i. Anterior openbite tendencies can cause the patient to subluxate the condyles and rotate the mandible over molar fulcrums to bring the anterior teeth together. This should not go undetected before treatment is completed because of the harmful consequences that are likely to accompany condylar subluxation.

B. Posterior relationships

Posterior teeth should be arranged to provide stable intercuspation in centric relation, and adequate disclusive pathways for cusps to travel through in eccentric excursions (Wasson 1979). The mesiodistal molar relationship can vary from an ideal Class I relationship to the almost Class II cusp-fossa occlusion, depending on the mesio-distal width of the anterior teeth, their angulation and inclination, and any rotations or spacing anteriorly.

The marginal ridge heights of the adjacent posterior teeth should be equal so that the long axes, mesiodistally, of the posterior teeth, will receive the closure forces down their long axes. The crowns should not be left mesially or distally tipped (Andrews 1976). (Begg and Kesling 1977). Lateral excursions during function require cusp-embrasure relationships of the buccal segments to ensure cusp passage (Andrews 1976). The lingual cusps of the upper molars should be more occlusal than the buccal cusps. Williamson (1981) says that the best functioning position for the maxillary molar lingual cusps is approximately one millimeter longer than the buccal cusps, when viewing straight across the occlusal plane. The trick is to have them prominent enough to seat in the central fossae of the lower molars, but not so prominent as to interfere with function (Andrews 1976).

The mandibular second molars must have a non-working groove for the maxillary mesio-lingual cusp to pass through (Wasson 1979). This is the most common place for a non-working interference to occur, because most mandibular second molars do not have three buccal cusps as do the first molars.

Wasson (1979) claims that it is essential to band second molars whenever possible, so they may be properly positioned. Occlusal interferences involving these teeth, he says, can be most damaging because they are located closest to the muscle forces which move the mandible.

Roth (1973) says that balancing side interferences are usually due to:

a. Insufficient lingual crown torque of the maxillary molars
b. Failure to truly establish a correction of the maxillary-mandibular relationship
c. Arch width incoordination or arch form incoordination
d. Too much lingual crown torque of the mandibular molars
e. Distal rotation of maxillary premolars
f. Insufficient mandibular arch width in the premolar region.

C. Anterior relationships - overbite, overjet, angulation and inclination

Thurow (1977) recommends limiting vertical canine overbite in finishing, so that in posttreatment settling of the occlusion, canines can then adjust to the optimum functional pattern for the individual. He says that if a deep canine overbite is produced, a vertical pattern will be predetermined as the canines continue to limit lateral functional movements from that time on. Roth (1981c) agrees that, at the end of appliance therapy, the anterior guidance should almost not be adequate. After appliance removal, he says, the curve of Spee will return and the overbite will deepen to provide a more ideal anterior guidance. Aubrey (1978), on the other hand, says that when a case is treated to an edge-to-edge relationship, it may settle and establish a normal overbite, but a few do not.

A common criticism from our gnathological colleagues concering many orthodontically treated occlusions is that the anterior teeth are frequently positioned in an end-to-end anterior relation and are unable to perform anterior function in the mutually protected occlusion (Tuverson 1980). Most orthodontists

are not accustomed to angulating upper canines as much as 11 degrees (Andrews 1976). According to Andrews, upper canines that are too upright interfere with the lower first premolars in lateral excursions (or lower second premolars in extraction cases).

The lack of adequate overbite of the anterior teeth in finished orthodontic cases can result from a discrepancy in anterior interocclusal arch length. The arch length discrepancy could be the result of excessively large lower anterior teeth, but more frequently it is the result of smaller upper anterior teeth, usually the lateral incisors, or improperly positioned upper anterior teeth (Tuverson 1980).

The 5 degree and 9 degree mesiodistal angulations of the upper central and lateral incisors are necessary to satisfy their contact point, aesthetic and functional requirements, and to occupy sufficient arch length, thus forcing the posterior teeth distally to permit normal posterior occlusion with normally tight contact points (Andrews 1976). Also, if the maxillary canines are too gingivally placed, they will occupy insufficient space (Roth 1976).

Upper and lower incisors must be properly inclined labiolingually to limit their extrusion (Andrews 1976). To achieve an interincisal angle of 139 degrees, Andrews claims that an interincisal crown angle of 174 degrees is needed (Figure 23). Properly inclined anterior crowns contribute to normal overbite and posterior occlusion, and to the protrusive phase of functional occlusion (Figure 24).

When the maxillary incisors have insufficient crown inclination, they take up less room in the arch. In such an instance, space opens distal to the cuspids unless the upper posterior teeth are brought forward into a more Class II position (Wasson 1979).

Because of the wide variation in skeletal and muscular patterns encountered clinically, it is sometimes difficult

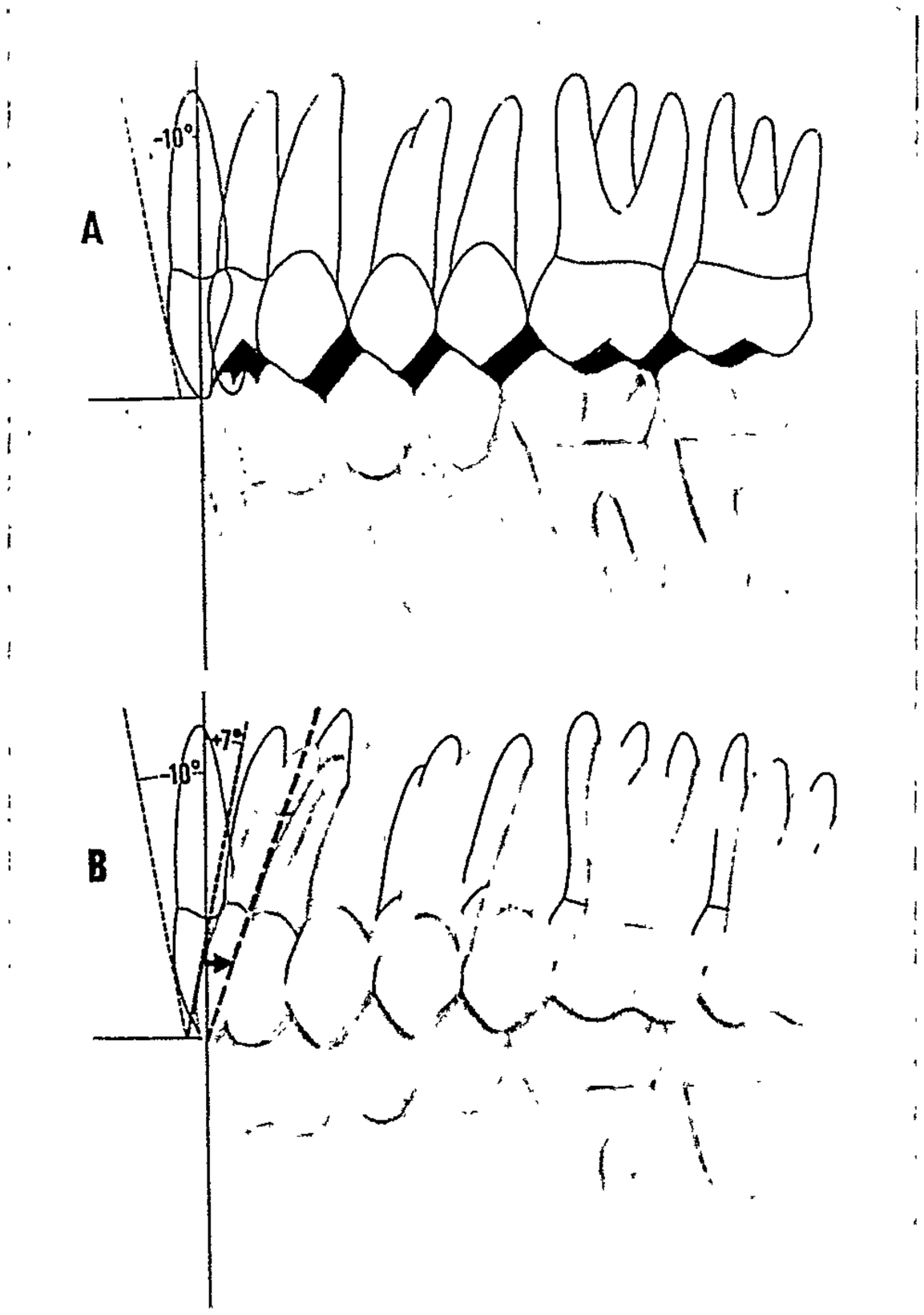

FIGURE 23. Effect of insufficient anterior tooth inclination on posterior relationships.

A. If anterior crowns are insufficiently inclined, all upper contact points are too mesial, preventing "normal occlusion".

B. When anterior crowns are properly inclined the contact points move distally, allowing for "normal" occlusion.

(From: Andrews 1976)

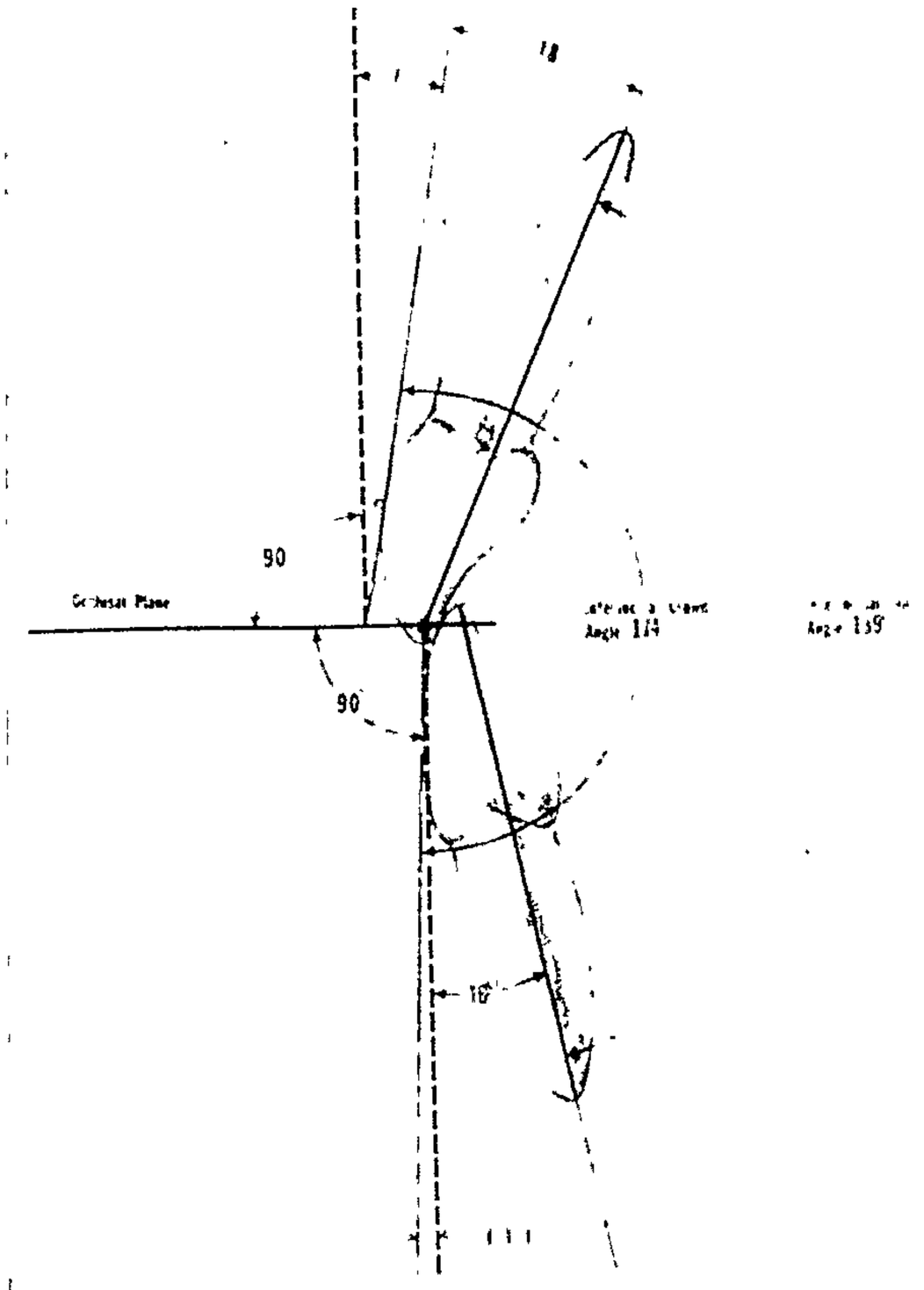

FIGURE 24. Interincisal crown angle versus interincisal tooth angle.
(From: Andrews 1976)

to treat to a specific angle for the maxillary incisor (Wasson 1979). Patients with Class III skeletal patterns will need more labial inclination of the maxillary incisors than will patients with Class II skeletal patterns. Another factor that influences the inclination of the upper incisor is the Collum angle - the angle between the crown and root of the central incisor. If the crown bends lingually on the root, much more lingual root torque will be needed to position the crown of the maxillary incisor properly to the mandibular incisor.

D. Plane of occlusion

The curve of Spee and the curve of Wilson should be relatively flat because this will help to resolve second molar prematurities by reducing the plane of posterior occlusion or compensating curve relative to the angle of the eminentia (Watson 1980). A reverse curve of Spee would place increased stress on the premolars and should be avoided. Also, complete flattening of the curve of Wilson may incorporate working bite interferences.

Sometimes banding the second molar is neccessary to get an effective foundation for flattening of the lower and upper planes of occlusion (Andrews 1976). If treatment mechanics, such as prolonged use of Class II elastics, cause a steepening of the occlusal plane, a steeper anterior disclusion is necessary to separate the posterior teeth (Wasson 1979). The more the occlusal plane parallels the condylar path, the less disclusion will be provided by the condyles. Williamson (1981) says that if the distal marginal ridge of the mandibular second molar is left too high, the occlusal plane for that individual tooth more closely parallels the protrusive and mediotrusive path which the condyles follow. When this occurs, the condyles lose their potential to separate the maxillary and mandibular teeth.

6.44 Tooth positioner

Kesling (1945) wrote that the philosophy of the tooth positioning appliance grew out of a desire to create some simple appliance that would influence all of the teeth to flow into their best possible position with relation to one another, without any interferenece from bands or wires, that would be effective under functional forces, that would produce arch form in accordance with type, that would further attain the desired harmony between facial features and tooth arrangement, and that would serve as a retainer to conserve all the advantages gained above. Perry (1969) says that by using positioners, less occlusal grinding, or none at all, may be required. Williamson (1981) disputes this.

Chiappone (1975) claims that by using the positioner as a tool to deliver a gnathological finish, almost any type of tooth movement can be accomplished. Most other authors are more cautious and selective in its use. Kiser (1974) does not use positioners in all cases because he believes that they are not indicated in all situations. Barnett (1978) says that we must always be mindful that the positioner will only be helpful in guiding the teeth to move to more ideal positions. It can only improve the finish and occlusal relations on a case already diagnosed properly, and well-treated up to this point. Too many orthodontists expect too much from a positioner (Roth 1976). The properly constructed tooth positioner is a fine finishing appliance for a well-treated case. A poorly constructed positioner can ruin an excellent result. Any attempt to make large corrections with the positioner will prevent it from seating properly and lead to almost certain failure (Thurow 1972). Wasson (1979) claims that the positioner provides positive three-dimensional control, which helps the teeth settle into the most "ideal" functional and esthetic relationship without losing the centric relation position of the mandible.

Vorhies (1960) studied the effectiveness of the tooth positioner on ten patients and found that:
A. A tooth positioner does not establish a definitive pattern in the selective depression or eruption of teeth.
B. Demonstrable quantitative changes may be accomplished with a tooth positioner in a shorter period of time.
C. Improvement of crown inclination of anterior teeth is possible, but apparent success in some cases is an illusion and a resultant of other movements.
D. The axial changes of anterior teeth are primarily due to tipping when using positioners.
E. The mandible may open in a hinge or parallel manner, or not at all.

This was a very subjective study with few cases, too short a period of treatment and observation, and no control study, but it does serve to emphasize the limitations of the positioner. Actually, very little scientific study has been done on the way it works, or the long term effects of positioner wearing.

Another study was carried out by Lorentz (1973) on preformed standardized positioners, which, he says, were developed by Theodor Schuchard in 1952, on the assumption that there is a small variation of tooth size, but a great variety of malocclusions, most of which are anomalies of bite. He concluded that the standardized, ready-made positioner is not the answer to every malocclusion, but can be a good appliance for cooperative patients. This type of appliance, however, can cause more problems than it can solve in some instances. It is important that the anterior radius not be excessive, since it will tend to widen the upper arch more than the lower, with attendent incisor and canine overjet problems (Thurow 1972). Also, this type of positioner can cause problems with regards to centric discrepancies.

Most authors believe that the positioner set-up, including the bite registration and the arch form, are critical and should be individualized to the specific case (Ricketts,

Bench, Gugino, Hilders and Schulof 1979). A facebow mounting is essential. Williamson et al (1980) say that, since a positioner requires the teeth to be apart while in use, it is important that the maxillo-mandibular relationships be the same, on the articulator, that is used for its construction, as they are in the patient. If the casts are not mounted on an articulator so that the patient's hinge axis is reproduced, they will open on a different arc of closure from that of the patient. Since the positioner is constructed with the casts separated 1 or 2mm, this would force the patient's teeth to fit together on the wrong arc of closure. Depending on the direction of the error, either the posterior teeth or the anterior teeth, might occlude prematurely when the patient uses his own arc of closure (Wasson 1979).

Cottingham (1969), Barnett (1978) and Chiappone (1980) describe their gnathological techniques for positioner construction. Smart, McKinnon and Grave (1975) and Roche (1980) use only plane line articulators. Anderson and Schramm (1976) describe a method for production of a positioner using Bioplast (ethyl, vinyl-acetate) in the Biostar moulding appliance. Godfrey and Spence (1971) suggest using conventional mouthguard material in a flask for making tooth positioners. McBride and Mellor (1974) describe a method using a silicone rubber.

All authors agree that patient co-operation is essential. Smart et al (1975), Cottingham (1969) and Kiser (1974) discuss their methods for obtaining patient cooperation. Some authors use the positioner in combination with lower fixed appliances (Ricketts et al 1979), some use the positioner for a short period only (3 to 6 months) prior to other retaining devices (Cottingham 1969), (Chiappone 1975), some use it as a retainer (Smart et al 1975), while some even use it as a permanent retainer (Roche et al 1980). The long-term "jiggling" effects of the tooth positioner on the periodontium have not been investigated.

