

CHAPTER 3

AN OVERVIEW OF THE EDGEWISE APPLIANCE

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AN OVERVIEW OF THE EDGEWISE APPLIANCE3.1 INTRODUCTION

Orthodontic appliances have been described by Jarabak and Fizzell (1963) as devices used to produce tooth movement; they have passive and active components. The passive elements of the edgewise appliance include bands, brackets, tubes and headgear which provide the means of attachment for the active components which may be wires (in many shapes and sections), helical springs or elastics. These active components perform work since they exert a force or create a force system which in turn produces motion through a measurable distance. It must be an appropriate kind of force that will act on the tooth and induce a change in the root environment and allow the tooth to assume a new position.

Because forces generally cannot be applied to a tooth through its centre of resistance, but only to the coronal areas, a complicating restriction exists; a tooth cannot simply be pushed or pulled or twisted from one position to another because the force is not in line with its centre of resistance and bodily movement is seldom completely achieved, (intrusion or extrusion are notable exceptions). Instead, a moment is set up which creates some degree of tipping or rotation. Elaborate force systems must then be applied to this restricted region of the tooth (the crown) to effect eventual movement to a stable and aesthetic position. (Jarabak and Fizzell, 1963: p19).

3.2 PASSIVE ATTACHMENTS

3.2.1 The Edgewise Bracket

Bracket design within the edgewise group varies considerably in different slot dimensions and angulation, overall dimensions and auxiliary functions thus creating a range of available choices. The original edgewise bracket designed by Angle was single winged, constructed of soft gold and with a slot size of 0.022" x 0.028" (0.558 mm x 0.717 mm) (Angle, 1929). The twin bracket has since been developed by effectively joining together two single brackets on the one base. They vary from 2 - 4.5 mm and have a greatly increased ligating area under the wings.

3.2.1.1 Bracket width: is instrumental in root control in both the mesiodistal plane and for axial rotation. A force applied to a tooth creates a moment which rotates the bracket and the attached tooth, until the two points of archwire make contact with the outer ends of the bracket or tube slots. Thurow (1982: p166) also writes that an optimum bracket width exists, this being equal to half the width of the tooth. The proportion is not critical but should be close. With this proportion in mind a bracket width of approximately 3.5 mm is suitable for bicuspids, cuspids and laterals. Lower incisors require close control over rotations and brackets also of 3.5 mm should be used, upper central incisors having the widest bracket (Thurow, 1982: p166).

3.2.1.2 Bracket friction: increasing the area of contact between

the archwire and the slot will increase friction at the same rate that it reduces force per unit area, so that these effects neutralise each other. The important factor is the force generated between bracket slot and the archwire as the collateral tipping tendency of the tooth is resisted by the wires engagement in the slot; the wide bracket having an advantage here. It should be noted that increasing force will not help overcome frictional resistance to free any frictional locking; the tipping moment must be altered. (Thurrow, 1982: p168).

3.2.1.3 Slot dimension usually two sizes are available for bracket and tube slots (with some variation in depth)

0.022" x 0.028" (0.56 x 0.71 mm)

0.018" x 0.025" (0.47 x 0.63 mm)

(Thurrow, 1982: p169; Graber and Swain, 1985: p579).

With wide brackets slot size is not so critical and a 5° tipping clearance is easily controlled (Thurrow, 1982: p169).

With torque control using rectangular wires, a close engagement of the wire in the bracket slots is needed. The thickness of any rectangular wire used for torque control should be kept within 0.002" (0.05 mm) of the width of the slot for standard brackets.

Slot depth: rectangular wires in torque applications must be seated with the outer working edges fully engaged in the slot. Slots should be deep enough to ensure full engagement. (Thurrow, 1982: p169).

3.2.1.4 Angulation of bracket slots: slots may be angulated in two planes:

(i) occlusogingival angulation: will influence mesiodistal tipping.

(ii) buccolingual angulation: of the milled slot, so that a rectangular wire will enter the slot at some angle other than perpendicular to the face and will effect buccolingual tipping in the same way as torquing the wire.

(i) occlusogingival angulation: is designed to angulate the slot so that it is parallel to the occlusal plane instead of perpendicular to the root, with the aim of optimising the mesiodistal tipping angulation of the tooth without the need for bends in the archwire. Occlusogingival slot angulation is achieved equally by angulating the standard bracket on the tooth. Thurow believes that simply angulating the bracket is the most controllable approach because it can be adjusted as required for the anatomy of the individual dentition, while the manufactured slot angulation is based on average values and it becomes more difficult to judge the compensatory angulation for the individual. On the other hand, Roth (in Graber and Swain, 1985: p677) recommends a fully preadjusted straightwire bracket prescription. Preangulation can eliminate the need for basic arch adjustment in the affected plane but there remains a need for compensatory adjustments to the archwire to meet requirements of tooth tipping, individual anatomy, wire size and stiffness and these are not necessarily adequately met by the bracket preangulation. (Thurow, 1982: p173; Graber and Swain, 1985:

pp576-577).

(ii) buccolingual angulation (torque angulation) - the side of critical working contact between archwire and bracket slot for torque action is usually the shallower side; therefore full slot depth seating is essential for torque control. In Class II, Division 1 cases retraction of the upper anterior teeth may require no torque adjustments to the archwire if slot angulation is ideal for the patient's needs but additional tipping (or relief of excessive tipping) is often desirable in many cases (Thurrow, 1982: pp173-174).

Advantages of slot angulation ("built-in")

- * reduction of archwire bending
- * use of a specific type of slot angulation for a specific tooth in the arch such as a cuspid or central incisor is recommended and provides greater control.

Disadvantages of slot angulation ("built-in")

- * inventory needs are greatly increased with right and left versions increasing the probability of misfiling and misplacement.

Selection of preadjusted brackets (not to a set prescription) Thurrow (1982: pp177-178) suggests the following angulation for specific teeth:

Bicuspid and lower incisors: No angulation of bracket or slot needed with twin brackets.

Cuspids: Bracket angulation of about 5° for mesial crown angulation. Torque angulation is not essential but some torque control from the archwire may be needed to keep the crown tipped lingually.

Upper central incisors : Torque slot angulation should be $20^{\circ} - 25^{\circ}$.

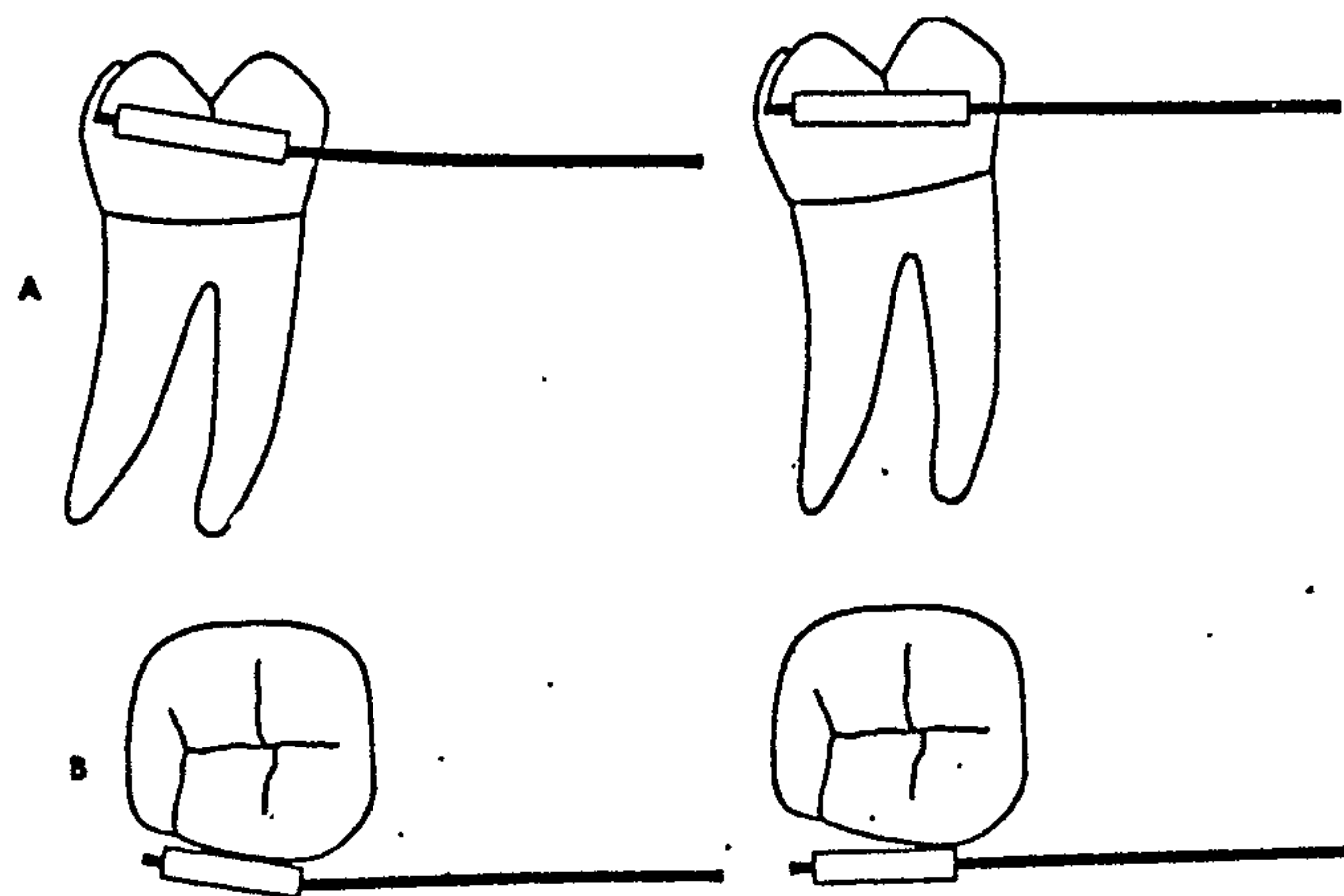
No bracket angulation is required.

Upper lateral incisors: Bracket angulation of $4^{\circ} - 8^{\circ}$: torque angulation of about 5° less than the central incisors will maintain the correct relationship between lateral and central incisors.

Molars: The last molar should preferably have buccal tube angulation to provide a slight distal tipping action. A double or triple buccal tube is desirable to increase the options of auxiliary use; provision for a lingual or palatal arch attachment is useful for molar control (e.g. transpalatal bar).

The molar buccal tube: should have a 10° built-in offset to place the molar buccal surface at an angle to the line of occlusion of the arch, the mesiolingual cusp is more prominent than the distobuccal cusp. The lower molar has a smaller offset ($5^{\circ} - 7^{\circ}$) and this eliminates the use of bayonet bends in the archwire (See Figure 3.1). In second molar tubes a similar offset is needed and the first molar tube should be converted to an open bracket (Proffit, 1986: p304).

Commercial variations in preadjusted brackets range from prescriptions that offer a total set of preadjustments for every tooth to a wide range of preadjusted brackets that allow the practitioner to determine the preadjustments for each case.



A, Angulation of molar tubes with the distal end inclined occlusally introduces a distal tipping moment that will help control mesial collateral moments introduced by auxiliary traction. B, Control over mesial rotation requires either a bend in the archwire or distobuccal angulation of the tube.

Figure 3.1
Thurrow , 1982: p.190.

