared with trapeziometacarpal joint replacement (Swanson) (WMD = 2.0 degrees, 95% CI -3.18 to 7.18, fixed effect, p=0.45) (Figure 6.3d).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 03 Trapeziectomy with interpositional arthroplasty (T & IA) versus T, T & LRTI, and joint replacement (Swanson)
 Outcome: 03 Range of motion - palmar abduction (degrees) (post intervention)

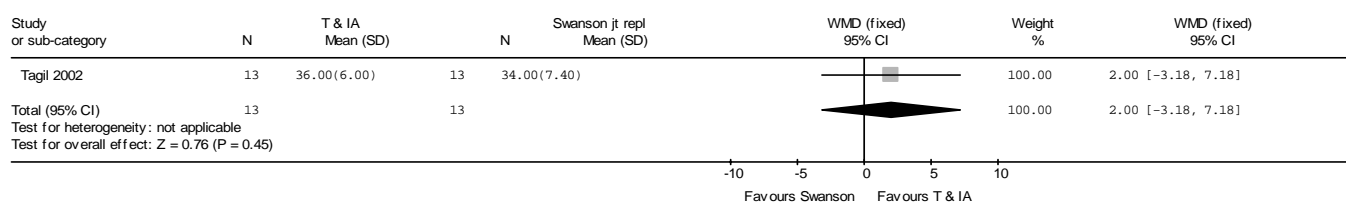


Figure 6.3d Comparison of range of palmar abduction (degrees) for trapeziectomy with interpositional arthroplasty versus trapeziometacarpal joint replacement (Swanson)

Trapeziometacarpal joint imaging

There was one trial which measured scaphometacarpal distance in millimetres at rest (Tagil & Kopylov 2002). They found a significant decrease in the scaphometacarpal distance in the trapeziectomy and interpositional arthroplasty group when compared with the Swanson joint replacement group (WMD = -3.5 mm, 95% CI -5.0 to -2.0, fixed effect, $p < 0.01$) (Figure 6.3e).

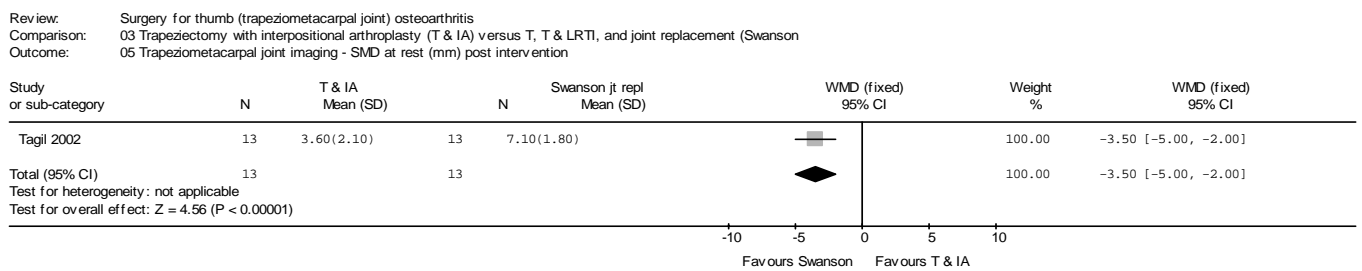


Figure 6.3e Comparison of scaphometacarpal distance (mm) for trapeziectomy with interpositional arthroplasty versus trapeziometacarpal joint replacement (Swanson)

Adverse effects

There were four trials which reported adverse effects (Belcher & Zic 2001, Davis, et al. 2004 (b and c), Tagil & Kopylov 2002(Appendix E.6c)). There was no difference in the adverse effects following trapeziectomy and interpositional arthroplasty when compared with trapeziectomy, trapeziectomy with LRTI or trapeziometacarpal joint replacement (Swanson) (RR = 1.19, 95% CI= 0.74 to 1.92, $p=0.47$) (Figure 6.3f).

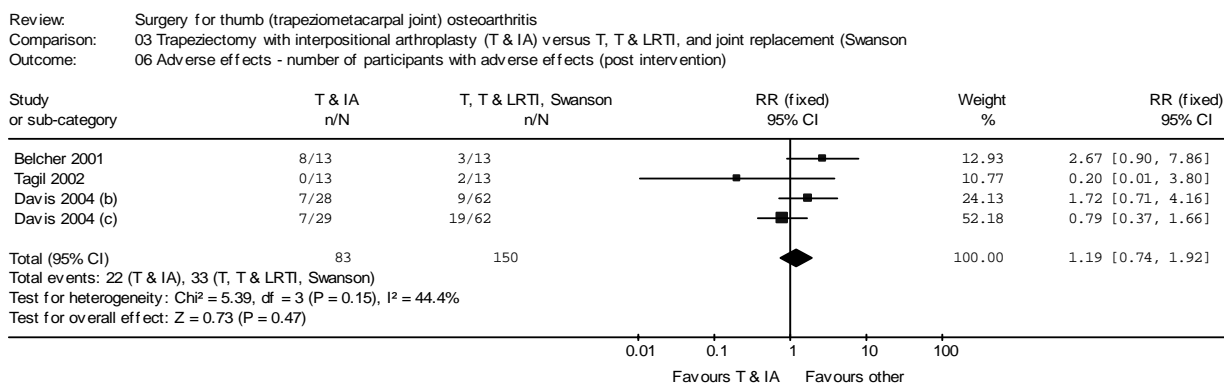


Figure 6.3f Comparison of number of participants with adverse effects for trapeziectomy with interpositional arthroplasty versus trapeziectomy, trapeziectomy with LRTI or trapeziometacarpal joint replacement (Swanson)

Trapeziometacarpal joint replacement (Swanson) versus trapeziectomy with interpositional arthroplasty

Trapeziometacarpal joint replacement (Swanson) was compared with trapeziectomy with interpositional arthroplasty (APL) by Tagil & Kopylov (2002).

Pain

There was one trial which measured pain on a continuous 100 mm VAS scale examining the effect of trapeziometacarpal joint replacement and any other procedure (Tagil & Kopylov 2002). There was no difference in pain relief between trapeziometacarpal joint replacement and trapeziectomy with interpositional arthroplasty (WMD = -5.0 mm, 95%CI -17.41 to 7.41, fixed effect, $p=0.43$) (Figure 6.4a).

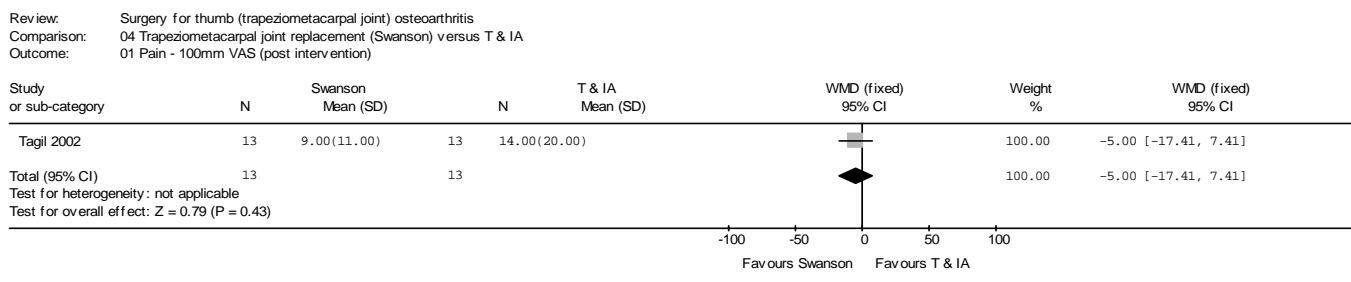


Figure 6.4a Comparison of the VAS scores (mm) for trapeziectomy with joint replacement versus trapeziectomy with interpositional arthroplasty

Weakness

There was one trial which measured lateral pinch strength in kp/cm² (Tagil & Kopylov 2002). There was no difference in lateral pinch strength between trapeziometacarpal joint replacement when compared with trapeziectomy with interpositional arthroplasty (WMD = -0.01, 95%CI=-0.11 to 0.09, fixed effect, p=0.84) (Figure 6.4b).

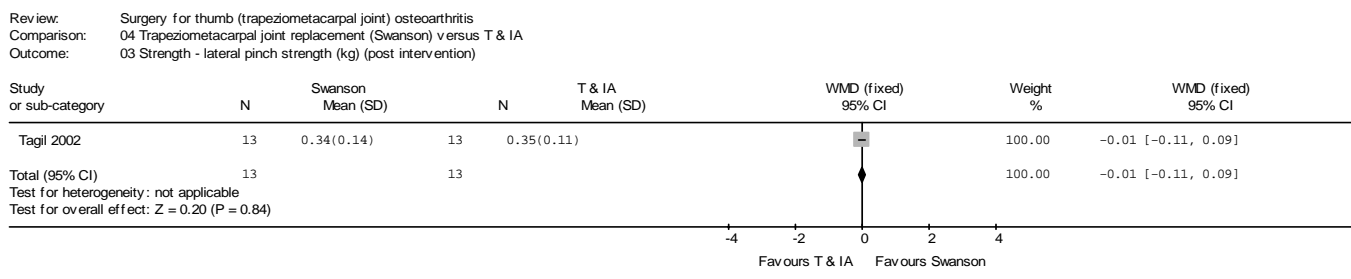


Figure 6.4b Comparison of lateral pinch strength (kg) for trapeziectomy with joint replacement versus trapeziectomy with interpositional arthroplasty

Contracture

There was one trial which measured range of palmar abduction motion in degrees (Tagil & Kopylov 2002). There was no difference in the range of palmar abduction between

the trapeziometacarpal joint replacement and trapeziectomy with interpositional arthroplasty (WMD = -2.0 degrees, 95%CI -7.01 to 3.01, fixed effect, p=0.43) (Figure 6.4c).

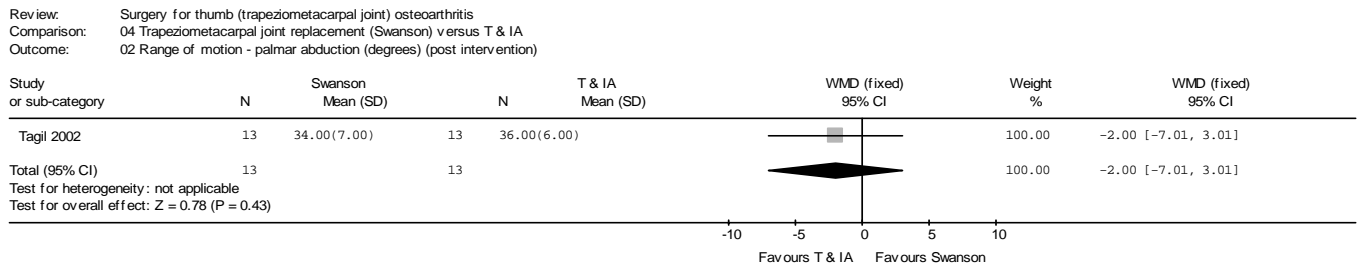


Figure 6.4c Comparison of palmar abduction range for trapeziectomy with joint replacement versus trapeziectomy with interpositional arthroplasty

Trapeziometacarpal joint imaging

There was one trial which measured scaphometacarpal distance in millimeters (Tagil & Kopylov 2002). They found a significant increase in the scaphometacarpal distance in the trapeziometacarpal joint replacement group when compared with trapeziectomy with interpositional arthroplasty at rest (WMD = 3.5 mm, 95%CI 2.04 to 4.96, fixed effect, p<0.01) (Figure 6.4d).

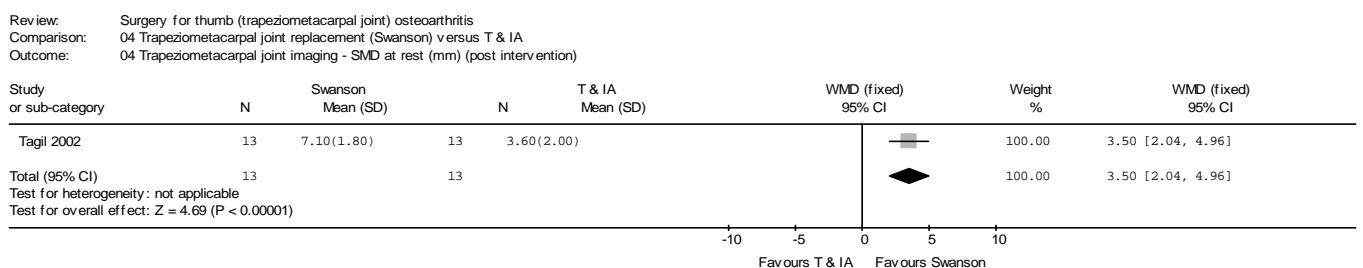


Figure 6.4d Comparison of scaphometacarpal distance (mm) for trapeziectomy with joint replacement versus trapeziectomy with interpositional arthroplasty

Adverse effects

There was one trial which reported adverse effects (Tagil & Kopylov 2002 (Appendix E.6d)). There was no difference in the adverse effects of trapeziometacarpal joint replacement when compared with trapeziectomy with interpositional arthroplasty (RR = 5.0, 95% CI= 0.26 to 95.02, p=0.28) (Figure 6.4e).

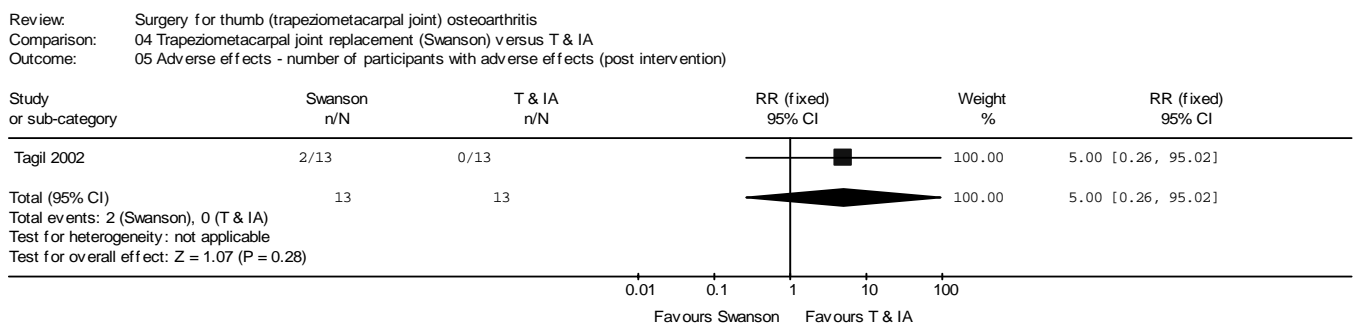


Figure 6.4e Comparison of number of participants with adverse effects for trapeziectomy with joint replacement versus trapeziectomy with interpositional arthroplasty

Trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Trapeziectomy with ligament reconstruction was compared with trapeziectomy and LRTI (FCR) by Gerwin et al. (1997), Kriegs-Au et al. (2004).

Pain

There was one trial (Kriegs-Au et al. 2004) which measured pain on a dichotomous scale, recording the number of participants with frequent or constant pain. There was no difference in the number of participants with frequent or constant pain between trapeziectomy with ligament reconstruction and trapeziectomy with ligament

reconstruction and tendon interposition (RR = 1.1 subject, 95%CI 0.07 to 15.57, p=0.96) (Figure 6.5a).

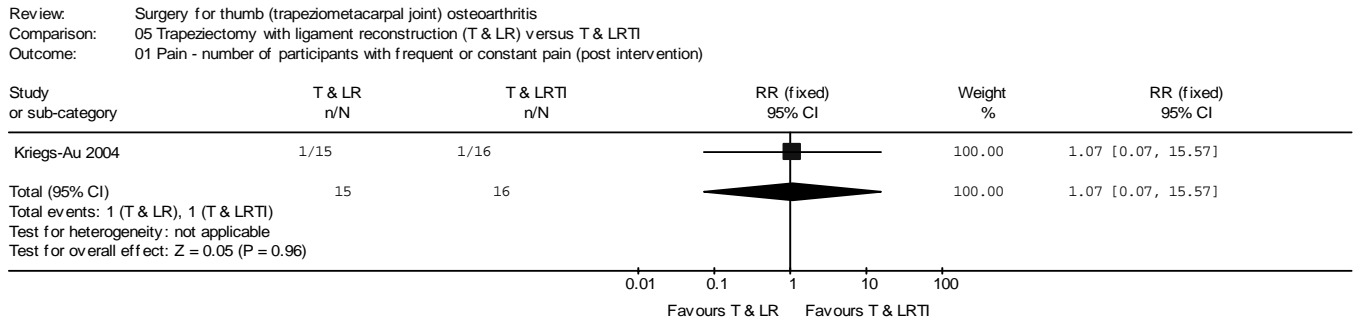


Figure 6.5a Comparison of the number of participants with frequent or constant pain for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Weakness

There was one trial which measured lateral pinch strength in kilograms (Gerwin et al. 1997). There was no difference in lateral pinch strength between trapeziectomy with ligament reconstruction and trapeziectomy with ligament reconstruction and tendon interposition (WMD = 0.60 kg, 95%CI= -0.73 to 0.1.93, p=0.38) (Figure 6.5b).

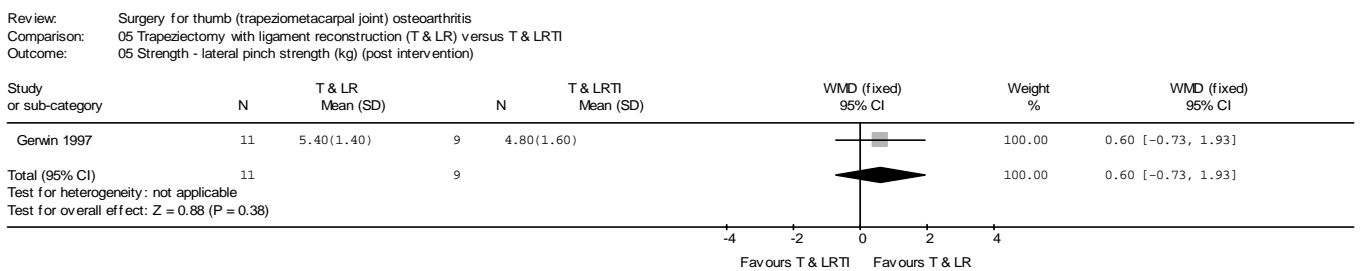


Figure 6.5b Comparison of lateral pinch strength (kg) for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Contracture

There were two trials which measured range of palmar abduction motion in degrees (Gerwin et al. 1997, Kriegs-Au et al. 2004). The two groups were not heterogenous ($p=0.04$) and overall there was a significant improvement in range of motion in the trapeziectomy with ligament reconstruction group when compared with trapeziectomy with ligament reconstruction and tendon interposition (WMD = 3.0 degrees, 95% CI 0.21 to 5.34, fixed effect, $p=0.03$) (Figure 6.5c).