Trask (1975) suggests the use of 1.25% acidulated phosphate fluoride gel, placed in the occlusal portions of the positioner after band removal, can be of great benefit to the enamel.

6.5 OCCLUSAL EQUILIBRATION

Despite exacting orthodontic mechanotherapy, the proper amount of overtreatment, and the use of positioners for final settling, a proper registration of centric relation after correction often reveals primary points of initial contact, as well as cuspal interferences in lateral movement (Heide and Thorpe 1965). Orthodontic appliances themselves cannot produce the final balance. This may be accomplished by proper selective grinding for occlusal harmony. Sirna (1968) believes that prematurities causing occlusal trauma are a disruptive factor in completed orthodontic cases, and a contributory cause of minor relapses.

Roth (1976) suggests that there should be some reason, other than the occlusion not meeting the concept of an ideal, before equilibration is undertaken. In regard to the post-orthodontic case, occlusal equilibration is too often employed to overcome the shortcomings of the tooth positions attained during treatment. Roth (1981c) says that for a case to be equilibrated to a stable centric requires a case that has most of the proper tooth positions to begin with, and one that is reasonably close to centric. He believes that the orthodontist must utilize a specific set of criteria for a functional occlusion goal throughout diagnosis, treatment planning, treatment and retention.

Good orthodontic therapy is a prerequisite to occlusal equilibration, which should also be an essential part of every orthodontist's armentarium (Heide and Thorpe 1965). According to Dawson (1974), every orthodontist should learn the principles and techniques of occlusal equilibration. No one, he says, can be in a better position to equilibrate orthodontic patients than the orthodontist himself. Roth (1981a), on the other hand, feels that it is not practical

for the orthodontist, time-wise, to perform a correct occlusal equilibration on a large majority of his patients.

According to Begg and Kesling (1977), equilibration is a scientifically correct procedure because it simulates the occlusal and incisal attrition of Stone Age man by reducing the vertical length of tooth crowns. This also improves the crown/root ratio of the teeth. Kirveskari (1979), on the other hand, maintains that artificially produced wear does not necessarily have the same consequences as natural wear in heavy function, because the function has changed, the oral environment is different. Each case must be judged individually. He believes that selective elimination of the harmful factors only is indicated.

Kirveskari (1979) says that the retrusive path is associated with the unconscious swallow reflex, which is independent of teeth conditioning. When teeth are present, they participate in the stabilization of the mandible during these swallows, and their contribution must be in harmony with the primary stabilization by the joints and musculature, otherwise a permanent form-function disharmony arises. According to Moyers (1973), once the occlusal interferences are removed, the median occlusal position reflex, associated with the unconscious swallow, is again dominant. McNamara (1978) found that harmony of median occlusal position was related to elimination of: pain in the occlusal components; asymmetric mandibular joint displacement; supracontacts of the dentition during functional and parafunctional mandibular movements, and prolonged EMG mandibular muscle activity and jaw reflexes, tested by median occlusal position closure and tooth contact stimulus. Posselt (1971) found that selective grinding resulted in improvement followed by remission of symptoms in 50% of his experimental group, while an additional 45% improved, and only 5% showed no improvement.

Occlusal adjustment for an orthodontic patient is not the same as in an occlusion that has been stable for some time (Thurow 1972). It is permissible to change the shape of

cusps, fossae, or inclines during treatment if such changes will benefit stability after the tooth is moved (Dawson 1974). Dawson also believes that if the occlusion can be corrected in the position of retention, stabilization of the teeth in that position will be enhanced. Aubrey (1978) suggests equilibration 3 to 4 months after band removal, and says that all postorthodontic patients present occlusal problems that can be helped with equilibration. On the other hand, Roth (1976) says that if at all possible, the posttreatment orthodontic case should not be equilibrated until growth has been completed. The changes in the occlusal relationships that usually occur as a result of growth are sufficient to alter the results of an equilibration, so that equilibration results usually will not remain stable during the growth period.

Unfortunately, most well intentioned occlusal adjustment is performed without a clear-cut goal of what is to be achieved, or without a thorough understanding of the dynamics of occlusion (Roth 1980). The aim of occlusal adjustment is to provide: (Klineberg 1980)

A. A distribution of tooth contacts around the arch on the maximum number of teeth at retruded jaw position.

B. An absence of cuspal interferences from retruded jaw position and median occlusal position.

C. Multidirectional freedom from retruded jaw position for all eccentric jaw movements.

Anyone with a handpiece, greenstone and carbon paper can grind teeth, but few can accomplish the proper objectives (Roth 1976). Acceptable equilibration depends on: (Dawson 1974)

A. Accurate manipulation of the mandible to find the interfering inclines. This may require prior splint therapy (Roth 1976).

B. Accurate working of the interfering surfaces.

C. Selective grinding to eliminate the interferences and shape tooth contacts to produce the most stable relationship with the best possible function.

D. Readjustment of the occlusion until stressed teeth reach

an equilibrium with their respective periodontal ligaments and become stable.

Dawson (1974) divides equilibration procedures into:

A. Elimination of interferences to centric relation

- Grind only inclines, not cusps.
- Upper teeth are always adjusted on the inclines that face the same direction as the slide.
- Lower teeth are adjusted by grinding inclines that face the opposite direction from the path of the slide.

a. Interferences to the arc of closure - anterior slide

Mesial inclines of upper

Distal inclines of lower

b. Interference to the line of closure - lateral slide

Deviation toward cheek - Buccal inclines of upper
- Lingual inclines of lower

Deviation toward tongue - Lingual inclines of upper
- Buccal inclines of lower

B. Elimination of lateral excursion interferences

a. Balancing side

Buccal inclines of upper

Lingual inclines of lower

b. Working side

Lingual inclines of upper

Buccal inclines of lower

C. Elimination of protrusive interferences

Distal inclines of upper

Mesial inclines of lower

D. Harmonization of anterior guidance

- Check centric anterior contacts.
- Check long centric freedom.
- Check protrusive posterior disclusion.
- Check lateral group function or canine protection.

McNamara (1976a) says that not only should the above occlusal positions be considered, but also median occlusal position, due to its anatomical and neuromuscular significance.

Chiappone (1975) differentiates between occlusal equilibration and occlusal touch-up. Equilibration, he says, is a very exacting procedure and, if performed properly, should mean a pantographic survey, mounting of the case on an articulator, the case to be equilibrated first on the articulator and then back to the patient's mouth, with a remount procedure done after that to ensure that the results you have given the patient are exactly what you performed on the mounted models. Occlusal touch-up simply is cleaning up any centric prematurities where marginal ridge contact might be in prematurity, or where there might be a slight balancing or working interference.

Zachrisson and Mjor (1975) used forty-eight premolars to study pulp and dentine reactions to extensive grinding of human teeth. No significant discomfort was reported by the patients, except for an initial period of a few days during which there was increased sensitivity to temperature changes. The histologic findings indicated no or only minor, transient pulp and dentine reactions.

Occlusal equilibration is not without its critics. Marbach (1980) believes central factors, rather than peripheral influences such as those related to occlusion, may control mandibular dysfunction. He says that in the absence of evidence of an anatomic and physiologic basis for occlusal equilibration, it should be recognized for what it is - a widely practiced placebo. Goodman et al (1976) reported that 16 out of 25 patients had a total or nearly total remission of their symptoms after mock equilibrations. Glickman (1971) claims that all kinds of physiologic principles of occlusion are invoked to justify individual methods of occlusal adjustment, but the origin and factual background for the principles are vague. Most methods of occlusal adjustment, he says, are exercises in technical precision with minimal biologic relevance. Mathews says that occlusal equilibration in post-orthodontic treatment, recommended by some, should at least be viewed with caution in a dentition which is still undergoing adjustment, and

is an integral part of a growing dentofacial complex. The gap between intent and accomplishment in the field of occlusal adjustment makes the need for research self-evident.

CHAPTER 7

Aim of the Present Investigation

7. AIM OF THE PRESENT INVESTIGATION.

From the evidence presented in the literature review, it can be concluded that there are still many questions that need to be answered on the subject of occlusion, and, in particular, on occlusal considerations in orthodontic therapy. The literature, although extensive, is full of controversy and is, in large part, conjectural. Much long-term research is needed if some or all of the issues are to be clarified for the benefit of the patient and the orthodontist. This preliminary study is only a small step towards achieving this broader objective.

The present investigation deals specifically with the occurrence of residual malocclusion problems, residual occlusal disharmonies, and temporomandibular joint dysfunction signs and symptoms, in a group of patients treated by the Begg technique. This assessment was undertaken post-retention, after the so-called initial "settling" of the occlusion had taken place.

By a comparison of the findings, it was hoped that a relationship may exist between "form" and "function". In other words, does "good function" follow on from "good form", and can "dysfunction" of the masticatory system be related to "form" or "function" of the occlusion in posttreatment orthodontic patients? It would be of great benefit to orthodontists if they could define the tooth arrangement necessary to meet the criteria for a "good" functioning occlusion. If this were the case, treatment mechanics and methods could be altered to facilitate the achievement of the individual patient's functional needs.

CHAPTER 8

Material

8. MATERIAL

Ten patients who had previously had fixed appliance therapy using the Begg technique in the postgraduate clinic at the United Dental Hospital, Chalmers Street, Sydney, were recalled at random. No initial dental cast records were available for study, only the orthodontic history forms. The orthodontic histories of the patients in this study are shown in Table 1.

The patients ranged from 17 to 21 years of age at the time of examination, with an average age of 19 years. One patient (AH) was excluded from the study because he had had an extraction of a lower first molar subsequent to orthodontic therapy, resulting in tipping and drifting of some teeth. The period since discontinuance of retainer ranged from 18 months to 64 months, with an average of 32 months out of retention.

Three patients were classified as having Class I crowding malocclusions originally, one had a Class I malocclusion with upper anterior protrusion and anterior openbite, two had Class II Division 1 malocclusions with bimaxillary protrusion, one had a Class II Division 1 subdivision malocclusion, one had a Class II Division 1 malocclusion with deep anterior overbite, and two had Class III malocclusions.

The shortest period of Begg therapy was patient RK (Class III) who had 18 months of earlier treatment with a chin-cap and butterfly appliance prior to full banding. The other Class III patient (GG) also had earlier treatment, with a chin-cap and rapid maxillary expansion appliance.

The only non-extraction case was patient RK (Class III). Patient TH had a congenitally missing 45. All other teeth were removed in the course of the treatment plan. Third molars were not considered in this study. The average period of active treatment was 20 months, and the average retention period was 12 months.

TABLE 1. Orthodontic histories.

NAME/SEX		ORIGINAL ANGLE MALOCCLUSION	EXTRACTIONS	AGE AT START OF TREATMENT	MONTHS OF ACTIVE TREATMENT	MONTHS OF RETENTION	TYPE OF RETAINER	PERIOD POST-RETENTION	AGE AT THIS EXAMINATION
KH	F	Class I Crowding	15,25,35,45	14½yrs	16mths	12mths	Begg U	19mths	18½yrs
TH	F	Class I Crowding	14,24,34,45	12½yrs	20mths	18mths	Begg U	64mths	21yrs
DH	F	Class II D.1 Bimax. Pro.	14,24,34,44	15½yrs	20mths	14mths	Begg U	25mths	20½yrs
LH	F	Class II D.1 Bimax. Pro.	14,24,34,44	14yrs	24mths	10mths	Begg U	25mths	19yrs
SK	F	Class I Open Bite. Upper Protrusion	14,24,34,44	14yrs	40mths	7mths	Begg U	19mths	19½yrs
RK	M	Class III	-	12½yrs	6mths	15mths	Hawley U	45mths	18½yrs
GG	M	Class III	15,25,35,45	13yrs	15mths	12mths	Begg U	36mths	17yrs
FL	F	Class II D.1 Deep bite	16,26,36,46	13yrs	23mths	10mths	Begg U	18mths	17yrs
KM	F	Class II D.1 Subdivision	14,24,34,44	13½yrs	18mths	12mths	Hawley U&L	30mths	18½yrs

CHAPTER 9

Methods

9. METHODS

9.1 Static Analysis Index (Si)

Maxillary and mandibular impressions were taken of each patient, and casts constructed in hard stone (Velmix). These casts were then used to make an assessment of the static occlusion, based on Andrews'Six Keys (Andrews 1972, 1976).

The molar relationship (Key I) was determined according to three criteria:

A. The distal surface of the distobuccal cusp of the upper first permanent molar made contact, and occluded with, the mesial surface of the mesiobuccal cusp of the lower second molar

B. The mesiobuccal cusp of the upper first permanent molar fell within the groove between the mesial and middle cusps of the lower first permanent molar.

C. The mesiolingual cusp of the upper first molar seats in the central fossa of the lower first molar.

Table 2 shows the scoring of the molar relationship in each patient according to these criteria.

The long axis of the clinical crown (LACC) and the LA-point were drawn on each tooth on the casts. For all teeth except molars, the LACC was drawn on the vertical mid-developmental ridge on the labial or buccal surface of the crown (Figure 26). For molars, it was drawn on the dominant vertical groove on the buccal surface. The LA-point was made at the mid-point of LACC. The occlusal plane was taken as a flat surface upon which the casts were placed, occlusal surface downwards.

In assessing the crown angulation (Key II), the angle formed by the LACC and a line perpendicular to the occlusal plane was measured on a flat surface with a metal ruler and a protractor (Figure 27). Andrews' "ideal" measurements are shown in Table 3. A "plus reading" was awarded when the gingival portion of the long axis of the crown was distal to the incisal portion. A "minus reading" was assigned when

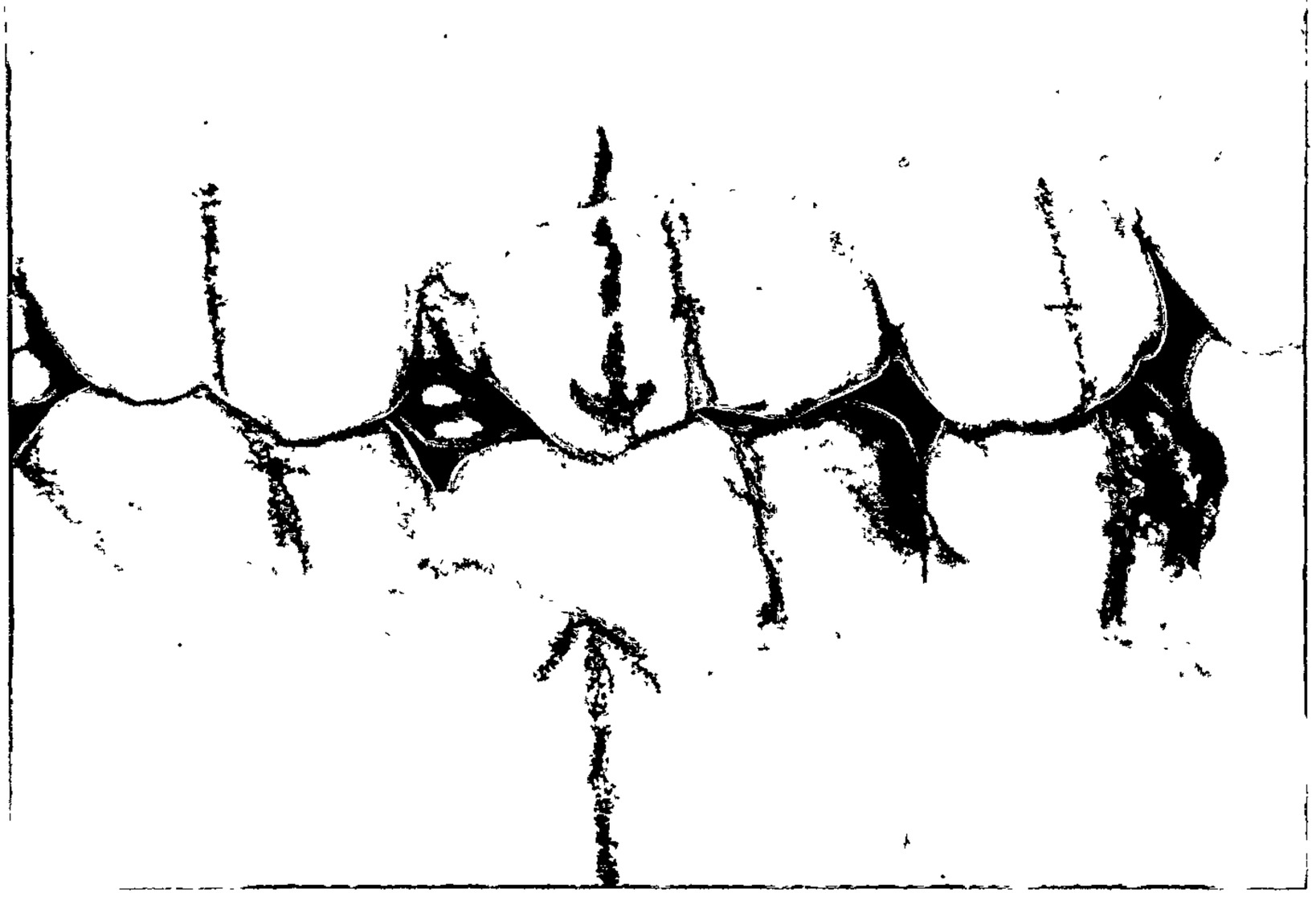

FIGURE 25. Assessment of molar relationship.