Other bracket designs: There is considerable variety of bracket designs available. For example, other brackets available are:

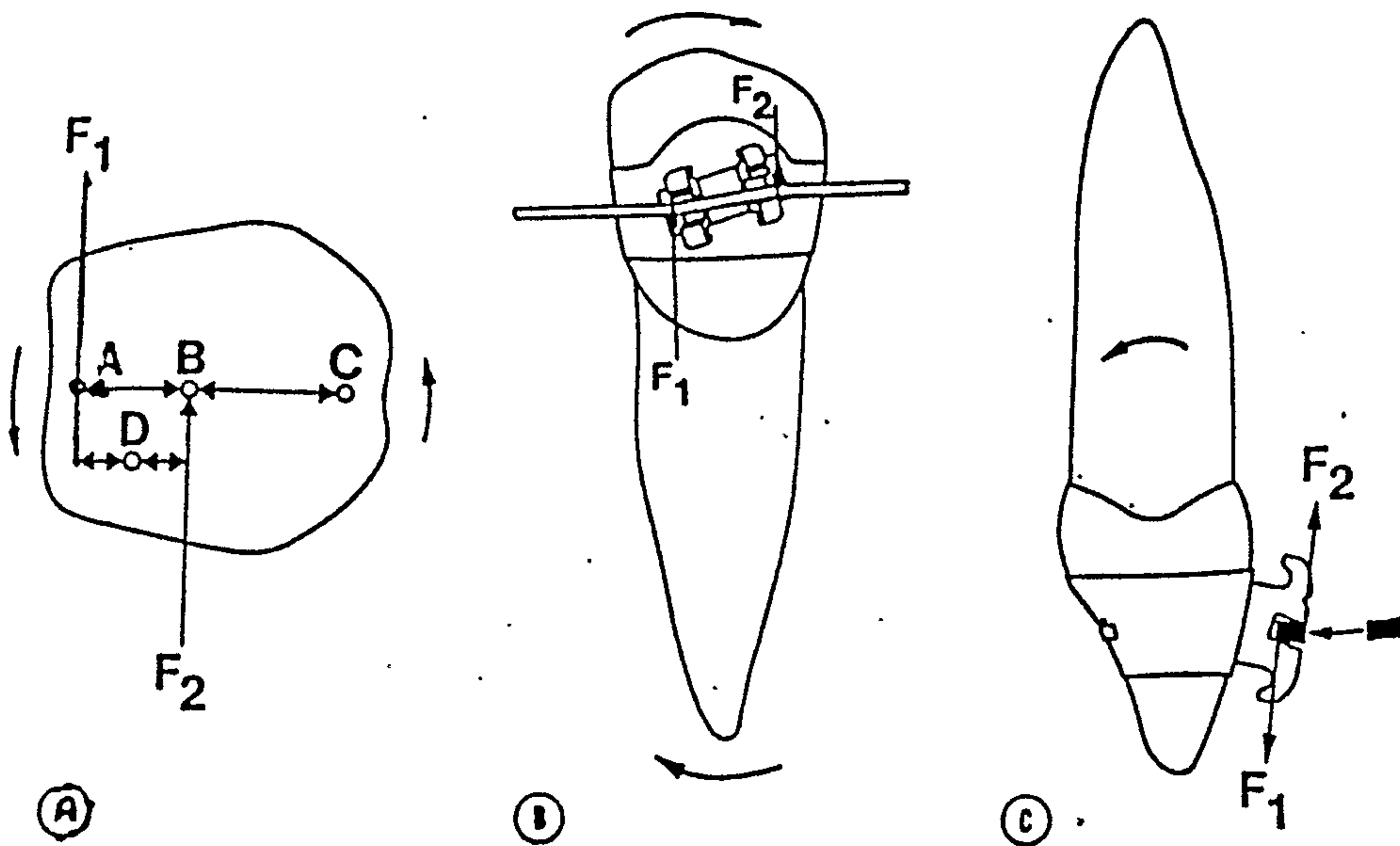
- * the Lewis bracket which has a lever arm to deflect the archwire and rotate the tooth, two rotation wings and a single bracket. Its ability to obtain easy tooth rotation and overcorrection is its advantage.
- * the Steiner bracket has flexible rotation arms and does not rely on the flexibility of the archwire for tooth rotation.
- * the Broussard bracket is a twin bracket with a vertical slot to accept 0.018" (0.47 mm) auxiliary wire for uprighting and canine retraction.
- * combination edgewise and Begg brackets are also available.

(Graber and Swain, 1985: p572).

3.2.1.5 The straightwire appliance with preadjusted brackets for control in three planes: In 1971 the "A Company" manufactured the Andrews straightwire appliance in which all of the brackets had the ability to control tooth movement in three planes of space simultaneously, i.e. producing in conjunction with archwires torque, tip and in/out movement control in all teeth. Many manufacturers now offer similar appliances, their objective being to minimise archwire adjustments.

Mesiodistal tipping: As discussed earlier (3.2.1.4) in mesiodistal tipping a couple may be produced either by a bracket tipped on its base, or a slot that is angulated within the bracket (manufactured). The "tip" is designed to angulate the bracket so that it is parallel to the occlusal plane instead of perpendicular to the root thus eliminating bends in the final archwire.

Buccolingual torque: Torquing tooth movement (buccolingual) is dependent on the interaction of rectangular wires in rectangular slots, thus forming a couple at the bracket, (See Figure 3.2C). The slot may be torqued relative to the base of the bracket or the bracket base may be torqued relative to the tooth surface (Meyer and Nelson, 1978). (See Figure 3.5)



A, Moments of rotation. Two equal forces are acting in the same plane on this body. The moment of rotation ($M=Fd$) is the same at points A,B,C,D, or any other selected point. B, Tip. Built-in tip produces a moment of rotation as a result of the force couple (F_1 and F_2). C, Torque. Built-in torque produces a moment of rotation as a result of a force couple (F_1 and F_2).

Figure 3.2

Meyer and Nelson, 1978: p.487.

In/out offsets: Account for the distance between the wire and the tooth surface avoiding rotational and translational effects (Meyer and Nelson, 1978).

The dynamics and clinical implications of triple control brackets.

Variations in bracket prescriptions range from stock appliances that offer a total set of preadjustments to those that allow the practitioner to determine the preadjustment for each tooth. The preadjustments are designed to produce an ideal final tooth position. Incremental adjustments are achieved by gradually increasing the archwire size rather than by sequential wire

adjustments. The final ideal tooth position will result from maximum expression of the preadjusted attachments with maximum slot expression being achieved by placement of full sized wires.

Meyer and Nelson (1978) go on to state that it is a mistake to believe the preadjusted appliance reacts clinically in the same way as a conventional (standard) edgewise appliance and they list some clinical differences:

(i) Torque forces between wires and brackets:

* placement of the first rectangular archwire produces anterior and posterior torquing forces, the magnitude of which depends on the wire size as it relates to slot size. Consider a built-in torque on a maxillary incisor bracket of 7° . This is the angle formed between the face of the crown and the floor of the bracket slot. It will produce a root angulation of approximately 20° depending on the fit of the wire to the slot, i.e. a wire completely filling the slot gives 20° of root angulation. For example, a 0.0215" x 0.028" wire in a 0.022" slot will produce 18.2° of root torque; an 0.018" x 0.028" wire in a 0.022" slot will produce 8° of root torque, etc. (See Figure 3.3).

* as torque is applied to the anterior teeth the resulting forces are transferred to the posterior teeth. Torquing couples created by maxillary anterior brackets will tend to cause mesial movement of posterior teeth and flaring of the incisors. To avoid this posterior anchorage enhancement must be incorporated at an earlier stage than is needed in the standard appliance. (See Figure 3.3C).

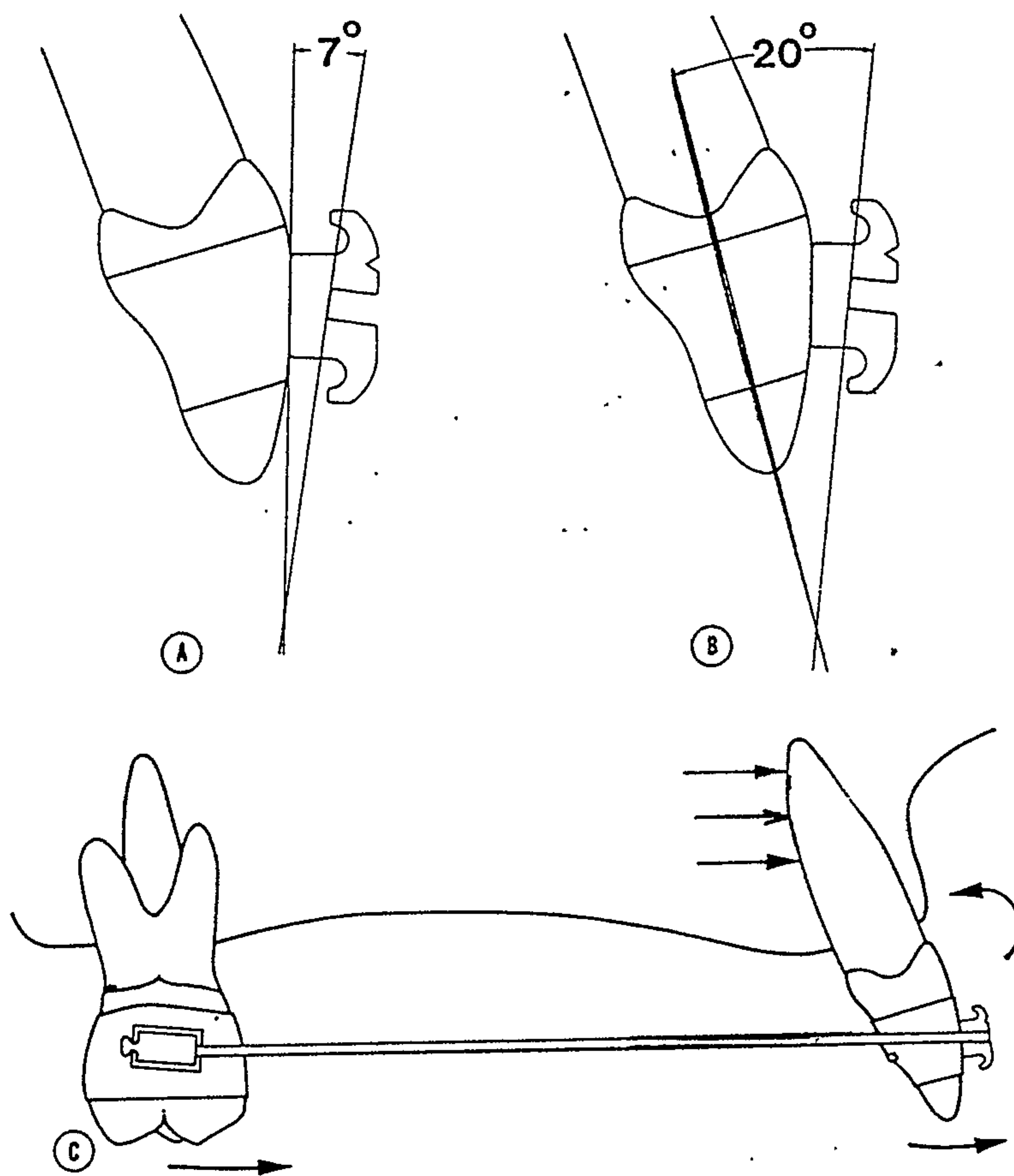
* lower posterior crown tipping may occur and will need counteractive tipping moments. (Meyer and Nelson, 1978).

(ii) Mesiodistal angulation: "built-in" bracket tip will begin acting with the first archwires creating a mesial crown tip. (See Figure 3.2B).

* Early anchorage enhancement may be necessary if mesial movement of the buccal segments is to be avoided.

* Highpull headgear force applied to the maxillary first molars (distal root tilt 5°) with a face bow may enhance distal tipping action of the brackets causing excessive distal root position of the first molar and excessive mesial tip of the crown. If high-pull headgear is to be used consider reducing preadjusted angulation for the upper first molar. (Meyer and Nelson, 1978).