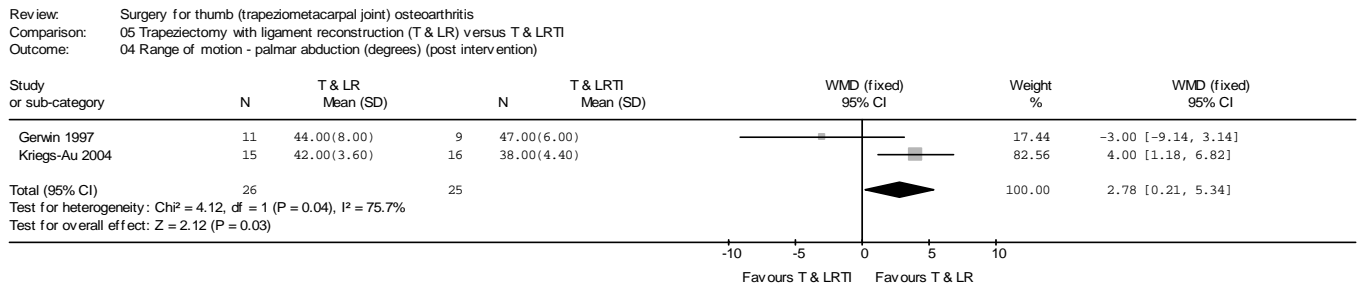


Figure 6.5c Comparison of palmar abduction range of motion (degrees) for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Hand function

There was one trial (Kriegs-Au et al. 2004) which measured physical function on a dichotomous scale, recording the number of participants with moderate or severe difficulty with daily function. There was no difference in the number of participants with moderate or severe difficulty with daily function in the trapeziectomy with ligament reconstruction group when compared to trapeziectomy with ligament reconstruction and tendon interposition (RR = 0.36, 95% CI 0.04 to 3.05, $p=0.35$) (Figure 6.5d).

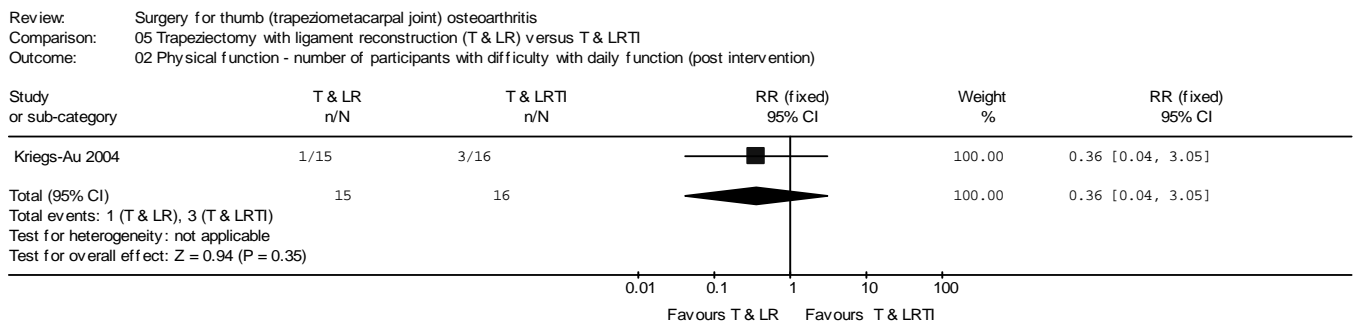


Figure 6.5d Comparison of the number of participants with difficulty with daily function for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Patient global assessment

There was one trial which reported patient global assessment (Kriegs-Au et al. 2004) on a dichotomous scale. The Buck-Gramcko Score reported the number of participants with good to excellent scores. There was no difference between the number of participants with good to excellent scores in the trapeziectomy with ligament reconstruction group when compared to trapeziectomy with ligament reconstruction and tendon interposition (RR = 1.23, 95%CI 0.97 to 1.56, p=0.08) (Figure 6.5e).

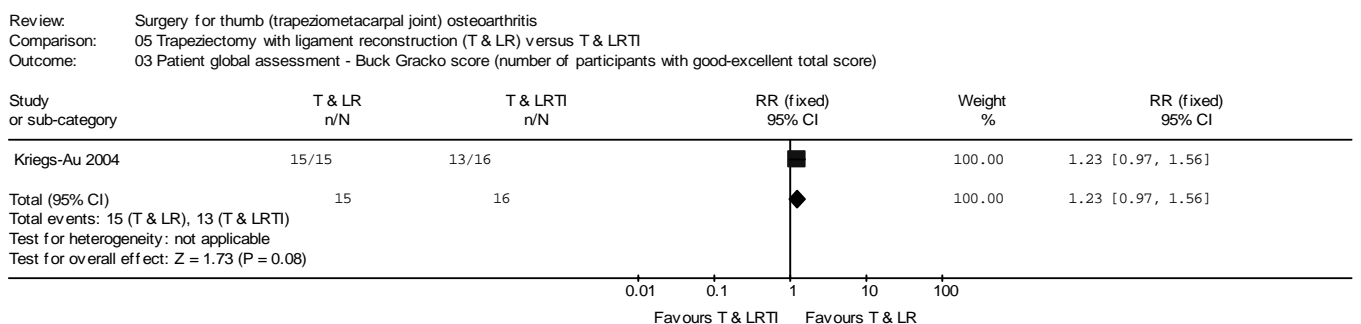


Figure 6.5e Comparison of the number of participants with good-excellent on the Buck-Gramcko score for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Trapeziometacarpal joint imaging

There was one trial which measured scaphometacarpal distance in millimeters at rest (Gerwin et al. 1997). There was no difference in the scaphometacarpal distance between the trapeziectomy with ligament reconstruction group and trapeziectomy with ligament reconstruction and tendon interposition (WMD=0.70 mm, 95% CI -0.50 to 1.90, fixed effect, p=0.25) (Figure 6.5f).

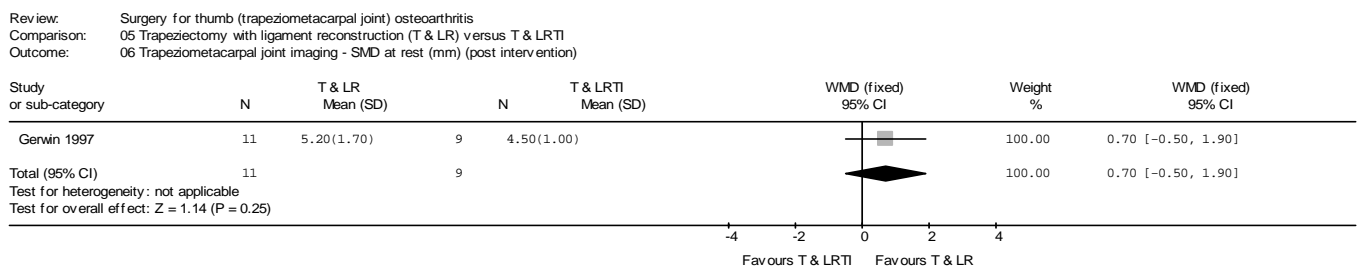


Figure 6.5f Comparison of scaphometacarpal distance (mm) for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

Adverse effects

There was one trial which reported adverse effects (Kriegs-Au et al. 2004 (Appendix 4.3 Table 5)). There was no difference in the presence of adverse effects between trapeziectomy with ligament reconstruction when compared with trapeziectomy with ligament reconstruction and tendon interposition (RR=0.71, 95% CI= 0.14 to 3.68, p=0.68) (Figure 6.5g).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis
 Comparison: 05 Trapeziectomy with ligament reconstruction (T & LR) versus T & LRTI
 Outcome: 07 Adverse effects - number of participants with adverse effects (post intervention)

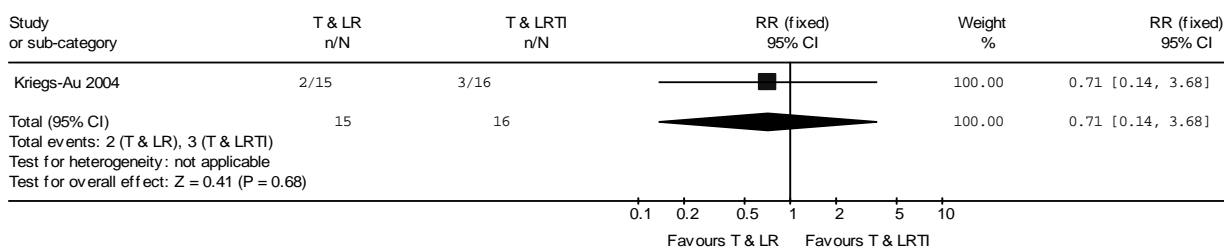


Figure 6.5g Comparison of the number of participants with adverse effects for trapeziectomy with ligament reconstruction versus trapeziectomy with ligament reconstruction and tendon interposition

DISCUSSION

The trapeziometacarpal joint is the site most commonly requiring surgical reconstruction for osteoarthritis in the upper extremity (Pellegrini, Olcott & Hollenberg 1993). Many surgical procedures have been described for this condition, however surgeons preferences remain largely based on personal experience rather than a 'methodologically sound assessment of primary studies' (Martou, Veltri & Thoma 2004). The purpose of this systematic review of randomised controlled clinical trials was to determine whether any one procedure is superior to another for a given stage of trapeziometacarpal osteoarthritis.

The detailed search strategy of the electronic databases, combined with hand searching of conference proceedings and reference lists of published studies is likely to have identified all relevant studies of surgery for trapeziometacarpal osteoarthritis. This review aimed to compare seven procedures commonly used in clinical practice: volar ligament reconstruction, metacarpal osteotomy, trapeziometacarpal arthrodesis,

trapeziectomy, trapeziectomy with LRTI, trapeziectomy with interpositional arthroplasty, and trapeziometacarpal joint replacement. However, the search strategy identified an eighth procedure, trapeziectomy with ligament reconstruction, and it was considered appropriate to include this procedure in the review as well. Seven studies reporting randomised controlled trials were identified which examined five (trapeziectomy, trapeziectomy with ligament reconstruction, trapeziectomy with ligament reconstruction and tendon interposition (LRTI), trapeziectomy with interpositional arthroplasty, and trapeziometacarpal joint replacement) of the eight surgical procedures for trapeziometacarpal osteoarthritis. One of these studies compared three surgical procedures (Davis, Brady & Dias 2004), whereas the other papers compared two procedures. While this review intended to examine the efficacy of surgical procedures in terms of the stage of trapeziometacarpal osteoarthritis (I - IV), all the randomised controlled trials were conducted on a mixed group of people with mostly Stage III-IV trapeziometacarpal osteoarthritis. It was not feasible to subgroup the participants into stages since the studies did not provide the necessary details. Therefore, at this time, the review is unable to make recommendations about three of the commonly-used surgical procedures (volar ligament reconstruction (without trapeziectomy), metacarpal osteotomy or trapeziometacarpal arthrodesis), or the superiority of any surgical procedure for any particular stage of trapeziometacarpal osteoarthritis.

The quality of the seven included studies was quite high (mean 5.4/8, range 3-7 PEDro score). Four studies achieved a PEDro score of 6 or higher. The main inadequacies were failure to use an intention to treat analysis (7/7), failure to blind assessors (3/7), and failure to state the number of subjects available for follow-up (3/7). The high

quality of the studies improves the reader's confidence about the strength of the conclusions and recommendations.

Overall most studies reported the outcomes of interest which were pain, weakness, contracture, hand function, patient global assessment, trapeziometacarpal joint imaging and adverse effects. However, it was still difficult comparing studies because there were crucial differences in the reporting and taking of outcomes measurements. Firstly, some outcomes were measured continuously and dichotomously. For example, pain was measured by different people on a continuous scale (Visual Analogue Scale (Belcher & Nicholl 2000)) and a dichotomous scale (number with resting pain (Davis, et al. 2004)). This therefore prevented pooling and required separate analyses. Secondly, some outcomes were measured using the same continuous scale but with different measurement tools, and reported in different units. For example, weakness was measured with the Jamar dynamometer and reported in kilograms in one study (Davis, et al 2004) while in another study, it was measured with a Martins Vigorimeter and reported in kp/cm² (Tagil & Kopylov 2002). In these cases, we used the standardized mean difference (SMD) for the analysis rather than weighted mean difference. Thirdly, a variety of measures were sometimes reported for the same outcome. For example, various measurements of contracture were taken, including palmar and radial abduction, opposition and the amount of flexion deficit. In these cases, we chose to analyse the most commonly-reported and clinically-relevant outcome (palmar abduction) to facilitate comparison between trials. Lastly, some studies reported percentage change of outcome measures rather than mean (SD) values. It was only possible to include their results in the analysis when the authors sent further information.

Pain was measured in all studies, providing eight comparisons (four continuous and four dichotomous) of pooled trials for the five procedures. There was no significant difference in pain between procedures, ie, no procedure appears to be superior to any other in the relief of pain. However, if the smallest clinical effect worth detecting after surgery is considered to be a difference of 2 cm on the VAS or a 20% reduction in the number of participants with resting pain, then the 95% confidence intervals for the effect on pain exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in pain exists between the five procedures.

Weakness was measured in all studies with actual values provided in six studies. This provided continuous outcomes for five procedures. There was no significant difference in lateral pinch strength between the procedures, ie, no particular procedure appears to be superior to any other in the outcome of lateral pinch strength. Furthermore, there is enough power to detect a clinically worthwhile difference of 0.8 kg pinch strength. Therefore, we can be confident that no significant differences exist. Martou (2004) also concluded that no procedure was superior to any other in improving strength, and suggested that thumb and hand strength appeared to be more affected by the amount of pain relief than any specific surgical procedure.

Contracture was measured in all seven studies, however, only five included the measurement of palmar abduction for individual groups in their study (Belcher & Nicholl 2000, Belcher & Zic 2001, Gerwin et al. 1997, Kriegs-Au et al. 2004, Tagil & Kopylov 2002). This provided five continuous outcomes for five procedures. A statistically significant increased range of palmar abduction was found after the trapeziectomy & ligament reconstruction procedure when compared with trapeziectomy

with ligament reconstruction and tendon interposition, as well as trapeziectomy with ligament reconstruction and tendon interposition over trapeziectomy. However, these differences are not clinically significant, amounting to only a few degrees or millimetres.

Hand function was not measured consistently across all studies. Three studies measured function on a continuous scale, two used the 100 mm VAS (Belcher & Nicholl 2000, Belcher & Zic 2001), while another used the Disabilities Arm, Shoulder, Hand questionnaire (DASH (0-100) (De Smet et al. 2004). One study measured function on a dichotomous scale, reporting the number of participants with 'moderate difficulty with daily function' as part of the Buck-Gramcko score (Kriegs-Au et al. 2004). This provided two pooled continuous comparisons and two dichotomous comparisons for three procedures. There was no significant difference in hand function between procedures in any comparison, with no procedure appearing superior to any other in the improvement of hand function. However, if the smallest clinical effect worth detecting is considered to be a 2 cm decrease in hand function (0=full function) or a 20% reduction in the number of participants with difficulty with daily function, then the 95% confidence intervals for the effect on hand function exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in hand function exists between three of the procedures.

Global patient assessment was only measured by Kriegs-Au et al. (2004), providing two dichotomous comparisons for two procedures. There was no significant difference in patient global assessment between procedures, ie, no procedure appears to be superior to any other in the improvement in patient global assessment. However, if the smallest

clinical effect worth detecting is considered to be a difference of ten points on the Buck-Gramcko scale, then the 95% confidence intervals for the effect on pain exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in patient global assessment exists between the two procedures.

Trapeziometacarpal joint imaging provided measurements of scaphometacarpal distance (mm) and was reported in five studies. It has historically been considered that greater distance is desirable, to maintain length of the thumb and thereby preserve strength. The only significant difference in the scaphometacarpal distance was in the study which compared trapeziometacarpal joint replacement (Swanson) with trapeziectomy and interpositional arthroplasty (APL) (Tagil & Kopylov 2002). Joint replacement demonstrated better preservation of scaphometacarpal distance but was not associated with any increase in thumb strength. These findings confirm the conclusions of Davis et al (2004) and Lins (1996) who also did not find any association between scaphometacarpal distance and thumb strength. There was only one study which reported a correlation between scaphometacarpal distance and thumb strength (De Smet et al. 2004). However, this correlation ($r=0.36$) was not strong enough (Dumholdt 2000) to support a relationship between thumb length and pinch strength.

Of the seven studies, five provided a detailed description of adverse effects at follow-up whereas two did not (De Smet et al. 2004, Gerwin et al. 1997). The adverse effects fell into the following categories: tendon rupture (FCR) / adhesion; scar tenderness; pain and erythema; sensory change (includes radial nerve dysfunction); cut palmar branch median nerve; neuroma; instability; and complex regional pain syndrome (CRPS) (Type 1). There were significantly fewer adverse effects following a simple trapeziectomy

when compared to trapeziectomy with LRTI or trapeziectomy with interpositional arthroplasty. Conversely, there were significantly more adverse effects following trapeziectomy with LRTI than trapeziectomy, trapeziectomy with interpositional arthroplasty, or trapeziectomy with ligament reconstruction. Furthermore, these differences were not isolated to the more minor complications (such as adhesion of the scar over the tendon donor site) that may result from the process of harvesting the tendon (Appendix E.6, Tables 1-5). Therefore, it appears that trapeziectomy alone is a safer procedure and likely to result in fewer complications, whereas trapeziectomy with LRTI is likely to result in more complications than the other commonly-used procedures studied in this review.

Surgery for trapeziometacarpal osteoarthritis is considered when conservative approaches fail and pain and dysfunction at the base of the thumb persist. Of the surgical options included, this systematic review has failed to identify an additional benefit in terms of pain, weakness, contracture, hand function, or patient global assessment than any other. Further, it has found that the simplest approach, a trapeziectomy, is associated with fewer adverse effects than the other commonly-used procedures studied in this review, and that the trapeziectomy with LRTI is associated with more. Therefore, unless there are strong indications to do otherwise, trapeziectomy alone should be used because it achieves good outcomes (as good as the other procedures) and it has fewer adverse effects. Similarly, unless there are strong indications to do otherwise, trapeziectomy with LRTI should be avoided because it causes more adverse effects.

CHAPTER 7

DISCUSSION

CONCLUSION

Summary of Main Findings

The technique most likely to aggravate pain at the base of the thumb in musculoskeletal physiotherapists is the PA glide using thumb tips

The alignment of the joints of the thumb during performance of a PA glide is associated with thumb pain

There is no difference between two splint and exercise regimens in the conservative management of trapeziometacarpal osteoarthritis

There is no evidence of superiority of any one surgical procedure over another in the surgical management of trapeziometacarpal osteoarthritis

Limitations of the studies

Study 1

Study 2

Study 3

Study 4

IMPLICATIONS FOR PREVENTION AND MANAGEMENT OF TRAPEZIOMETACARPAL OSTEOARTHRITIS

Physiotherapy population

General patient population

FUTURE RESEARCH DIRECTIONS

SUMMARY

CONCLUSION

The aim of this project was to investigate the factors associated with the prevention and management of trapeziometacarpal joint pain. Samples of two populations were studied: musculoskeletal physiotherapists and the general population. In this concluding chapter, the main findings are summarised and the limitations of the studies discussed. Finally, clinical implications for the prevention and management of trapeziometacarpal joint pain are presented, and future research questions identified.