TABLE 2. Scoring the molar relationship

6 criteria (RHS + LHS) = 6 points = MR score 0

5 criteria (RHS + LHS) = 5 points = MR score 1

4 criteria (RHS + LHS) = 4 points = MR score 1

3 criteria (RHS + LHS) = 3 points = MR score 1

2 criteria (RHS + LHS) = 2 points = MR score 5

1 criterion (RHS + LHS)= 1 point = MR score 5

0 criterion (RHS + LHS)= 0 point = MR score 5

TABLE 3. Andrews' measurements for crown angulation

TOOTH	MEASUREMENT (Degrees)	TOOTH	MEASUREMENT (Degrees)
17	5	37	2
16	5	36	2
15	2	35	2
14	2	34	2
13	11	33	5
12	9	32	2
11	5	31	2
21	5	41	2
22	9	42	2
23	11	43	5
24	2	44	2
25	2	45	2
26	5	46	2
27	5	47	2

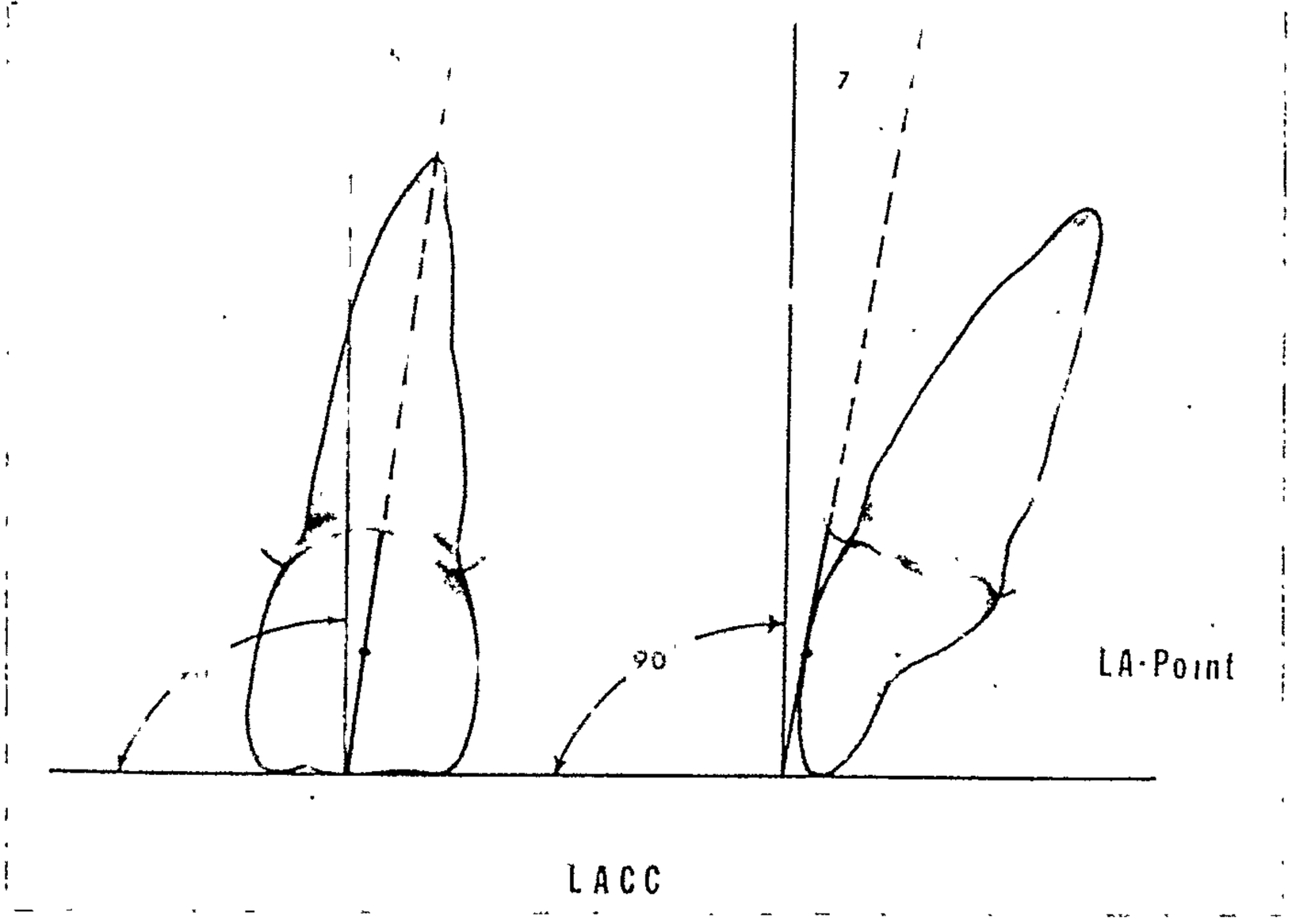

FIGURE 26. Long axis of the clinical crown (LACC).

For all teeth except molars, the LACC is at the vertical mid-developmental ridge on the labial or buccal surface of the crown. For molars it is the dominant vertical groove on the buccal surface. It is represented by a line parallel to the specified ridge or groove, and tangent to the middle of the clinical crown on the labial or buccal surface. The LA point is the mid-point of the LACC.

(From: Andrews 1976)

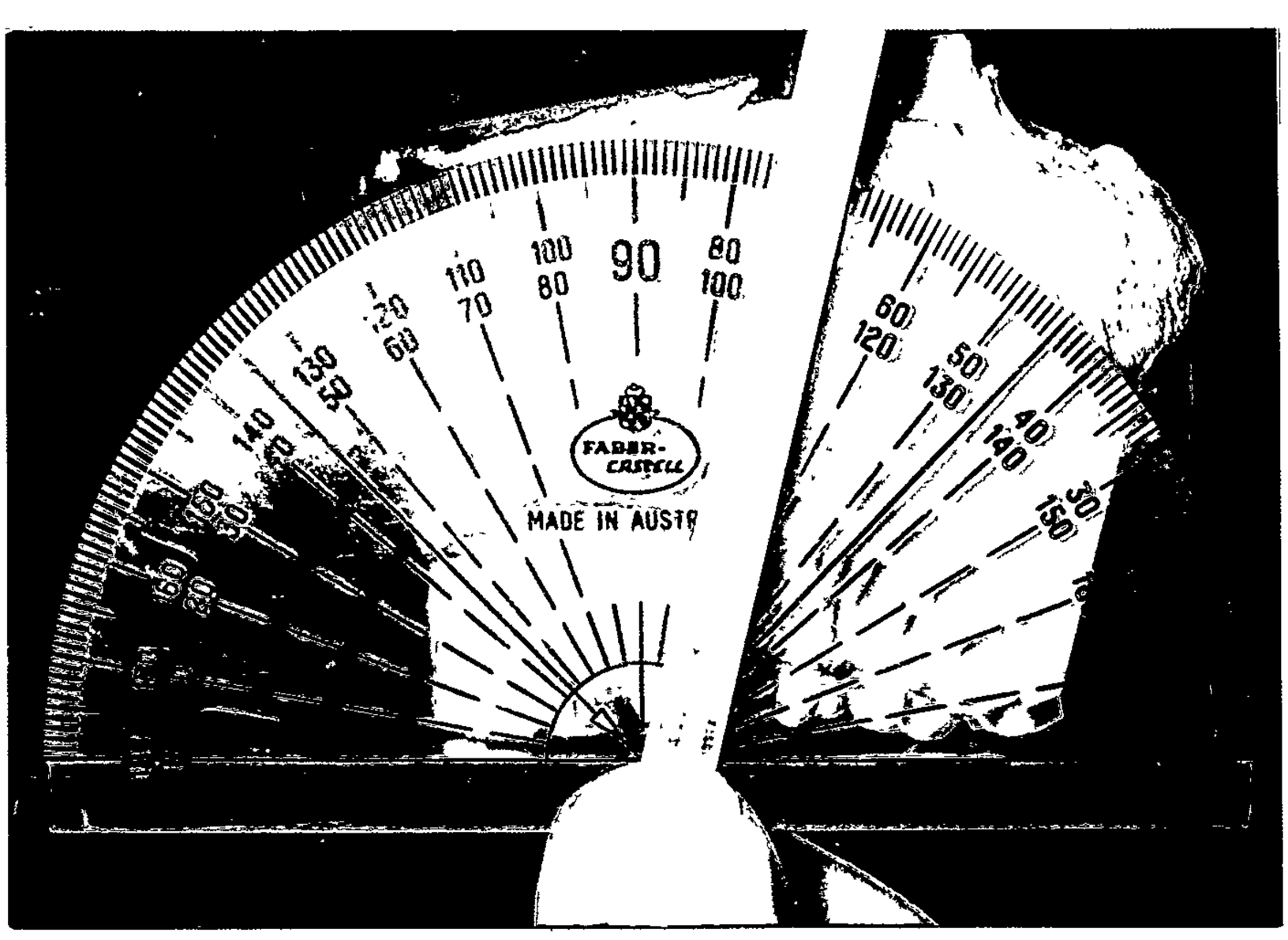

FIGURE 27. Measurement of crown angulation.

the gingival portion of the long axis of the crown was mesial to the incisal portion. In recording the angulation of the teeth in this study, the measurements were recorded of the variation in degrees from Andrews' "ideals". A "plus reading" was assigned when the tooth had excessive angulation. A "minus reading" was assigned when the tooth had insufficient angulation. A mean variation was assessed by adding all the measurements for each tooth (bilaterally) and dividing by the number of measurements. The total variation points in each patient were the sum of all variation degrees (disregarding the "plus" and "minus" signs). A score was then given to each patient for crown angulation, according to the total variation points (Table 4).

In assessing the crown inclination (Key III), the angle formed by the line which bears 90 degrees to the occlusal plane, and a line that was tangent to the middle of the clinical crown, on the labial or buccal surface at the LA-point, was measured on a flat surface with a metal ruler and a protractor (Figure 28). Andrews' "ideal" measurements are shown in Table 5. A "plus reading" was given if the gingival portion of the tangent line was lingual to the incisal portion. A "minus reading" was recorded when the gingival portion of the tangent line was labial to the incisal portion. In recording the inclination of the teeth in this study, the measurements were made of the variation in degrees from Andrews' "ideal" measurements. A "plus reading" was assigned when the tooth had excessive crown inclination. A "minus reading" was made when the tooth had insufficient crown inclination. A mean variation was assessed for each tooth by adding all the measurements (bilaterally) and dividing by the number of measurements. The total variation points in each patient were the sum of all variation degrees (disregarding the "plus" and "minus" signs). A score was then given to each patient for crown inclination, according to the total variation points (Table 4).

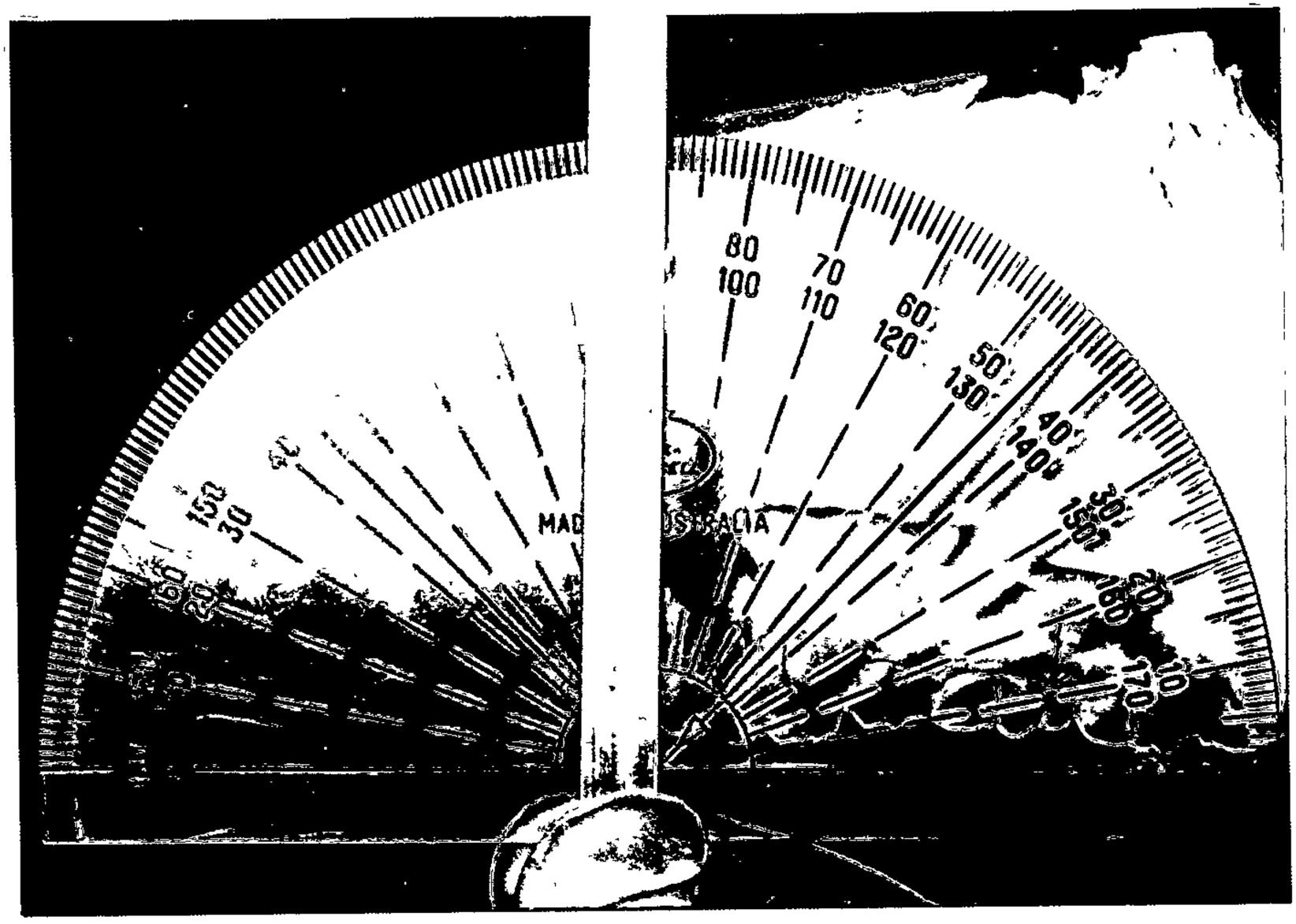

FIGURE 28. Measurement of crown inclination.

TABLE 4. Assessing the crown angulation score and crown inclination score

TOTAL VARIATION POINTS	ANGULATION/INCLINATION SCORE
Less than 100	0
100 - 150	1
Greater than 150	5

TABLE 5. Andrews' measurements for crown inclination

TOOTH	MEASUREMENT (Degrees)	TOOTH	MEASUREMENT (Degrees)
17	-9	37	-35
16	-9	36	-30
15	-7	35	-22
14	-7	34	-17
13	-7	33	-11
12	3	32	-1
11	7	31	-1
21	7	41	-1
22	3	42	-1
23	-7	43	-11
24	-7	44	-17
25	-7	45	-22
26	-9	46	-30
27	-9	47	-35

For the assessment of rotations, the curve of the arch was established, and rotations were measured as the angle between a line tangent to the LA-point of the tooth under consideration, and a line tangent to the curve of the arch (Figure 29). Only rotations of 10 degrees or more were counted in this study. Table 6 shows the criteria for scoring the number of rotations in each patient.

Any open contact points were assessed with the aid of dental floss. If no definite tension was felt interproximally on removal of the dental floss, an open contact was recorded. The criteria for scoring the number of open contact points in each patient is shown in Table 7.

The curve of Spee recordings were measured between a flat surface and the deepest point of the curve from incisors to second molars (Figure 30). The two sides, right and left, were then averaged to give the measurement, which was then scored according to the criteria shown in Table 8.

The scores awarded for each of the Six Keys of Andrews were then added together. Each individual, therefore, had a total static analysis score ranging from 0 to 30 points. Then, according to the number of points, a Static Analysis Index (Si) was awarded (Table 9).

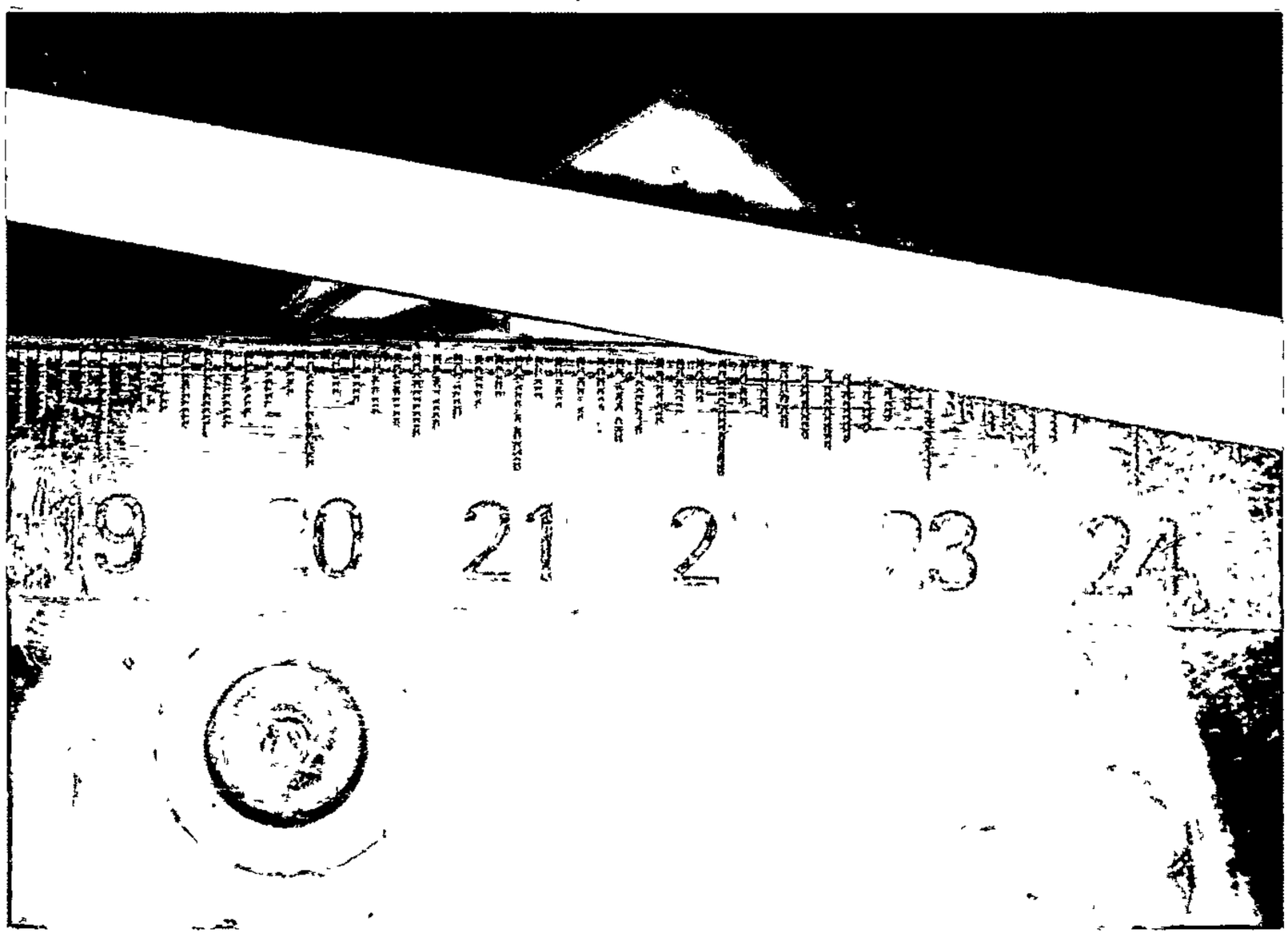

FIGURE 29. Measurement of rotations.