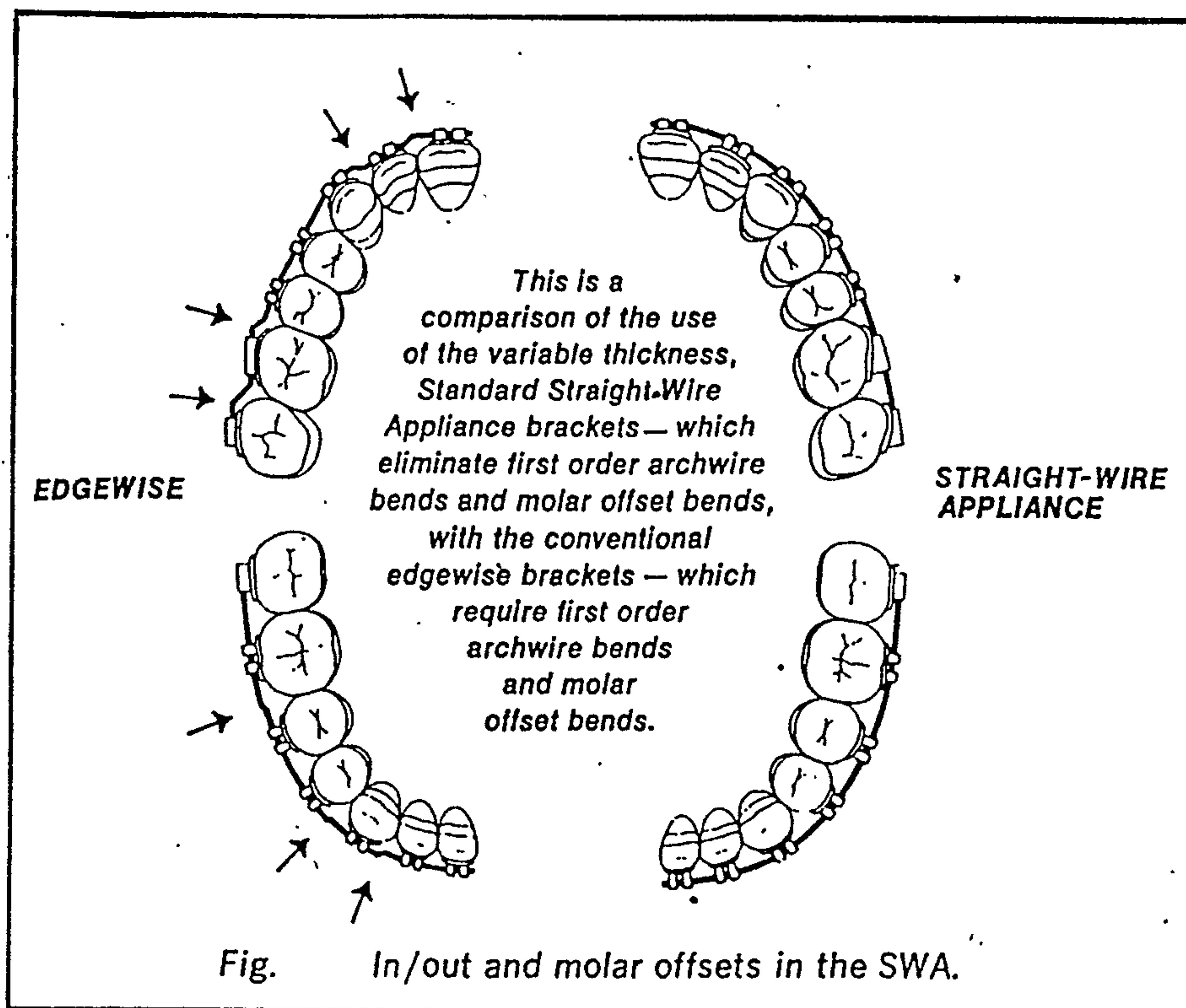
(iii) In and out preadjustments (offset): when built into the bracket enables considerable reduction in archwire bending. In/out forces applied to a tooth to position it labiolingually or buccolingually will have rotational and translational effects. Preadjusted appliances alter the distance between the wire and the tooth surface in varying amounts around the arch to accomplish in/out positioning. (Meyer and Nelson, 1978).



A. When torque in a bracket is designed by a manufacturer to be 7 degrees, the 7 degrees refers to the angle between the bracket slot and the bracket base. B. Root angulation (often measured in head films), when related to the bracket slot, might be in the range of 20 degrees. C. Because of the resistance presented by the lingual wall of the anterior bony socket, anterior torquing couples can result in mesial movements of the posterior teeth.

Figure 3.3
Meyer and Nelson, 1978: p490.

Andrews (1976) states there is a constant pattern in the upper teeth and also in the lower teeth which allows the relative thicknesses to be incorporated in the bracket design. This eliminates first order bends and enables en masse space closure along straight archwires. (See Figure 3.4)



Bracket position for the straightwire appliance.

Figure 3.4
Andrews, 1976: p92.

Andrews (1976) describes the positioning of the brackets at the mid-point of the long axis of the clinical crown; this being best located at the mid-developmental ridge that runs vertically and is the most prominent portion of the central area of the labial or buccal surface. (L.A.C.C.) The bracket slot is placed at the mid-

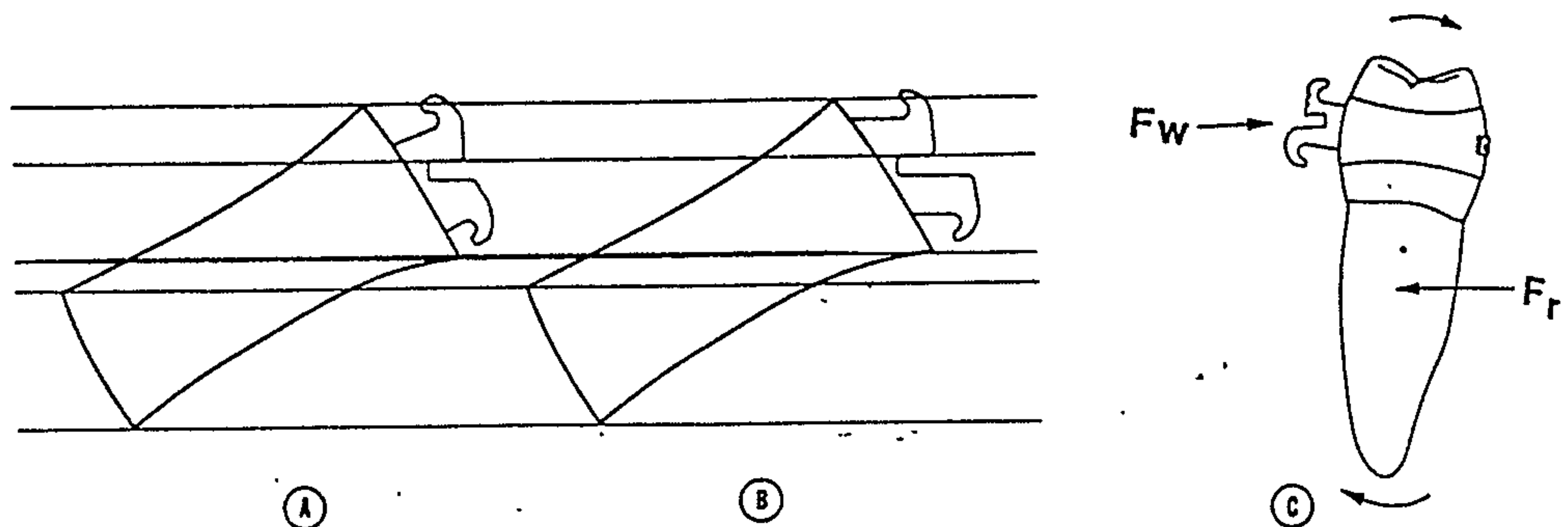
point of this line and is called the L.A. point (clinical centre of the crown). Andrews suggests that a sulcus depth of about 1 mm should be considered here.

3.2.1.6 Review of the literature on torque angulation and the bracket base

Lindquist writing in Graber and Swain (1985: p578) mentions the wide variation in the preangulated torque in brackets: e.g. $+7^{\circ}$ with Andrews (straightwire) appliance and $+22^{\circ}$ recommended by Ricketts (1979) and Thurow (1982) for upper central incisors. He explains that both extremes are viable and with the upper central incisor there are two factors which must be considered:

- (i) The location of the bracket (incisogingivally) is at the centre of the clinical crown which is further to the gingival than many orthodontists prefer. They feel that a more incisally placed bracket helps in overbite correction but to achieve the same degree of torque the slot angulation must be changed (upwards towards 22°).
- (ii) If undersized rectangular arches are used then brackets with greater torque are needed. Thus an interplay between archwire size and slot size is a factor, some practitioners preferring the lighter forces from smaller, less rigid rectangular archwires.

Another contentious issue is Andrew's use of torque built into the bracket base. Lindquist is in agreement with Meyer and Nelson (1978) that there is nothing magical about this and it has the same effect as torque built into slot angulation. (See Figure 3.5).



A. Bracket stem at angle to slot. B. Bracket stem parallel to slot. Brackets are positioned on band so that resultant torque is the same; that is, the slot/tooth positions are identical if bracket placement is guided on the slot. C, in and out. Buccal and lingual movements are accompanied by rotational moments of small magnitudes due to force couple F_w (archwire) and F_r (resistance of bony socket)..

Figure 3.5
Meyer and Nelson, 1978: p488.

3.3 ACTIVE COMPONENTS

3.3.1 The Continuous Arch

Continuous or complete arches extending from molar to molar are the primary source of control and force distribution in a high percentage of edgewise therapy. The following is an overview of archwire use for the edgewise appliance.

3.3.1.1 Initial levelling archwires and their force equivalence

For initial bracket levelling with adjacent tooth anchorage and a primary objective of wide ranging tooth movement:

0.016" nickel titanium alloy archwire outperforms 0.0175" stainless

steel multi-strand archwire; 0.018" nickel titanium will outperform 0.012" round stainless steel. (Kusy, 1981; Drake et al, 1982)

An alternative initial alignment is the multiple loop wire constructed in 0.014" or 0.016" round high tensile stainless steel wire. Because of the extra length of wire between brackets, there is greater flexibility and activation, they can provide very efficient means of initial alignment for extreme anterior crowding. (Graber and Swain, 1985: p596). The new nickel titanium alloys are equivalent to this multiloop wire without the time consuming wire bending. (Drake et al, 1982; Kusy and Stevens, 1987).

3.3.1.2 Intermediate levelling and retraction archwires

The goals of this set of archwires are as follows:

- (i) final correction of anterior rotations and displacements.
- (ii) beginning of overbite correction through levelling the curve of Spee.
- (iii) continued correction of faulty axial inclinations.
- (iv) retraction of lower anterior teeth as a unit to prepare anchorage in non-extraction cases or retraction of lower canines into extraction space.
- (v) retraction of the upper canines into extraction space.

Intermediate Archwire Succession

Following on from the initial levelling archwire, a further flexible wire is added, usually a 0.016" stainless steel, which should remain with continued adjustments until all gross corrections are made, progressing to 0.018" then 0.020" with an 0.022" slot. Steps in

archwire diameter will vary, but ordinarily each arch should be approximately 0.002" larger than the previous one. (Thurow, 1982: p294).

Drake et al (1982) found that Beta titanium can be substituted for stainless steel in many edgewise arches, its minimal permanent deformation would result in less archwire changing and reshaping. It also has good formability and weldability and can be shaped for closing loops. It is of value where flexibility is required. The 0.017" x 0.025" and 0.019" x 0.025" Beta titanium wires have twice the stiffness or resistance to deformation in the horizontal plane and equal rigidity in the vertical plane; compared with 0.016" or 0.018" round stainless steel wire (respectively) and Kusy and Greenburg (1981) further state that Beta titanium is a superior intermediate wire to stainless steel.