Summary of Main Findings

The technique most likely to aggravate pain at the base of the thumb in musculoskeletal physiotherapists is the PA glide using thumb tips

The PA glide is a spinal manipulative therapy technique commonly used during the assessment and management of people with cervical dysfunction. Unfortunately, musculoskeletal physiotherapists commonly complain of thumb pain, aggravated by performing these techniques. A national survey of musculoskeletal physiotherapists identified techniques requiring the application of longitudinal pressure through the thumb tips, namely the unilateral and central PA glides, as the techniques most likely to aggravate work-related thumb pain.

The alignment of the joints of the thumb during performance of a PA glide is associated with thumb pain

An observational study identified an association between the alignment of the metacarpophalangeal and interphalangeal joints of the thumb during performance of PA glides, and work-related thumb pain. In particular, it found that physiotherapists who

were able to maintain their metacarpophalangeal and interphalangeal joints in extension during performance of a PA glide reported a lower prevalence of work-related thumb pain. These findings have important clinical implications for the practice and teaching of manual therapy techniques. Those physiotherapists who are physically unable to maintain this alignment may benefit from a thermoplastic splint which holds the metacarpophalangeal and / or interphalangeal joints at 0° extension.

There is no difference between two splint and exercise regimens in the conservative management of trapeziometacarpal osteoarthritis

In the sample of the general population, a new regimen for the conservative management of trapeziometacarpal osteoarthritis was compared with the traditional approach over a six-week period. This new regimen incorporated the thumb strap splint, which was designed to prevent the thumb collapsing into metacarpophalangeal hyperextension, and an abduction exercise program. There was no additional benefit of this approach over the traditional approach of a short opponens splint and pinch exercises, however overall, participants improved in the outcomes of pain, strength and hand function. With no difference between the groups in outcome measures, the intervention chosen can be determined by the individual's specific requirements, the extent of disease, and the demands placed upon the joint by occupation, domestic duties, hobbies and sports.

There is no evidence of superiority of any one surgical procedure over another in the surgical management of trapeziometacarpal osteoarthritis.

Surgery for trapeziometacarpal osteoarthritis is considered when conservative approaches fail and pain and dysfunction at the base of the thumb persist. A systematic review of the literature was undertaken to determine whether there was evidence of efficacy of one procedure over another. Of the surgical options included, this review

has sufficient evidence to be confident that there is no additional benefit in terms of strength of any particular procedure over another. At this time, there is insufficient evidence to be confident that there is no difference in terms of the outcomes of pain, physical function, patient global assessment or range of motion.

Further, this review has identified that the simplest approach, a trapeziectomy, is associated with fewer adverse effects than the other commonly-used procedures studied in this review, and that trapeziectomy with LRTI is associated with more. Therefore, unless there are strong indications to do otherwise, trapeziectomy alone should be used because it achieves good outcomes (ie, as good as the other procedures reviewed) and it has fewer adverse effects. Similarly, unless there are strong indications to do otherwise, trapeziectomy with LRTI should be avoided because it causes more adverse effects.

Limitations of the studies

The studies reported in this thesis should be interpreted in light of the following limitations:

Study 1

Study 1 investigated the prevalence of pain in the thumbs of Australian musculoskeletal physiotherapists by surveying Level II and III members of Musculoskeletal Physiotherapy Australia. While this national survey is one of many to report the prevalence of occupational injuries in physiotherapists, it is the first to determine the most aggravating spinal manipulative therapy technique. In fact, the survey identified that 85-87% of respondents complained of thumb pain which was aggravated by

performing PA glides. The main limitation of this study was the low response rate (22.2%), yet most respondents reported a history of work-related thumb pain. In fact, if one assumes that the painful respondents were the only musculoskeletal physiotherapists with work-related thumb pain in the whole population, these figures suggest that one in five musculoskeletal physiotherapists had work-related thumb pain during the year 2000. This study suggests that performing certain spinal manipulative therapy techniques can contribute to the development of work-related injuries.

Study 2

Study 2 investigated the alignment of the joints of the thumb during performance of a PA glide, and was conducted at a conference for musculoskeletal physiotherapists. Participants were asked to provide details about their history, if any, of work-related thumb pain and then to perform a PA glide on a force platform. This study aimed to correlate the two variables, the presence of work-related thumb pain and joint alignment. The main limitation of the study is that it was possible for some physiotherapists who had reported a history of work-related thumb pain to have demonstrated an alignment which they had subsequently adopted to relieve pain. In these cases, they would fall into the pain group even though they would be performing a PA glide using an alignment which did not aggravate thumb pain.

Study 3

Study 3 was a blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb. The trial failed to identify an additional benefit of one splint and exercise regimen over another. Perhaps the main limitation of this study was that the similarities in the intervention outweighed the

differences; after all, both regimens included a hand-based thermoplastic splint and a pain-free exercise program. Furthermore, the assessment of outcomes was limited by the following considerations:

Pain was measured at rest in the clinic. Many participants did not report pain at rest, but rather that pain was present during specific aggravating activities. It may have been more relevant to measure pain during performance of a specific activity.

The assessment of strength caused pain. Unfortunately, many people reported an aggravation of pain when pinching the pinch gauge, and reduced their effort accordingly. Therefore, the final pinch measurement became more indicative of pain than strength.

The Sollerman Test of Hand Function was an appropriate test of hand function for this group of patients, because it tested everyday activities of living. However, this sample was only mildly disabled, and most people were able to complete the test, using the correct hand grip, within 20 seconds. This resulted in a range of scores from 60-80 and so relatively small improvements in function were difficult to identify

Study 4

Study 4 was a systematic review of surgery for trapeziometacarpal osteoarthritis. The detailed search strategy of the electronic databases, combined with hand searching of conference proceedings and reference lists of published studies, identified all relevant studies of surgery for trapeziometacarpal osteoarthritis. Unfortunately, this search failed to identify any randomised controlled studies on three of the commonly-used

surgical procedures. Also, there was insufficient evidence to conclude that any one procedure produces greater benefits in terms of pain, physical function, patient global assessment or range of motion. Therefore, in the absence of these studies, it is only possible to be confident about the conclusions between the procedures reviewed.

IMPLICATIONS FOR PREVENTION AND MANAGEMENT OF TRAPEZIOMETACARPAL OSTEOARTHRITIS

Physiotherapy population

The results of the first two studies suggest that the performance of spinal manipulative therapy techniques is implicated in the development of work-related thumb pain. Study 1 identified that the performance of unilateral and PA glides is responsible for the aggravation of thumb pain. Study 2 provided evidence that maintenance of metacarpophalangeal and interphalangeal joint extension during performance of these glides is associated with a lower incidence of thumb pain. Certainly, at the moment, there is evidence to suggest that musculoskeletal physiotherapists with work-related thumb pain should be encouraged to align their metacarpophalangeal and interphalangeal joints in extension during performance of PA glides. Furthermore, it would seem reasonable to suggest that those physiotherapists with work-related thumb pain who are unable to align their joints in extension, should be provided with a thermoplastic thumb splint which holds the joints in extension for them.

General patient population

The results of Study 3 confirm that there was no difference in outcomes following two splint and exercise regimens. Therefore, the decision about which splint or exercise should be provided to a given patient can be based upon the patient's individual requirements, the extent of disease, and the specific demands associated with their occupation, domestic tasks, hobbies and sports. Furthermore, it may be appropriate to provide some patients with a variety of splints to wear during different activities throughout the day.

There was no evidence of superiority of one regimen over another, yet both groups improved. While it is possible that other factors contributed to this improvement, there was nevertheless, a significant reduction in pain, an increase in strength and improvement in hand function within six-weeks of intervention. This information is useful for prognostic purposes. Lack of such improvement may indicate that the splint or exercise should be modified, or that the patient needs to explore alternative options, such as surgery.

The results of Study 4 similarly failed to demonstrate superiority of any one surgical procedure over another in improving the outcomes of pain, physical function, patient global assessment, strength, or scaphometacarpal joint distance on imaging. However, at the moment, there is only enough evidence to be confident that there is no difference in strength. There is sufficient evidence to be confident that when compared with the other procedures reviewed, trapeziectomy was associated with the least adverse effects, and that trapeziectomy with LRTI was associated with the most. This information

serves to provide guidelines for the safe performance of surgery to the trapeziometacarpal joint, and contributes to the decision-making process for the surgeon so that the choice of surgical procedure can be based on the best available evidence.

FUTURE RESEARCH DIRECTIONS

A number of issues which deserve investigation have been raised from the work reported in this project. The results of the first two studies suggest that performing certain spinal manipulative therapy techniques, particularly without the metacarpophalangeal and interphalangeal joints in extension, are important factors in the development of work-related thumb pain. Further research is required to determine whether:

- i. Teaching student physiotherapists to maintain metacarpophalangeal and interphalangeal joint extension during performance of PA glides would reduce the prevalence of work-related thumb pain
- ii. The provision of a thermoplastic thumb splint, to be worn during performance of spinal manipulative therapy techniques, would reduce the prevalence of work-related thumb pain.

The randomised controlled trial demonstrated that there was no difference in the improvement in outcomes following the two different splint and exercise regimens. While this may have been due to the similarities in the interventions, further studies which include a 'no-splint' group are needed to determine whether the observed improvements in both groups were due to the intervention itself or other factors such as the placebo or Hawthorne effect.

The systematic review similarly failed to find a difference in outcomes following the five commonly-used surgical procedures. There is a need for more trials on these five procedures, to be confident of whether there is a difference in the outcomes of pain, weakness, contracture, hand function, and patient global assessment. There is also a need for randomised controlled trials to evaluate the outcomes of the other commonly-used surgical procedures, in particular volar ligament reconstruction (without trapeziectomy), metacarpal osteotomy and trapeziometacarpal arthrodesis. Additionally, it is necessary that the standard 'simple' trapeziectomy performed by Belcher (2000) and De Smet (2004) be compared with the trapeziectomy with K wire fixation and 6 weeks immobilization performed by Davis (2004), to determine whether there is any difference in outcome as a result of the K wire and prolonged immobilization.

To be most useful, and allow inclusion in future systematic reviews, clinical trials of conservative or surgical management of trapeziometacarpal osteoarthritis would be of high quality and adequately reported (Gummesson, Atroshi & Ekdahl 2004). Satisfying the CONSORT 22-item checklist (Sauerland & Davis 2004) will enable readers to assess clinical trial quality and the validity of results (Moher et al 2003). Ideally, these trials would be randomised and include concealed allocation, blind outcome assessment, intention to treat analysis, and consistent timing of outcome measures (suggest 3 months, and 1 and 5 years). Further, clinical trials need to be adequately reported, with outcomes presented as mean (SD) (or 95% confidence interval) of pre-intervention, post-intervention and change scores. To aid comparability of clinical trials, outcome measures would include:

- Pain: mean and SD on a VAS as well as number of participants with resting pain
- Weakness: mean and SD of pinch strength (2 point or lateral) in kg using the B & L pinch gauge (B & L Engineering, Santa Fe Springs, CA 90670)
- Contracture: mean and SD of the measurement of thumb trapeziometacarpal joint palmar abduction in degrees
- Hand function: mean and SD of an objective test such as the Sollerman Test of Hand Function
- Patient global assessment: health-related quality of life measure such as the short Form-36 Health Survey (SF-36)
- Trapeziometacarpal joint imaging: mean and SD of scaphometacarpal distance in millimeters at rest and during pinch
- Adverse effects: list according to the following headings - scar tenderness; tendon rupture or adhesion (FCR); sensory changes; neuroma; CRPS (Type 1); revision surgery.

SUMMARY

The studies in this thesis investigated important factors for the prevention and management of trapeziometacarpal joint pain. A national survey was performed, and an observational study of a cross-section of the population of musculoskeletal physiotherapists undertaken, so that factors associated with the prevention of work-related thumb pain in musculoskeletal physiotherapists could be identified. Further, a randomised controlled trial and a systematic review were undertaken of the conservative

and surgical management of trapeziometacarpal osteoarthritis respectively. Neither identified evidence of superiority in any approach over another. Considering the population is aging and that the majority of people with trapeziometacarpal osteoarthritis are healthy and physically active, development of effective preventative and management strategies is crucial.

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APPENDIX A.1

Wajon A, Ada L (2003): Prevalence of thumb pain in physical therapists practicing spinal manipulative therapy. *Journal of Hand Therapy* 16:237-244.

Prevalence of Thumb Pain in Physical Therapists Practicing Spinal Manipulative Therapy

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Pain at the base of the thumb is a common problem, especially in physical therapists practicing spinal manipulative therapy. Certain techniques involve compressive forces applied longitudinally through the thumb and first ray. These forces may cause subluxation at the first carpometacarpal (CMC) joint unless ligamentous support is sufficient to withstand these deforming forces.

Physical therapists are susceptible to a variety of occupational musculoskeletal injuries. Pain in the wrist and hands is common, with annual prevalence of 29.6% in the general physical therapy population, second only to low back pain (45%).¹ Bork et al.¹ reported that physical therapists who routinely performed manual therapy were 3.5 times more likely to complain of musculoskeletal symptoms than other physical therapists. Cromie et al.² similarly found an increased risk of pain in the thumbs of manual physical therapists, with 33.6% of their 536 respondents complaining of thumb pain lasting more than three days, with a severity score on a visual analogue scale (VAS) of 3/10 or greater. West and Gardner³ reported that 82% of their respondents

ABSTRACT: Thumb pain is a common complaint of physical therapists. The purpose of this study was to investigate the prevalence, presentation, and techniques associated with aggravation of thumb pain in physical therapists practicing spinal manipulative therapy and the management strategies used to deal with pain. A survey was sent to members of Musculoskeletal Physiotherapy Australia. Data were collected from subjects who had completed postgraduate study in manipulative physical therapy. Of the 155 subjects who responded, 83% complained of pain in their thumbs aggravated by performing manipulative therapy techniques in the preceding year (2000). The most common presentation of pain included mild pain (3.8/10) at the metacarpophalangeal joint, with multiple, short-lived episodes. Techniques most commonly responsible for aggravation of symptoms were unilateral (87%) and central posteroanterior glides (85%). Most subjects (74%) changed their choice of treatment technique to alleviate symptoms. Suggestions are made about the safe alignment of the thumb during performance of spinal manipulative therapy techniques.

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complained of an aggravation of pain when performing manual therapy techniques.

To determine whether any specific manipulative therapy technique was more likely to cause pain than another, information was collected about the prevalence and presentation of painful episodes in the thumbs of physical therapists practicing spinal manipulative therapy in one year. Factors affecting the presence and severity of pain were identified, along with the effect of certain techniques on the aggravation of symptoms. Management strategies were analyzed to understand the problem further.

METHODS

A loose-leaf survey was sent to all 1,444 members of Musculoskeletal Physiotherapy Australia (MPA) with *MPA News*, their quarterly publication. The MPA uses a three-tiered professional development framework for membership:

- Level 1: Nontitled members with an interest in musculoskeletal health
- Level 2: Titled members who have completed postgraduate education in manipulative therapy
- Level 3: Specialist members

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To encourage readers to complete the survey, the findings of our pilot study were described in the newsletter.⁵

The subjects of this study were the level 2 and 3 members who responded to the survey. It was assumed that level 2 and 3 physical therapists would spend more of their working hours using manipulative therapy techniques and would be more likely to report an aggravation of pain due to these techniques. Of the 698 level 2 and 3 members who received the survey, 155 (22.2%) replied. This low response rate was disappointing. Nevertheless, 83% of respondents complained of pain in their thumbs, aggravated by performing spinal manipulative therapy, with most complaining of pain being aggravated by two similar techniques. Because analysis of specific aggravating techniques had not been performed previously, it was deemed worthwhile to continue with this study, even with our low response rate. The study was approved by the Ethics Committee of the University of Sydney. Return of the survey to the researchers was taken as evidence of consent to participate.

The survey consisted of a series of questions regarding demographics, work practices, and presentation of pain. Specific questions about the presentation of pain included the severity of pain, which was measured using a 10-cm VAS, with 0 representing no pain and 10 the worst pain imaginable. Other details about the presentation of pain included the location, frequency, and duration of painful episodes experienced during 2000. Further questions regarding performance of specific manipulative therapy techniques aimed to determine the most aggravating techniques. The techniques included central posteroanterior (PA) glides (Figure 1A), unilateral PA glides (Figure 1B), and transverse glides (Figure 1C), all using thumb pressures. Other techniques included the PA glide using a pisiform (C) grip, lumbrical grip, and soft tissue massage. Subsequent management strategies chosen by each physical therapist also were examined (Appendix).

Data analysis included descriptive data of each variable summarized as percentages of the respondents, with severity of pain (10-cm VAS) reported as mean \pm SD. Spearman rank correlation coefficient

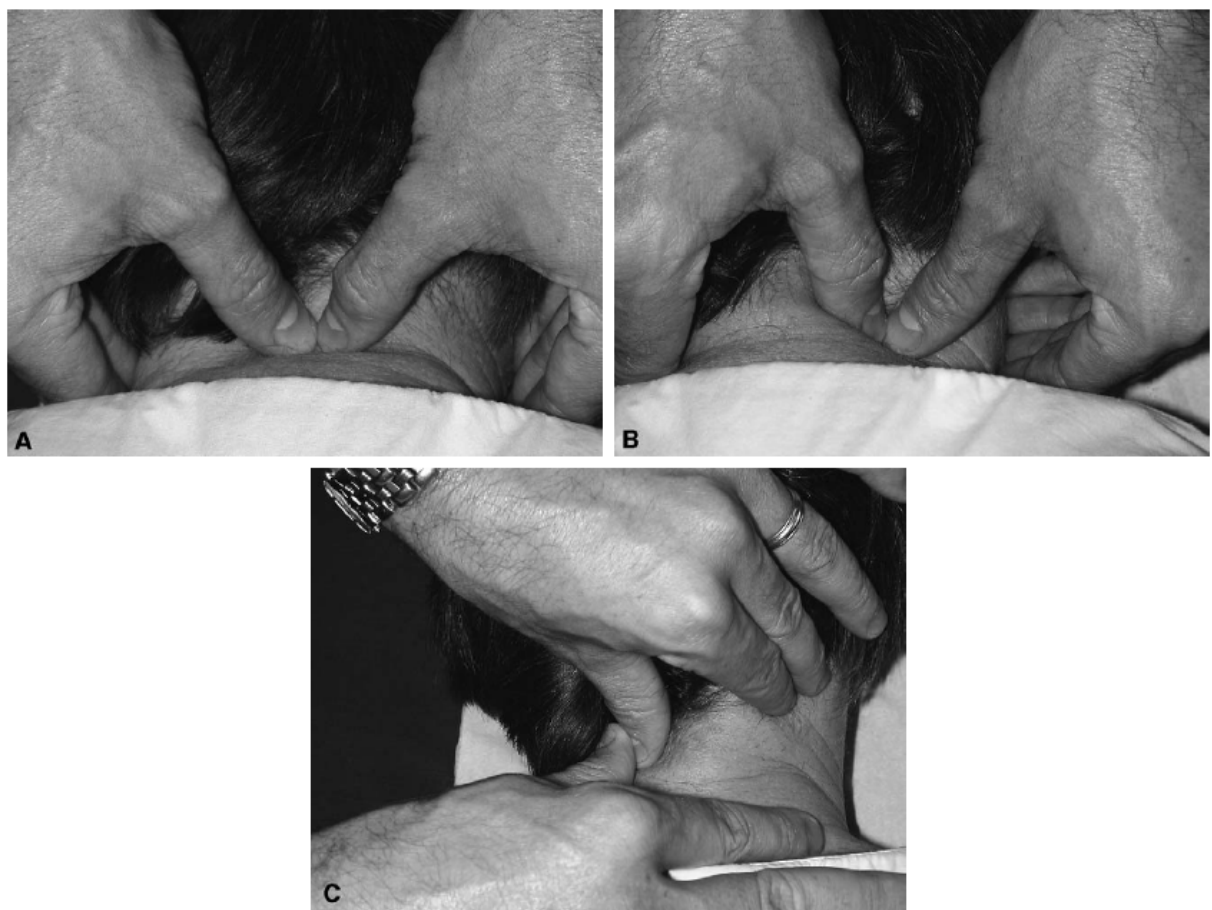


FIGURE 1. (A) Spinal manipulative therapy technique of central PA glides using thumb pressures. (B) Spinal manipulative therapy technique of unilateral PA glides using thumb pressures. (C) Spinal manipulative therapy technique of transverse PA glides using thumb pressures.

r_s was used to determine whether there was an increased prevalence of thumb pain as another variable changed.⁶ Chi-square analysis was used to determine whether there was any association between severity of symptoms and certain spinal manipulative therapy techniques.