TABLE 6. Assessing the rotation score

NUMBER OF ROTATED TEETH	ROTATION SCORE
0	0
1 - 3	1
Greater than 3	5

TABLE 7. Assessing the contact point score

NUMBER OF OPEN CONTACT POINTS	CONTACT POINT SCORE
0	0
1 - 3	1
Greater than 3	5

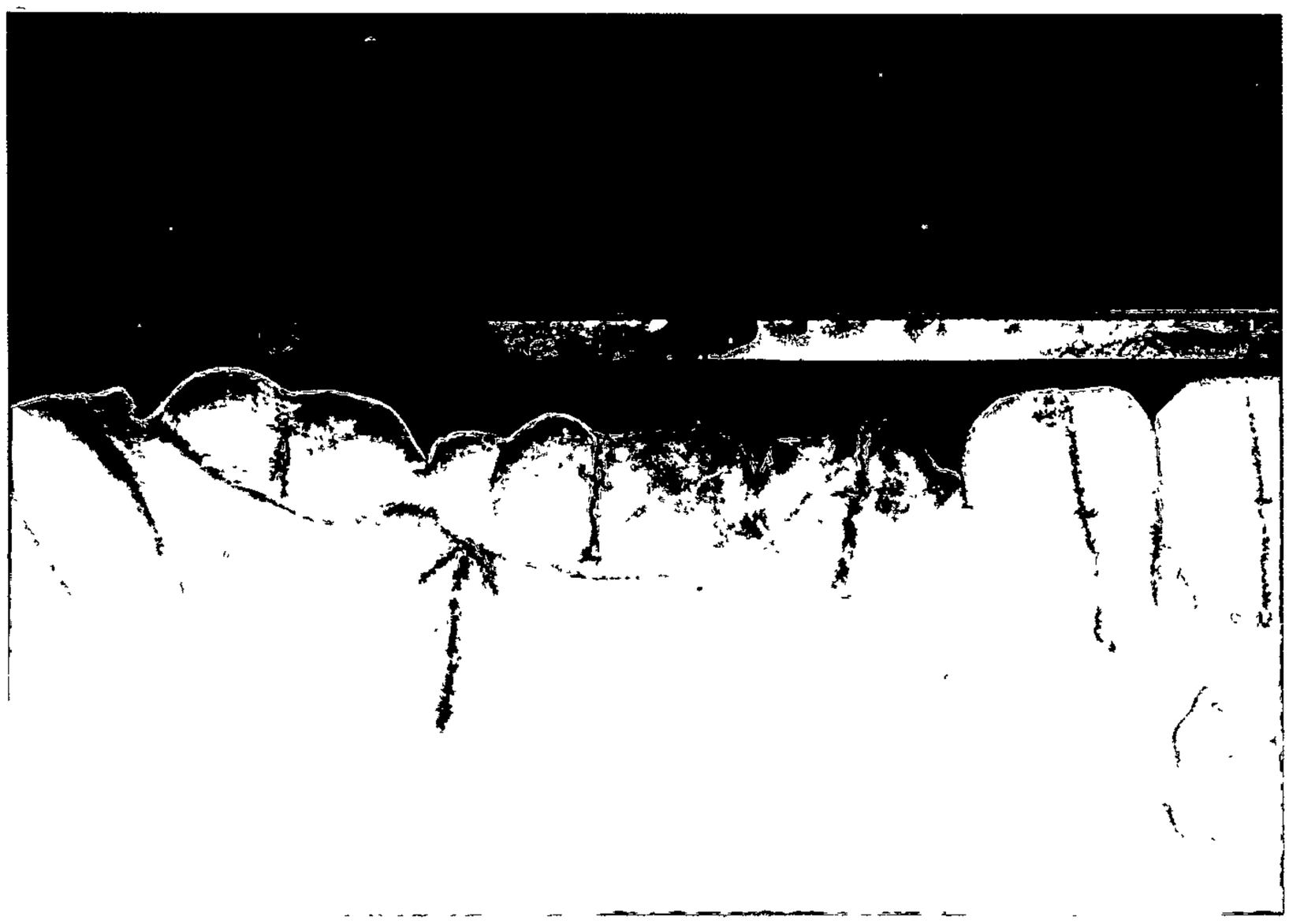

FIGURE 30. Measurement of the curve of Spee.

TABLE 8. Assessing the curve of Spee score

CURVE OF SPEE (mm)	CURVE OF SPEE SCORE
Less than 1.5	0
1.5 - 2.5	1
Greater than 2.5	5

TABLE 9. Static Analysis Index (Si)

TOTAL STATIC ANALYSIS SCORE	STATIC ANALYSIS INDEX
1 - 10	SiI
11 - 20	SiII
21 - 30	SiIII

9.2 Anamnestic Dysfunction Index (Ai)

In order to form a comprehensive opinion of the severity of any subjective symptoms, Helkimo's Anamnestic Dysfunction Index (Ai) (Helkimo 1974a, 1974b, 1974c) was used, on the basis of the patient's report of different symptoms of dysfunction of the masticatory system:

Ai0 comprised individuals who, according to the anamnesis, were free from any symptoms of dysfunction in the masticatory system. They did not report any of the symptoms in AiI or AiII.

AiI comprised individuals with mild symptoms of dysfunction. They had reported that they had one or more of the following symptoms: temporomandibular joint sounds, feeling of fatigue of the jaws, feeling of stiffness of the jaws on awakening or on movements of the lower jaw. None of the symptoms given under AiII were reported.

AiII comprised individuals judged as having severe symptoms of dysfunction. When reporting their history they had described one or more of the following symptoms as common: difficulties in opening the mouth wide, locking, luxations, pain on movement of the mandible, pain in the region of the temporomandibular joint or of the masticatory musculature. Toothache, headache and pain in the neck and shoulders were not included in the anamnestic index.

9.3 Clinical Dysfunction Index (Di)

The index for clinically demonstrable dysfunction of the masticatory system was designed on the basis of five symptoms, each judged according to a three grade scale of severity using 0, 1 or 5 points (Helkimo 1974a, 1974b, 1974c). "No symptom" was awarded 0; a mild symptom, 1; and a severe symptom, 5 points (Table 10). The five symptoms were: impaired range of movement of the mandible, impaired function of the temporomandibular joint, pain on movement of the mandible, muscle pain, and temporomandibular joint pain. Therefore, "dysfunction" is defined as the presence of any of these five symptoms.

The index for mobility of the mandible was based on measurements of maximal opening (distance between cutting edges of incisors + vertical overbite), maximal movement to right and left, and maximal protrusion. Estimations were made of the degree of deviation from values of a symptom-free population, as given by Agerberg (1967). Each movement was evaluated separately and given a score of 0, 1 and 5, according to the limits given in Table 11. The scores for the four different movements were added, and the sum(E) was in turn evaluated and given a final value of 0, 1 or 5, according to the index code shown in Table 11.

Impaired function of the temporomandibular joint was judged as follows:
0 point was awarded for a straight path of movement of opening and closing of the mandible, without palpable temporomandibular joint sounds.
1 point was awarded for any form of palpable temporomandibular joint sound or visible lateral deviation (greater than 2mm) of the path of movement during opening or closing of the mandible.
5 points were awarded for clinically demonstrable locking or luxation of the temporomandibular joint when the various movements of the mandible were performed. Here locking is to be understood as an occasional blocking of

TABLE 10. Clinical Dysfunction Index (Di) (Helkimo 1974b)

A. Symptom:	IMPAIRED RANGE OF MOVEMENT/MOBILITY INDEX	
Criteria:	Normal range of movement	0 point
	Slightly impaired mobility	1 point
	Severely impaired mobility	5 points
B. Symptom:	IMPAIRED TEMPOROMANDIBULAR JOINT FUNCTION	
Criteria:	Smooth movement without TMJ sounds and deviation on opening or closing movements less than 2mm	0 point
	TMJ sounds in one or both joints and/or deviation greater than 2mm on opening or closing movements	1 point
	Locking and/or luxation of the TMJ	5 points
C. Symptom:	MUSCLE PAIN	
Criteria:	No tenderness to palpation in masticatory muscles	0 point
	Tenderness to palpation in 1-3 palpation sites	1 point
	Tenderness to palpation in 4 or more palpation sites	5 points
D. Symptom:	TEMPORMANDIBULAR JOINT PAIN	
Criteria:	No tenderness to palpation	0 point
	Tenderness to palpation laterally	1 point
	Tenderness to palpation posteriorly	5 points

E. Symptom: PAIN ON MOVEMENT OF THE MANDIBLE

Criteria:		
	No pain on movement	0 point
	Pain on 1 movement	1 point
	Pain on 2 or more movements	5 points

F. Sum A + B + C + D + E = Clinical Dysfunction Score (0 - 25 points)

G. Clinical Dysfunction group 0 - 5, according to code

H. Clinical Dysfunction Index (Di), according to code

Code:

0 point	= Dysfunction group 0	= Clinically symptom-free (Di0)
1-4 points	= Dysfunction group 1	= Clinically mild dysfunction (DiI)
5-9 points	= Dysfunction group 2	= Clinically moderate dysfunction (DiII)
10-13 points	= Dysfunction group 3	= Clinically severe dysfunction (DiIII)
15-17 points	= Dysfunction group 4	= Clinically severe dysfunction (DiIII)
20-25 points	= Dysfunction group 5	= Clinically severe dysfunction (DiIII)

TABLE 11. Mandibular Mobility Index (Helkimo 1974b)

A. MAXIMAL OPENING OF MOUTH	
Greater than 40mm	0 point
30 - 39mm	1 point
Less than 30mm	5 points
B. MAXIMAL LATERAL MOVEMENT TO THE RIGHT	
Greater than 7mm	0 point
4 - 6mm	1 point
Less than 4mm	5 points
C. MAXIMAL LATERAL MOVEMENT TO THE LEFT	
Greater than 7mm	0 point
4 - 6mm	1 point
Less than 4mm	5 points
D. MAXIMAL PROTRUSION	
Greater than 7mm	0 point
4 - 6mm	1 point
Less than 4mm	5 points
E. Sum A + B + C + D	**Mandibular mobility score (0 - 20)**

F. Mandibular mobility index according to code:

0 point = Mobility index 0 = normal mandibular mobility
1-4 points= Mobility index 1 = slightly impaired mobility
5-20 points= Mobility index 5 = severely impaired mobility

short duration (fixation) of a mandibular movement. Luxation is to be understood as a forward dislocation of the condylar head out of the glenoid fossa, combined with fixation in that position.

Muscle pain was said to be present if the musculature of the masticatory system was clearly tender to palpation - that is, only if the palpation produced a clear reaction of the patient (such as a palpable reflex) or if the patient stated that the site palpated was clearly more tender to palpation than the surrounding structures, or corresponding structures on the other side.
0 point was awarded if none of the muscles examined were tender to palpation.
1 point was awarded for tenderness to palpation in 1 to 3 areas palpated.
5 points were awarded if tenderness to palpation was recorded in at least 4 areas.
In the examination for muscle pain, the following bilateral areas were palpated, as illustrated by Klineberg (1980c): deep masseter muscle, superficial masseter muscle, posterior part of the temporal muscle, anterior part of the temporal muscle, insertion of the temporal muscle in the coronoid process, lateral pterygoid muscle and medial pterygoid muscle.

Temporomandibular joint pain was understood as tenderness of the temporomandibular joints to palpation from the side and via the external auditory meatus.
0 point was awarded if the temporomandibular joints were not tender to palpation.
1 point was awarded if tenderness to palpation was recorded on palpation laterally to the joint (unilaterally or bilaterally).
5 points were awarded when tenderness to palpation (unilaterally or bilaterally) was recorded on palpation from behind via the external auditory meatus and ear diseases had been ruled out.

Pain on movement was said to be present if such pain could

be provoked by letting the patients themselves systematically perform different movements of the mandible, and by requesting them to report any pain they might feel during such movements. In doubtful cases the movements were repeated against resistance of the examiner's hand.
0 point was awarded if all the movements could be performed without pain.
1 point was awarded if pain was reported only on one movement.
5 points were awarded if any 2 or more movements of the jaw produced pain.

The scores awarded for the five symptoms were then added together. Each individual, therefore, had a possible total dysfunction score ranging from 0 to 25 points. The higher the score, the more severe the disorder. Dysfunction groups 0, 1 and 2 (Table 10) were given index values DiO, DiI and DiII. Dysfunction groups 3,4,5 were pooled to form one dysfunction index value DiIII.

9.4 Index for Occlusal State (Oi)

The occlusion was evaluated from a morphofunctional point of view to give the occlusal index (Table 12). The number of teeth, the number of occluding teeth, and the presence of occlusal interfernces were observed on casts set up on a Denar Mark II articulator, and checked by clinical examination of the occlusion (Figures 31, 32 and 33). Maxillary and mandibular impressions were taken and hard stone casts were constructed. A facebow transfer procedure, using the Denar Slidematic Facebow, established the relationship of the maxillary dentition to the horizontal reference plane (Appendix III). Bilateral manipulation of the mandible was used to record retruded contact position (Appendix II), and this record was used to mount the mandibular cast on the articulator (Appendix III). Lateral checkbite and protrusive checkbite records were taken in the mouth, the progressive side shift adjustments were set to the 6 degree average anatomic dimensions, and the immediate side shift and protrusive adjustments were made (Appendix III).

The number of occluding teeth, the occlusal interferences between retruded position and intercuspal position, and articulation interferences, were observed by the use of GHM occlusion test foil inserted in GHM Miller clamping tweezers, first on the articulator, and then again in the mouth (Figures 31, 32 and 33).

Each individual had a total occlusal state score ranging from 0 to 20 points. An index for occlusal state was given according to the number of points (Table 12).

TABLE 12. Index for Occlusal State (Oi) (Helkimo 1974b)

A. NUMBER OF TEETH	
28 - 32	0 point
20 - 27	1 point
Less than 20	5 points
B. NUMBER OF OCCLUDING TEETH	
24 - 32	0 point
16 - 23	1 point
2 - 15	5 points
C. OCCLUSAL INTERFERENCES BETWEEN RP AND IP	
No interferences - a straight, symmetric anterior slide from RP to IP (distance less than 2mm)	0 point
Mild interferences - one or both of the following findings:	
a. Unilateral contact in RP and during the slide to IP (distance less than 2mm)	
b. Lateral deviation of the mandible less than ½mm during the slide from RP to IP	1 point
Severe interferences - one or both of the following findings:	
a. Lateral deviation of the mandible greater than ½mm during the slide from RP to IP	
b. The distance between RP and IP is greater than 2mm	5 points

D. ARTICULATION INTERFERENCES

No disturbances in the articulation	0 point
Mild interferences - one or both of the following findings:	
a. Interference on the laterotrusion side distally to canines	
b. Unilateral contact on protrusion	1 point
Severe interferences - interference on the mediotrusion side (unilaterally or bilaterally)	5 points

E. Sum A + B + C + D = Occlusal state score (0-20 points)

F. Index for Occlusal State (Oi) according to code:

0 point =	No disturbance in occlusion or articulation	= 0i0
1-4 points=	Moderate disturbances in occlusion or articulation	= 0iI
5-20 points=	Severe disturbances in occlusion or articulation	= 0iII

FIGURE 31. Assessment of occlusal contacts.

FIGURE 32. Assessment of anterior guidance.

FIGURE 33. Assessment of mediotrusive interferences.

9.5 The grading system and limitations of the investigation

The values 0, 1 and 5 for the signs and symptoms should not be interpreted strictly mathematically; that is, the score 5 should not be regarded as five times as severe as the score 1. The number 5 (instead of 2 or 3, for example), as a symbol of a severe symptom, was chosen so that it could be recognized, at a glance, how many severe symptoms an individual had. The Anamnestic Dysfunction Index (Ai), the Clinical Dysfunction Index (Di) and the Occlusal State Index (Oi) were determined from those of Helkimo (1974b), using his criteria. A new index, the Static Analysis Index (Si), was formulated on the basis of Andrews' Six Keys (1972, 1976) and styled on the above indices.

The validity of the indices used is difficult to test; that is, whether the indices really measure what they are supposed to do. The indices used, however, are intended mainly for use in descriptive epidemiology and for longitudinal comparisons (Helkimo 1974b). It might be questioned why the limits were chosen at specific "cut points" for each criterion, since this arbitrary choice is important, and an improper choice could lead to errors of interpretation. Generally speaking, such indices are valid if, in describing their use, an investigator provides a clear statement of what is measured, and how it is measured. This constitutes a working definition of the disease or condition under study, and data collected and comparisons made on this basis are valid, even though another investigator might not completely agree with the variables included or the methods of measurement (Helkimo 1974b).

Despite endeavours to evaluate the signs and symptoms objectively, a certain degree of subjectivity was unavoidable, especially since some of the examination methods used required cooperation of the patient, or were based on subjective evaluation of the patient's reaction to a certain step of the examination. Moreover, it was not feasible to retake all of the records for reproducibility studies of the many variables involved in the study, since some

patients could not make further appointments, and because of the complexity of testing each variable.

Weinberg (1980) emphasizes the limitations in using a scientific method in clinical research. He says that if we could follow the scientific method in the investigation of temporomandibular pain-dysfunction syndrome, a simple cause-and-effect relationship might be demonstrated that would eliminate controversy and confusion, and provide an almost one hundred precent cure. However, the problem in human research is that we cannot isolate the variables as we can in a test-tube situation. Therefore, a clinical correlation does not necessarily prove causality; it shows a trend. Unless the variables are isolated, variable A can be correlated with variable B without the experimenter being aware that other variables C, D and E are also at work producing the effect of variable B. (Figure 34).

Empiricism is the practice of relying on observations and experiment, especially in the natural sciences. (Weinberg 1980). Correlations indicate a trend, not a cause-and-effect relationship (Figure 35). These trends such as occlusion, stress, palliative and/or definitive treatment, are applied clinically. The documented results, in a sufficient sampling, permit a constant feedback mechanism which facilitates an on-going re-evaluation of the original trend. This continual process of re-evaluation is necessary to support the original trend, but does not prove it. Under the circumstances, it is the best available; however, it leads to controversy and confusion if the reporting of a trend is thought to be a proof, as if it were validated by the scientific method (Weinberg 1980).