Thurow (1982: p294) suggests that with the intermediate wires no space closure is done with the 0.016" archwire except to the extent of relieving crowding. Space closure is best completed before placing the finishing rectangular archwire and on the widest gauge round wire usually 0.020" in a 0.022" x 0.028" slot. For bite opening all the intermediate lower wires should have a reverse curve of Spee to the buccal sections. For anchorage control anti-tip bends for the molar tube are placed along with toe-in or bayonet bends if not preangulated.

3.3.1.3 Overview of continuous arch mechanics using the straightwire brackets

A. Initial levelling and alignment

(i) Commence with gentle forces from a flexible archwire: 0.0175" multi-strand stainless steel or 0.016" nickel titanium. In standing incisor teeth are not connected or only passively tied to the archwire, until the canines can be retracted to create space.

(ii) With the pre-torque/preangulated brackets the canine crowns should be laced back to second molars (if banded) using 0.009" ligature wire. This is to control mesial tip of the canine crown that occurs with placement of the initial archwires in the preangulated brackets in both extraction and non-extraction cases. If molar anchorage is critical then headgear should be commenced at the beginning of treatment. The lace-back prevents the mesial movement of the canine crown under the influence of the archwire in a preangulated bracket and allows the distal root movement to occur. When possible second molars are banded to assist anchorage control. (Andrews, 1976; Bennett, 1985).

(iii) 0.014" or 0.016" stainless steel archwires are placed next. Distal ends are turned back at second molars to control forward crown movement which results with the tip angulation. This wire provides further root axis alignment and bracket levelling.

(iv) 0.018" archwire is placed next and gentle elastics, either intramaxillary or intermaxillary (Class II elastics) are applied, depending on the case and the desirability to extrude molars or not.

B. Overjet correction and anchorage control

In Class II, Division 1 cases the upper anterior teeth are retracted using Class II elastics, if molar extrusion is permissible. In the

cases with a marked Class II maxillary overjet, selective headgear is introduced to support buccal teeth while intramaxillary force is also used to assist anterior retraction using sliding mechanics.

(Bennett, 1985; Proffit, 1986: pp424-429).

C. Overbite correction is achieved using:

(i) an exaggerated curve of Spee in the upper arch (not more than 3 mm) and reverse curve of Spee in the lower archwires (not more than 2mm). (Bennett, 1985).

(ii) intermaxillary Class II elastics producing molar extrusion into the freeway space. This is to be avoided in high angle cases.

(iii) banding of lower second molars and use the elastics from them. (Andrews, 1976; Proffit, 1986: p424).

D. Space closure:

Controlled space closure is done, using sliding mechanics, to move groups of teeth. The positioning of lower incisor teeth, in relation to the facial complex is important, usually on or 1-2 mm in front of the AP plane.

Summary of sliding mechanics

(i) Use gentle forces.

(ii) Minimum of .018" or preferably 0.020" archwires.

(iii) If rectangular archwires are needed thin down in the molar region to assist free sliding.

(iv) Teeth adjacent to the extraction sites should be ligated with wire to prevent any roll into the extraction spaces.

(v) Selective use of Class II elastics and/or intramaxillary elastics. (May need headgear to reinforce anchorage.)

(vi) If rectangular wire is used, use slightly heavier than normal forces, with labial crown torque in the incisor region. (Andrews, 1976; Bennett, 1985).

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3.3.1.4 Finishing archwires for the standard edgewise bracket.

Heavy rectangular archwires may be used to adjust arch form and torque (buccolingual inclinations) groups of teeth or segments. They may also be used to stabilise an arch while anteroposterior arch relationships are corrected by Class II elastics. For example, the lower arch is often prepared as an anchorage unit by the use of a rectangular archwire to prevent mesial movement of the dental arch in Class II elastic traction.

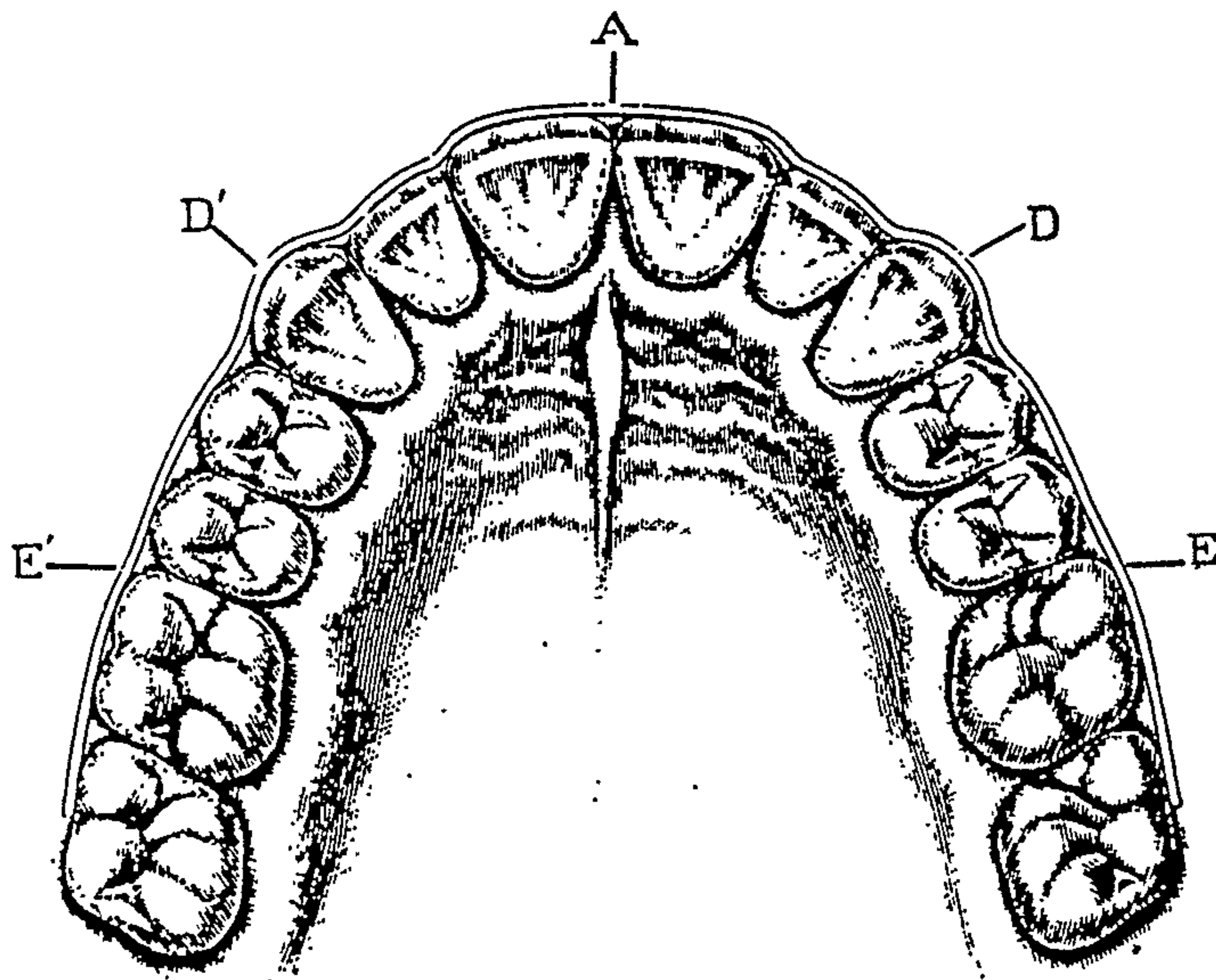
Ideal arch form - if standard edgewise brackets are used then the archwire must take the form of the outline of the buccal and labial surfaces of the teeth. Angle advised the formation of an ideal arch and it is still basically recommended for standard brackets.. (See Figure 3.6).

Thurrow (1982: p156) describes the ideal rectangular arch formation: using pencil marks on stainless steel preformed archwires, shaping initially on the models and with final adjustments being made in the mouth.

First order bends: determine the labial curvature of the incisor segment; this is vital and should be individualised.

Second order bends: are the sharp bends at the cuspid prominences; care is needed not to over expand.

Third order bends: are the slight adjustments at the lateral incisor and molar and again are individualised for each case; teeth anatomy and bracket levels can indicate a much smaller offset for many patients.



Upper arch with wire contoured to the labial (buccal) surfaces.

Figure 3.6
Angle, 1928: p1154.

Note: The lower arch is similar to the upper but without lateral incisor offsets.

Rectangular archwires in the straightwire appliance:

In the straightwire appliance the need for archwire bends has been greatly reduced. The in/out bends and the tip angulation bends are eliminated. The third order torque bends are reduced by the incorporation of torque angulation. However the torque needed in many bracket slots is considerable. For incisors the slot is angled so that the root is placed lingually to the crowns (positive torque), canines stand relatively upright while premolars and molars require increasing amounts of negative torque to position the roots buccally, not lingually.

The amount of torque depends to some extent on the following factors:

- (i) the degree of torque angulation incorporated in the "prescription".
- (ii) where on the labial surface the bracket is placed; if placed towards the middle of the crown less torque is needed; if placed incisally more torque is required.
- (iii) the slot fit by the archwire - if loose more torque is needed in the wire. (Andrews, 1976; Proffit, 1986: p304).

3.3.2 The Jarabak Light Wire Appliance

Introduction

The edgewise appliance may also be used with light wire or differential light force techniques. High tensile spring wire of a small gauge (0.012", 0.014", 0.016" or 0.018") is used. By forming numerous loops in the archwire a lighter, more continuous force is produced which can be adapted to effect rotational changes and torque. Jarabak and Burstone have perhaps been the major proponents of light wire with edgewise brackets, while Begg and Kesling have introduced their own bracket design (Graber, 1972: pp557-560). The recent introduction of nickel titanium alloys means that continuous archwires, with exceptional springiness, can be used in the initial levelling stages. They have better properties than multi-strand steel wires and properties similar to a steel archwire with multiple loops in terms of springiness and flexibility. Their application has displaced the multiple looped archwire and has led to considerable time saving in reduced archwire changes and wire ending. (Proffit, 1986: p254; Kusy and Stevens, 1987).

3.3.2.1 Jarabak and Fizzell (1963: pp307-339) describe the active components of their light wire appliances as follows:

The helical loop spring is a force storing unit designed in the shape of a coil with cantilever arms extending from each end of the coil helix. The force from the cantilever arms gives direction to the unit of force, while the force magnitude comes from the wire, its modulus of elasticity, its diameter and the number of turns in the helix of this highly elastic system. A large diameter coil decreases the force and a small diameter coil increases the force. The helical loops are classified in three spatial configurations (See Figure 3.7).

(i) Vertical helical loop springs will release stored energy by moving teeth in an anteroposterior direction.

(ii) Horizontal helical loop springs can be used to add reciprocal forces in a vertical plane for the intrusion or depression of the anterior teeth and for the selective extrusion of posterior teeth.