RESULTS

Demographics

The characteristics of the subjects ($n = 155$) are summarized in Table 1. Most respondents (59%) were women, age 41 to 50 (48%), and had worked in physical therapy for 16 years or more (53%). More than half of the respondents (61%) spent greater than 31 hours per week treating patients.

Prevalence and Presentation of Pain

Of respondents, 83% ($n = 129$) complained of pain in their thumb aggravated by performing spinal manipulative therapy techniques, with 62% of this group reporting pain in both thumbs. The mean score for severity of pain was 3.75 (SD 1.9) on the VAS. Of the respondents with pain, 68% reported more than four episodes during the year, and 62% complained of symptoms lasting less than one week. The pain was located most commonly at the first metacarpophalangeal (MCP) joint (43%), followed by the MCP and CMC joints together (23%), and the CMC joint alone (18%). The presence of pain at the interphalangeal (IP) joint or other joints combined was negligible (<10%) (Table 2).

Factors Affecting Presence of Pain

There was no correlation between increasing prevalence of thumb pain ($n = 155$) with age ($r_s = 0.04$, $p = 0.67$), sex ($r_s = 0.05$, $p = 0.53$), hand dominance ($r_s = 0.07$, $p = 0.39$), or years worked ($r_s = 0.10$, $p = 0.23$). With increasing age, the location of pain tended to change. The youngest age group reported the highest incidence of pain at the MCP joint (69%), whereas the oldest group had the highest incidence of pain at the CMC joint (30%) (Figure 2).

Effect of Spinal Manipulative Therapy Techniques

Physical therapists were asked whether they regularly performed certain spinal manipulative therapy techniques and whether performance of these techniques aggravated symptoms (Appendix). Of the physical therapists who regularly performed the technique, PA glides using thumb pressures were the most common cause of increased thumb pain (unilateral glide = 87% [Figure 1B] and central = 85% [Figure 1A]). The least aggravating spinal manipulative therapy technique was the pisiform (C) grip (29%) (Figure 3A).

Thumb pain was aggravated by using a stronger grade of spinal manipulative therapy and by treating a large number of patients with similar diagnoses in approximately 80% of the painful respondents. More than 60% complained of an aggravation of symptoms with increased repetitions and working longer hours each day (Figure 3B).

Factors Affecting Severity of Pain

To determine whether any factor was associated with an increased severity of pain, further analysis was performed on subjects with VAS greater than 5 ($n = 31$). There was no association between VAS greater than 5 and age, sex, or working more than 30 hours per week ($p = 0.6$ to 0.9). The technique of transverse glides (Figure 1C) was associated with aggravating symptoms with a VAS greater than 5 ($\chi^2 = 3.9$, $p = 0.04$); however, unilateral and central PA glides (using thumb pressures) and other techniques using either the lumbrical or the pisiform grip were not associated with a VAS greater than 5 ($p = 0.2$ to 0.9).

Management Strategies Used to Deal with the Pain

Physical therapists were asked whether their symptoms were severe enough for them to seek intervention, use splints or taping, or change their choice of treatment technique. Of the painful respondents, 74% chose to alleviate symptoms by changing their choice of treatment technique. Less

TABLE 1. Characteristics of the Subjects ($n = 155$)

	Male 63 (41%)	Female 92 (59%)			
Gender					
Age (yr)	21-30	31-40	41-50	51-60	
	16 (10%)	55 (35%)	74 (48%)	10 (6%)	
Years of work in manual therapy	0-5	6-10	11-15	16-20	>20
	12 (8%)	19 (12%)	44 (26%)	39 (25%)	44 (28%)
Hours per week treating patients	<15	16-30	31-45	>45	
	10 (7%)	50 (33%)	68 (45%)	24 (16%)	
Presence of pain	Yes	No			
	129 (83%)	26 (17%)			

TABLE 2. Presentation of Pain over a 12-month Period (n = 129)

Pain intensity (0-10)	VAS = 3.8 (SD = 1.9)				
	Right	Left	Both		
Painful side	37 (29%)	12 (9%)	80 (62%)		
No. episodes	1-3	4-6	>7		
	41 (32%)	31 (24%)	56 (44%)		
Duration of each episode	0-1 wk	1-2 wk	2-4 wk	>4 wk	
	79 (62%)	25 (20%)	10 (8%)	14 (11%)	
Location of pain	MCP	MCP and CMC	CMC	IP	IP, MCP, and CMC
	55 (43%)	30 (23%)	23 (18%)	8 (6%)	7 (5%)

than one third used splints or taping (29%), reconsidered their career (27%), or reduced their hours of patient contact (25%). Only a small minority (6%) sought intervention from either a physical therapist or a medical specialist (Figure 4).

Therapists with more severe pain (VAS >5) were more likely to change their choice of treatment technique ($\chi^2 = 8.4, p = 0.004$), seek medical intervention ($\chi^2 = 6.2, p = 0.01$), or consider a change in career ($\chi^2 = 6.2, p = 0.01$) than those with milder pain (VAS <5). They also reduced their hours of patient contact ($\chi^2 = 4.5, p = 0.03$) but were unlikely to consider consulting a physical therapist ($\chi^2 = 1.2, p = 0.27$) or use taping or a splint ($\chi^2 = 0.3, p = 0.87$).

DISCUSSION

This study found that 83% of respondents complained of an aggravation of thumb pain due to the performance of spinal manipulative therapy tech-

niques, with 85% to 87% of the painful respondents complaining of thumb pain aggravated by PA glides (unilateral and central). If we take our low response rate (22.2%) into consideration and assume that only physical therapists with thumb pain responded to our survey, we could extrapolate the prevalence of pain to be 18.4% of the population during 2000. This percentage, the most conservative interpretation, is a large sample of the physical therapy population, confirming that certain spinal manipulative therapy techniques are a risk for the development of work-related injuries. Our finding is comparable with findings of Cromie et al.² and West and Gardner,³ who reported a prevalence of 19% and 20% for pain in the thumbs and wrists of general physical therapists. Although this study does not attempt to address the cause of thumb pain in general physical therapists, it does suggest that physical therapists who complain of pain in the thumbs during performance of spinal manipulative therapy techniques are likely to be aggravating their symptoms with continued performance of these techniques.

The pain was most commonly of mild intensity and located at the MCP joint or the CMC joint (84%). Of the painful respondents, more than 60% reported more than four episodes during 2000, with most reporting the symptoms lasting less than one week (62%). This pattern of pain presentation (intensity, location, frequency, and duration) is consistent with that observed clinically in patients with early stages of osteoarthritis at the CMC joint. Symptoms tend to be mild and diminish with modification of activities of daily living and aggravating activities but return when activities are resumed. It is assumed that our painful respondents changed their techniques and avoided aggravating maneuvers while in pain, but when symptoms settled returned to previous techniques. This would be consistent with our findings of numerous short-lived episodes of pain.

Certain spinal manipulative therapy techniques involve application of pressure through the tips of the thumbs to produce passive intervertebral movements to the spine. These techniques may form the basis of examination and treatment. The techniques have been described by Maitland,⁷ specifying speed, direction, point of contact, and depth of application

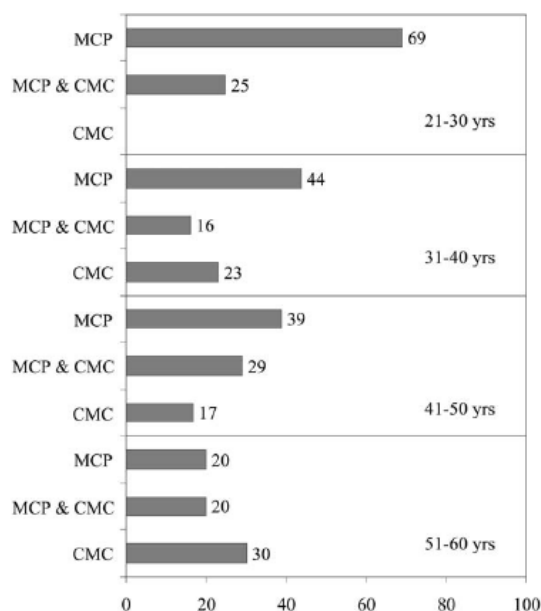
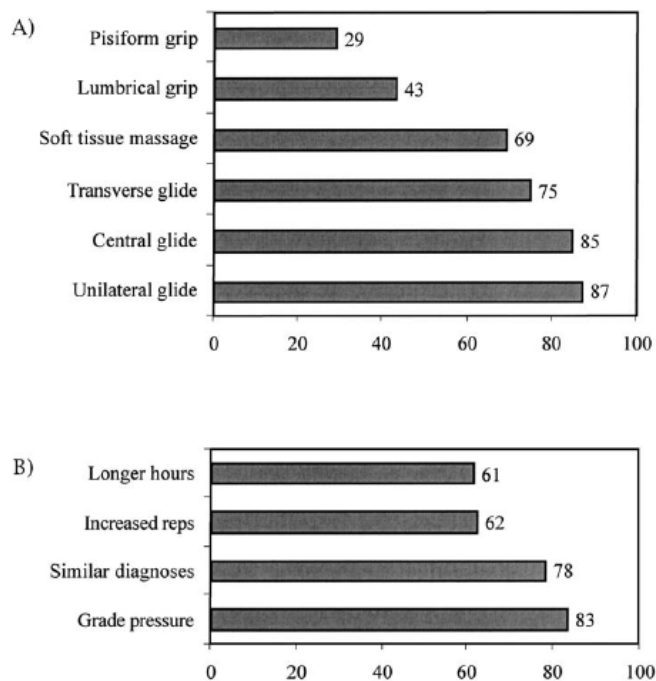


FIGURE 2. Percentage of respondents in each age group reporting pain in the MCP joint, both MCP and CMC joints, and CMC joint alone.

FIGURE 3. Percentage of physical therapists who complained of an aggravation of thumb pain associated with (A) certain spinal manipulative therapy techniques and (B) work practices.



of pressure. Information to be gained includes behavior of pain through range, end-feel, range, and the quality of any resistance or muscle spasm that may be present. The alignment of the manipulative physical therapist's thumb may be difficult to control and positioned anywhere from 30° flexion to 70° hyperextension at the interphalangeal and MCP joints.

Pain may arise from structures at either the MCP joint or the CMC joint. Potential sources of pain at the MCP joint include the proper and accessory collateral ligaments, the volar plate, and the joint capsule. At the CMC joint, there are five supporting ligaments, which combine with the extrinsic and the intrinsic muscles to maintain stability.⁸ Irritation to either the joint or the muscular structures may be responsible for the aggravation of pain in the thumbs of manipulative physical therapists. Moulton et al.⁹ and Jonsson et al.¹⁰ argued that hypermobility at the MCP joint is related to the development of osteoarthritis at the CMC joint. This discussion explains the mechanism by which pain at the MCP joint and CMC joint is caused by joint laxity and hypermobility.

The position of the MCP joint has been found to alter contact pressures at the CMC joint and to play a role in the development of osteoarthritis.⁹ Hypermobility of the MCP joint allows hyperextension at the joint under load, causing reciprocal flexion and adduction of the first metacarpal and dorsal subluxation at its base. It is proposed that manipulative physical therapists who complain of pain at the MCP joint may have primary hypermobility, being unable to control hyperextension of the MCP joint during performance of PA glides.

Symptoms are likely to move from the MCP joint to the CMC joint as time and instability progress. Dorsal subluxation at the CMC joint has been observed clinically in static positions of lateral pinch and adduction, even in the normal joint.¹¹ It is enhanced by the application of force and progressive palmar ligamentous insufficiency, ultimately reducing stability of the joint.¹² Abnormal translation of the metacarpal on the trapezium results in the generation of excessive shear forces on the palmar CMC joint surfaces,^{9,13} accelerates the process of cartilage degeneration,^{14,15} and corresponds to the contact areas associated with the production of arthritic surface lesions.¹⁵ This would explain the increased prevalence of pain at the MCP joint in the younger group, with hypermobility at the MCP joint being responsible for symptoms. With increasing age and

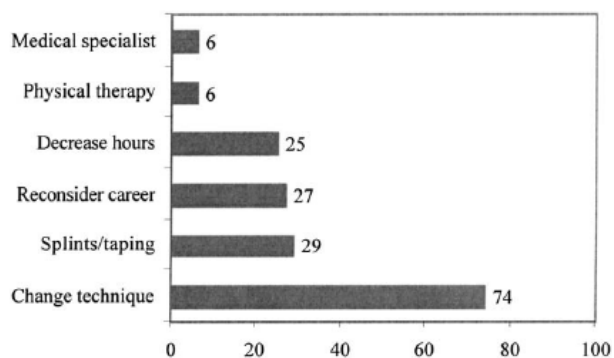


FIGURE 4. Percentage of physical therapists who chose each management strategy to alleviate symptoms.

progressing instability associated with years of spinal manipulative therapy techniques performed through a hypermobile MCP joint, the pain is likely to move toward the CMC joint. This supports our finding of an increased prevalence of pain at the CMC joint with increasing age.

The most common strategy to reduce pain involved changing treatment techniques (74%). This is consistent with the finding of Cromie et al.,² who stated that 73% of physical therapists who reported pain in their survey changed or modified their technique. West and Gardner³ reported 91% of their respondents modified techniques as a result of their hand injury. It is not possible to determine how the technique was changed in our group; however, it would be reasonable to suggest that physical therapists with pain in their thumb aggravated by PA glides consider using physiologic techniques, exercise, or advice in an effort to reduce the amount of force applied through the tips of their thumbs.

Alternative management strategies included using splints or taping (29%) and seeking physical therapy or medical treatment (6%). This contrasts with the findings of West and Gardner,³ who reported that 55% of their hand-injured respondents had used braces, splints, or other orthoses, with most also seeking physical therapy treatment. It may be assumed that physical therapists were able to control their symptoms sufficiently by changing techniques, without the need for further intervention.

Emerging evidence provides support for spinal manipulative therapy in the management of spinal pain,¹⁶ and although our study suggests unilateral and central PA glides are a cause of pain in the thumbs of physical therapists, it is important not to discard the techniques. For this reason, every effort must be made to determine how the techniques may be performed safely.

First, the alignment of each of the thumb joints should be considered during performance of spinal manipulative therapy techniques. In subjects who have a hypermobile MCP joint, every effort should be made to reduce secondary subluxation of the CMC joint. The palmar beak ligament is the primary stabilizer of the CMC joint, resisting dorsal subluxation and excessive shear forces.¹³ It is taut with pronation of the thumb, and is the primary stabilizer in lateral pinch.¹⁴ Positioning the thumb in pronation and avoiding hyperextension of the MCP joint should resist the tendency to dorsal subluxation at the CMC joint during performance of PA glides. Theoretically, this alignment would reduce the strain to the palmar ligamentous structures and enhance stability at the CMC joint.

Physical therapists who have pain at the base of the thumb and difficulty preventing MCP hyperextension may be fitted with a small thermoplastic splint to maintain slight MCP joint flexion.^{9,17} Moulton

et al.⁹ suggested that such an approach may minimize symptoms and progression of joint degeneration. The splint would be custom fitted and worn during performance of spinal manipulative therapy techniques.

Alternatively, tools may be used for the performance of PA pressures to reduce aggravation of thumb pain. Although it is essential that a tool should not impair the operator's ability to sense biomechanical parameters of resistance, active recoil, and resistance-free range,¹⁸ it also should enable the operator to use it without pain. The Superthumb [OPC (Orthotic and Prosthetic Centre), Port Melbourne, Victoria, Australia] and Kneeshaw (prototype, not commercially available) devices were compared with the pisiform grip in six physical therapists who had experienced thumb or hand pain attributable to performance of spinal manipulative therapy.¹⁸ Neither device was as comfortable as the pisiform grip for either the patient or the physical therapist.¹⁸ Considering the pisiform grip was the least likely technique to aggravate thumb pain, it remains possible that devices such as these are able to reduce the aggravation of thumb pain caused by performing PA glides using thumb pressures, during performance of spinal manipulative therapy.

CONCLUSIONS

Thumb pain is common in physical therapists practicing spinal manipulative therapy. Techniques requiring the application of longitudinal pressure through the thumb tips, such as unilateral and central PA glides, are most likely to cause pain, whereas the pisiform grip was the least aggravating technique. The most common strategy used to control these symptoms involved changing the choice of treatment technique. Changes to the way these techniques are performed, such as altering the alignment of the joints of the thumb and wearing a supportive splint, are suggested as ways to restrict the development of articular disease.

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(The Appendix appears on the next page.)

Statement of co-author confirming authorship contribution of the PhD candidate

As co-author of the paper “Prevalence of thumb pain in physical therapists practicing spinal manipulative therapy”, I confirm that Anne Wajon has made the following contributions: conception and design of the research, analysis and interpretation of the findings, writing the paper and critical appraisal of content.

Signed _____ Date _____

Have you experienced pain in your thumb?

Please tick the appropriate box

- Age: 21-30yrs 31-40 yrs 41-50 yrs 51-60
- Sex: Female Male
- Hand Dominance: Right Left
- For how many years have you been working in manual therapy? 0-5 yrs 6-10 yrs 11-15yrs 16-20yrs >20
- In which state did you complete your Manip Therapy training? NSW Qld Vic SA WA
- How many hours per week do you treat patients? <15 hrs 16-30 hrs 31-45 hrs >45 hrs
- Have you ever experienced pain in your thumbs which was aggravated by performing manual therapy techniques? Yes No

If yes, please complete the following questions:

Tick more than one response if necessary.