Weinberg (1980) says that there are several disadvantages with the empirical method as applied to temporomandibular pain-dysfunction syndrome. A differential diagnosis must be made before one of the trends (occlusion, for example) can be applied clinically. This can produce errors in the experimenter's diagnosis which would unknowingly negate the results. Thus, the documented results would be a false-

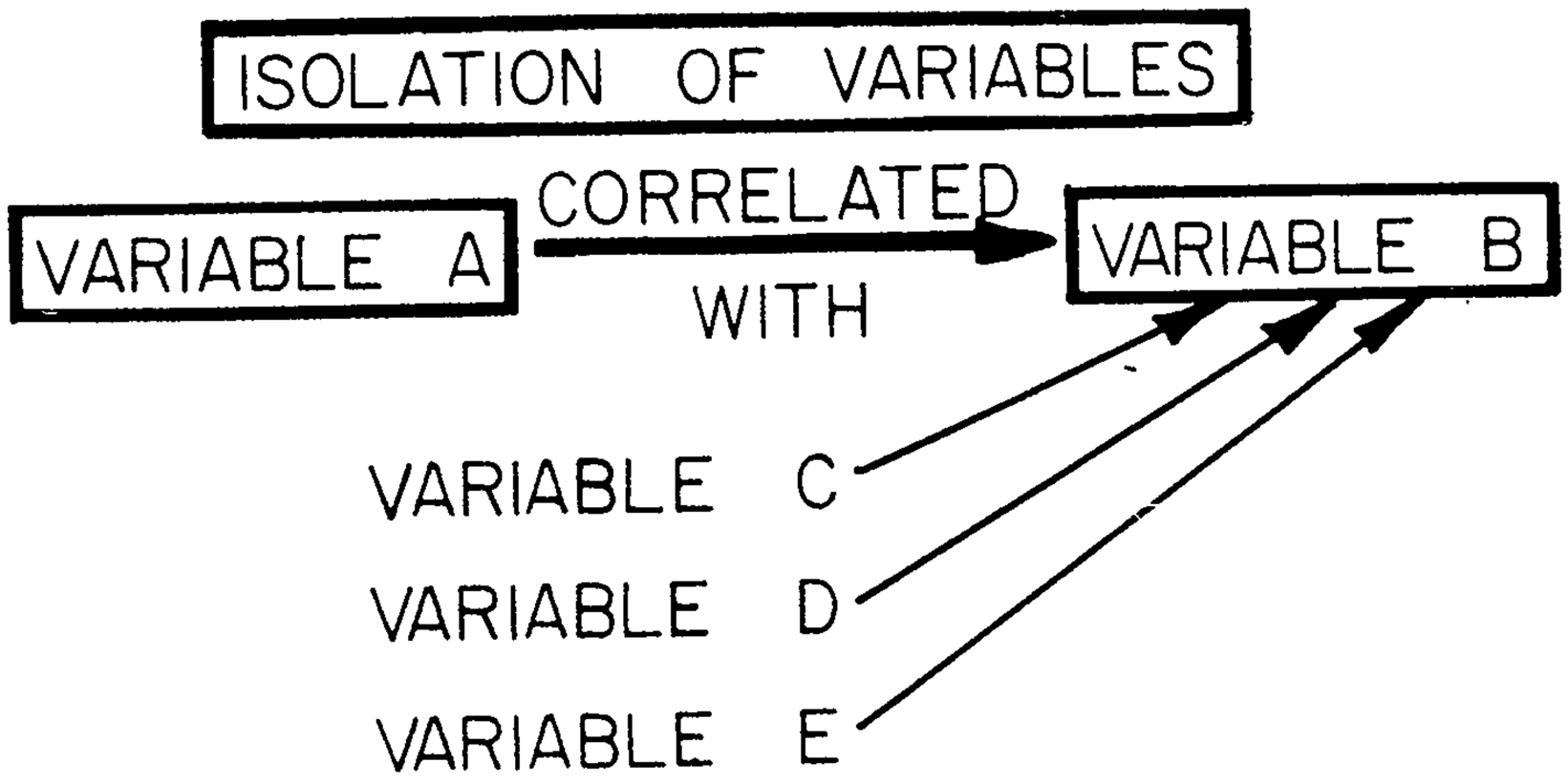

FIGURE 34. Isolation of variables.

(From: Weinberg and Lager 1980)

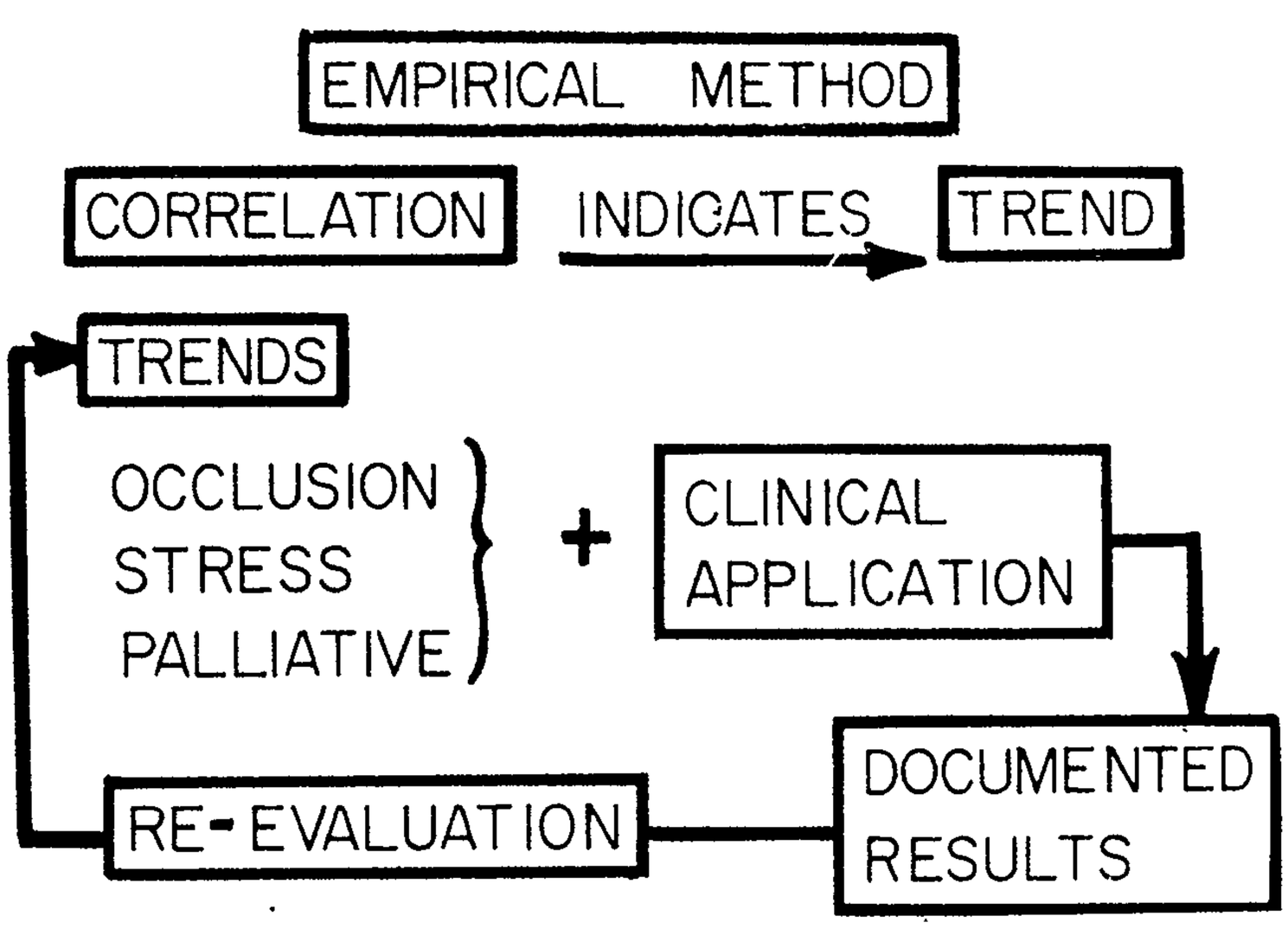

FIGURE 35. The empirical method.

Correlation indicates a trend, not cause-and-effect.

(From: Weinberg and Lager 1980)

negative response. During the re-evaluation process, experimental bias can unconsciously prejudice the results in either direction, depending on the preconceived opinion of the clinician (Figure 36). It is obvious that this procedure deviates from the scientific method which isolates one variable at a time. This stresses the need for continual documentation and re-evaluation of those trends that have been reported. The process is long and repetitive, but essential to progress (Weinberg 1980).

Despite the above limitations to the use of the indices used in this study, they did provide a method for assessment of form and function which did allow an initial clinical evaluation of each patient's occlusal problems. All of the methods used could be described as clinical procedures which can be used by orthodontists for re-evaluation of trends. Only long-term follow up with a larger sample size and comparison of individual change over time will help determine the reliability of the indices used, since only a small sample size was used in this study.

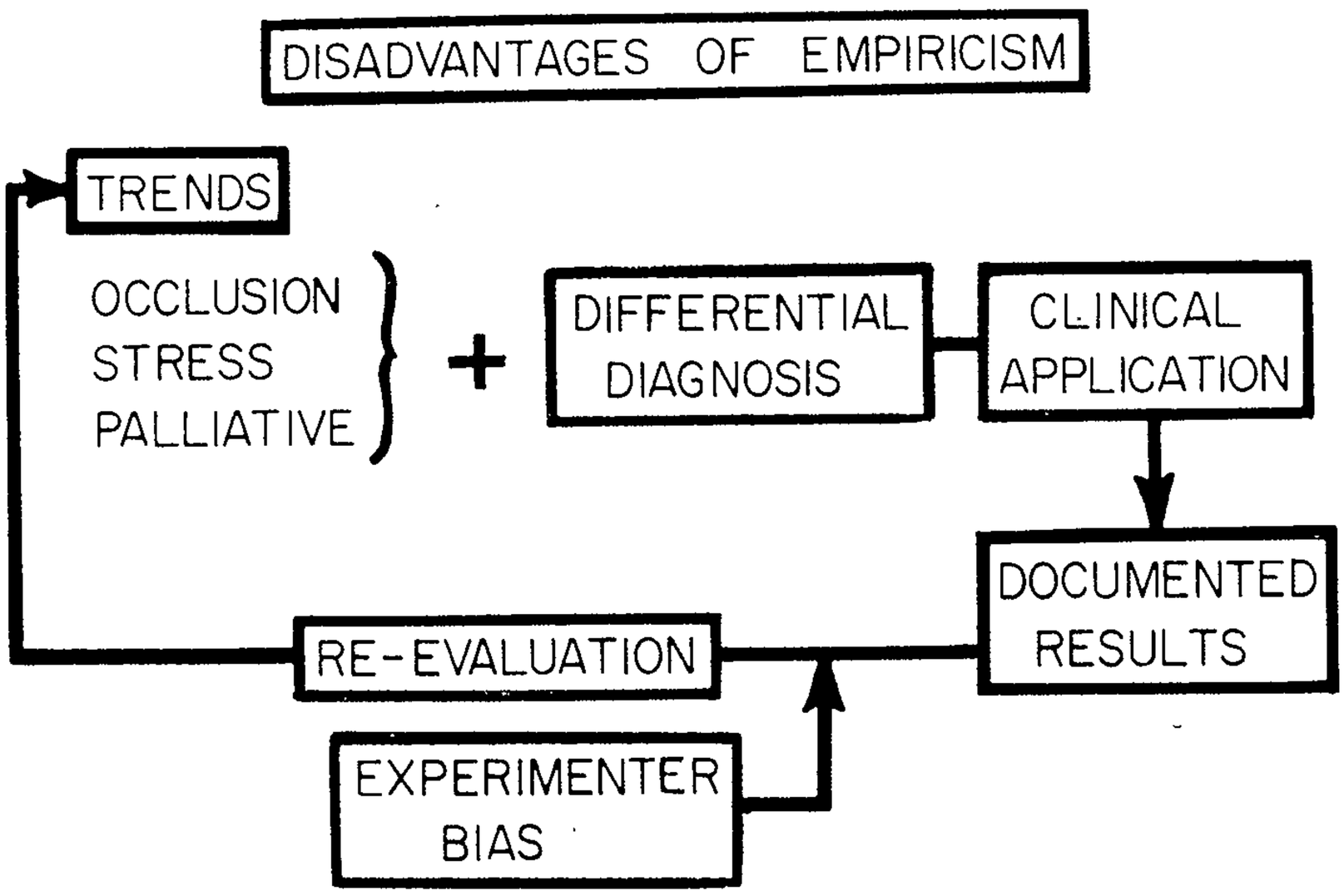

FIGURE 36. Disadvantages of empiricism.

Differential diagnosis and experimentor bias affect the re-evaluation of the trend being tested.

(From: Weinberg and Lager 1980)

CHAPTER 10

Results

and

Discussion

10. RESULTS AND DISCUSSION

According to the Static Analysis Indices (Table 23), none of the patients in this investigation had a "normal" static occlusion, as defined by Andrews' six keys. A consideration here may be that Andrews' six keys are too "idealistic", and that variations are "normal". Andrews (1972) says that if the orthodontist knows what constitutes "right" he can then directly, consistently, and methodically identify and quantify what is "wrong". The findings of this investigation indicate that, due to individual variation, differentiation of "right" from "wrong" is not always clear. It appears that Andrews' six keys provide a more objective evaluation system for the orthodontist to help in treatment planning, to help determine what may need to be done, or maybe what should have been done, but care must be used in assessing whether or not treatment goals or success have been achieved.

It may be assumed that, within this orthodontically treated group, varying degrees of severity and types of malocclusions were present prior to treatment. It may also be assumed that the finished orthodontic results were influenced by those factors which govern the quality of any completed case, namely, the skill and judgement of the operator, the cooperation and biologic response to treatment of the patient, and the methodology itself.

The molar relationship assessment is shown in Table 13. Only one patient (TH) had all three criteria bilaterally. Four patients (DH,LH,SK,KM) had reasonable molar relationships, while four patients (KH,RK,GG,FL) had poor molar relationships, according to Andrews' criteria. Criterion C was present 12 times, criterion B was present 11 times and criterion A was present 3 times. It appears that criterion A, in which the distal surface of the distobuccal cusp of the upper first permanent molar contacts and occludes with the mesial surface of the mesiobuccal cusp of the lower second molar, was the most difficult to achieve, and the one that was

overlooked in treatment. This may also be associated with the fact that it is the only criterion involving the second molars which are not usually banded in the Begg technique, and which, from the crown angulation and crown inclination assessments in this study, show relatively large variations from Andrew's measurements.

The results of the crown angulation assessments are shown in tables 14, 15 and 16. Two patients (DH,GG) were classified as having poor crown angulations overall, five patients (KH,TH,LH,SK,KM) were classified as having reasonable crown angulations, while two patients (RK,FL) were classified as having good crown angulations. When specific teeth were assessed for average values to the nearest degree, it became evident that the second molars showed the greatest variation from Andrew's measurements. The upper second molars showed the greatest variation, being insufficiently angulated - they were tipped distally. The lower second molars were excessively angulated - they were tipped mesially. The upper canines were insufficiently angulated - they were tipped mesially, but not enough. This insufficient tipping of canines may have an effect on canine guidance, although no definite relationship could be established in this study between crown angulation and type of anterior guidance.

The results of the crown inclination assessments are shown in tables 17, 18 and 19. Four patients (DH,SK,GG,KM) were classified as having poor crown inclinations overall, three patients (KH,RK,FL) were classified as having reasonable crown inclinations, and two patients (TH,LH) were classified as having good crown inclinations. Specific teeth were assessed for average values to the nearest degree. Less variations from Andrew's measurements were present in these measurements than the average values for crown angulation, although greater total variations were present in crown inclinations, and more patients scored 5 points for crown inclination than for crown angulation. Again, upper second molars showed the greatest average variation - they had excessive crown inclinations, bringing

their palatal cusps inferiorly. Gnathologists are critical of orthodontists for failing to band second molars, which often interfere with lateral excursions, and this appears justified from this study. It also appears that there is greater mean variation in canine crown angulation than canine crown inclination in the maxillary arch. This result suggests that greater attention should be given to canine crown angulation during treatment, so that a basis can be provided for establishing an "adequate" anterior guidance. It must be emphasized here that the mean variation measurements were made only to show a trend for individual teeth in one direction; that is, excessive angulation or insufficient angulation, excessive crown inclination or insufficient crown inclination. Because of the great variations that were present between individuals, and because of the limitations regarding accuracy of measuring to within one degree, the study was not involved with exact average measurements.

The rotation scores are shown in Table 20. No patient was without rotations. However, only three patients (KH,GG,FL) had 5-point scores. These three patients also had 5-point molar relationship scores, suggesting that rotations may affect the molar relationship.

The contact point scores are shown in Table 21. Three patients (TH,LH,KM) were without open contact points. Two patients (KH,FL) had 5-point scores. These scores could not be related to crown angulation, crown inclination or curve of Spee scores.

The curve of Spee scores are shown in Table 22. Overall, these measurements were quite satisfactory, with only one patient (GG) having an excessive curve of Spee. These results tend to suggest the stability of bite opening in Begg therapy.

In summary, no definite conclusions could be drawn about the relationship between the various keys. In other words,

it could not be uniformly shown that the absence of one or more of the six characteristics permits the prediction of the other error factors. There seems to be a compromise between the characteristics, which has great variability, and depends in large extent on stability factors other than just occlusal aspects.

No patient had a Static Analysis Index of SiO. Five patients (TH,LH,SK,RK,KM) had indices of SiI, three patients (KH,DH,FL) had indices of SiII, and one patient (GG) had an index of SiIII.

When the points for each patient were added for each key, it was found that the curve of Spee (10), contact point (14) and crown angulation (15) criteria were more nearly achieved, and that the criteria for rotations (21), crown inclination (23) and molar relationship (24) were less successfully achieved. The light tipping forces and round wire used in the Begg technique may account for the stability of bite opening, the reasonable mesiodistal crown angulations and contact points, but may also be responsible for inability to control buccolingual root movement. Failure to band second molars may account for the surprisingly high molar relationship score.

According to the indices for occlusal state (Table 27), none of the patients had a morphofunctionally "normal" occlusion. However, since third molars were not included in this study, only one patient (RK) could score 0 for "number of teeth", since he was a non-extraction case. If this is taken into consideration, patient TH could have an occlusal state index score of 0i0.

In all subjects the number of occluding teeth was greater in the intercuspal position than in the retruded position. The recordings of the number of occluding teeth were taken in the intercuspal position. Four patients (TH,LH,RK, GG) had no occlusal interferences between retruded position and intercuspal position. In none of the patients was the

distance between retruded position and intercuspal position greater than 2mm. These findings may have been increased if occlusal splints had been used prior to assessment (Roth 1981c), and if temporomandibular joint radiographs had been used to distinguish between functional and dysfunctional retruded position (Weinberg 1979, 1980). In two patients (DM,KH) mild interferences between retruded position and intercuspal position were present. In these patients there was unilateral contact in retruded position and during the slide to intercuspal position, and lateral deviation of the mandible less than ½mm. In three patients (KH,SK,FL) there was lateral deviation of the mandible greater than ½mm during the slide from retruded position to intercuspal position. Premature contacts in retruded position occurred on the second molars in three patients (KH,LH,DH), on the first molars in two patients (SK,LH), on the second premolars in three patients (KH,LH,FL), and on the first premolars in one patient (FL).