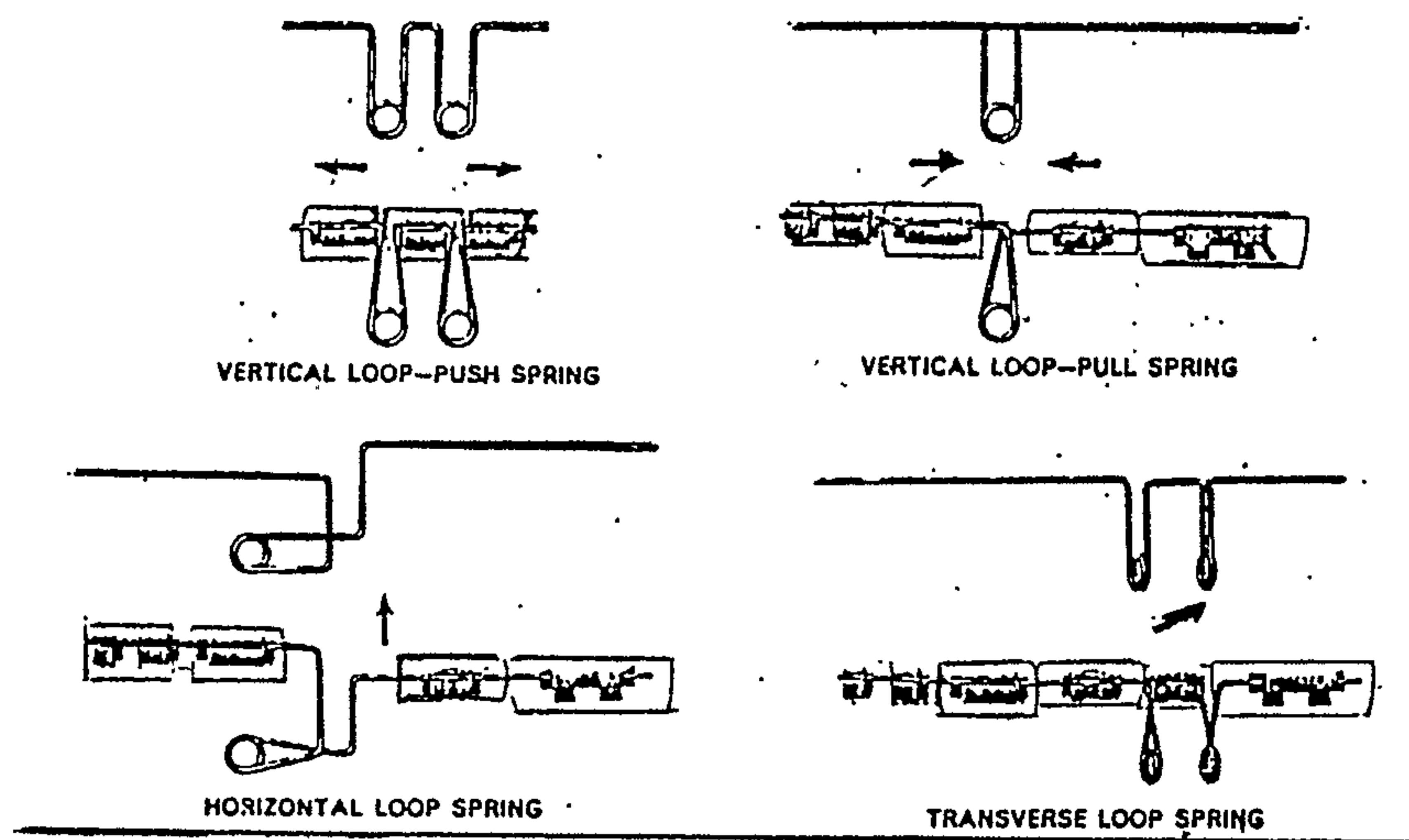
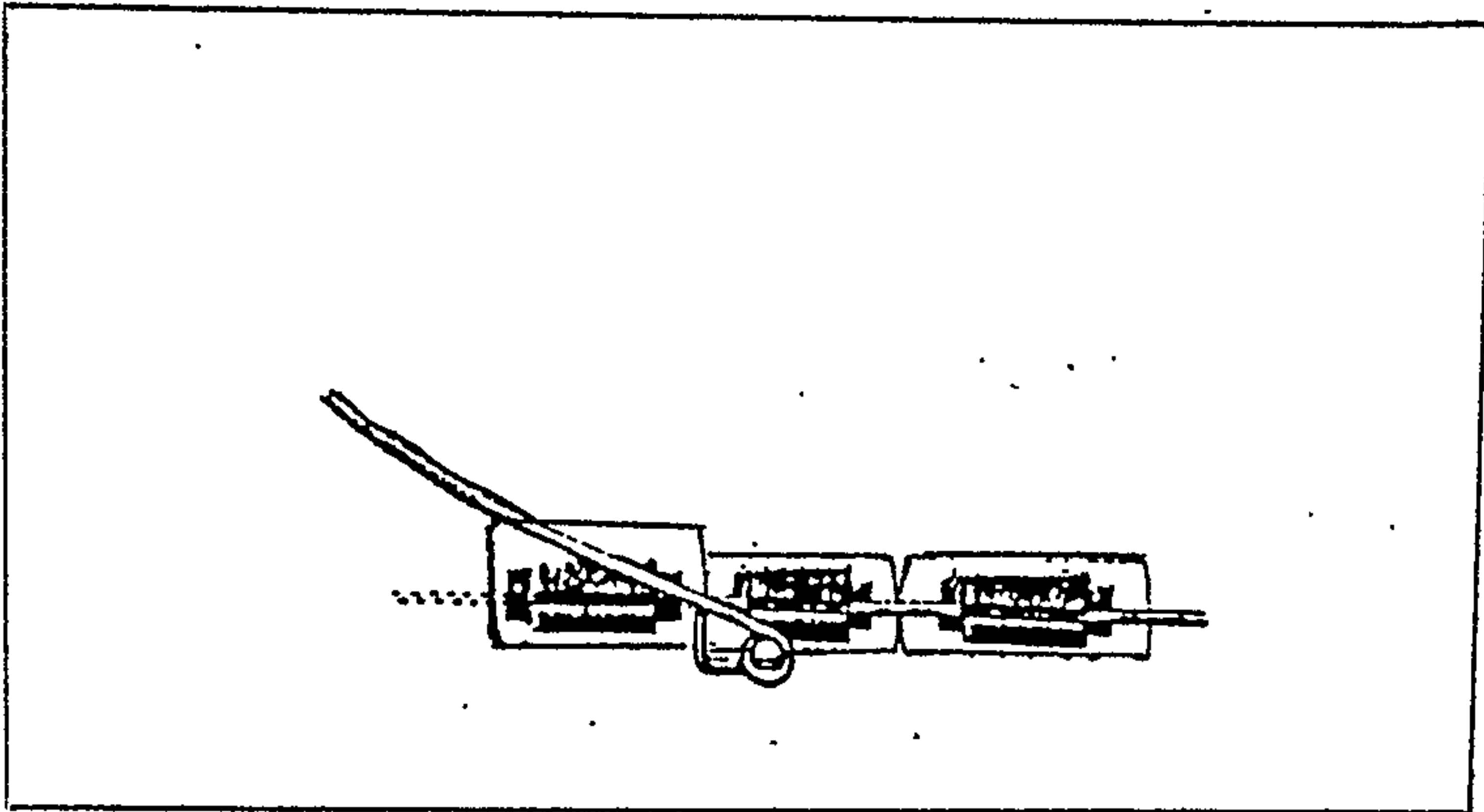


Figure 3.7
Jarabak and Fizzell, 1963: p310.

Classification of helical loop springs according to direction of force action. Vertical loop push spring, used for anteroposterior expansion. Vertical loop pull spring, used for space closure in the anteroposterior plane. Horizontal loop, used for expansion in the vertical plane. Transverse loop spring, used for expansion in the mediolateral direction.

(iii) Lingual root torque for upper anterior teeth; this is achieved with square or rectangular wire with horizontal helical loops in the archwire. The archwire distal to the loop is engaged in the molar tubes, while the anterior section is tied to the incisor brackets. The system of forces tips the roots of the incisors lingually. The arch is activated by placing lingual root torque bends into the labial part of the wire between the helical loops.

(See Figure 3.8).



Horizontal loop square or edgewise arch, used to tip the roots of maxillary anterior teeth lingually, a function usually done more slowly and less efficiently with torque.

Figure 3.8
Jarabak and Fizzell, 1963: p316.

3.3.3 The (Burstone) Segmented Arch

The segmented arch has been designed by Burstone to also deliver light constant forces with reasonable control over the anchor units. Unlike the typical continuous wire, the segmented arch has multiple cross sections. The section of the segmented arch involved in tooth movement (active) will have spring wire properties, a low load deflection rate and a high elastic load limit; these properties result in less permanent deformation and produce light continuous forces. The other section of the arch is concerned with anchorage (passive) preservation while a rigid wire is used to enhance this

anchorage and is described as a posterior stabilizing unit; it is usually 0.0215" x 0.028" stainless steel wire in the right and left segments and it may be joined by a transpalatal bar for further anchorage control. (Burstone, 1966).

For Class II, Division 1 Treatment

In extraction cases a light force is first applied to retract the cuspids; a 0.010" x 0.020" stainless steel cuspid retraction spring is used. The cuspid is either tipped and uprighted, or translated depending on anchorage. The posterior section of the cuspid retraction unit is of 0.021" x 0.025" stainless steel and has anti-tip back bends. This mechanism eliminates the friction inherent in sliding mechanics of a bracket along an archwire and results in minimal forward displacement of the anchorage units.

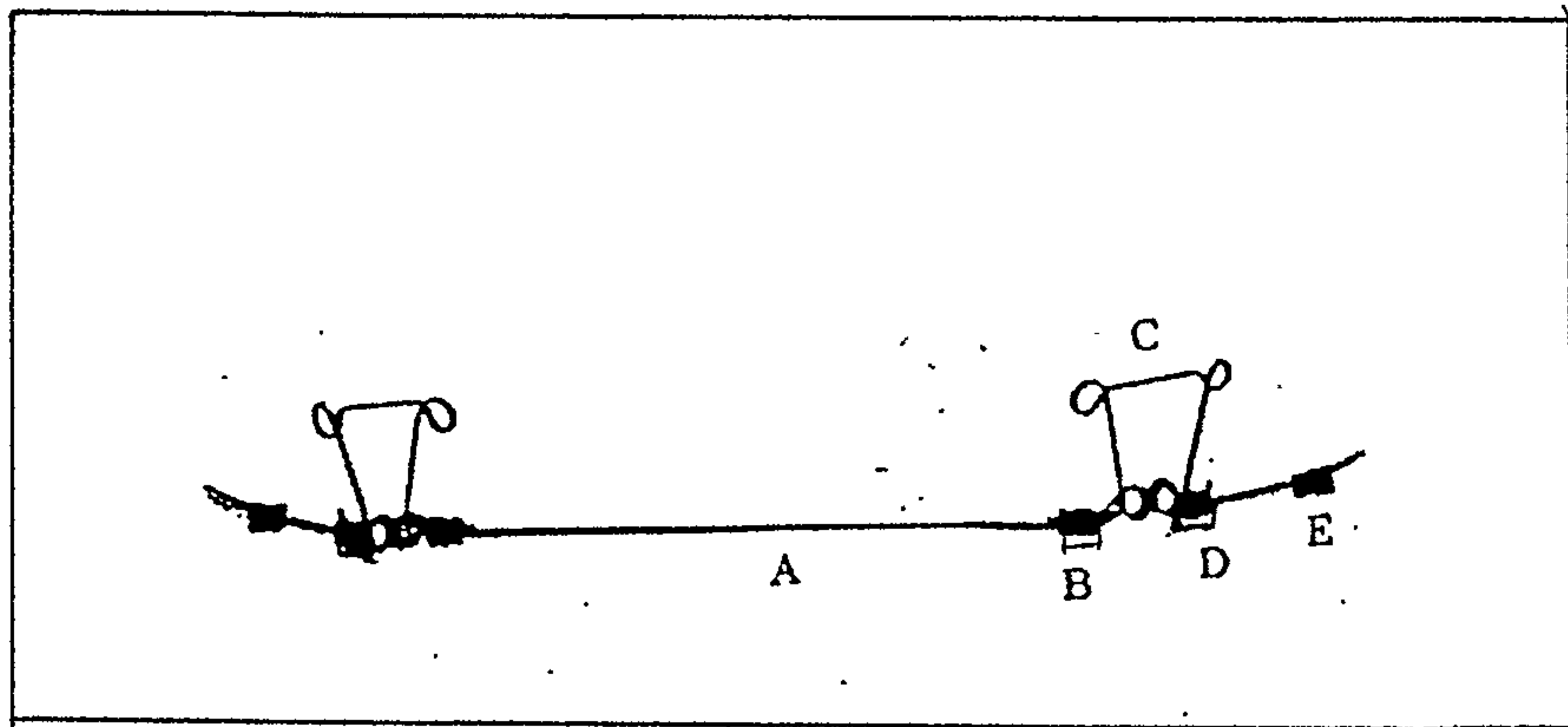
Once the cuspid crown is tipped distally the apical retraction is begun using a root spring which produces a couple on the cuspid crown.