- Which side are your symptoms: Right Left Both
- Where is the pain in your thumb: IP jt MP jt CMC jt

Please mark the greatest severity of your symptoms on this VAS:

no pain _____ worst pain imaginable

- How many episodes of pain did you have in the year 2000? one-three four-six >seven
- How long did each of these episodes last? 0-1wk 1-2wks 2-4wks >4wks
- Did you regularly perform the following techniques? *Perform the techniques* *Aggravate symptoms*
- If so, tick the box if it aggravated your symptoms?
- | | |
|--|------------------------------|
| <input type="checkbox"/> central PA (thumb pressures) ↓ | <input type="checkbox"/> yes |
| <input type="checkbox"/> unilateral PA (thumb pressures) ↘ | <input type="checkbox"/> yes |
| <input type="checkbox"/> transverse (thumb pressures) → | <input type="checkbox"/> yes |
| <input type="checkbox"/> PA (C grip) | <input type="checkbox"/> yes |
| <input type="checkbox"/> Lumbrical grip | <input type="checkbox"/> yes |
| <input type="checkbox"/> Soft tissue massage | <input type="checkbox"/> yes |
| <input type="checkbox"/> Other, _____ | |
- Were your symptoms aggravated by:
- Longer hours worked per day?
 - Stronger grade of pressure applied with technique?
 - Increased number of repetitions performed?
 - Treating like conditions / types of patients each day?
 - Other, _____
- Were your symptoms severe enough for you to:
- Use splints or taping to control symptoms?
 - Seek intervention from a physiotherapist?
 - Change your treatment techniques?
 - Reduce your hours of patient contact?
 - Consider a change in career?
 - Seek intervention from a medical specialist?
 - Other, _____

APPENDIX A.2

Investigation of the prevalence of pain at the base of the thumb in Australian manipulative physiotherapists: Ethics approval

APPENDIX A.3

Investigation of the prevalence of pain at the base of the thumb in Australian manipulative physiotherapists: Survey

APPENDIX B.1

Alignment of the thumb during performance of PA mobilisations to the cervical spine: Ethics approval

APPENDIX B.2

Alignment of the thumb during performance of PA mobilisations to the cervical spine: Participant Information Statement



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ALIGNMENT OF THE THUMB DURING PERFORMANCE OF PA MOBILISATIONS TO THE CERVICAL SPINE

You are invited to take part in the above study. Your participation will provide information about the alignment of the joints of the thumb during performance of PA mobilisation techniques. The study is being conducted by Anne Wajon, Dr Louise Ada, Prof Kathryn Refshauge and Assoc/Prof Jack Crosbie. It will contribute toward Anne Wajon's PhD at the University of Sydney.

If you agree to participate, you will be requested to attend the Convention Centre trade display where we will be set up. On this occasion you will be asked about your levels of pain and dysfunction during performance of PA glides on the cervical spine. Other information will be collected, including your age, sex, years of manual therapy, and location and severity of any pain. The alignment of your interphalangeal (IP) and metacarpophalangeal (MCP) joints will be photographed as you perform a PA glide onto a force plate, mimicking the technique that you would use when performing a PA glide using thumb-grip on the cervical spine. None of these measurements or test procedures should cause you any lasting pain. The testing should take approximately 10 minutes.

All aspects of the study, including results and photographs, will be strictly confidential and only the investigator's named above will have access to information on participants except as required by law. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

While we intend that this research study furthers our knowledge of the biomechanics of manual therapy techniques, and may improve our teaching in the future, it may not be of direct benefit to you.

Participation in this study is entirely voluntary: you are not obliged to participate and - if you do participate - you can withdraw at any time. Whatever your decision, it will not affect your relationship with the investigators.

After you have read this information, Anne Wajon will be available to discuss the study further, and answer any questions you may have. If you would like to know more at any stage, please feel free to contact her on (02)9482 5522, or 0414 564 187. This information sheet is for you to keep.

Any person with concerns or complaints about the conduct of a research study can contact the Manager for Ethics Administration, University of Sydney on (02) 9351 4811.

APPENDIX B.3

Alignment of the thumb during performance of PA mobilisations to the cervical spine: Consent form



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I, , give consent to my participation
Name (please print)

in the research project titled:

ALIGNMENT OF THE THUMB DURING PERFORMANCE OF
PA MOBILISATIONS TO THE CERVICAL SPINE

Conducted by: Anne Wajon, Louise Ada, Kathryn Refshauge, Jack Crosbie.

In giving my consent I acknowledge that:

1. The procedures required for the project have been explained to me, and any questions I have about the project have been answered to my satisfaction;
2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with family and /or friends.
3. I am aware of the risks and inconveniences associate with the project;
4. I understand that I can withdraw from the study at any time, without affecting my treatment or my relationships with the researcher(s) now or in the future.
5. I understand that my involvement is strictly confidential and no information about me will be used in any way which reveals my identity.

Signed:.....Date:.....

Name:

APPENDIX B.4

Alignment of the thumb during performance of PA mobilisations to the cervical spine: Data sheet

(Please complete details or circle correct response)

Section 1. Demographic details

a)	Name	
b)	Age	
c)	Sex	<i>male / female</i>
d)	Hand dominance	<i>right / left</i>
e)	On average, how many hours per week have you treated patients this year?	<i>hrs/wk</i>
f)	How many years have you been working in manual therapy?	<i>yrs</i>
g)	Have you ever experienced pain in your thumbs which was aggravated by performing PA glides on the cervical spine?	<i>yes / no</i>

If you answered *no* to 1g), please hand this sheet to Anne Wajon to proceed with testing

If you answered *yes* to 1g), please complete section 2 in relation to pain you experienced in your thumb, aggravated by performing manual therapy to the cervical spine, in the last 12 months.

Section 2. Pain details

	Right	Left
a) Which side were your symptoms? (you may tick both boxes)		
b) Where was the worst pain in your thumb? (IP jt, MCP jt, or CMC jt)		
c) Please grade the severity of your symptoms at their worst (___/10)		
d) How many episodes of pain did you experience in the last 12 months?		
e) On average, how long did each episode last? (days)		
f) Which is the most aggravating technique? (central or unilateral PA, transverse glide)		

Additional comments:

APPENDIX C.1

Wajon A (2000): The thumb 'strap splint' for dynamic instability of the trapeziometacarpal joint. *Journal of Hand Therapy* 13:236-237.

APPENDIX D.1

Wajon A, Ada L (2005) No difference between two splint and exercise regimens for people with osteoarthritis of the thumb: A randomised controlled trial.
Australian Journal of Physiotherapy 51: 245-249.

Statement from co-author confirming authorship contribution of the PhD candidate

As co-author of the study: “No difference between two splint and exercise regimens for people with osteoarthritis of the thumb: a randomised controlled trial”, I confirm that Anne Wajon has made the following contributions: conception and design of the research, analysis and interpretation of the findings, writing the paper and critical appraisal of content.

Signed _____ Date _____

APPENDIX D.2

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: Ethics approval

APPENDIX D.3

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: Consent form



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A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb

You are invited to participate in the above study. Your participation will provide clinical information about the problems individuals with arthritis and instability at the base of the thumb suffer. In addition, examination of the specific role of splinting and exercise in improving stability at the base of the thumb will increase our understanding of the condition, as well as assist physiotherapists in the prescription of the most appropriate treatment techniques.

If you agree to participate, you will be required to attend the physiotherapy practice at 4/49 Palmerston Rd, Hornsby. On the first occasion you will be randomly allocated into one of two groups, and information about your levels of pain and dysfunction during particular activities of daily living will be recorded. Measurements of strength will be carried out and you will complete a test of hand function. None of these measurements or test procedures should cause you any lasting pain. You will be fitted with a splint for your thumb and advised on when and where to wear it over the following two weeks. This visit should take approximately 45 minutes.

At two weeks, your splint will be checked and you will be retested using the same routine as the before. At this time you will also be instructed in a specific exercise programme to strengthen your thumb. This visit will require 45 minutes of your time. At four weeks, your splint and home exercises will be checked in a brief visit, followed by the final review at six weeks when you repeat the strength and functional testing as before. Once again this visit will last approximately 45 minutes.

The cost of this treatment programme will be reduced in appreciation for your involvement and commitment to the study. Each of the four visits will be charged at \$30, with the splint being free of charge. The cost of the six week programme will be \$120, a total saving of \$98. Each of the two groups will receive a thumb support splint and specific exercise programme. We believe that you will benefit from the intervention involved in the study, regardless of which group you are in. If at the end of the study, you would like to try the alternate splint and exercise program, you will be offered them at no cost.

Any information about you that is obtained in connection with this study will remain confidential and will only be disclosed with your written permission. However, the results of the study may be published or disclosed to other people in a way that will not identify you. Your decision whether or not to participate will not affect your relationship with your physiotherapist or your referring doctor. If you decide to participate, you are free to withdraw consent and discontinue at any time.

Any person with concerns or complaints about the conduct of a research study can contact the Manager of Ethics and Biosafety Administration, University of Sydney, on (02) 9351 4811. If you have any questions, Anne Wajon (9482 5522) would be happy to answer them. You will be given a copy of this form to keep.

APPENDIX D.4

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: Consent form



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<http://www.fhs.usyd.edu.au/Academic/PT/>

I, _____, hereby voluntarily consent to participate in the research entitled:

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb,

conducted by Anne Wajon and Louise Ada.

I understand that the information obtained from this research may be used in future research, and may be published. However, my right to privacy will be retained, ie: personal details will not be revealed.

The procedure as set out in the attached information sheet has been explained to me and I understand what is expected of me and the benefits and risks involved. My participation in the project is voluntary.

I acknowledge I have the right to question any part of the procedure and can withdraw at any time without this being held against me.

I have been familiarised with the procedure.

Signed by subject _____

Date _____

Witness _____ (Name)

_____ (Signature)

_____ (Date)

APPENDIX D.5

A randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: Data sheet

Name:	DOB:	Age:	Gender:	Handedness:	Affected side:	Date:
Occupation:	Hobbies / Sports:		Ins: private / pens / W Comp / DVA / 3 rd party / other			

EXCLUSION CRITERIA:	DeQuervains tendinitis	Carpal tunnel syndrome	Scapho-lunate instability	STT joint osteoarthritis	Trigger thumb	Steroid inject. <6/52 prior	Previous surg to TM jt
----------------------------	------------------------	------------------------	---------------------------	--------------------------	---------------	-----------------------------	------------------------

HISTORY:	Treated side: R / L		OUTCOME MEASURES:	Session 1: Wk 0	Session 2: Wk 2	Session 3: Wk 6
Duration symptoms			Date			
Prev. intervention			Side			
Aggravating activities			VAS score			
Relieving techniques			Location tenderness (V / R / D)			
Xray staging (Date)			Grind test (+ve or -ve)			
Medications (now)			Grip strength - kg			
Other jts involved			Pinch strength – 2 point (kg)			
Pal abd / Rad abd (deg)			Pinch strength – lateral (kg)			
Comments			Sollerman score (____/80)			

APPENDIX D.6

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: Scoring sheet for Sollerman Test

No.	Test Item	Task Complete	Correct Grip	Time	Difficulty	SCORE
1	put key into lock and turn 90deg					
2	turn door handle in supination					
3	pick up four coins from the table surface and put two coins into each purse mounted on the wall					
4	close and open the zippers of the purses mounted on the wall					
5	pick up coins from the purses and put on the bottom of the box					
6	lift wooden cubes over edge of a 5 cm height					
7	lift iron over edge of 5 cm height					
8	turn one screw mounted on wall one complete turn in supination with a screw driver					
9	pick up four different sized nuts and put on bolts mounted on wall					
10	unscrew lid of jars					
11	do up four different sized buttons					
12	with knife and fork cut dough into four pieces					
13	put tubigrip stocking on the other hand					
14	write name with a pen					
15	fold a piece of paper and put into an envelope					
16	put small or large paper clip onto an envelope					
17	lift telephone receiver and put it to the ear					
18	lift the one litre pure-pak and pour water into the jug					
19	lift the jug, filled with one litre of water, by the handle and pour water into a cup					
20	pick up cup by the handle and pour water from the cup into the jug					

APPENDIX D.7

A blinded, randomised, controlled trial of the efficacy of a new splint and exercise program for people with osteoarthritis of the thumb: individual subject data

Subject	VAS (/10)			Tip pinch (kg)			Sollerman Test (/80)			
	Week	0	2	6	0	2	6	0	2	6
Exp										
3		1.8	0	0.3	.5	1	1	60	66	56
5		2	0	0	6.5	7	6	69	79	80
7		1.8	3.1	0.3	7.3	6.5	7.3	67	71	80
9		4.7	6.5	8.5	5.5	3.8	2	72	68	66
10		1	3.7	#	4.5	4.5	#	68	67	#
14		0	0.1	0.1	2	4	4	70	74	75
15		2.7	0.3	0	3	3	4	73	75	78
17		2.2	1.6	3.9	7	7	7.5	60	74	75
18		2.3	2	0	5	6	7.5	75	75	77
21		3	2.6	2	4.5	6	7.5	77	79	77
23		6.6	3	0.2	2.5	3	4	60	71	79
24		4.8	2	3.5	5.5	7	8	75	76	79
27		1	2.5	0	4	4	4	70	75	78
29		5.3	5	1	4	4	4.5	50	68	76
30		5.4	0	0	4	4.5	2.5	67	70	72
32		0	0.9	1	2.5	3.5	1.5	69	66	67
36		3.8	1.5	0	4	4.5	5.2	71	74	78
37		5	2.4	1	3	3.5	5	69	73	77
40		3.5	2.4	1	1.5	2	2.5	69	72	76
MEAN		3.0	2.1	1.3	4.0	4.5	4.7	67.9	72.3	74.8
SD		1.9	1.7	2.1	1.8	1.7	2.2	6.5	4.0	6.1
Control										
1		5	0	0	3	3.5	4	67	77	78
2		6	0.5	1	3.5	4	4	67	72	74
4		1.5	1.1	.5	2.8	2.8	2.8	59	64	66
6		1.6	0.7	0	3.8	3.8	4	75	75	78
8		3	2.3	0.1	2.5	3.2	3.5	72	76	74
11		7	6.8	*	2.3	2.3	*	67	67	*
12		2.7	2.3	3.5	2	3	3	72	72	75
13		0.9	0	#	3.5	4.8	#	72	72	#
16		2.6	1.3	@	3.5	3	@	65	61	@
19		0	0	0	4.8	4.5	4	69	72	77
20		0	0	@	5	7	@	78	80	@
22		2.8	0	0	3	3.5	3.5	71	73	75
25		0	@	@	4	@	@	70	@	@
26		6	2.5	0	7	9.3	9	70	76	79
28		1	0.3	0.1	3.3	4	4	69	69	79
31		0	1.1	0	6.5	6.5	7	72	74	80
33		3.5	2.3	0	2.5	3	3	72	75	77
34		5	3.5	2	2	3	2.5	67	72	74
35		4	2.7	2.5	2.5	3	2.8	68	70	74
38		5	3.8	1.7	2	2.5	2.5	68	70	73
39		4	4.3	3	4	4.5	4.5	73	73	76
MEAN		2.9	1.8	0.9	3.5	4.1	4.0	69.7	72	75.6
SD		2.2	1.8	1.2	1.4	1.7	1.7	3.9	4.4	3.3

Code for reasons participants were unable to attend for measurement:
 @=unexpected overseas travel; # = discomfort in splint; *=ill-health

APPENDIX D.8 Mean (SD) scores, mean (SD) differences within groups, and mean differences between groups (95%CI) for all outcomes

Outcome	Scores						Differences within groups				Differences between groups			
	Wk 0		Wk 2		Wk 6		Wk 2-Wk 0		Wk 6-Wk 0		Wk 2-Wk 0		Wk 6-Wk 0	
	(n=40)		(n=39)		(n=34)		(n=39)		(n=34)		(n=39)		(n=34)	
											Exp-Con		Exp-Con	
	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>	<i>Exp</i>	<i>Con</i>
	(n=19)	(n=21)	(n=19)	(n=20)	(n=18)	(n=16)								
VAS (cm)	3.0 (1.9)	2.9 (2.2)	2.1 (1.8)	1.8 (1.8)	1.3 (2.2)	0.9 (1.2)	-0.9 (2.1)	-1.3 (1.7)	-1.8 (2.5)	-2.3 (2.0)	0.4 (-0.8 to 1.6)		0.5 (-1.1 to 2.0)	
Tip pinch (kg)	4.0 (1.8)	3.5 (1.4)	4.5 (1.7)	4.1 (1.7)	4.7 (2.2)	4.0 (1.7)	0.4 (0.8)	0.6 (0.7)	0.7 (1.6)	0.6 (0.6)	-0.2 (-0.7 to 0.3)		0.1 (-0.8 to 0.9)	
Sollerman splint off (-80)	67.9 (6.5)	69.7 (3.9)	72.3 (4.0)	72.0 (4.4)	74.8 (6.1)	75.6 (3.3)	4.3 (5.6)	2.4 (3.0)	6.8 (8.0)	6.1 (2.7)	2.0 (-0.9 to 4.9)		0.7 (-3.6 to 5.0)	

APPENDIX D.9

Results of ANOVA with repeated measures of differences in pain, strength and hand function between groups over time

	Week 2 – Week 0		Week 6 – Week 0	
	F (1, 37)	<i>p</i>	F (1, 32)	<i>p</i>
VAS (cm)	0.45	0.50	0.34	0.57
Tip pinch strength (kg)	0.56	0.46	0.03	0.86
Sollerman test (-80)	1.91	0.18	0.11	0.74

APPENDIX D.10

Results of ANOVA with repeated measures of pain, strength and hand function for all participants over time

	Week 2 – Week 0		Week 6 – Week 0	
	T (38)	<i>p</i>	T (33)	<i>p</i>
VAS (cm)	3.7	0.0007	5.3	0.000007
Tip pinch strength (kg)	-4.2	0.0002	-2.9	0.006
Sollerman test (-80)	-4.6	0.00005	-6.3	0.000000

APPENDIX E.1

Surgery for thumb (trapeziometacarpal joint) osteoarthritis: protocol

Wajon A, Ada L, Edmunds I (2004): Surgery for thumb (trapeziometacarpal joint) osteoarthritis (Protocol for a Cochrane Review). In: *The Cochrane Library*, Issue 1. Chichester, UK: John Wiley & Sons, Ltd.

Surgery for thumb (trapeziometacarpal joint) osteoarthritis (Protocol)

Wajon A, Ada L, Edmunds I



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Surgery for thumb (trapeziometacarpal joint) osteoarthritis (Protocol)

Wajon A, Ada L, Edmunds I

This Review should be cited as:

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Date of most recent substantive amendment: 03 September 2003

ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

The main objectives of this systematic review are to assess:

- 1 The effect of surgery in reducing pain and increasing range of motion, strength, and hand function in patients with Stage I, II, III and IV trapeziometacarpal OA.
- 2 Whether there is any change (improvement or deterioration) in outcome measures between 12 months and 5 years follow-up following surgery for trapeziometacarpal OA. .