Two patients (TH,FL) had no disturbances in the articulation. Three patients (DH,LH,FL) had bilateral canine guidance, one patient (RK) had unilateral canine guidance and premolar guidance on the other side, one patient (KH) had unilateral canine guidance, one patient (KM) had unilateral anterior group guidance, two patients (TH,GG) had bilateral anterior group guidance, and one patient (SK) had no anterior guidance due to an anterior openbite. On protrusion, three patients (TH,FL,GG) had bilateral contact on both centrals, four patients (KH,LH,DH,KM) had unilateral contact on one central, one patient (RK) had bilateral contact on lower canines to upper lateral, and one patient (SK) had no anterior contact due to an anterior openbite. Five patients (KH,SK,RK,GG,KH) had contacts on the mediotrusive side. Three of these patients (KH,RK,GG) had unilateral mediotrusive contacts, while the other two patients (SK,KM) had bilateral mediotrusive contacts. Second molar contacts were present in all five of these patients, first molars were involved in two of the patients (SK,RK), and upper first and lower second premolars were involved in one patient (RK). The present investigation, therefore, supports

the conclusion that cuspal interferences are common in posttreatment orthodontic patients, even after a period of "functional settling".

For each patient no relationship could be established between the crown angulation or crown inclination of specific teeth, and mediotrusive interferences involving those teeth. Second molars, however, did show the greatest mean variations for crown angulations and crown inclinations, as well as being the most common mediotrusive interferences.

When the static analysis scores were grouped in "successful" order, the result was TH,LH,(RK,KM),SK,DH,FL,KH,GG. When the occlusal state scores were grouped in "successful" order, the result was TH,LH,RK,GG,DH,FL,KH,KM,SK. A surprising finding was that patients TH,LH,RK,DH,FL,KH were grouped in that order for both static analysis scores and occlusal state scores. This suggests that, at least to some extent, occlusal function follows occlusal form, and, as such, the functional occlusion may be partly under the control of the orthodontist in his achievement of the static form. Patients KM and SK, on the other hand, had relatively low static analysis scores, but relatively high occlusal analysis scores, while patient GG had a relatively high static analysis score, but a relatively low occlusal state score.

The Anamnestic Dysfunction Indices for the patients in this study are given in Table 24. Only two subjects reported pain dysfunction in the masticatory system. In one patient (DH) the symptoms were classified as mild, while in the other patient (SK) the symptoms were classified as severe. The patient with severe symptoms reported having the symptoms prior to treatment. No other patient reported having pretreatment symptoms.

The scores for the five characteristics, from which the Clinical Dysfunction Index is made up, are shown in Table 26. Only two patients (SK,RK) had any impairment of mandibular mobility as seen in Table 25. Patient Sk had

maximal opening of the mouth of only 36mm, maximal lateral movement to the right of 5mm, and maximal protrusion of 6mm. Patient RK had maximal protrusion of 4mm.

Four patients (KH,TH,FL,KM) had smooth movement of the temporomandibular joint, with deviation on opening or closing movements less than 2mm, and no temporomandibular joint sounds. Three patients (LH,RK,GG) had temporomandibular sounds, but no luxations or locking. Two patients (DH,SK) reported occasional locking and luxations.

Six patients (KH,TH,LH,RK,GG,FL) had no tenderness to palpation in the masticatory muscles. Patient KM had tenderness of the lateral pterygoid muscles bilaterally. Patient DH had tenderness of the lateral pterygoid muscles bilaterally, and deep masseter muscle on the right side. Patient SK had tenderness of the lateral pterygoid muscles bilaterally, deep and superficial masseter muscles bilaterally, and anterior temporalis muscles bilaterally.

Temporomandibular joint pain was only present in one patient (SK), and this was laterally to the joint. Pain on movement was recorded in the same patient (SK), and this was on wide opening.

From Table 26 it can be seen that three patients (KH,TH,FL) had Clinical Dysfunction Indices of DiO, four patients (LH,RK,GG,KM) had indices of DiI, one patient (DH) had an index of DiII and one patient (SK) had an index of DiIII. The two patients with Anamnestic Dysfunction Indices of AiI (DH) and AiII (SK), had Clinical Dysfunction Indices of DiII and DiIII respectively. This indicates a possible relationship between subjective awareness and clinically demonstrable dysfunction. However, none of the patients with Clinical Dysfunction Indices of DiI reported any subjective symptoms. This may indicate a "sub-clinical threshold level" of dysfunction, or an "adaptation" by the patient to minor dysfunction. The patients in this investigation were possibly still within an "adaptive" age group. Further study is needed to see if this coincides

with the concept of Weinberg (1979) that temporomandibular joint physiologic adaptation occurs where the joint does not remodel, but tolerates condylar displacements with minimal or subclinical symptoms.

Malocclusion is only one factor in a greater aetiological complex with regard to temporomandibular joint dysfunction. Anterior open bite, however, has been found to be fairly common in patients with symptoms of temporomandibular dysfunction (Mohlin and Kopp 1978). The current study supported this conclusion, in that the patient with DiIII (SK), had an anterior openbite. There was lack of anterior guidance in lateral and protrusive movements, and a "fulcruming effect" on the temporomandibular joints. However, the finding of Mohlin, Ingervall and Thilander (1980), that Angle Class III malocclusion has the strongest influence on the degree of mandibular dysfunction, according to Helkimo's Clinical Dysfunction Index, was not shown in this study. Both patients who originally had skeletal Class III malocclusions, had relatively low Clinical Dysfunction Indices, even though one of them (GG) had the highest Static Analysis Index.

When the results of the four indices are compared for each patient (Table 28), it became obvious that it is not possible at the present time to find a direct clinical correlation between occlusal form, occlusal function and signs and symptoms of temporomandibular joint dysfunction, since the "limits of neuromuscular adaptability" and other variables cannot be isolated. This in agreement with the concept of Weinberg (1980) that an empirical method, with a constant feedback mechanism which facilitates on-going re-evaluation, must be applied to temporomandibular joint dysfunction research, rather than a scientific method, which isolates one variable at a time.

TABLE 13. Results of molar relationship assessment

PATIENT	RHS CRITERIA	LHS CRITERIA	POINTS	MR SCORE
KH	C	C	2	5
TH	A + B + C	A + B + C	6	0
DH	B + C	B + C	4	1
LH	B + C	B + C	4	1
SK	B	B + C	3	1
RK		C	1	5
GG		A	1	5
FL		B	1	5
KM	B + C	B + C	4	1

TABLE 14. Results of crown angulation assessment

TOOTH	KH	TH	DH	LH	SK	RK	GG	FL	KM
17	-4	-17	-10	-3	-11	-3	-3	-5	-10
16	-5	+13	+2	-1	+1	+2	+3		-2
15		+12	+4	+13	+7	+2		-2	+4
14	+3					+3	+4	-5	
13	-2	-4	-6	+2	-3	+2	-5	-3	-8
12	-2	-6	+2	0	-1	-1	+2	+1	-6
11	-6	-2	-3	-2	+5	+3	+4	-2	-4
21	-5	-3	-7	-2	+1	-2	-4	-2	0
22	+1	-6	0	-1	-1	-6	-11	-4	-3
23	-6	-6	-6	-10	-13	-3	-21	-7	-13
24	-1					-3	+2	-4	
25		+2	+7	+3	-8	-2		-12	0
26	-8	+5	+8	+3	-1	+8	-12		-4
27	-15	-8	-13	-9	-13	-3	-10	-17	-14
37	+14	+15	+6	0	+10	+6	-1	-4	-1
36	-2	+4	+11	+2	+2	+5	+2		-3
35		+1	+11	+6	+11	+1		-1	+8
34	-4					+2	-5	0	
33	-15	+1	-2	-5	-1	-3	-14	-4	-13
32	-12	-3	+5	-4	+1	-1	-2	-2	-5
31	-4	-2	+2	-9	-1	0	-3	-3	-3
41	-2	-2	-2	-1	-4	-4	-3	-2	-6
42	-3	-3	-10	-8	-4	-5	-11	0	-8
43	-9	+5	-8	-2	-6	-5	-20	-2	-9
44	0					-2	-9	+1	
45		0	+10	+8	+9	-1		0	+7
46	+3	0	+10	+5	+3	+13	+7		+3
47	+16	+15	-6	+5	+16	+12	+13	-2	0

Code: + = Excessive angulation (degrees)
- = Insufficient angulation (degrees)

TABLE 15. Crown angulation scores

PATIENT	TOTAL ANGULATION VARIATION POINTS	ANGULATION SCORE
KH	142	1
TH	135	1
DH	151	5
LH	104	1
SK	133	1
RK	93	0
GG	161	5
FL	85	0
KM	134	1

TABLE 16. Mean crown angulation variations for specific teeth

TOOTH	MEAN VARIATION (Degrees)
11,21	-2
12,22	-2
13,23	-6
14,24	0
15,25	+2
16,26	+1
17,27	-9
31,41	-3
32,42	-4
33.43	-2
34,44	-2
35,45	+5
36,46	+4
37,47	+6

TABLE 17. Results of crown inclination assessment

TOOTH	KH	TH	DH	LH	SK	RK	GG	FL	KM
17	+6	+3	+13	+3	+3	-1	+9	+3	0
16	+9	+3	-5	-6	+4	-3	-2		-2
15		+4	0	+5	+7	+1		-8	-5
14	+7					+1	+10	-6	
13	+2	0	-12	-6	+5	+4	+10	+3	-14
12	+1	+1	0	+3	+1	+5	+13	+3	-15
11	-4	-6	-2	0	-1	+12	+5	+2	-19
21	-4	-6	-2	+3	0	+12	+11	+1	-18
22	+3	+1	0	+1	+1	+6	+16	-2	-18
23	+2	-2	-8	-5	+8	+8	+15	-1	-26
24	+5					+4	+14	-6	
25		+1	+2	+5	+9	+4		-1	-3
26	+7	-4	-5	0	+5	-1	+7		-1
27	+6	+3	+13	+8	-2	-3	+9	+13	0
37	-3	-2	+23	+9	+5	+1	-1	+10	-1
36	-1	0	+10	+6	+12	-2	-2		+3
35		+4	+7	+6	+14	+8		-1	-5
34	+2					+7	-14	-4	
33	-6	+1	+7	+3	+11	+9	-14	+3	-16
32	-9	-9	+8	0	+10	+10	-18	+10	-10
31	-9	-9	+5	+4	+2	+12	-26	+13	+1
41	-7	-2	+6	+3	+12	+12	-19	+14	-3
42	-5	-10	+7	0	+10	+11	-21	+11	0
43	-10	+7	+4	+2	+8	+9	-9	+7	-11
44	0					+4	-8	0	
45		+1	+10	+6	+14	+4		0	-5
46	+3	-4	+8	+6	+12	-1	-1		-9
47	-5	-7	+21	+9	+5	+3	-1	+7	-9

Code: + = Excessive crown inclination (degrees)
- = Insufficient crown inclination (degrees)

TABLE 18. Crown inclination scores

PATIENT	TOTAL INCLINATION VARIATION POINTS	INCLINATION SCORE
KH	116	1
TH	90	0
DH	178	5
LH	99	0
SK	171	5
RK	142	1
GG	255	5
FL	129	1
KM	194	5

TABLE 19. Mean crown inclination variations for specific teeth

TOOTH	MEAN VARIATION (Degrees)
11,21	-1
12,22	+1
13,23	-1
14,24	+4
15,25	+1
16,26	0
17,27	+5
31,41	0
32,42	0
33,43	0
34,44	-2
35,45	+4
36,46	+2
37,47	+4

TABLE 20. Rotation scores

PATIENT	NUMBER OF ROTATIONS	ROTATION SCORE
KH	4	5
TH	2	1
DH	2	1
LH	1	1
SK	3	1
RK	2	1
GG	6	5
FL	4	5
KM	3	1

TABLE 21. Contact point scores

PATIENT	NUMBER OF OPEN CONTACT POINTS	CONTACT POINT SCORE
KH	5	5
TH	0	0
DH	2	1
LH	0	0
SK	1	1
RK	3	1
GG	3	1
FL	5	5
KM	0	0

TABLE 22. Curve of Spee scores

PATIENT	CURVE OF SPEE(mm) LHS	RHS	CURVE OF SPEE SCORE
KH	2.0	2.0	1
TH	1.0	1.5	0
DH	1.0	1.0	0
LH	1.5	2.0	1
SK	2.0	1.5	1
RK	2.0	2.5	1
GG	3.5	2.5	5
FL	1.5	0.5	0

TABLE 23. Static Analysis Index (Si) results

	KH	TH	DH	LH	SK	RK	GG	FL	KM
A. MOLAR RELATIONSHIP SCORE	5	0	1	1	1	5	5	5	1
B. CROWN ANGULATION SCORE	1	1	5	1	1	0	5	0	1
C. CROWN INCLINATION SCORE	1	0	5	0	5	1	5	1	5
D. ROTATION SCORE	5	1	1	1	1	1	5	5	1
E. CONTACT POINT SCORE	5	0	1	0	1	1	1	5	0
F. CURVE OF SPEE SCORE	1	0	0	1	1	1	5	0	1
G. STATIC ANALYSIS SCORE	18	2	13	4	10	9	26	16	9
H. STATIC ANALYSIS INDEX (Si)	II	I	II	I	I	I	III	II	I

TABLE 24. Anamnestic Dysfunction Index (Ai) results

PATIENT	ANAMNESTIC DYSFUNCTION INDEX (Ai)
KH	0
TH	0
DH	I
LH	0
SK	II
RK	0
GG	0
FL	0
KM	0

TABLE 25. Mandibular Mobility Index results

	KH	TH	DH	LH	SK	RK	GG	FL	KM
A. MAXIMAL OPENING OF MOUTH	0	0	0	0	1	0	0	0	0
B. MAXIMAL MOVEMENT TO RIGHT	0	0	0	0	1	0	0	0	0
C. MAXIMAL MOVEMENT TO LEFT	0	0	0	0	0	0	0	0	0
D. MAXIMAL PROTRUSION	0	0	0	0	1	1	0	0	0
E. MANDIBULAR MOBILITY SCORE	0	0	0	0	3	1	0	0	0
F. MANDIBULAR MOBILITY INDEX	0	0	0	0	1	1	0	0	0

TABLE 26. Clinical Dysfunction Index (Di) results

	KH	TH	DH	LH	SK	RK	GG	FL	KM
A. MANDIBULAR MOBILITY INDEX	0	0	0	0	1	1	0	0	0
B. IMPAIRED TMJ FUNCTION	0	0	5	1	5	1	1	0	0
C. MUSCLE PAIN	0	0	1	0	5	0	0	0	1
D. TMJ PAIN	0	0	0	0	1	0	0	0	0
E. PAIN ON MANDIBULAR MOVEMENT	0	0	0	0	1	0	0	0	0
F. CLINICAL DYSFUNCTION SCORE	0	0	6	1	13	2	1	0	1
G. DYSFUNCTION GROUP 0 - 5	0	0	2	1	3	1	1	0	1
H. CLINICAL DYSFUNCTION INDEX (Di)	0	0	II	I	III	I	I	0	I

TABLE 27. Index for Occlusal State (Oi) results

	KH	TH	DH	LH	SK	RK	GG	FL	KM
A. NUMBER OF TEETH	1	1	1	1	1	0	1	1	1
B. NUMBER OF OCCLUDING TEETH	0	0	5	1	5	0	1	5	5
C. INTERFERENCES BETWEEN RP AND IP	5	0	1	0	5	0	0	5	1
D. ARTICULATION INTERFERENCES	5	0	1	1	5	5	5	0	5
E. OCCLUSAL INDEX SCORE	11	1	8	3	16	5	7	11	12
F. INDEX FOR OCCLUSAL STATE (Oi)	II	I	II	I	II	II	II	II	II

TABLE 28. Comparison of indices

	KH	TH	DH	LH	SK	RK	GG	FL	KM
Si	II	I	II	I	I	I	III	II	I
Ai	0	0	I	0	II	0	0	0	0
Di	0	0	II	I	III	I	I	0	I
Oi	II	I	II	I	II	II	II	II	II

CHAPTER 11

Summary

11. SUMMARY

The literature review provided many areas of controversy with regard to occlusion in general, and occlusal considerations in orthodontic therapy in particular. Chapter 2 provided pertinent anatomical and physiological aspects of functional occlusion. Movements and positions of the mandible were discussed, with particular reference to retruded position, intercuspal position and median occlusal position. The question of what is temporomandibular joint functional "adaptation" was raised, since this is relevant to the possible pathological effects resulting from occlusal disharmonies. Chapter 3 explained the difference between static occlusion and functional occlusion, and provided certain criteria which may be used, with reservations, to assess these concepts clinically. Chapter 4 described "ideal" occlusal contacts, and studies on occlusal interferences in orthodontically treated and untreated occlusions. Chapter 5 reviewed current thoughts on the possible effects of occlusal disharmony on the stability of orthodontic results, on temporomandibular joint dysfunction, on bruxism and on occlusal trauma, and emphasized the role of prevention. Chapter 6 examined the application of static and functional occlusal concepts to orthodontic therapy, with the accent on orthodontic therapy limitations. The need for a functional consideration of occlusion in diagnosis and treatment planning, especially in patients with temporomandibular joint dysfunction before treatment, in adult patients, and in patients having orthognathic surgery was stressed, as well as the need for improved finishing procedures. The use of Stage IV mechanics in the Begg technique and the tooth positioner were also discussed. The role of occlusal equilibration in orthodontic therapy was presented.

In the present investigation, nine patients, with an average age of 19 years, previously treated by the Begg technique, were recalled at random. The average period out of retention was 32 months. These patients represented a

mixture of original malocclusion types.

Each patient was assessed according to four indices:

1. A new index was formulated for this study, the Static Analysis Index, which was based on Andrews' Six Keys (molar relationships, crown angulations, crown inclinations, rotations, contact points, curves of Spee), and determined from study casts.
2. Anamnestic Dysfunction Index of Helkimo, which was based on the subjective symptoms of the patient.
3. Clinical Dysfunction Index of Helkimo, which was based on five symptoms (impaired range of movement of the mandible, impaired function of the temporomandibular joint, pain on movement of the mandible, muscle pain, temporomandibular joint pain), and determined clinically from examination of the patient.
4. Index for Occlusal State of Helkimo, which was based on four morphofunctional criteria (number of teeth, number of occluding teeth, occlusal interferences between retruded position and intercuspal position, articulation interferences), and determined from casts on a Denar Mark II articulator and clinical examination of the patient.