Anterior Retraction

Retraction of four anteriors follows the cuspid retraction. The retraction assembly consists of three parts:

- (i) anterior segment 0.0215" x 0.028"
- (ii) right and left anterior retraction springs
- (iii) right and left base arches.

As with a cuspid retractor, washers attach the springs to the anterior and posterior segment and are crimped in place distal to the lateral brackets. (See Figure 3.9).



Anterior Retraction assembly (A) Anterior segment. (B) Anterior adjustment washer. (C) Spring. (D) Adjustment washer on the base arch. (E) Tie-back washer.

Figure 3.9
Burstone, 1966: p110.

Deep Bite Correction is accomplished by a combination of anterior intrusion and posterior extrusion if differential diagnosis/treatment plan permits this. The segmented arch will again need the posterior anchorage unit (0.018" x 0.080" wire); joined by a transpalatal bar in the maxilla and a lingual arch in the mandible. A triple tube is used on the upper molar bands, the gingival tube is used for the intrusive springs. The intrusive arch is 0.018" x 0.022" with a 3 mm helix mesial to the auxiliary tube. A low force level is desirable to avoid root resorption and any

excessive reciprocal buccal segment extrusion if not wanted. (See Figure 3.10) (Burstone, 1966 and 1977).

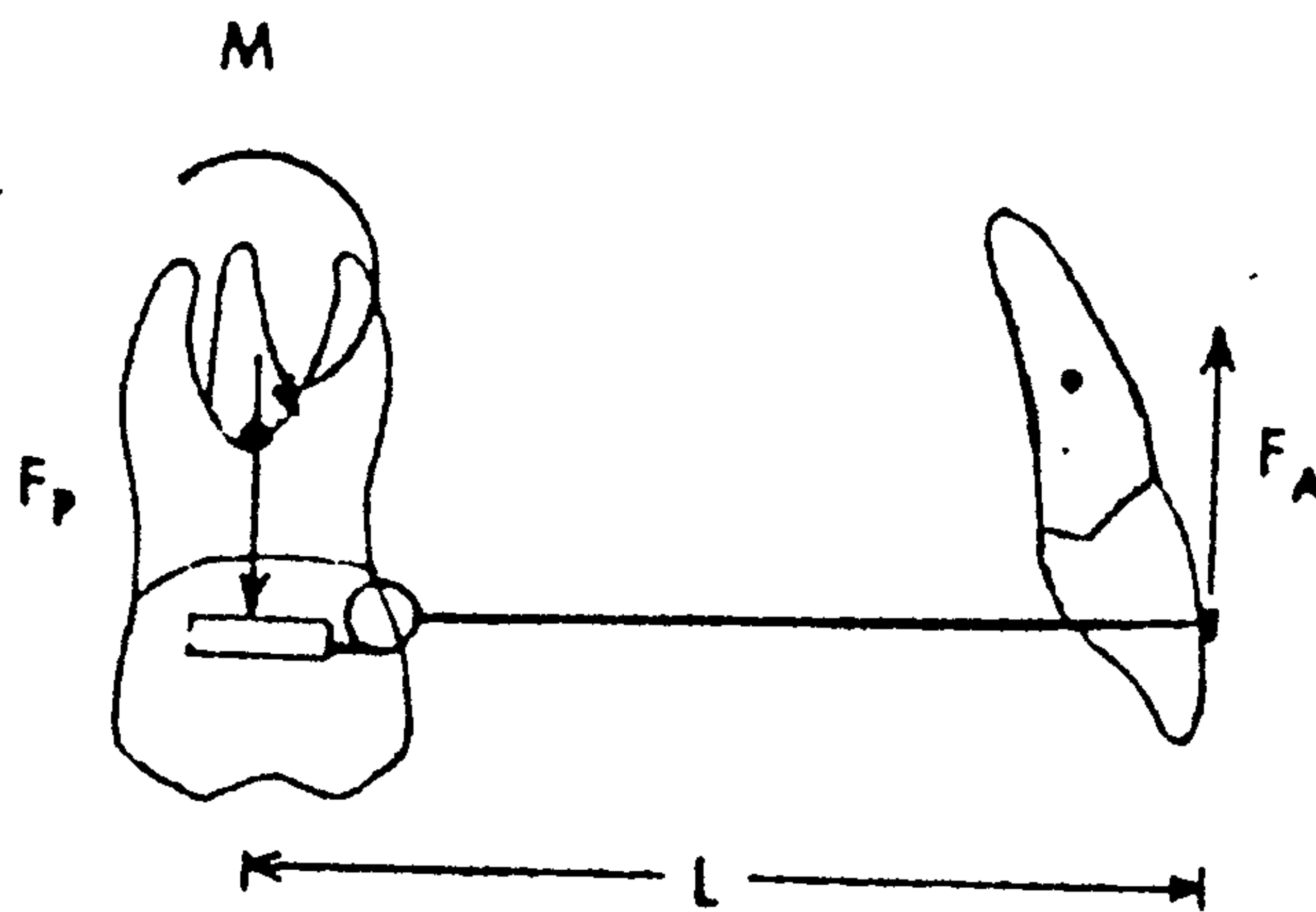


Figure 3.10 Anterior Intrusive Arch
Burstone, 1977: p5.

3.3.4 Rickett's Bioprogressive Therapy

Sectional arch treatment is characteristic of all the bioprogressive therapy, whether non-extraction, extraction, mixed dentition or adult treatment. By breaking up the arches into various segments during treatment all three planes of space may be considered:

anteroposterior, vertical and transverse (or buccolingual). This concept of sectional arch mechanics has been adopted by Ricketts et al (1979) in the development of Bioprogressive Therapy where the anchorage units are again enhanced with rectangular sectional buccal arches connected by a transpalatal arch of various designs.

Continuous arches are avoided until the end of treatment when they are used for torque movements. The active sections of the archwire consist of the utility bypassing arch which fits into the molar tube auxiliary and is constructed of 0.016" x 0.016" chrome cobalt wire, designed to apply light continuous force. Brackets are pretorqued, the centrals, 22° , laterals, 14° and cuspids 7° of lingual root torque.

The intrusion utility arch

This arch is characterized by step-down bends between the first molar and the lateral incisors to bypass occlusal forces. A slight incisal labial root torque should be applied to control the inclination of the teeth as the incisors tend to move labially while they intrude. Light forces are ensured by the use of a small diameter archwire (0.016" x 0.016" in 0.018" slots) and with the long span between first molars and the incisors. Wire heavier than 0.016" should not be used even in 0.022" slots. Reciprocal extrusion

forces are set up in the molar anchorage units, although not a problem in the normal to brachyfacial pattern; in dolichofacial cases these extrusion forces need to be controlled with highpull headgear. The second molar and premolar can be incorporated into the posterior segment for better anchorage control. Forward movement of incisors occurs with the intrusion force and places a strain on posterior anchorage.

Activation: is by 30° molar tip-back bends and 30° buccal root torque in 0.018" slots.

Contraction utility arches: double delta incisor retraction arches also of 0.016" x 0.016" chrome cobalt wire to apply light continuous forces (See Figure 3.12).

Levelling and Traction Buccal Sections. Preformed levelling and closing sections are available in 0.016" x 0.022" nitinol. Traction sections are also available and to counteract the negative responses of Class II elastics to the buccal segment, a small helix distal to the upper cuspids is incorporated. They are fabricated of 0.016" x 0.016" blue elgiloy.

3.3.4.1 Class II, Division 1 treatment sequence

Non-extraction mechanics: (Where the patient's growth potential and the facial pattern are diagnosed as suitable - see 2.2.5, 2.5.2 and 2.5.3.)

(i) Where needed orthopaedic extraoral traction is applied to the maxilla.

(ii) At the same time the lower arch is levelled with a utility intrusion arch which provides anterior light intrusion force and a

reciprocal uprighting and distal tipping of the molar anchorage. Next a stabilizing utility arch (0.016" x 0.022") can be placed to provide torque control and a stable base to align the lower buccal segments.

(iii) Light levelling arches are overlayed to gain bracket alignment of the buccal segment (use 0.016" nickel titanium wire).

(iv) Finally a lower ideal rectangular arch is placed.

Maxillary levelling and retraction (See Figure 3.11). While the lower arch is levelled the Class II molar relationship would have been virtually corrected, opening space in the buccal segment and the following sequence now applies:

(i) bond/band buccal segments and level molar to canine segment.

(ii) fit 0.016" traction segments and Class II elastics may be commenced once the lower rectangular ideal arch is in place. Here the upper buccal segments only are pitted against the whole lower arch for continued correction of the Class II relationship.

Upper incisor alignment, intrusion and retraction When the Class II relationship has neared correction the upper incisors are engaged to effect torque and intrusion prior to the retraction. Using the following sequence:

(i) after anterior alignment either an 0.016" square or 0.016" x 0.022" upper utility arch is placed to provide intrusion and torque.

(ii) the maxillary anterior teeth once intruded are retracted with an upper closing (double delta utility arch). Note: that Class II elastics are never applied to the anterior teeth.

(iii) ideal upper arch placement: 0.016" square or 0.016" x 0.022"

arch is used depending on torque needed.