BACKGROUND

Osteoarthritis at the base of the thumb is a common problem (Armstrong 1994), especially in women in the fifth to seventh decades of life (Swigart 1999). Clinical symptoms include pain, stiffness, and weakness, which cause considerable interference to overall hand function (Menon 1995). Typically patients report disability during a variety of occupations, domestic tasks, hobbies and sports, with pain localised to the base of the thumb (Flatt 1995).

Conservative intervention consists of therapeutic heat and massage, splints designed to reduce the pain (Colditz 2000) and preserve the web space (Poole 2000), exercise regimens to strengthen the thenar musculature and restore dynamic stability at the trapeziometacarpal joint (Taylor 2000), and anti-inflammatory medications to relieve the pain (Docken 1987). Such measures can result in a decrease in pain, increase in strength and improvement in hand function (Wajon). However, for some patients, symptom relief with conservative intervention is inadequate and/or short lived. Persistent pain, weakness and instability leads the patient to consider surgery.

Since the severity of symptoms of OA at the trapeziometacarpal joint does not necessarily correspond with the radiographic stage of the disease, the decision to proceed with surgery is determined by the extent that pain and loss of function interfere with activities of daily living (Glickel 2001a). Other considerations include the patient's age and specific functional demands. However, the radiographic stage of the disease (Glickel 2001) will help in determining the most appropriate surgical procedure. The commonly performed procedures for each stage of OA, using the staging system described by Eaton (Eaton 1987), will now be reviewed.

Patients with Eaton Stage I OA (Eaton 1987) at the trapeziometacarpal joint have ligamentous laxity resulting in joint space widening, but normal articular contours. They need a surgical procedure which will stabilise the joint and attempt to prevent the progression of osteoarthritis. A volar ligament reconstruction (Eaton 1984) aims to relieve pain, maintain a functional range of motion and improve stability. Such surgically stabilised joints are considered to be less likely to develop degenerative changes because they are not subject to shear forces (Freedman 2000). Alternatively, a metacarpal osteotomy may be performed to redistribute trapeziometacarpal contact area and load, away from

the compromised volar joint surface to the normal dorsal surface (Hobby 1998). This procedure has been found to be an effective biomechanical alternative to ligament reconstruction in patients with Eaton Stage I osteoarthritis (Tomaino 2000).

Patients with Eaton Stage II OA (Eaton 1987) have early degenerative changes to the trapeziometacarpal joint, and the choice of surgical procedure is likely to be influenced by the severity of their symptoms and their functional demands. Surgical procedures appropriate for Stage II OA include volar ligament reconstruction, metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy (with or without LRTI), interpositional arthroplasty, or trapeziometacarpal joint replacement. Metacarpal osteotomy has been reported to provide lasting pain relief, correct any adduction contracture and restore strength (Hobby 1998). Trapeziometacarpal arthrodesis is the procedure of choice for younger, high-demand patients, including those with posttraumatic arthritis, because of the stability and increased strength achieved (Fulton 2001). However, arthrodesis results in significant loss of motion at the base of the thumb and has been associated with compensatory hyperextension at the metacarpophalangeal joint (Bamberger 1992). Trapeziectomy alone has traditionally been the procedure chosen for the low-demand elderly patient with more advanced disease (Davis 1997). However this procedure can result in pain and weakness because it cannot prevent proximal migration of the first metacarpal, causing impingement between the metacarpal and scaphoid with loss of length of the thumb ray (Downing 2001). A variety of procedures have been designed to address these problems. Trapeziectomy with ligament reconstruction and tendon interposition (LRTI) (Burton 1986) was found to improve strength and restore web space, however the potential for recession of the metacarpal and instability at the pseudoarthrosis site remains a concern (Kuschner 1996). Alternative interpositional arthroplasties include procedures which excise either all or part of the trapezium, and interpose the space with materials such as silicon (O'Leary 2002), allograft (Trumble 2000, Schmidt 2000), or polypropylene (Marlex) (Muermans 1998). Trapeziometacarpal joint replacements are also indicated for patients with Eaton Stage II osteoarthritis. Examples of prosthetic designs include the ball-and-socket type arthroplasty (Hannula 1999) and the joint resurfacing type arthroplasty (Avanta), both of which can be either cemented (eg. de la Caffinière) or non-cemented (eg. Ledoux) (Wachtl 1998) prostheses. Replacement of the degenerative articular joint surface with a prosthesis has the potential to reproduce normal kinematics and stability at the joint in the presence of intact ligaments (Uchiyama 1999), but unfortunately these prostheses have also been reported to subside, loosen, dislocate and break (Linscheid 2000).

Patients with Eaton Stage III OA (Eaton 1987) show advanced degenerative changes at the trapeziometacarpal joint, with marked joint space narrowing, joint debris and subluxation, and significantly greater trapezium tilt than patients with Eaton Stage I or II (Bettinger 2001). The increased severity of degenerative

joint disease requires surgical procedures which improve function as well as relieve symptoms. Procedures include metacarpal osteotomy (Hobby 1998), trapeziometacarpal arthrodesis, trapeziectomy with or without LRTI, interpositional arthroplasty, or trapeziometacarpal joint replacement (Hannula 1999).

Patients with Eaton Stage IV OA (with both trapeziometacarpal and scapho-trapezium-trapezoidal (STT) joint arthritis), need a procedure which adequately addresses pain arising from both the trapeziometacarpal and STT joints. Surgical procedures for these patients include trapeziectomy, trapeziectomy with LRTI, interpositional arthroplasties and trapeziometacarpal and STT joint replacements. Interpositional arthroplasties for Stage IV osteoarthritis, such as the Swanson silicone implant arthroplasty (Swanson 1972) and the Helal silicone rubber ball spacer (Grange 1983), remove the entire trapezium. A trapezium sparing double interposition joint replacement (Barron 1998) replaces both the trapeziometacarpal and STT joints, and can be performed for Stage IV osteoarthritis. These procedures aim to relieve pain and restore motion, strength and hand function.

Considering the variety of procedures available for each stage of OA, there remains uncertainty regarding which procedure will achieve the best outcomes for any given stage of trapeziometacarpal OA (Hartigan 2001).

OBJECTIVES

The main objectives of this systematic review are to assess:

- 1 The effect of surgery in reducing pain and increasing range of motion, strength, and hand function in patients with Stage I, II, III and IV trapeziometacarpal OA.
- 2 Whether there is any change (improvement or deterioration) in outcome measures between 12 months and 5 years follow-up following surgery for trapeziometacarpal OA. .

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

All trials which report clinically relevant outcomes will be included regardless of methodological quality. Truly randomised, quasi-randomised and controlled trials will be used in the review. Allocation concealment (Schulz 1995), blinding (of participants, investigators and outcome assessment), intention-to-treat analysis (Egger 1997) and completeness of follow-up will be assessed for all trials, but will not be used as inclusion / exclusion criteria. We plan to include trials that compare at least two surgical procedures for the same Stage of osteoarthritis, including:

1. In Stage I trapeziometacarpal OA:
 - a. Volar ligament reconstruction
 - b. Metacarpal osteotomy

2. In Stage II trapeziometacarpal OA:
 - a. Volar ligament reconstruction
 - b. Metacarpal osteotomy
 - c. Trapeziometacarpal arthrodesis
 - d. Trapeziectomy
 - e. Trapeziectomy with LRTI
 - f. Interpositional arthroplasty
 - g. Trapeziometacarpal joint replacement

3. In Stage III trapeziometacarpal OA:
 - a. Metacarpal osteotomy
 - b. Trapeziometacarpal arthrodesis
 - c. Trapeziectomy
 - d. Trapeziectomy with LTRI
 - e. Interpositional arthroplasty
 - f. Trapeziometacarpal joint replacement

4. In Stage IV trapeziometacarpal OA:
 - a. Trapeziectomy
 - b. Trapeziectomy with LRTI
 - c. Interpositional arthroplasty
 - d. Trapeziometacarpal and STT joint replacement

5. The long-term effects of each surgical procedure, compared at 12 months and any period greater than five years.

Types of participants

Trials will be considered which include subjects of any age and gender with a clinical diagnosis of Stage I-IV trapeziometacarpal osteoarthritis. Staging of OA will be reported according to the system of Eaton and Glickel (Eaton 1987), p.459:

Stage I Articular contours normal
 Slight widening of the joint space
 Stage II Slight narrowing of the joint space
 Minimal sclerotic changes
 Joint debris <2mm diameter
 Stage III Joint space markedly narrowed or obliterated
 Cystic changes, sclerotic bone, varying degrees of dorsal subluxation
 Joint debris >2mm in diameter
 Scaphotrapezial joint appear normal
 Stage IV Complete deterioration of trapeziometacarpal joint, as in Stage III
 Scaphotrapezial joint narrowed with sclerotic and cystic changes apparent.

Where trials have used patients who have had procedures also performed at the MP joint, they will form a subgroup of the main surgical procedure performed at the trapeziometacarpal joint. Information about characteristics of participants such as duration of symptoms, occupation, handedness and side of dysfunction will be recorded.

Types of intervention

Trials will be considered that include surgery to the trapeziometacarpal joint. Various surgical procedures are recommended based on the severity of osteoarthritis. Such surgical procedures include:

Volar ligament reconstruction
 Metacarpal osteotomy
 Trapeziometacarpal arthrodesis
 Trapeziectomy
 Trapeziectomy with LRTI
 Interpositional arthroplasty
 Trapeziometacarpal joint replacement

Trials that compare at least two surgical procedures will be analysed. A complete list of potential comparisons is described under Methods of the Review.

Types of outcome measures

Outcome assessment in osteoarthritis requires reliable, valid and responsive measurement techniques (Bellamy 1999). The OMER-ACT III Conference in 1996 recommended a core set of outcome measures for use in trials of OA (Bellamy 1997). These included: pain, physical function, patient global assessment and imaging techniques for studies of one year or greater (Bellamy 1997a). For pain, the visual analogue scale will be used. For physical function, hand function will be used. The global assessment outcome, directed towards the assessment of the trapeziometacarpal joint, will use measurements of range of motion, grip or pinch strength. For studies with greater than one year follow-up, results of imaging will be used. Adverse effects of surgery and post-operative management will be recorded where available.

Analysis of the effect of surgery on pain will be performed for continuous variables. The continuous variable of pain will be measured in centimetres on a visual analogue scale. If there are not at least two trials that report pain, the analysis will be performed for dichotomous variables. The dichotomous variable will be the presence of absence of pain. Then, pain reported in centimetres on the visual analogue scale will be collapsed to dichotomous data.

Analysis of the effect of surgery on physical function will be performed for continuous variables. The continuous variable of physical function will be measured using functional scales of upper limb activities which will be normalised. Examples of functional scales are the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (Hunsaker 2002), Sollerman Test of Hand Function (Sollerman 1995), and the Jebsen Hand Function Test (Jebsen 1969).

Analysis of the effect of surgery on patient global assessment will be performed for continuous variables of range of motion and strength. The amount of palmar and radial abduction (web space) will be measured in degrees, and opposition (the distance from the thumb to the 3rd metacarpal) will be measured in centimetres (Casanova 1992). The continuous variables of grip and pinch

strength (2 point pinch, 3 point pinch, or lateral pinch) will be measured in kilograms.

Analysis of the effect of surgery on radiological changes will be performed for studies of greater than one years follow-up. Dichotomous variables of radiological outcomes will be reported.

Analysis of any adverse effects resulting from trapeziometacarpal surgery will be performed. Examples of adverse effects are the presence of Complex Regional Pain Syndrome (Type I), non-union, dislocation, wound infection, implant fracture, silicone synovitis, and nerve compression.

SEARCH STRATEGY FOR IDENTIFICATION OF STUDIES

See: search strategy

Search strategy for the following databases:

-MEDLINE <1966 to May 2003>

-CINAHL <1982 to May 2003>

-AMED <1985 to May 2003>

1 exp osteoarthritis/

2 (degenerative adj (joint or arthritis)).tw.

3 (osteoarthritis or osteoarthrosis).tw.

4 or/1-3

5 thumb/

6 (trapeziometacarpal or thumb or CMC joint).tw.

7 (basal joint or base of thumb).tw.

8 or/5-7

9 4 and 8

10 su.fs.

11 Arthroplasty/

12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.

13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.

14 or/10-13

15 9 and 14

16 clinical trial.pt.

17 randomized controlled trial.pt.

18 tu.fs.

19 dt.fs.

20 random\$.tw.

21 (double adj blind\$).tw.

22 placebo\$.tw.

23 or/16-22

24 15 and 23

Database: EMBASE (Science Direct) <1974 - May 2003>

1 exp OSTEOARTHRITIS

2 (degenerative adj (joint or arthritis)).tw.

3 (osteoarthritis or osteoarthrosis).tw.

4 or/1-3

5 thumb

6 (trapeziometacarpal or thumb or CMC joint).tw.

7 (basal joint or base of thumb).tw.

8 or/5-7

9 4 and 8

10 su.fs.

11 arthroplasty/

12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.

13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.

14 or/10-13

15 9 and 14

16 exp clinical trial/

17 comparative study/

18 major clinical study/

19 randomization/

20 crossover procedure/

21 double blind procedure/

22 single blind procedure/

23 placebo/

24 prospective study/

25 ((clinical or controlled or comparative or placebo or prospective or randomi#ed) adj2 (trial or study)).ti,ab.

26 (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).ti, ab.

27 ((single\$ or double\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).ti,ab.

28 (cross?over\$ or (cross adj1 over\$)).ti, ab.

29 or/13-25

30 15 and 29

Search strategy for the

-Cochrane Central Register of Controlled Trials <1st quarter 2003>

- Cochrane Database of Systematic Reviews <1st quarter 2003>

- Database of Abstracts of Reviews of Effects <1st quarter 2003>

- Cochrane DSR, ACP Journal Club, and DARE

1 exp OSTEOARTHRITIS

2 (degenerative adj (joint or arthritis)).tw.

3 (osteoarthritis or osteoarthrosis).tw.

4 or/1-3

5 thumb

6 (trapeziometacarpal or thumb or CMC joint).tw.

7 (basal joint or base of thumb).tw.

8 or/5-7

9 4 and 8

10 su.fs.

11 arthroplasty/

12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.

13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.

14 or/10-13

15 9 and 14

The database searches will be supplemented by hand searching the following:

Conference proceedings:

1 International Federation Society of Hand Surgeons (1991-2002)

2 American Society Surgery Hand (1990-2002)

3 American Society Hand Therapists (1990-2002)

4 Australian Hand Surgery Society

Reference lists:

textbooks

reviews

previous trials

METHODS OF THE REVIEW

Computerised bibliographic databases: the Cochrane Controlled Trials Register (Cochrane Library Issue xx, 2003) MEDLINE (1996-May 2003), CINAHL (1982-May 2003), AMED (1985-May 2003), and EMBASE (1974-May 2003) will be searched. Searches will be performed using key words (MeSH) related to osteoarthritis, trapeziometacarpal joint, and surgery, without language restrictions. Two reviewers will identify relevant studies from titles and abstracts (where available), and obtain full paper copies. Additional studies will be identified from reference lists, and by hand searching relevant conference proceedings.

To determine whether a trial should be included, two reviewers will independently assess the trial according to predetermined criteria. These criteria will be that: the trial was randomised or quasi-randomised; intervention was surgery (either volar ligament reconstruction, metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy with or without LRTI, interpositional arthroplasty or joint replacement), and pain, strength, range of motion, or hand function was measured as an outcome. There will be no exclusion on the basis of previous intervention or procedures to the metacarpophalangeal joint. Blinding of the assessor will be recorded but will not be a criteria for inclusion.

To be included, both reviewers must agree that the trial meets these criteria. Trials that are selected by each reviewer will be compared and discussed where disagreement occurs. Where agreement can not be reached, a third reviewer will be involved to resolve disagreements. For potentially relevant non-English language trials, we will attempt to organise translation into English. Trials will be categorised by surgical procedure.

The reviewers (AW and IE) will assess the methodological quality of included trials using the 11-item PEDro scale (Mosely 2002), which is based on the Delphi List (Verhagen 1998) and available at The Physiotherapy Evidence Database (PEDro) (<http://www.pedro.fhs.usyd.edu.au/FAQs/Scale/scaleitems.htm>). Items are: specification of eligibility criteria; random allocation to group; concealed allocation; groups similar at baseline; blinding of all

subjects, therapists and assessors; outcome measurements obtained from more than 85% of all subjects; data analysed by 'intention to treat'; between-group statistical comparisons reported; reporting of point measures and measures of variability. The reviewers will discuss the quality rating where disagreement occurs. There will be no exclusion according to the score but this score will be used for sensitivity analyses. Authors will be contacted to provide missing information or clarify unclear data. The reviewers will independently extract trial and outcome data from the included trials and record details of the methods, participants, comparison, and outcomes by using checklists.

The Cochrane Collaboration's Review Manager software program (RevMan 4.2) will be used for all analyses. Data for all pre-specified outcomes will be entered and cross checked. The main comparisons to be made are between the following surgical procedures:

1A. In Stage I trapeziometacarpal OA:

a. Volar ligament reconstruction

b. Metacarpal osteotomy

1B. In Stage II trapeziometacarpal OA:

a. Volar ligament reconstruction

b. Metacarpal osteotomy

c. Trapeziometacarpal arthrodesis

d. Trapeziectomy

e. Trapeziectomy with LRTI

f. Interpositional arthroplasty

g. Trapeziometacarpal joint replacement

1C. In Stage III trapeziometacarpal OA:

a. Metacarpal osteotomy

b. Trapeziometacarpal arthrodesis

c. Trapeziectomy

d. Trapeziectomy with LRTI

e. Interpositional arthroplasty

f. Trapeziometacarpal joint replacement

1D. In Stage IV trapeziometacarpal OA:

a. Trapeziectomy

b. Trapeziectomy with LRTI

c. Interpositional arthroplasty

d. Trapeziometacarpal and STT joint replacement

If there are insufficient trials, subgroup analysis will be performed by comparing:

2A for Stage I:

a. Volar ligament reconstruction versus any other procedure

b. Metacarpal osteotomy versus any other procedure

2B for Stage II:

a. Volar ligament reconstruction versus any other procedure

b. Metacarpal osteotomy versus any other procedure

c. Trapeziometacarpal arthrodesis versus any other procedure

d. Trapeziectomy versus any other procedure

e. Trapeziectomy with LRTI versus any other procedure

f. Interpositional arthroplasty versus any other procedure

g. Trapeziometacarpal joint replacement versus any other procedure

2C for Stage III:

- a. Metacarpal osteotomy versus any other procedure
- b. Trapeziometacarpal arthrodesis versus any other procedure
- c. Trapeziectomy versus any other procedure
- d. Trapeziectomy with LRTI versus any other procedure
- e. Interpositional arthroplasty versus any other procedure
- f. Trapeziometacarpal joint replacement versus any other procedure

2D for Stage IV:

- a. Trapeziectomy versus any other procedure
- b. Trapeziectomy with LRTI versus any other procedure
- c. Interpositional arthroplasty versus any other procedure
- d. Trapeziometacarpal and STT joint replacement versus any other procedure

If there are still insufficient trials, subgroup analysis will be performed by comparing:

3 for any Stage

- a. Volar ligament reconstruction versus any other procedure
- b. Metacarpal osteotomy versus any other procedure
- c. Trapeziometacarpal arthrodesis versus any other procedure
- d. Trapeziectomy versus any other procedure
- e. Trapeziectomy with LRTI versus any other procedure
- f. Interpositional arthroplasty versus any other procedure
- g. Trapeziometacarpal joint replacement versus any other procedure

The outcomes for each comparison are:

- 1 pain
- 2 physical function
- 3 patient global assessment

4 imaging

5 adverse effects

Trials using similar methods of measurement for the primary outcome of pain or the secondary outcomes of range of motion, grip or pinch strength, or hand function at similar times post-intervention will be considered for pooling. The Cochrane Collaboration's Review Manager software program (RevMan 4.2) will be used for analyses. Where the same methods of measurement were used, the effect sizes will be reported as weighted mean differences and 95%CI. Where different methods of measurement were used, the effect size will be reported as standardised mean differences and 95%CI. A fixed effects model will be used throughout except where heterogeneity exists. A test of heterogeneity of the data will be performed and if significant ($p < 0.1$ using the Q statistic) the source of heterogeneity will be investigated by doing a sensitivity analysis and considering clinical reasons for potential clinical heterogeneity. If deemed appropriate to pool then a random effects model will be used.