By use of these indices, an attempt was made to find a clinical correlation between occlusal "form", occlusal "function" and signs and symptoms of temporomandibular joint dysfunction. No direct correlations could be found, thereby agreeing with the concept of multifactorial aetiology of occlusal dysfunction and temporomandibular joint dysfunction. Occlusal problems, however, were definitely present in this posttreatment orthodontic group of patients. The need for long-term serial study was emphasized.

CHAPTER 12

Conclusions

12. CONCLUSIONS

1. The present study indicates that comparing one individual with another adds little to the definition of "acceptable" occlusion. It would appear that this leads to "mean value" reasoning, and tells the orthodontist little about the individual. This suggests that future investigation should involve accumulation of data of long-term serial studies of individuals, and of how each individual changes over a period of time, rather than a comparison of individuals at a specific time.

2. Modern dental treatment is designed to focus on one overriding goal - optimally maintainable oral health, within the wide range of structural and functional variation which biologically has to be considered "normal". All that the orthodontist can do at the present time, is to develop in his own mind, a concept of what constitutes a healthy, well-functioning dentition, strive to establish this, and presume that this has been a contribution to the creation and maintenance of health for the individual patient.

3. Because no control group was used in this study or, more importantly, no records of the patients before treatment were available, no conclusion could be made regarding criticism levelled at the orthodontist for "creating" occlusal disharmony and temporomandibular joint dysfunction. However, from the findings of this study, it may be concluded that the criticism of the orthodontist for "ignoring" occlusal disharmonies in posttreatment patients, seems justified. The most notable result of the present investigation was that occlusal interferences are definitely present in a group of posttreatment orthodontic patients after an initial period of "functional settling".

4. No relationship could be established between "dysfunction" and "unsuccessful" static or functional orthodontic results. Despite the absence of a cause-and-effect relationship, those patients with signs and symptoms of dysfunction of

the temporomandibular joints also had occlusal disharmonies. The orthodontist is in a good position to follow up the patient through a changing time, when the patient can be diagnosed for possible occlusal problems - this advantage should be optimized regardless of whether orthodontic therapy caused, helped, or had no effect on the occlusal pattern. Because the orthodontist upsets the original "balance" of the occlusion, he incurs a definite responsibility for the well-being of the patient's occlusion, but not necessarily for all changes that follow his treatment, since many factors are unpredictable, such as aging changes, genetic predisposition to pathologic changes, as well as abnormal functional forces and psychological factors.

5. The current study supports the conclusion that no appliance or mechanotherapy can terminate the need for astute diagnostic ability, and that Begg therapy is no exception. The orthodontist does not treat patients by any technique or philosophy without experiencing some degree of "failure". Orthodontists must look realistically and objectively at the shortcomings of orthodontic therapy in an attempt to reduce the number and extent of the "failures". This is particularly true of finishing and retention techniques, which should be related to individual treatment "needs", rather than routine office procedures. The use of different types of finishing procedures in the Begg technique, such as Stage IV mechanics and tooth positioners, and their influence on the occurrence of occlusal problems, are areas of study that need further investigation.

6. Considering the occurrence of occlusal interferences in this study, occlusal equilibration may be a necessary supplement to orthodontic therapy, after the initial "functional settling" period has taken place, although further investigation of the long-term benefits of this procedure needs to be carried out.

7. It appears likely that, with increasing demands for orthodontic therapy, and with the requirements for higher standards of finishing, the time factor may prevent

orthodontists from carrying out occlusal equilibration procedures, which may be done by an appropriate general practitioner or occlusion specialist. The orthodontist should, however, have time for prevention and diagnosis of occlusal problems. The orthodontist should have the diagnostic ability and armentarium to clinically determine the presence of occlusal abnormality, not only from a static viewpoint, but from a functional viewpoint as well. This may involve use of a semi-adjustable articulator as a diagnostic aid. The orthodontist should also have the knowledge to recognize early temporomandibular joint dysfunction, and the ability to do minor occlusal adjustments. In this way communication between specialists, and between orthodontist and referring dentist, will be enhanced, and more realistic expectations of orthodontic therapy will be assumed.

8. The findings of this investigation indicate that second molars should be banded towards the end of Begg therapy, due to the unpredictability of their eruption position, especially when the first molars are moved during treatment. Also, care must be taken during Begg treatment to angulate the maxillary canines sufficiently so that a satisfactory anterior guidance can be established during the posttreatment "functional settling" period. Consideration must also be given to arch coordination during treatment.

9. Only serial study will reveal whether long-term stability of occlusal positions is maintained, or whether new equilibrium forces acting on the teeth cause "acceptable" static and functional occlusion results to change from time to time, so that many of the conclusions of this study as well as others, cannot yet be proven.

10. Without long-term research and serial study, the controversy of what constitutes an "acceptable" occlusion which will minimize the "potential" for pathology, will remain. Obviously this is a reflection of the present state of the "art" of orthodontics. "The complexity of the subject

is overwhelming, but pursuit of some answers is essential for our expanding progress in patient care" (Watson 1981).

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APPENDIX I

Glossary

APPENDIX I - GLOSSARY (Solberg 1979, Klineberg 1980b, Andrews 1976)

Bennett shift (mandibular side shift) - the bodily side shift of the mandible which occurs during a lateral jaw movement.

Border movement - any extreme mandibular movement limited by bone, ligaments, or soft tissues.

Bruxism - the clenching or grinding of teeth when not chewing or swallowing.

Bruxofacet - A supracontact which can be diagnosed as a site of tooth-to-tooth contact during shorter and longer rubbing mandibular movement. Bruxofacets appear as glossy, rather flat or slightly curved surfaces, and are coincidental with another similar contact or facet on the opposing arch. Such facets may or may not be a pathologic factor in producing dysfunctional symptoms.

Crown angulation - the angle formed by the long axis of the clinical crown and a line perpendicular to the occlusal plane.

Crown inclination - the angle formed by a line tangent to the middle of the labial or buccal long axis of the clinical crown, and a line perpendicular to the occlusal plane.

Curve of Spee - the antero-posterior curvature of the occlusal surfaces, beginning at the tip of the lower canine and following the buccal cusp tips of the premolars and molars, and continuing to the anterior border of the ramus.

Curve of Wilson - an imaginary concave line drawn medio-laterally to touch the cusp tips of similar teeth on each side of the lower arch, due to the upper posterior teeth slanting outward and the lower posterior teeth slanting inward.

Deflective occlusal contact - a supracontact which diverts the mandible from a normal path of closure.

Disclusion - in contact movements, the separation of segments of teeth by another segment having steeper guiding inclines.

Dual bite - an occlusion with an antero-posterior retruded position-intercuspal position distance of more than 2mm,

where two separate and distinct occlusal positions, in or close to, the retruded position and intercuspal position respectively, can be taken up.

Dysfunction - a state of morphofunctional disharmony resulting either in pathologic changes in the tissues or a functional disturbance.

Envelope of function - the individual jaw movement cycle occurring from intercuspal position and returning to intercuspal position in function. It is a three dimentional movement. A masticatory sequence is a composite of individual envelopes of function from the beginning of mastication until swallowing occurs.

Functional angle of occlusion - the angle formed by the teeth as the jaw moves into and from intercuspal position. It is influenced by anterior tooth arrangement and cusp height of posterior teeth.

Intercuspal position (centric occlusion) - is the habitual jaw position in which teeth are in static contact. Intercuspal clench position is the jaw position in which there is maximal tooth contact.

Immediate side shift - a mandibular side shift in which the orbiting condyle moves essentially straight medially as it leaves centric relation.

Laterotrusive contact (working side contact) - tooth contact occurring when the mandible moves laterally, away from the midline, usually between maxillary buccal and lingual cusps and mandibular buccal and lingual cusps.

Long axis of the clinical crown - for molars the LACC is identified by the dominant vertical groove on the buccal surface. For all other teeth it is at the vertical mid-developmental ridge. Viewed from the mesiodistal perspective, the LACC is represented by a line tangent to the middle of the crown's labial or buccal surface.

Long axis point - the mid-point of the long axis of the clinical crown.

Long centric - freedom to close the mandible either into centric relation or slightly anterior to it without varying the vertical dimension of occlusion.

Maximal protrusion - the horizontal distance between the

intercuspal and maximal protruded position with contact between the lower and upper teeth.

Maximal lateral movement - the horizontal distance between a point in the median plane in intercuspal position and maximal lateral position to the right and left with contact between the lower and upper teeth.

Mediotrusive angle - the angle formed by the sagittal plane and the path of the mediotrusive condyle during lateral movement as viewed in the frontal and horizontal planes. The mediotrusive angle in the sagittal plane is the angle made by the protrusive condyle path and the mediotrusive condyle path. The mediotrusive angle in the horizontal plane is known as the Bennett angle.

Maximal opening - the maximal vertical mobility of incision inferiorly, or the vertical distance in the median plane between the incisal edges of the upper and lower central incisors at maximal active opening of the mouth plus the vertical overbite.

Median occlusal position - the position of tooth contact developed by a snap closing movement from a moderate jaw opened position.

Mediotrusive contact (balancing side contact) - tooth contact occurring when the mandible moves medially, towards the midline, usually between maxillary lingual cusps and and mandibular buccal cusps.

Occlusal interference - supracontact hampering or hindering smooth, gliding, harmonious jaw movements with the teeth maintaining contact or cuspal contacts.

Orbiting condyle - the condyle on the mediotrusive side that moves downwards, forwards and medially along the guiding incline of the articular fossa.

Postural jaw position (rest position) - is not a border position but is the static jaw position that arises when the jaw is held suspended from the skull in its neuromuscular sling, when the jaw and facial muscles are relaxed. It is a muscular position determined by the visco-elastic properties of the protein and connective tissue elastic elements of muscle and the superimposed myotatic stretch reflexes generated in the antigravity muscle by the

primary afferent innervation of muscle spindles.

Progressive side shift - a mandibular side shift which occurs at a rate or amount which is directly proportional to the forward movement of the orbiting condyle.

Retruded position (centric relation) - the spatial position of the jaw with tooth contact, when the condyles are located in their uppermost position in the glenoid fossa. This is a braced jaw position, rarely achieved in function in the natural dentition. It is a guided jaw position (a border position) recorded for clinical treatment procedures.

Rotating condyle - the condyle on the laterotrusive side around which lateral jaw movement occurs. There is unlikely to be a pure rotation, but rather an associated component of lateral, posterior, anterior or inferior condyle movement as well.

Settling - the adjustment of the various structures of the denture that occurs as a result of cellular reactions taking place in the bone of the alveolar process, in the periodontal membrane, and in the cementum, when the teeth, no longer mechanically supported, are subjected to the forces of occlusion and the pressures emanating from the environmental muscles.

Supracontact - any area in the occlusal scheme which hinders the remaining occlusal surfaces from making a many-pointed and stable contact. Supracontact is a morphological term and does not necessarily imply a dysfunctional or pathological situation.

Terminal hinge axis - a border position of the condyles equivalent to retruded position where, on guided opening, there is no translation of the condyles.

APPENDIX II

Checkbite Procedure

APPENDIX II - CHECKBITE PROCEDURE (Dawson 1974, Denar Mark II Technique Manual)

The orthodontist should always manipulate the patient's mandible in obtaining the checkbite. The patient must not be instructed or allowed to bite or close down in such a manner as to cause flexion of the mandible or movement of the teeth in obtaining the record. The patient should lie back flat, chin pointed up with the neck stretched. Working from a seated position behind the patient, the orthodontist firmly stabilizes the patient's head between his forearm and rib cage. All four fingers of each hand are placed on the lower border of the mandible. The thumbs are placed over the symphysis, with the tips touching each other. When pressure is applied, it is exerted downward and backward. The net effect is a kind of torquing of the mandible, which seats the condyles up into their most superior position. With a gentle touch, the open jaw is lightly manipulated into the terminal hinge position by using short arcs of 2 to 3mm.

The checkbite record should be made at a vertical opening that does not permit the first interfering tooth to contact. Two thicknesses of hard baseplate wax, trimmed so that the anterior teeth are not included in the bite, are heated around the outer edge to a dead soft consistency, and pressed against the upper teeth. The mandible is then guided so that the mandibular teeth indent the wax. The wax checkbite is chilled in water and then checked in the mouth. After this it is used to mount the mandibular cast on the articulator (Appendix III).

Lateral checkbite and protrusive checkbite records are then taken. The patient is first trained to allow the orthodontist to arc the mandible in hinge rotation with the patient's rotating condyle in its most retruded position and the orbiting condyle advanced approximately 7mm. A wax wafer composed of two thicknesses of hard baseplate wax, not covering the anterior teeth, and built up posteriorly so that there is even contact with the

mandibular teeth, is positioned on the maxillary teeth. The mandible is guided into right lateral closure. On the working side, the thumb is released and all four fingers used to exert upward pressure on the working condyle. On the balancing side, the same thumb-finger relationship that was used for centric manipulation should be maintained except that pressure should be exerted toward the working condyle. While maintaining pressure with both hands, the orthodontist asks the patient to slide the jaw to the right side and a recording is taken. The lateral checkbite is chilled in water and checked in the mouth. The left lateral checkbite is then recorded in a similar fashion. The protrusive checkbite recording is taken with the patient sliding the mandible forward, but with the orthodontist maintaining a firm hold on the mandible to make sure the condyles are staying up against the eminentia during movement. These checkbite records are then used to make the necessary adjustments on the Denar Mark II articulator (Appendix III).

APPENDIX III

Slidematic Facebow

and Denar Mark

II Articulator

APPENDIX III - SLIDEMATIC FACEBOW AND DENAR MARK II ARTICULATOR

The Denar Mark II articulator is of the Arcon construction, which, together with the Slidematic Facebow, enables quick and easy mounting of maxillary and mandibular casts.

The facebow transfer procedure establishes the relationship of the maxillary dentition to the horizontal reference plane so that the maxillary cast may be mounted on the articulator in the coorect anatomical position. The Slidematic Facebow uses the external auditory meatus reference point for determining the arbitrary hinge axis location. The built-in reference pointer aligns the bow with the horizontal reference plane. The measuring bow need not be mounted on the articulator during the transfer procedure. The bow, when detached from the reference pin, can be used again immediately with additional transfer jigs (reference pin, bitefork assembly and articulator index).

The anterior reference point is marked on the patient's right side using the Reference Plane Locator and Marker. The point is 43mm above the incisal edge of the right central or lateral incisor. The bitefork is covered with two thicknesses of softened biteplate wax. With the bitefork arm to the patient's right, the fork is placed in the mouth, aligning the patient's midline with the index ring on the fork, so that it is parallel with the patient's coronal and horizontal planes. The reference pin is attached to the measuring bow, and then the facebow is assembled on the patient. The bow is raised or lowered so that the anterior reference pointer aligns with the anterior reference point marked on the patient (Figure 37). When all necessary tightening clamps have been fixed, the facebow is removed from the patient, and the transfer jig is detached from the measuring bow. The transfer jig is then assembled on the articulator, and the maxillary cast is placed in the wax index on the bitefork. The cast is

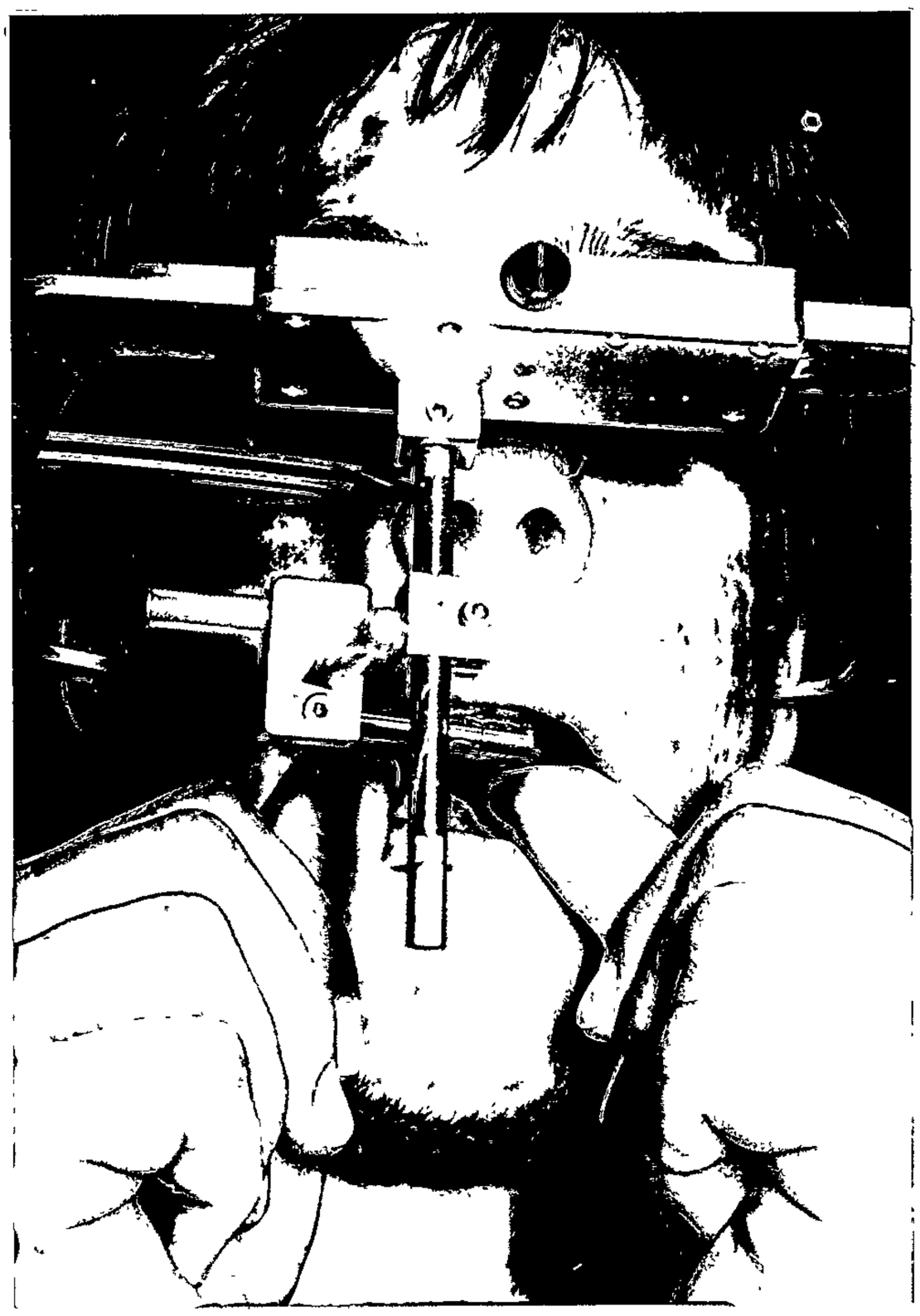

FIGURE 37. Slidematic facebow positioned on patient.

mounted with plaster to the mounting plate.