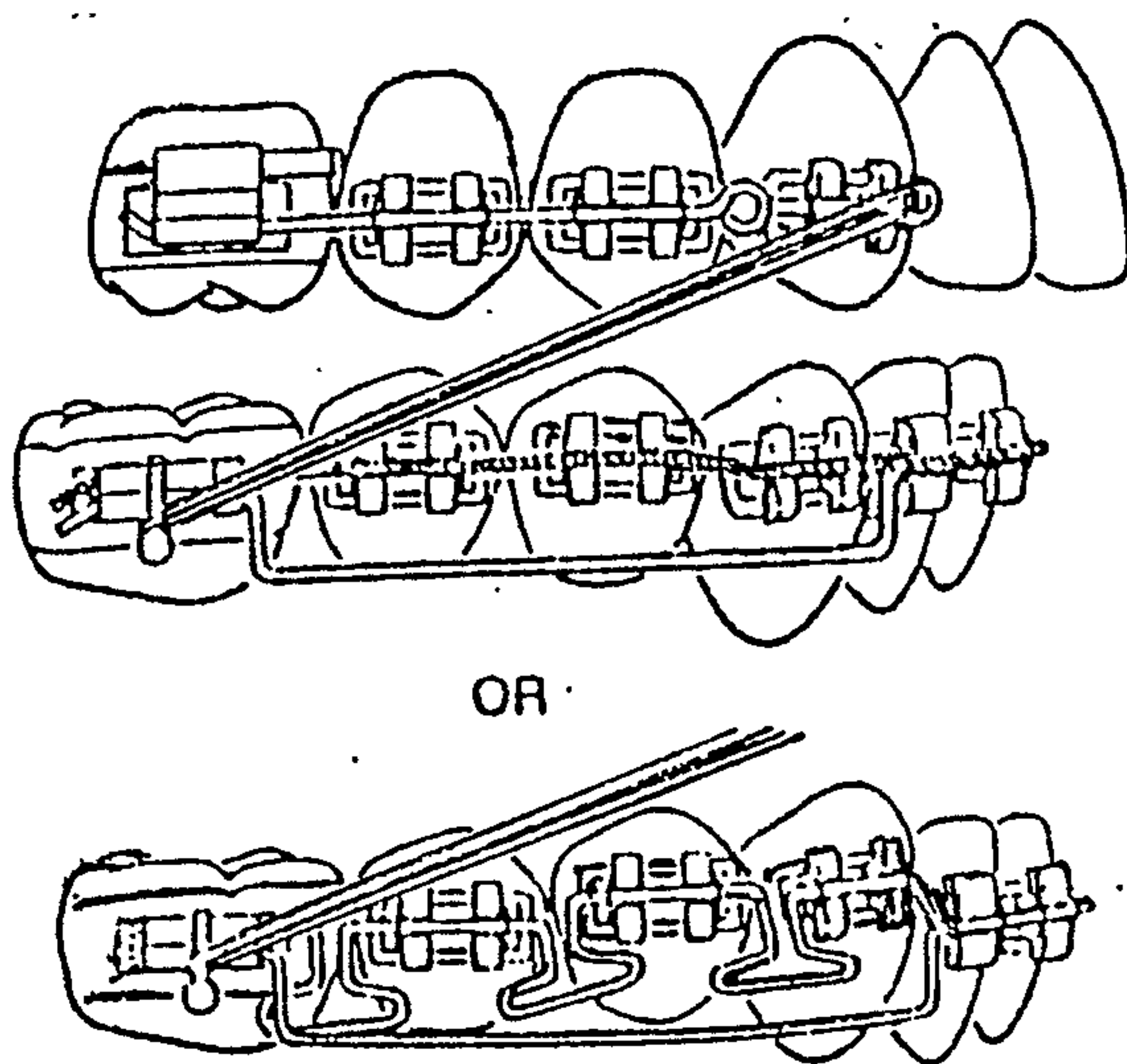
(iv) before debanding light round archwires with ideal arch form may be utilized to allow function to "seat" occlusion. (Bench et al, 1978; Ricketts et al, 1980: p171.

3.3.4.2 Extraction mechanics - the following treatment sequence applies:

- (i) stabilization of the upper molar anchorage
- (ii) retraction and uprighting of cuspids with sectional arch mechanics
- (iii) use of the utility arch to intrude incisors
- (iv) retraction and consolidation of the incisor segments using the double delta contraction utility arches with torque being applied at the same time.
- (v) light Class II elastics can be used to create a Class I molar relationship
- (vi) place ideal archwires (0.016" x 0.016")

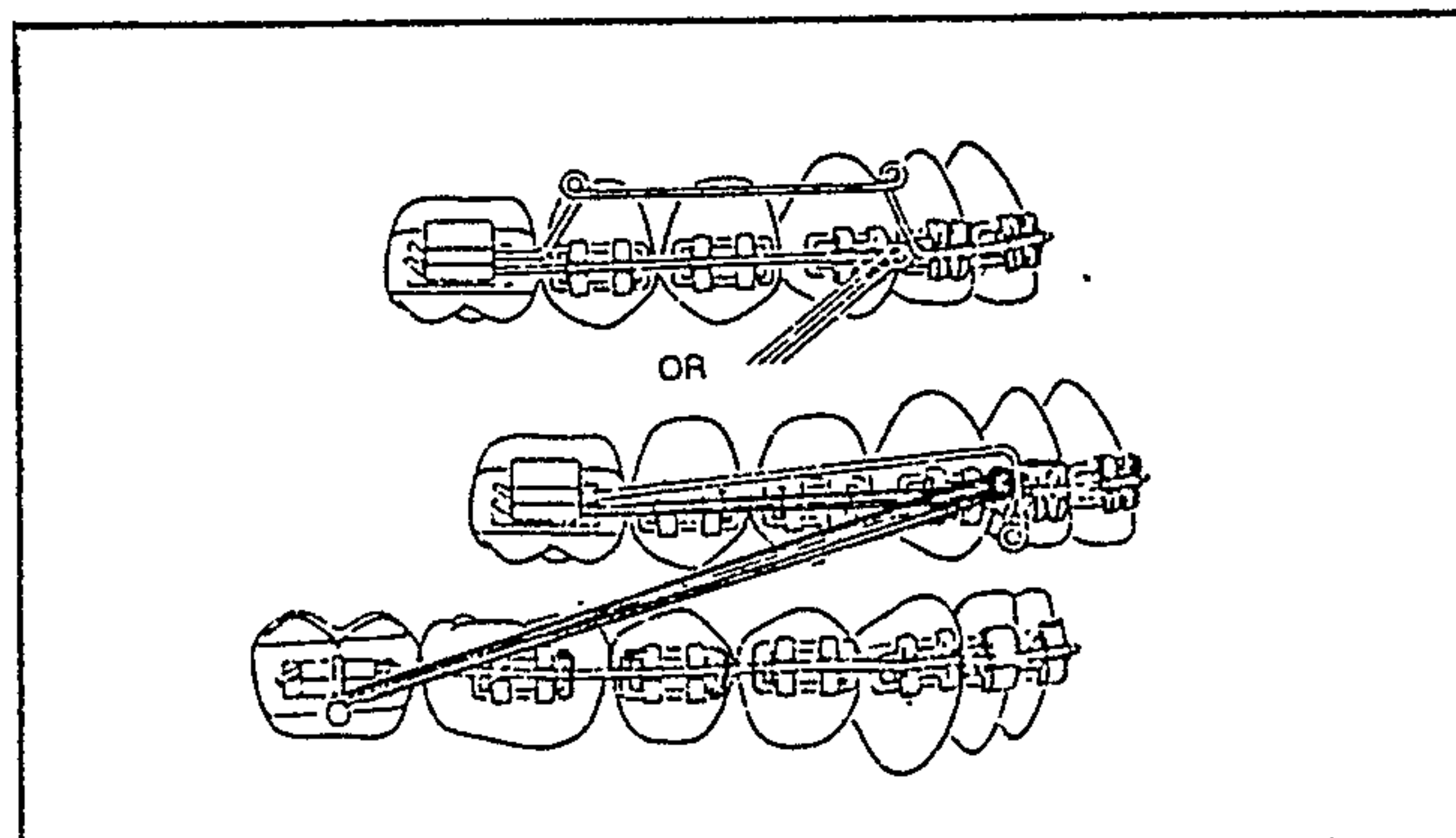
Anchorage Control in extraction cases:

- (a) suitable headgear traction to upper molars
- (b) the Nance palatal arch with plastic button against the rugae
- (c) moderate anchorage is provided with a quad helix or the utility intrusion arch will also provide molar anchorage. (Bench et al, Part 9, 1978).



Non-extraction. Following intrusion of the lower canines, the lower buccal segments are aligned with a light round, Twistoflex or nickel titanium overlay archwire. Once the lower buccal segments have been engaged, Class II elastics to an upper buccal traction section are started. Note the small closed helix distal to the cuspid which functions to prevent a distal tipping of the cuspid with Class II elastics.

Figure 3.11
Bench et al, Part 9, 1978: p433.



Following intrusion of the upper incisors, the maxillary anterior teeth are retracted with an upper closing utility arch or an upside-down closing arch. The second molars are engaged in the lower ideal arch as soon as practical.

Figure 3.12

Bench et al, Part 10, 1978: p437.

3.3.4.3. Summary of the bioprogressive therapy principles from Ricketts et al, 1979: pp 15-31.

* Torque control throughout treatment allows tooth movements such as incisor intrusion or cuspid retraction to be guided away from the denser cortical bone, so that movement takes place in vascular trabecular bone; this is especially important for intrusion mechanics (See also Kuhn, 1968). Torque control to molars can be used also to increase anchorage by torquing roots against the cortical plate.

Deep overbite in dolichofacial vertical patterns with already excessive lower facial height are best treated with intrusion of anterior teeth rather than extrusive mechanics to posterior teeth

which would further increase lower face height and cause a backward mandibular rotation and a worsening profile.

Ricketts et al, (1979: pp22-30) also write that incisor intrusion is the treatment of choice for extreme brachyfacial hypodivergent cases, because most of these cases have strong muscular function and will resist molar extrusion. (See also Schudy, 1965; Burstone, 1977). This is further compounded by the distal displacement of condyle in the fossa in deep overbite cases which limits the needed backward rotation that should occur with extrusion of buccal teeth. (Ricketts et al, 1979: p22).

* Sectional arch treatment is a basic procedure in

Bioprogressive Therapy and it has the following advantages:

(i) it allows lighter, more continuous forces by virtue of the long utility arm.

(ii) Class II elastic forces can be kept low, being directed against the upper buccal segments only, providing less stress in lower maximum anchorage cases and the elastics can not extrude upper anterior teeth in the retraction stage, because they act only on the upper buccal segment. (Ricketts et al, 1979: pp15-31).

(iii) the use of bioprogressive mechanics such as intrusion and retraction utility arches enables Class II deepbite cases to be treated with minimal posterior extrusion and is therefore suitable in the dolichofacial retrognathic cases provided highpull headgear is used. (Ricketts et al, 1979: pp22-30; Nanda, 1981).

CHAPTER 4

THE SELECTION OF TREATMENT

MECHANICS

CHAPTER 4

THE SELECTION OF TREATMENT MECHANICS

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THE SELECTION OF TREATMENT MECHANICS

4.1 INTRODUCTION

The recent literature reveals that several authors, such as Schudy (1964,1965), Sassouni (1970), McNamara (1981), Roth (Graber and Swain, 1985:p.671), Thurow (1982 : p117) and Proffit (1986: pp366-368) emphasise that Class II, Division 1 malocclusion exists in many different facial patterns that will respond differently to any given set of treatment mechanics, thus the mechanotherapy must be carefully selected to suit the individual case without causing detrimental side effects.

Roth (in Graber and Swain, 1985: p671) writes that in order to maintain a manageable range of orthodontic appliances and auxiliaries in his practice, he divides the treatment mechanics into two categories:

- (i) those used on normal to brachyfacial types, with a forward mandibular growth rotation; and
- (ii) those utilized for the more dolichofacial types (i.e. faces which display short posterior face height in proportion to anterior face height and/or short rami) which often have a backward rotation tendency under treatment.

Thurow (1982) also differentiates between cases that have flat mandibular and occlusal planes (low angle or hypodivergent cases) and those cases with steep mandibular planes and weak masticatory musculature that cannot afford mandibular opening, because of the

aesthetic and functional changes associated with downward and backward rotation of the chin (Thurrow, 1982: p 117).

In selecting mechanics, Roth (in Graber and Swain, 1985: p671) emphasises that the important considerations are facial pattern and whether the curve of Spee can be levelled by extrusion of posterior teeth or whether it needs to be levelled by intrusion of anterior teeth and what type of forces can be safely applied without causing undesirable opening or closing of the mandibular plane as an effect of the treatment mechanics.

Thurrow (1982: pp114-118) suggests that with anteroposterior corrections, there are few alternatives, but their selection and combination can make a great difference in results. He lists four broad classes of orthodontic forces that can affect anteroposterior intermaxillary relationships:

- (i) extraoral traction is the only available force that does not exert a reciprocal effect if the extrusion/intrusion forces are controlled to suit the case.
- (ii) intermaxillary elastic traction, as well as providing a mesiodistal force to the upper anterior segment and lower molars, will provide some vertical force component extruding the lower molars and the upper anterior segment.
- (iii) musculature can affect mesiodental movement, often in a negative way (tongue and lip forces).
- (iv) tipping forces will always result in reciprocal root

movement.

In the first category the normal to brachyfacial pattern, the literature indicates that it is safe and often desirable to level the curve of Spee by extrusion of the buccal teeth, by reverse curve of Spee and exaggerated compensating curves to the continuous archwires and with the use of Class II elastics and cervical headgear in the anteroposterior correction, where the vertical components of force further extrude the buccal teeth. It is recommended that second molars be banded to assist in arch levelling and anchorage control.