POTENTIAL CONFLICT OF INTEREST

None known

SOURCES OF SUPPORT

External sources of support

- No sources of support supplied

Internal sources of support

- No sources of support supplied

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Surgery for thumb (trapeziometacarpal joint) osteoarthritis (Protocol)

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* Indicates the major publication for the study

COVER SHEET

Title	Surgery for thumb (trapeziometacarpal joint) osteoarthritis
Reviewers	Wajon A, Ada L, Edmunds I
Contribution of reviewer(s)	All authors contributed to the development of this protocol.
Issue protocol first published	2004/1
Review first published	/
Date of most recent amendment	26 November 2003
Date of most recent SUBSTANTIVE amendment	03 September 2003
Most recent changes	Information not supplied by reviewer
Date new studies sought but none found	Information not supplied by reviewer
Date new studies found but not yet included/excluded	Information not supplied by reviewer
Date new studies found and included/excluded	Information not supplied by reviewer
Date reviewers' conclusions section amended	Information not supplied by reviewer
Contact address	Mrs Anne Wajon Director Hand Therapy at Hornsby 2/49 Palmerston Rd Hornsby 2077 AUSTRALIA Telephone: 61 2 9482 5522 E-mail: anne@wajon.com.au Facsimile: 61 2 9482 5533
Cochrane Library number	CD004631
Editorial group	Cochrane Musculoskeletal Group
Editorial group code	HM-MUSKEL

Statement from co-authors confirming authorship contribution of the PhD candidate

As co-authors of the Cochrane review: “Surgery for thumb (trapeziometacarpal joint) osteoarthritis”, we confirm that Anne Wajon has made the following contributions: conception and design of the research, analysis and interpretation of the findings, writing the paper and critical appraisal of content.

Signed _____ Date _____

Signed _____ Date _____

APPENDIX E.2

Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Search strategy

Databases were searched according to the following search strategy:

- MEDLINE <1966 to Dec 2004>
- CINAHL <1982 to Dec 2004>
- AMED <1985 to Dec 2004>

- 1 exp osteoarthritis/
- 2 (degenerative adj (joint or arthritis)).tw.
- 3 (osteoarthritis or osteoarthrosis).tw.
- 4 or/1-3
- 5 thumb/
- 6 (trapeziometacarpal or thumb or CMC joint).tw.
- 7 (basal joint or base of thumb).tw.
- 8 or/5-7
- 9 4 and 8
- 10 su.fs.
- 11 Arthroplasty/
- 12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.
- 13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.
- 14 or/10-13
- 15 9 and 14
- 16 clinical trial.pt.
- 17 randomized controlled trial.pt.
- 18 tu.fs.
- 19 dt.fs
- 20 random\$.tw.
- 21 (double adj blind\$).tw.
- 22 placebo\$.tw.
- 23 or/16-22
- 24 15 and 23

- EMBASE (Science Direct) <1974 - Dec 2004>

- 1 exp OSTEOARTHRITIS
- 2 (degenerative adj (joint or arthritis)).tw.
- 3 (osteoarthritis or osteoarthrosis).tw.
- 4 or/1-3
- 5 thumb
- 6 (trapeziometacarpal or thumb or CMC joint).tw.
- 7 (basal joint or base of thumb).tw.
- 8 or/5-7
- 9 4 and 8
- 10 su.fs.

11 arthroplasty/
 12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.
 13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.
 14 or/10-13
 15 9 and 14
 16 exp clinical trial/
 17 comparative study/
 18 major clinical study/
 19 randomization/
 20 crossover procedure/
 21 double blind procedure/
 22 single blind procedure/
 23 placebo/
 24 prospective study/
 25 ((clinical or controlled or comparative or placebo or prospective or
 randomi#ed) adj2 (trial or study)).ti,ab.
 26 (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).ti,
 ab.
 27 ((single\$ or double\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).ti,ab.
 28 (cross?over\$ or (cross adj1 over\$)).ti, ab.
 29 or/13-25
 30 15 and 29

- Cochrane Central Register of Controlled Trials (CENTRAL) (Cochrane Library 2004, Issue 4)
- Cochrane Database of Systematic Reviews (Cochrane Library 2004, Issue 4)
- Database of Abstracts of Reviews of Effects (DARE) (Cochrane Library 2004, Issue 4)

1 exp OSTEOARTHRITIS
 2 (degenerative adj (joint or arthritis)).tw.
 3 (osteoarthritis or osteoarthrosis).tw.
 4 or/1-3
 5 thumb
 6 (trapeziometacarpal or thumb or CMC joint).tw.
 7 (basal joint or base of thumb).tw.
 8 or/5-7
 9 4 and 8
 10 su.fs.
 11 arthroplasty/
 12 (trapeziectomy or LRTI or suspension or joint replacement or arthroplasty).tw.
 13 (arthrodesis or fusion or osteotomy or ligament reconstruction).tw.
 14 or/10-13
 15 9 and 14

The database searches will be supplemented by hand searching the following:

Conference proceedings:

- International Federation Society of Hand Surgeons (1991-2004)
- American Society Surgery Hand (1990-2004)
- American Society Hand Therapists (1990-2004)
- Australian Hand Surgery Society (1990-2004)

Reference lists:

- textbooks
- reviews
- previous trials

APPENDIX E.3

Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Characteristics of excluded studies

Study	Reason for exclusion
Adams, Unsell & McLaughlin 1990	Observational study
Alnot & Muller 1998	Descriptive study
Amadio & De Silva 1990	Descriptive study
Atroshi, I. & Axelson 1997	Observational study
Atroshi, I, Axelsson & Nilsson 1998	Descriptive study
Bamberger et al. 1992	Observational study
Barron & Eaton 1998	Observational study
Battiston et al. 1979	Descriptive study
Bezwada et al. 2002	Observational study
Braun 1982	No intervention of interest
Budoff & Leonard 2002	Observational study
Burton, R 1973	Review
Burton, R.I. & Pellegrini 1986	Observational study
Burton, R 1987	Descriptive study
Camus et al. 2000	Observational study
Caputo & Bennett 1993	Observational study
Carroll 1987	Observational study
Chakrabarti, Robinson & Gallagher 1997	Observational study
Chamay & Piaget-Morerod 1994	Observational study
Clough, Crouch & Bennett 1990	Observational study
Conolly, Rath & Herbert 1989	Observational study
Conolly & Lanzetta 1993	Descriptive study
Creamer, Flores & Hochberg 1998	Review
Cristiani et al. 1997	Observational study
Dacatra & Torretta 2001	No intervention of interest
Damen, A, Van Der Lei & Robinson 1997	Observational study
Damen, A. et al. 2000	Observational study
Damen, A. et al. 2001	Observational study
Dell, Brushart & Smith 1978	Observational study
Dhar et al. 1994	Observational study
Dodaro et al. 1999	Observational study
Eaton, RG 1979	Observational study
Eaton, R.G. et al. 1984	Observational study
Eaton, R.G., Glickel & Littler 1985	No intervention of interest
Edmunds, Trevithick & Honner 1994	Observational study
Egloff 2002	Observational study
Eiken & Carstam 1970	Observational study
Ferlic, Turner & Clayton 1983	Observational study
Forseth & Stern 2003	No intervention of interest
Froimson 1987	Review
Fujiwara, Haraoka & Sumiya 2003	Observational study
Fulton & Stern 2001	Observational study
Galli et al. 2002	Observational study
Gibbons et al. 1999	Observational study
Hannula & Nahigian 1999	Observational study
Harrison, Smith & Maxwell 1977	Observational study
Hartigan, Stern & Kiefhaber 2001	Observational study
Hass & Baruch 1989	Observational study
Herren & Simmen 1997	Descriptive study
Hilty & Stober 1996	Observational study
Hobby, Lyall & Meggitt 1998	Observational study
Hofamann, Ferlic & Clayton 1987	Observational study

Hollevoet et al. 1996	Descriptive study
Holmberg & Lundborg 1996	Observational study
Isselin 2001	Observational study
Kaarela & Raatikainen 1999	Observational study
Kapandji & Heim 2002	No intervention of interest
Kleinman & Eckenrode 1991	Observational study
Kuhns, Emerson & Meals 2003	Observational study
Kuschner & Lane 1996	Review
Lane & Eaton 1987	Observational study
Lanzetta & Foucher 1995	Observational study
Le Viet et al. 1996	Observational study
Lins et al. 1996	Observational study
Linscheid 2000	Review
Lisanti et al. 1997	Observational study
Liu & Chang 1999	Observational study
Lovell et al. 1999	Observational study
MacDermid et al. 2003	Observational study
Marmor & Peter 1969	Review
Marmor 1972	Review
Masmejean et al. 2003	Observational study
McGovern et al. 2001	Observational study
Melone, Beavers & Isani 1987	Observational study
Mentzel et al. 2001	Descriptive study
Messina 2000	No intervention of interest
Messina & Messina 2002	No intervention of interest
Mo & Gelberman 2004	Observational study
Molitor, Emery & Meggitt 1991	Observational study
Muermans & Coenen 1998	Descriptive study
Mureau et al. 2001	Descriptive study
Nakajima et al. 1996	Observational study
Nilsson, Stefansson & Sollerman 2002	No intervention of interest
Nusem & Goodwin 2003	Review
Nylen, Johnson & Rosenquist 1993	Observational study
O'Leary, S et al. 1997	Observational study
O'Leary, ST et al. 2002	Observational study
Oka & Ikeda 2000	Observational study
Panciera & Panciera 1997	Observational study
Pellegrini & Burton 1986	Observational study
Pellegrini et al. 1996	No outcome of interest
Phaltankar & Magnussen 2003	Observational study
Pérez-Úbeda et al. 2003	Observational study
Rayan & Young 1997	Observational study
Roberts, Jabaley & Nick 2001	Observational study
Robinson, Aghasi & Halperin 1991	Observational study
Saehle, Sande & Finsen 2002	Observational study
Sakellarides 1989	Observational study
Schmidt, K., Schneider & Miehle 1993	Observational study
Schröder et al. 2002	Descriptive study
Schuhl 2001	Observational study
Smith et al. 2002	Observational study
Smíd & Janecka 2001	Descriptive study
Sondergaard, Konradsen & Rechnagel 1991	Observational study
Sotereanos, Taras & Urbaniak 1993	Observational study
Stussi, Dap & Merle 2000	Descriptive study
Swanson & Swanson 1983	Review
Takwale & Stanley 2002	Observational study
Thomsen, Jensen & Nygaard 2000	Observational study

Tomaino, Pellegrini & Burton 1995	Observational study
Tomaino 2000	Observational study
Van Cappelle, Elzenga & Van Horn 1999	Observational study
Van Cappelle, Deutman & Van Horn 2001	Observational study
Van Giffen, Van Ransbeeck & De Smet 2002	Observational study
Vandenbroucke et al. 1997	Observational study
Voulliaume et al. 2003	Observational study
Wachtl, Guggenheim & Sennwald 1997	Descriptive study
Wachtl, Guggenheim & Sennwald 1998	Observational study
Yang & Weiland 1998	Observational study
Young, BT & Rayan 1998	Observational study
Young, SD & Mikola 2004	Review
Zancolli 2001	Review

APPENDIX E.4 Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Characteristics of included studies

Study	Methods	Participants	Interventions	Outcome Measures
Belcher & Nicholl (2000)	<p>Randomised controlled, single centre trial.</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (APL)</p> <p>C: Trapeziectomy</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp/C= 58/63</p> <p>Gender (female/male): Exp/C= 19:4/18:1</p> <p>Stage of OA (mean): Exp/C=3.0/3.5</p>	<p>Surgery: Exp/C</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (using dorsal slip of APL). Post-op back-slab, then customised splint fitted at 2 weeks, including wrist in extension, thumb trapeziometacarpal joint in abduction and metacarpophalangeal joint in extension. Gentle mobilisation at 4 weeks, splint discharged at 6 weeks. /</p> <p>C: Trapeziectomy. Post-op back-slab, then customised splint fitted at 2 weeks, including wrist in extension, thumb trapeziometacarpal joint in abduction and metacarpophalangeal joint in extension. Gentle mobilisation at 4 weeks, splint discharged at 6 weeks.</p>	<p>Pain: A 10 cm visual analogue scale was used to assess thumb pain, with '0' indicating no pain and '10' terrible pain</p> <p>Physical function: A 100 mm visual analogue scale was used to score 'how well the hands work generally', with '0' indicating full function and '10' no use</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: trapeziometacarpal extension (radial abduction) and abduction (palmar abduction) were measured as the distance between the thumb interphalangeal joint crease and the palmar crease</p> <p>Strength: grip strength was measured with the Jamar dynamometer, and pulp (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kilograms</p> <p>Trapeziometacarpal joint imaging: Measurement of the distance between the base of the thumb metacarpal and the distal end of the scaphoid were reported as the scaphometacarpal distance in millimeters. The distance between the base of the thumb metacarpal and the radial border of the trapezoid were reported as trapeziometacarpal distance in millimeters</p> <p>Adverse effects: Complications of recurrent pain, instability, neuroma, sensory loss and tendon (FCR) rupture were reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Belcher & Zic (2001)	<p>Randomised controlled, single centre trial.</p> <p>Exp: Trapeziectomy with porcine dermal collagen xenograft (Permacol)</p> <p>C: Trapeziectomy</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp/C= 59/59</p> <p>Gender (female / male): Exp/C= 11:2/9:4</p> <p>Stage of OA (mean): Exp/C=4/4</p>	<p>Surgery: Exp/C</p> <p>Exp: Trapeziectomy with collagen xenograft (Permacol) interposition. Post-op back-slab, customised splint fitted at 2 weeks, gentle mobilisation at 4 weeks, splint discharged at 6 weeks</p> <p>C: Trapeziectomy. Post-op back-slab, customised splint fitted at 2 weeks, gentle mobilisation at 4 weeks, splint discharged at 6 weeks.</p>	<p>Pain: A 10 cm visual analogue scale was used to assess thumb pain, with '0' indicating no pain</p> <p>Physical function: A 10 cm visual analogue scale was also used to score 'how well the hands work generally'.</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: trapeziometacarpal extension (radial abduction) and abduction (palmar abduction) were measured as the distance between the thumb interphalangeal joint crease and the palmar crease in centimeters.</p> <p>Strength: grip strength was measured with the Jamar dynamometer, and pulp (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kilograms</p> <p>Trapeziometacarpal joint imaging: Measurement of the distance between the base of the thumb metacarpal and the distal end of the scaphoid were reported as the scaphometacarpal distance in millimeters.</p> <p>Adverse effects: Complications of neuroma, sensory change, erythema and pain, pain only and instability were reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Davis, Brady & Dias (2004 (a))	<p>Randomised controlled, multi-centre trial.</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (FCR)</p> <p>C: Trapeziectomy</p>	<p>Inclusion criteria: Age (mean): Exp / C= 59/58</p> <p>Gender (female/male): Exp / C= 62:0 / 62:0</p> <p>Stage of OA (mean): Exp / C=3.6 / 3.4</p>	<p>Surgery: Exp / C</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (using FCR). Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded</p> <p>C: Trapeziectomy. Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded.</p>	<p>Pain: The number of subjects who reported 'no pain or restrictions; discomfort with use, but no restrictions; pain with use, some restrictions; rest pain, no restrictions; rest pain, some restrictions; rest pain, severe restrictions; night pain' were recorded for each group</p> <p>Physical function: Not reported</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: palmar and radial abduction were measured for the whole study group preoperatively and at 1 year follow up.</p> <p>Strength: grip strength was measured with the Jamar dynamometer, and tip (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kilograms</p> <p>Trapeziometacarpal joint imaging: Standard AP and lateral radiographs and stress radiographs were taken to ensure the pseudarthrosis had not subluxed or dislocated.</p> <p>Adverse effects at 12 months: Complications of nerve dysfunction, tendon adhesion, scar tenderness and reflex sympathetic dystrophy were reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Davis, Brady & Dias (2004 (b))	<p>Randomised controlled, multi-centre trial.</p> <p>Exp : Trapeziectomy with palmaris longus interposition</p> <p>C: Trapeziectomy</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp / C= 60/58</p> <p>Gender (female/ male): Exp / C= 59:0 / 62:0</p> <p>Stage of OA (mean): Exp / C=3.7 /3.4</p>	<p>Surgery: Exp / C</p> <p>Exp: Trapeziectomy with interposition of palmaris longus tendon, sutured into a ball before placement into trapezial void. Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded</p> <p>C: Trapeziectomy. Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded.</p>	<p>Pain: The number of subjects who reported 'no pain or restrictions; discomfort with use, but no restrictions; pain with use, some restrictions; rest pain, no restrictions; rest pain, some restrictions; rest pain, severe restrictions; night pain' were recorded for each group</p> <p>Physical function: Not reported</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: thumb palmar and radial abduction were measured for the whole study group preoperatively and at 1 year follow up.</p> <p>Strength: grip strength was measured with the Jamar dynamometer, and tip (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kilograms</p> <p>Trapeziometacarpal joint imaging: Standard AP and lateral radiographs and stress radiographs were taken to ensure the pseudarthrosis had not subluxed or dislocated.</p> <p>Adverse effects at 12 months: Complications of nerve dysfunction, tendon adhesion, scar tenderness and reflex sympathetic dystrophy were reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Davis, Brady & Dias (2004 (c))	Randomised controlled, multi-centre \ trial. Exp : Trapeziectomy with palmaris longus interposition / C: Trapeziectomy with ligament reconstruction and tendon interposition (FCR)	Inclusion criteria: Age (mean): Exp / C= 60/59; Gender (female/ male): Exp / C= 59:0 / 62:0; Stage of OA (mean): Exp / C=3.7 /3.6	Surgery: Exp / C = Exp: Trapeziectomy with interposition of palmaris longus tendon, sutured into a ball before placement into trapezial void. Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded C: Trapeziectomy with ligament reconstruction and tendon interposition (using FCR). Post-op thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded	Pain: The number of subjects who reported 'no pain or restrictions; discomfort with use, but no restrictions; pain with use, some restrictions; rest pain, no restrictions; rest pain, some restrictions; rest pain, severe restrictions; night pain' were recorded for each group Physical function: Not reported Patient global assessment: Not reported Range of motion: thumb palmar and radial abduction were measured for the whole study group preoperatively and at 1 year follow up. Strength: grip strength was measured with the Jamar dynamometer, and tip (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kilograms Trapeziometacarpal joint imaging: Standard AP and lateral radiographs and stress radiographs were taken to ensure the pseudarthrosis had not subluxed or dislocated. Adverse effects at 12 months: Complications of nerve dysfunction, tendon adhesion, scar tenderness and reflex sympathetic dystrophy were reported