Next, checkbite records using two thicknesses of hard baseplate wax from the premolars posteriorly are taken (Appendix II). These include retruded position, right and left lateral positions and protrusive position. The articulator is turned upside down, the wax retruded position record is placed between the maxillary and mandibular casts, and the mandibular cast is secured with wooden sticks and sticky wax. The vertical dimension of the incisal pin is increased to allow for the thickness of the wax record, and a two-stage mixing procedure is used to secure the lower cast to the mounting plate (Figure 38).

The angle of inclination of the medial fossa wall to the sagittal plane is the progressive side shift adjustment, expressed on the Denar Mark II articulator in 5 degree increments (Figure 39). The progressive side shift has its principal influence on the balancing inclines of posterior cusps on the orbiting side, and on the direction of the ridges and grooves of posterior teeth, primarily on the orbiting side.

The medial fossa wall can be displaced straight medially by means of the immediate side shift adjustment, and is expressed in tenths of a millimetre (Figure 40). The immediate side shift of the mandible has primary influence on the width of the central groove of the posterior teeth.

The inclination of the protrusive condylar path is calibrated in increments of 5 degrees (Figure 41), and has an influence on the cuspal inclines anteroposteriorly. The posterior fossa wall of the Mark II articulator is non-adjustable, but is constructed to average anatomic dimensions. It is inclined posteriorly 25 degrees to allow for a backward movement of the rotating condyle as it moves outward.

The orbiting path is divided essentially into two components:

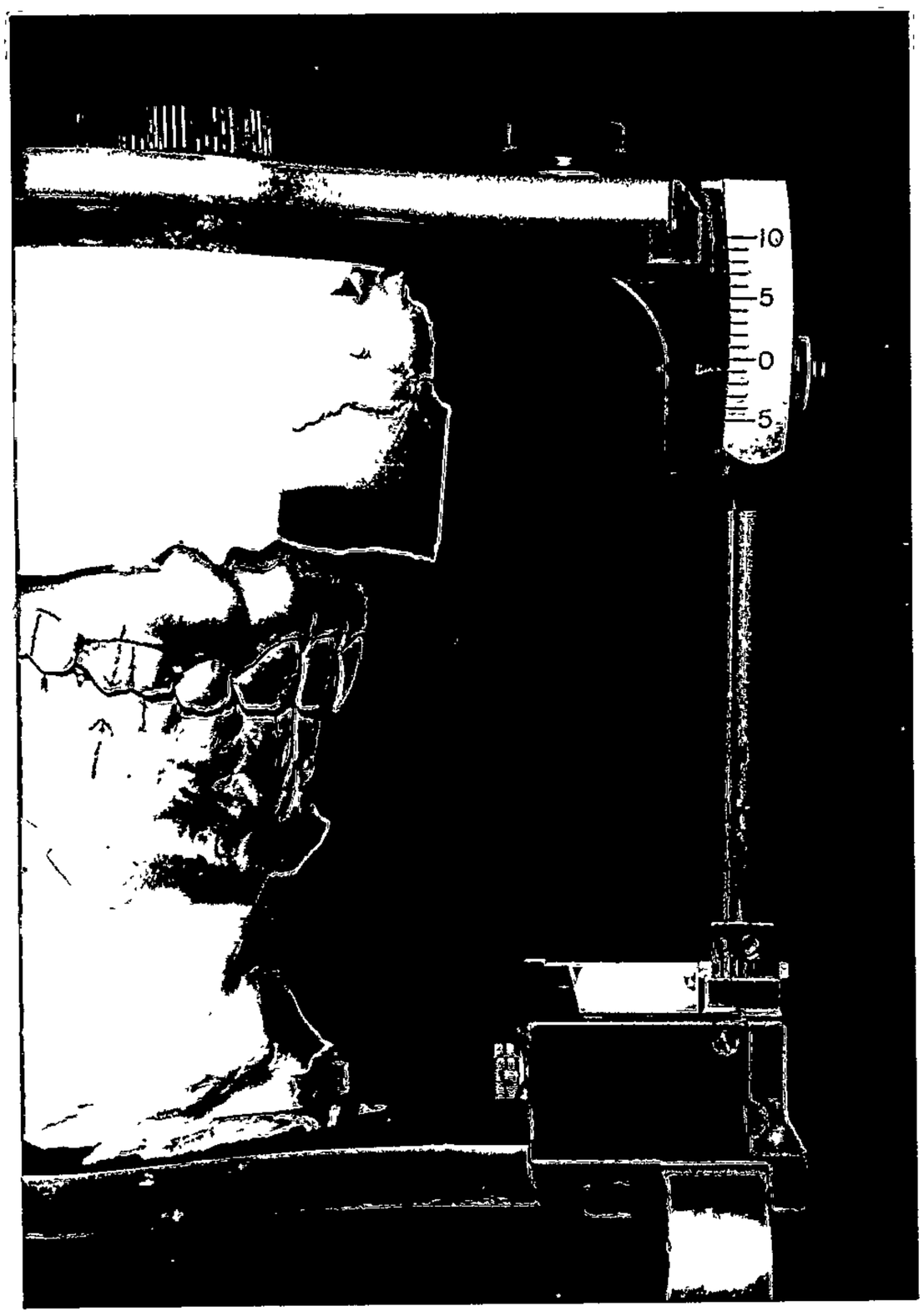

FIGURE 38. Casts mounted on articulator.

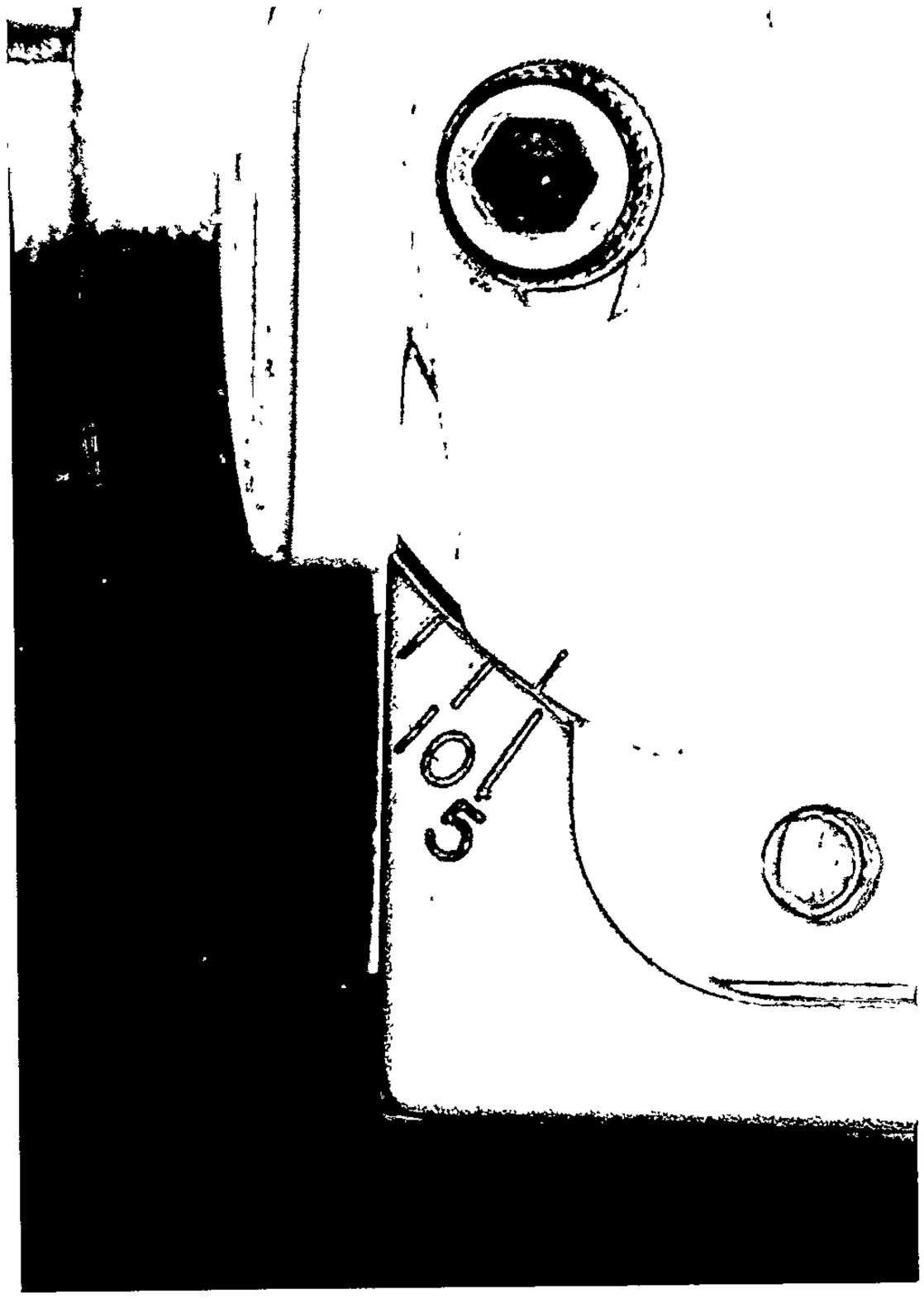

FIGURE 39. Progressive side shift adjustment.

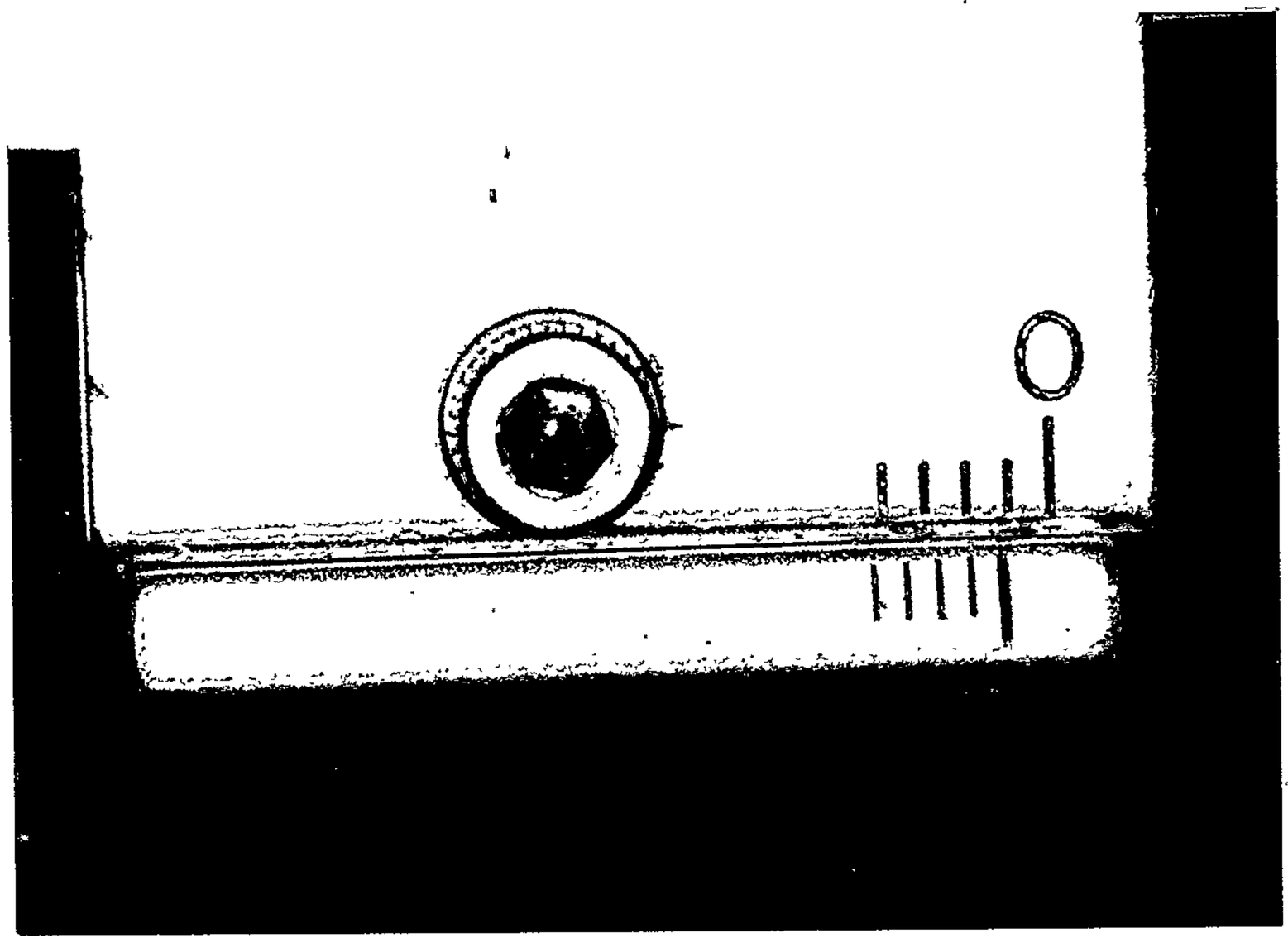

FIGURE 40. Immediate side shift adjustment.

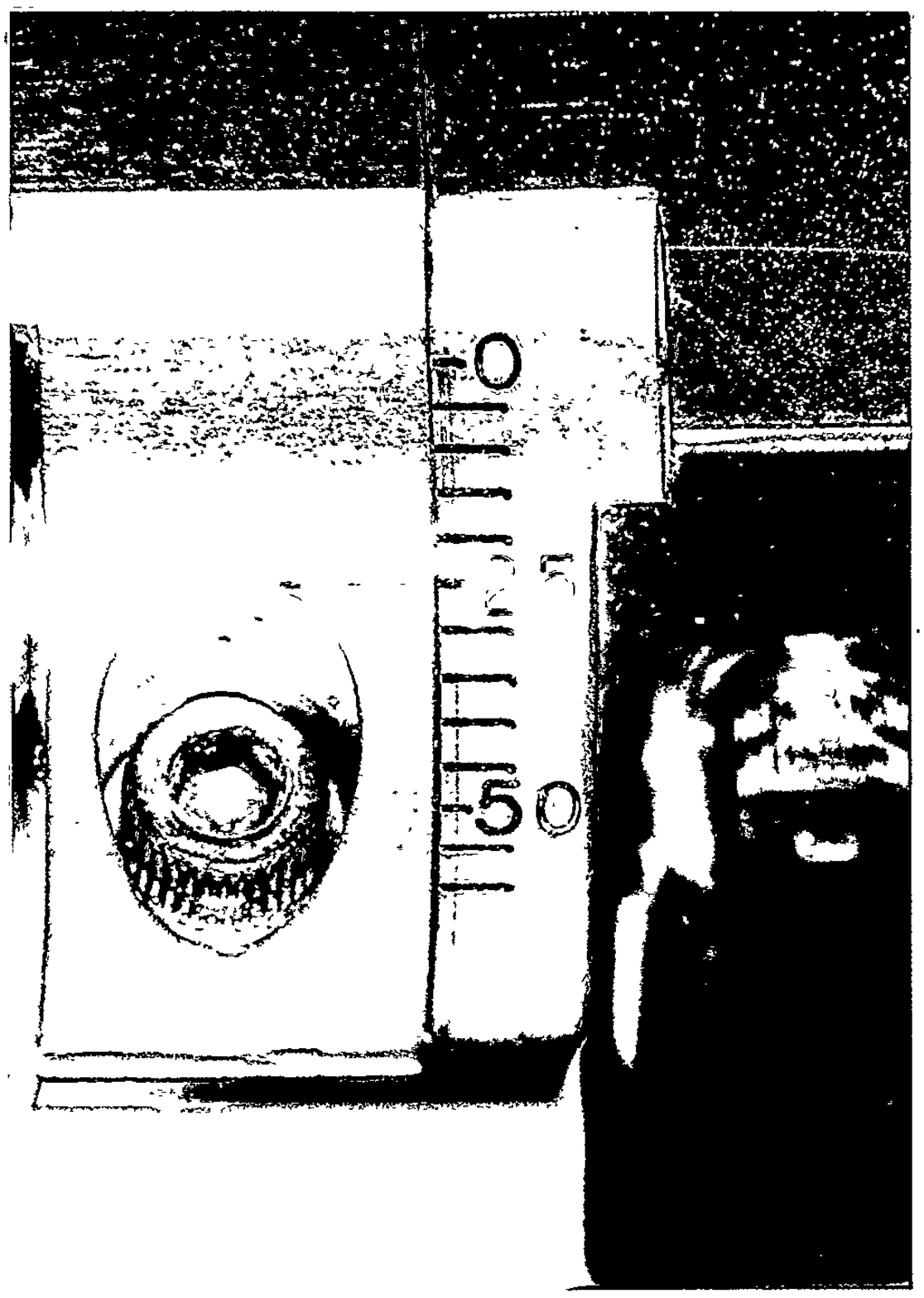

FIGURE 41. Protrusive condylar path adjustment.

immediate side shift and progressive side shift. With few exceptions, once the immediate side shift has occurred, the progressive side shift records are approximately parallel to each other, and are inclined approximately five to seven degrees to the sagittal plane. The biggest variable is in the immediate side shift component of the orbiting path. When adjusting the Mark II aticulator to lateral checkbite records, the progressive side shift adjustment is set to the six degree average anatomic dimension (Figure 39). The protrusive and immediate side shift adjustment lockscrews on both sides are loosened, and the protrusive condylar paths are set to 0 degrees, and the medial fossa walls are moved medially to the limit of their range of movement. The maxillary cast is firmly seated in the right lateral checkbite record on the mandibular cast. In this way the left condyle is positioned inward, downward and forward from its centric related position. The inclination of the left protrusive condylar path is increased until the superior wall of the fossa contacts the top of the condyle, and the left mesial fossa wall is moved laterally until it contacts the condylar element. The left lateral checkbite is then used to adjust the settings of the right articular fossa. The protrusive condylar path inclinations are set to zero degrees and then increased according to the protrusive checkbite record's effect on the superior fossa walls.

The rotating condylar path may be inclined upward or downward as the rotating condyle moves outward. The Denar Mark II articulator cannot be adjusted to upward or downward movements of the rotating condyle. It has the rotating condylar path preset to the average anatomic inclination of 25 degrees outward and backward.