Study	Methods	Participants	Interventions	Outcome Measures
De Smet et al. (2004)	<p>Randomised controlled trial</p> <p>Exp: Trapeziectomy with LRTI (FCR)</p> <p>C: Trapeziectomy</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp / C= 61.5 (10.2) / 58 (6.3)</p> <p>Gender (female/ male): Exp / C= 34:0 / 22:0</p> <p>Stage of OA (mean): Exp / C=not reported</p>	<p>Surgery: Exp / C</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (using entire FCR). Mobilisation started within a week with no immobilisation</p> <p>C: Trapeziectomy. Mobilisation started immediately.</p>	<p>Pain: Pain was scored on a 10cm visual analogue score (VAS)</p> <p>Physical function: The DASH (Disabilities Arm, Shoulder, Hand) was completed, with 0 = no disability and 100 = maximal disability</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: the 'web angle' is reported for both groups and increased from 63.6 deg to 84.8 deg postoperatively. No between group comparisons were made</p> <p>Strength: key pinch and grip strength were reported as percentages of post-op / preoperative scores. No raw scores were provided</p> <p>Trapeziometacarpal joint imaging: The trapezial space was reported as a percentage of post-op/ preoperative scores. No raw scores were provided</p> <p>Adverse effects: complications were not reported. One subject was considered a failure and not included in analysis at follow-up.</p>

Study	Methods	Participants	Interventions	Outcome Measures
Gerwin et al. (1997)	<p>Randomised controlled, single centre trial</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (FCR)</p> <p>C: Trapeziectomy with ligament reconstruction with Mitek suture anchor</p>	<p>Inclusion criteria: Age (mean): Exp/C= 61/62</p> <p>Gender (female/male): Exp/C= not stated</p> <p>Stage of OA (mean): Exp/C= not stated</p> <p>Number of subjects: Exp/C: 9/11</p>	<p>Surgery: Exp/C</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (FCR)</p> <p>C: Trapeziectomy with ligament reconstruction (no rolled tendon spacer used to place within the void of the resected trapezium). Post op management not stated</p>	<p>Pain: Not reported</p> <p>Physical function: Subjective overall satisfaction with the procedure was reported for the two groups</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: Radial and palmar abduction were measured in degrees and the ability of the thumb to touch the volar aspect of the 5th MP joint was recorded at 23 month follow-up.</p> <p>Strength: Grip strength was measured with the Jamar dynamometer, and 2 point and 3 point pinch strength were measured with a pinch-meter at 23 month follow-up and measured in kilograms</p> <p>Trapeziometacarpal joint imaging: The height of the reconstructed basal joint (scaphometacarpal distance) was measured on lateral radiographs both at rest and during pinch.</p> <p>Adverse effects: Not reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Kriegs-Au et al. (2004)	<p>Randomised controlled, single centre trial</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (FCR)</p> <p>C: Trapeziectomy with ligament reconstruction alone</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp/C= 58/59</p> <p>Gender (female/male): Exp/C= 12:4/13:2</p> <p>Stage of OA (number of subjects): Exp/C=Exp: 3 Stage II, 11 Stage III, 2 Stage IV / C: 2 Stage II, 11 Stage III, 2 Stage IV</p>	<p>Surgery: Exp/C</p> <p>Exp: Trapeziectomy with ligament reconstruction and tendon interposition (using FCR). Post-op spica cast for 3 weeks, replaced with customised thumb spica splint until 6 weeks. Active and active-assisted ROM and thenar strengthening exercises begun at 6 weeks</p> <p>C: Trapeziectomy with ligament reconstruction (no tendon interposition). Post-op spica cast for 3 weeks, replaced with customised thumb spica splint until 6 weeks. Active and active-assisted ROM and thenar strengthening exercises begun at 6 weeks.</p>	<p>Pain: Number of subjects reporting pain at rest and during strain are reported preoperatively, with pain frequency (never, occasional, frequent, constant) reported post-operatively</p> <p>Physical function: The number of subjects reporting moderate difficulty with activities of daily living (writing, brushing teeth, threading needle, turning key, opening tight jar, using knife or scissors, buttoning clothes, zipping clothes, picking up small objects, and playing cards) are reported</p> <p>Patient global assessment: Overall assessment of subjective outcomes were assessed with the grade of the total Buck-Gramcko score, with scores of 49-56/56 achieving an 'excellent' result, 40-48/56 'good', 28-39/56 'fair', and <28/56 'poor'</p> <p>Range of motion: Mean palmar and radial abduction were measured in degrees with a goniometer, and opposition (the ability to touch the palmar crease of the little finger with thumb tip), were measured both preoperatively and at final follow-up</p> <p>Strength: Grip strength was measured with the Martin vigorimeter, and tip (2 point) pinch was measured with a pinch-meter, and measured in bar [Pa]</p> <p>Trapeziometacarpal joint imaging: Standard PA and oblique radiographs were performed preoperatively and at follow-up. The index of the height of the arthroplasty space was calculated by dividing the scaphometacarpal distance by the length of the 1st metacarpal. The index was calculated both at rest and under stress post-operatively.</p> <p>Adverse effects: Complications of nerve irritation and Reflex Sympathetic Dystrophy were reported</p>

Study	Methods	Participants	Interventions	Outcome Measures
Tagil & Kopylov (2002)	<p>Randomised controlled, single centre trial</p> <p>Exp: Trapeziectomy with tendon interposition (APL)</p> <p>C: Trapeziectomy with Swanson silicone trapezium implant</p>	<p>Inclusion criteria:</p> <p>Age (mean): Exp/C= 62/62</p> <p>Gender (female/male): Exp/C= 12:1/12:1</p> <p>Stage of OA (mean): Exp/C= not stated</p>	<p>Surgery: Exp/C</p> <p>Exp: Trapeziectomy with tendon interposition (APL). Postoperative plaster cast immobilisation of the thumb for 5 weeks</p> <p>C: Trapeziectomy with Swanson silicone trapezium implant. Postoperative plaster cast immobilisation of the thumb for 5 weeks.</p>	<p>Pain: A 100 mm visual analogue scale was used to assess average daytime thumb pain, and the number of subjects with sleep disturbing pain and continuous pain were reported</p> <p>Physical function: The number of subjects reporting pain with heavy work and light work were reported</p> <p>Patient global assessment: Not reported</p> <p>Range of motion: Radial abduction and palmar abduction were measured with a goniometer.</p> <p>Strength: Grip strength, thumb tip (2 point) and key (lateral) pinch strength were measured with a Martin Vigorometer and reported in kp/cm².</p> <p>Trapeziometacarpal joint imaging: Measurement of the distance between the base of the thumb metacarpal and the distal end of the scaphoid were reported as trapezium height in millimeters. The measurement was repeated during pinch against the index finger to detect a further decrease in the functional trapezium space.</p> <p>Adverse effects: Complications of cyst formation and dislocation of the prosthesis in the Swanson group were reported</p>

APPENDIX E.5a Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for pain

Study (Comparison)	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Belcher & Nicholl (2000) T & LRTI / T	VAS (mm)	23	78	2	19	64	5	23	40	6	19	37	6						
Belcher & Zic (2001) T & IA / T	VAS (mm) (median / range)	13	78	48-99	13	77	62-92	13	47	7-81	13	16	2-67						
Davis et al. (1997) T / T & LRTI	Night pain (no.)	31	13		62	28		31	1		62	1							
Davis et al. (1997) T/T & IA	Night pain (no.)	31	13		59	30		31	0		59	2							
De Smet (2004) T & LRTI / T	VAS	34			22			34	2.4	2.05	22	3.25	2.33						
Gerwin et al. (1997) T & LRTI / T & LR	Not reported																		
Kriegs-Au et al. (2004) T & LRTI / T & LR	P at rest (no.)	16	13		15	9			3			1							
Tagil & Kopylov (2002) T & IA /Swanson	VAS (mm)	13	68	14	13	68	14	13	14	20	9	11							

APPENDIX E.5b Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for weakness

Study	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Belcher & Nicholl (2000) T & LRTI / T	Pinch-lat (kg)	23	3.3	0.4	19	3.5	0.5	23	4.0	0.3	19	3.7	0.4						
Belcher & Zic (2001) T & IA / T	Pinch-key (kg) (median / range)		3.5	1-7		3.5	0.5 -7		3	0.5 -7		4.5	2-8						
Davis et al. (1997) T / T & LRTI	Pinch-lat (CI)	31	3.7	3.3 - 4.1	62	3.4	2.9 - 3.8	31	4.8	4.4 - 5.2	62	4.5	4.1 - 5.0						
Davis et al. (1997) T/ T & IA	Pinch-lat (CI)	31	3.7	3.3 - 4.1	59	3.5	3-4	31	4.8	4.4 - 5.2	59	4.3	3.8 - 4.8						
De Smet (200)	Key pinch post/preop							34	111 %		22	102 %							
Gerwin et al. (1997) T & LRTI / T & LR	Pinch-lat (kg)							9	4.8	1.6	11	5.4	1.4						
Kriegs-Au et al. (2004) T & LRTI / T & LR)	Pinch-lat (<i>bar[Pa]</i>)	16	.23		15	.21			.25			.32							
Tagil & Kopylov (2002) T & IA /Swanson	Pinch kp/cm2	14	0.2	0.2	14	0.2	0.1	13	0.4	0.1	13	0.3	0.1						

APPENDIX E.5c Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for contracture

Study	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Belcher & Nicholl (2000) T & LRTI / T	TMJ abd (cm)	23	4.3	0.1	19	4.2	0.2	23	4.6	0.1	19	4.3	0.1						
Belcher & Zic (2001) T & IA / T	Abd (cm) (median /range)		4	3.5-5		4	3.5-5		4	2.5-5.5		4.5	3-5.5						
Davis et al. (1997) T / T & LRTI	Pal abd° (all grps)	31	33	11	62	33	11	31	39	10	62	39	10						
Davis et al. (1997) T / T & IA	Pal abd° (all grps)	31	33	11	59	33	11	31	39	10	59	39	10						
De Smet (2004) T & LRTI / T	Web angle both grps		63.6			63.6		34	84.8		22	84.8							
Gerwin et al. (1997) T & LRTI / T & LR	Pal abd°							9	47	6	11	44	8						
Kriegs-Au et al. (2004) T & LRTI / T & LR	Pal abd°	16	32		15	34			38			42							
Tagil & Kopylov (2002) T & IA /Swanson	Pal abd°		50	12		38	13		36	6		34	7						

APPENDIX E.5d Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for hand function

Study	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Belcher & Nicholl (2000) T & LRTI / T	Function score on VAS (cm)	23	57	3	19	54	4	23	39	5	10	30	4						
Belcher & Zic (2001) T & IA / T	Function VAS (mm) (median / range)	13	50	10-78	13	45	27-71	13	45	10-78	13	36	0-64						
Davis et al. (1997) T / T & LRTI	Not reported																		
Davis et al. (1997) T / T & IA	Not reported																		
De Smet (2004) T & LRTI / T	DASH score							34	33	29.6	22	27	22.8						
Gerwin et al. (1997) T & LRTI / T & LR	Subj satisfn % Fn 6 tasks							9	72		11	76							
Kriegs-Au et al. (2004) T & LRTI / T & LR	Sx again?	16			15				75			100							
Tagil & Kopylov (2002) T & IA / Swanson	Subj satisfaction %	14			14			13	85		13	100							

APPENDIX E.5e Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for patient global assessment

Study	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>N</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Kriegs-Au et al. (2004) T & LRTI / T & LR	Good to excellent in Buck-Gramcko score	16			15			16	13		15	15							

APPENDIX E.5f Surgery for thumb (trapeziometacarpal joint) osteoarthritis: Mean (SD) preoperative and postoperative scores for trapeziometacarpal joint imaging

Study	Measure	Pre-operative measures						Post-operative measures						Change scores					
		<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>			<i>Experimental</i>			<i>Control</i>		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Belcher & Nicholl (2000) T & LRTI / T	SMD(mm)	23	11.3	0.6	19	10.4	0.4	23	2.2	0.2	19	2.3	0.3						
Belcher & Zic (2001) T & IA / T	SMD(mm) (median /range)	13	10	4-13	13	13	7-13	3	3	1-8	13	4	1-6						
Davis et al. (1997) T / T & LRTI	Not reported																		
Davis et al.(1997) T/ T & IA	Not reported																		
De Smet (2004)	SMD % post/preop							34	57.5%		22	32%							
Gerwin et al. (1997) T & LRTI / T & LR	SMD (mm)							9	4.5	1.0	11	5.2	1.7						
Kriegs-Au et al. (2004) T & LRTI / T & LR	Trap space (mm)	16	11.9		15	10.7			4.1			3.6							
Tagil & Kopylov (2002) T & IA /Swanson	Trap height (mm)	14	10.7	1.6	14	10.8	1.6	13	3.6	2.0	13	7.1	1.8						

APPENDIX E.5g Surgery for thumb (trapeziometacarpal joint) osteoarthritis: number of participants with adverse effects

		Pain	Instability	Neuroma	Sensory loss	Tendon dysfunctn	Pain & erythema	RSD	Infection	Scar tender
Belcher & Nicholl (2000) T & LRTI / T	<i>Exp 23</i>	2	1	1	1	1				
	<i>Con 19</i>	1		1						
Belcher & Zic (2001) T & IA / T	<i>Exp 13</i>	1	2				5			
	<i>Con 13</i>			1	2					
Davis et al. (1997) T / T & LRTI	<i>Exp 31</i>			3	1			1		
	<i>Con 62</i>			3	3	8		2		3
Davis et al. (1997) T / T & IA	<i>Exp 31</i>			3	1					
	<i>Con 59</i>			3	4	6				1
De Smet (2004) T & LRTI / T	<i>Exp 34</i>									
	<i>Con 22</i>		1							
Gerwin et al. (1997) T & LRTI / T & LR	<i>Exp 9</i>	Not								
	<i>Con 11</i>	reported								
Kriegs-Au et al. (2004) T & LRTI / T & LR	<i>Exp 16</i>				2			1		
	<i>Con 15</i>				2					
Tagil & Kopylov (2002) T & IA /Swanson	<i>Exp 13</i>									
	<i>Con</i>		2							

**APPENDIX E.6a Surgery for thumb (trapeziometacarpal joint) osteoarthritis:
Adverse effects of T versus T & LRTI, and T & IA**

Study	Group	Tendon rupture / adhesion	Scar tenderness	Pain and erythema	Sensory change	Cut palmar cutaneous branch median nerve	Neuroma	Instability	CRPS (Type 1)
Belcher & Nicholl (2000)	Trapeziectomy (n=19)						1		
	T & LRTI (n=23)	1			1		1	1	
Belcher & Zic (2001)	Trapeziectomy (n=13)				2		1		
	Porcine collagen (n=13)			5				2	
Davis, Brady & Dias (2004 (a))	Trapeziectomy (n=31)				3	1			1
	T & LRTI (n=62)	8	3		3	3			2
Davis, Brady & Dias (2004 (b))	Trapeziectomy (n=31)				3	1			
	T & IA (n=59)	6	1		4	3			
De Smet et al. (2004)	Trapeziectomy (n=21) T & LRTI (n=34)							1	

**APPENDIX E.6b Surgery for thumb (trapeziometacarpal joint) osteoarthritis:
Adverse effects of T and LRTI versus T, T & IA, T & LR**

Study	Group	Tendon rupture / adhesion	Scar tenderness	Pain and erythema	Sensory change	Cut palmar cutaneous branch median nerve	Neuroma	Instability	CRPS (Type 1)
Belcher & Nicholl (2000)	T & LRTI (n=23) Trapeziectomy (n=19)	1			1		1 1	1	
Davis, Brady & Dias (2004 (a))	T & LRTI (n=31) Trapeziectomy (n=62)	4	1		1 6	2 2			1 1
Davis, Brady & Dias (2004 (C))	T & LRTI (n=31) T & IA (n=59)	4 6	2 1		2 4	1 3			1
Kriegs-Au et al. (2004)	T & LRTI (N=16) T & LR (n=15)								1

**APPENDIX E.6c Surgery for thumb (trapeziometacarpal joint) osteoarthritis:
Adverse effects of T & IA versus T, T & LRTI, and joint replacement (Swanson)**

Study	Group	Tendon rupture / adhesion	Scar tenderness	Pain and erythema	Sensory change	Cut palmar cutaneous branch median nerve	Neuroma	Instability	CRPS (Type 1)
Belcher & Zic (2001)	Porcine collagen (n=13) Trapeziectomy (n=13)			5	2		1	2	
Davis, Brady & Dias (2004 (b))	T & IA (n=30) Trapeziectomy (n=62)	3			2	1			1
Davis, Brady & Dias (2004 (c))	T & IA (n=29) T & LRTI (n=62)	3	1		2	2			2
Tagil & Kopylov (2002)	T & IA (n=13) Swanson (n=13)							2	

**APPENDIX E.6d Surgery for thumb (trapeziometacarpal joint) osteoarthritis:
Adverse effect of joint replacement (Swanson) versus T & IA**

Study	Group	Tendon rupture / adhesion	Scar tenderness	Pain and erythema	Sensory change	Cut palmar cutaneous branch median nerve	Neuroma	Instability	CRPS (Type 1)
Tagil & Kopylov (2002)	Swanson (n=13) T & IA (n=13)							2	

**APPENDIX E.6e Surgery for thumb (trapeziometacarpal joint) osteoarthritis:
Adverse effects of T & LR versus T & LRTI**

Study	Group	Tendon rupture / adhesion	Scar tenderness	Pain and erythema	Sensory change	Cut palmar cutaneous branch median nerve	Neuroma	Instability	CRPS (Type 1)
Kriegs-Au et al. (2004)	T & LR (n=15) T & LRTI (n=16)								1