(Schudy, 1965; Creekmore, 1967; Roth in Graber and Swain, 1985: p671)

The second category is described as the more dolichofacial hyperdivergent pattern and in these cases a backward rotation of the chin point caused by molar extrusion will lead to further deterioration in the facial aesthetics and Roth suggests that no heavy wires are used, only light wire with Jarabak loops where needed or the new nickel and Beta titanium alloy continuous archwires. Utility arches may also be used for overbite correction with anterior intrusive force to level the curve of Spee. Extraction of teeth is usually employed to slip posterior teeth forward allowing the mandible to hinge in the direction of closure.

Alternatively, the bioprogressive utility arch is used to intrude the incisors, sectional stabilising arches can be placed linking the molars and premolars and a sectional helical retraction arch is used to retract the upper anterior segment.

In this hyperdivergent pattern, Class II elastics are not used for anterior retraction. This is achieved instead with intramaxillary elastics on continuous archwires or with the Burstone anterior retraction spring or the bioprogressive retraction utility arch, high pull headgear and a Goshgarian palatal arch are used to counter reciprocal molar extrusion and also for posterior anchorage control. (Burstone, 1977; Roth, in Graber and Swain, 1985 p701)

4.2 ANTEROPosterior CORRECTION

Class II Division 1 correction in the anteroposterior plane is achieved by several approaches:

- (i) growth modification, so that growth corrects the problem.
- (ii) camouflage of the skeletal jaw discrepancy by orthodontic tooth movement; usually this requires extraction. The dental occlusion is corrected although the skeletal discrepancy remains.
- (iii) surgical correction of the jaw discrepancy.

The above categories of treatment are for skeletal Class II malocclusion. Differential growth correction or camouflage is not a consideration in the non-skeletal Class II malocclusion which would require only occlusal or dental correction relative to the jaws.

(Proffit, 1986: p419).

4.2.1 Growth Modification Treatment of the Class II Relationship

This is possible only in patients who have a significant amount of growth remaining; it should be carried out before or during the pubertal (adolescent) growth spurt. (See Chapter 2)

Although jaw growth continues after puberty, its magnitude is not enough for the correction of large skeletal jaw discrepancies.

Growth modification is indicated only in skeletal Class II cases where a forward mandibular growth pattern is predicted; it is not suitable in the dolichofacial, vertical growers. (Creekmore, 1967; Roth, in Graber and Swain, 1985: p701).

4.2.1.1 Selecting mechanotherapy for early Class II correction (mixed dentition)

The decision on the type of mechanics or appliance used in early growth modification will require analysis of the maxillary position. As discussed in Chapter 1, McNamara (1981) has suggested that in Class II treatment consideration of maxillary position is needed in selection of treatment mechanics. If there is mandibular deficiency or a retruded mandibular position and a normal maxilla, then correction of the skeletal Class II relationship is best achieved with early use of a functional appliance that will force the patient to function with the lower jaw forward, but restrain forward movement of the lower teeth on their base. The elastic stretch of the tissues has a similar effect to Class II elastics, creating a restraining force on the maxilla, while applying a forward pressure

on the lower arch (Proffit, 1986: p204-206). Stimulation of mandibular growth cannot be expected. However, an acceleration of growth is reported when the functional appliance is worn over a period of time (without enlargement). (Graber and Swain, 1985:p592; Proffit, 1986: p204-206), The exception being initially proclined lower incisors. (Graber and Newman, 1977: pp148-149).

If the maxilla is in a forward position the use of suitable extraoral force should be used to apply pressure across the maxillary sutures and so slow growth.

Indications for extraoral traction are:

- * excessive horizontal growth of the maxilla
- * some protrusion of the maxillary teeth
- * reasonably good mandibular growth
- * able to begin treatment well before pubertal growth spurt (often in mixed dentition) with a co-operative patient.

To produce the maximum skeletal change the following force application is suggested by Proffit (1986: pp206-208):

- * a heavy force 500 - 1000 grams
- * a force direction slightly above the occlusal plane, through the centre of resistance of the molar teeth using a cervical or horizontal anchorage
- * a force duration of 10 to 14 hours per day, taking 12 to 18 months
- * if a deep-bite exists, a lower utility arch can be added in conjunction with maxillary headgear, to intrude incisors removing

incisal interference to the maxillary distal force. The utility arch will also be useful for lower anchorage in the retraction of upper anteriors. (Ricketts et al, 1980: p144).

Discussion

Whether extraoral force or a functional appliance is used to modify maxillary growth, it is still essential to have a strong forward growth of the mandible to correct the Class II relationship. The more dolichofacial retrognathic cases are not suitable for this type of Class II anteroposterior correction (Creekmore, 1967; Schudy, 1973; Roth, in Graber and Swain, 1985: p701).

Proffit (1986: pp419-421) adds that starting treatment with functional appliances or suitable headgear as a first phase of treatment, to be followed by fixed appliances to obtain any necessary detailed occlusal correction, is a logical approach especially if the child is approaching puberty and has delayed eruption of permanent teeth. This is supported by Lindquist (in Graber and Swain, 1985:p607).

4.2.1.2 The ideal case for non-extraction edgewise treatment of the Class II relationship

The ideal patient is in the early permanent dentition; e.g. a 12 to 14 year old boy whose skeletal maturity is behind his dental development, but who has a favourable brachyfacial growth pattern (girls at 13 years are usually on the same developmental stage as boys at 15 years and too late for useful growth correction). When non-extraction is selected in the treatment plan, there should be a good, relatively uncrowded, upper and lower arch and the patient

should have a favourable forward mandibular growth pattern and be 1 to 2 years junior to their anticipated pubertal growth spurt (Proffit, 1986: p 419; Graber and Swain, 1985: p605).

In these ideal cases the immediate application of suitable headgear traction to the upper molars is desirable, so that the maximum differential growth potential is used to correct the Class II relationship. There is no need to wait until all the permanent teeth have erupted or to level and align the dental arches (Bench et al, 1978; Proffit, 1986: p419-420). Also in these growing cases where upper incisor protrusion is present, as the overjet is reduced with headgear traction, the lower everted lip will begin to close over the upper incisor (rather than lingual to it), creating a functional retraction of the upper incisors, while the lower incisor without excessive pressure from the lower lip will often tip labially as the circumoral soft tissue reaches equilibrium (Bench et al, Part 5: 1978).

The extraoral force will modify tooth movement in all three planes of space as well as restraining forward maxillary growth. Useful vertical maxillary growth may still continue providing for elongation of the upper buccal teeth through downward and backward eruption, and spaces should open in the maxillary arch, usually distal to the canines, along with a partial reduction of the overjet. This space enables further retraction of the incisors which is done after levelling and alignment is completed (Proffit, 1986: p420). The extraoral traction should be continued on after

correction to a Class I molar relationship so as to both reinforce anchorage, while the overjet is further reduced, and to minimise the differential growth between the maxilla and the mandible in the anteroposterior plane. It may also be necessary in these cases (where forward maxillary growth occurs), to maintain the use of the headgear throughout growth as a form of active retention (Proffit, 1986: p 421).

4.2.1.3 Anchorage considerations in non-extraction mechanics

The following considerations must be made if non-extraction mechanics is selected to assist anchorage control:

- * will levelling the curve of Spee in the lower arch move the incisal edge too far ahead of AP line (1mm of depth in curve of Spee needs 1mm of arch length)? Also, will the lower molar anchorage move forward protruding the lower incisor beyond AP under the force from Class II elastic use in correcting the overjet (Williams, 1969)? Tweed (1941) describes the use of Class II elastics to assist in non-extraction, full banded correction of the Class II molar relationship. Care is taken not to allow the lower incisors to be moved forward. (Proffit, 1986: p426).

To displace one arch relative to another requires large forces and the following stabilisation of lower anchorage is needed:

- * stabilise the lower arch with a close-fitting rectangular archwire (Tweed, 1941; Proffit, 1985:p426).
- * prepare lower anchorage by using Class III elastics off upper

headgear (if extrusion is permissible). This will upright and tilt lower teeth distally in preparation for use of Class II elastics (Tweed, 1941).

* incorporate the lower second molars in the appliance and attach the elastics to hooks on these teeth to increase lower anchorage and also give a more horizontal force component to the Class II elastics (Lindquist, in Graber and Swain, 1985: pp607-609; Proffit, 1986:p426).

4.2.2 Correction of the Class II Relationship Using Extraction Space

4.2.2.1 Introduction

Proffit writes that for patients who have entered or passed puberty, mild to moderate skeletal Class II problems and displacement of the teeth relative to their bony bases to achieve good occlusion, is compatible with reasonable facial aesthetics and that this "camouflage" can be quite successful, attaining considerable retraction of the upper incisors before an increasing prominence of the nose and unaesthetic nasolabial angle signal the effective limits of this treatment (Proffit, 1986: p212). The location of extraction sites and their effect on the profile has been discussed in Chapter 2. To recap, in order to preserve a profile, or improve a convex profile, the extraction site may be varied; for example, to preserve a profile extract teeth more posteriorly (second premolars or molars), or if there is a convex profile, extract upper first premolars and lower second premolars. If facial balance is good and crowding is minimal upper second molars can be considered for extraction (Ackerman and Proffit, 1970; Graber and Swain, 1985: p94). However posterior sites provide much less potential for incisor retraction, e.g. extraction of upper second molars provides about 2 mm of additional space on each side. (Graber and Swain, 1985: p94).

Proffit (1986: pp212-213) stresses that in the more severe Class II problems it may be possible to obtain good occlusion, but only at the expense of facial aesthetics because upper incisors must be

displaced so far distally to compensate for mandibular deficiency.

Growth in a vertical direction is seen as an advantage in certain extraction cases because of the extrusion that accompanies most orthodontic mechanics. It is very helpful to have some vertical growth during treatment, to avoid any downward, and backward, rotation of the mandible (Creekmore, 1967 ; Proffit, 1986: p214).

4.2.2.2 The ideal case for extraction treatment of the Class II relationship.

- * too old for successful growth modification
- * mild to moderate skeletal Class II jaw relationship
- * reasonably good alignment of teeth (so that the extraction space would be available for controlled anteroposterior displacement and not used to relieve crowding.)
- * good vertical facial proportions should exist. In extreme brachyfacial deep overbite cases extraction should be avoided (Schudy, 1965; Creekmore, 1967; Proffit, 1986: p214).

4.2.2.3 The decision on extraction or non-extraction treatment for Class II correction.

Treatment planning for Class II correction in the preadolescent or adolescent, with a skeletal jaw discrepancy is a multifactorial problem. As a general principle, if the patient exhibits good skeletal growth and co-operates well, it is possible to achieve a good result without extraction. While if growth, co-operation, or both, are poor, extractions may be the best approach. However, if there is a total "failure to co-operate" this can be disastrous even for extraction cases and it may be best to defer treatment.

(Godfrey, personal communication: 1987) Attempted growth modification in a poorly growing patient produces unstable results, while extractions and camouflage in a poorly growing patient can provide acceptable results (Schudy, 1964; Cohen, 1966; Proffit,

1985: p216).

It is obvious that growth prediction in Class II treatment would be of value in deciding on an extraction or non-extraction approach to the Class II correction and this has been widely recognised in the literature by Björk (1963,1969), Ricketts (1972), Johnston (1975), etc. However these methods cannot account for the changes in direction of growth and dental eruption that have been shown to occur in the mandible and maxilla (Björk and Skieller, 1983).

With this uncertainty about growth direction in mind, Ackerman and Proffit (1970) have suggested the use of "therapeutic diagnosis" to evaluate growth response and patient co-operation with treatment, rather than rely on one growth prediction alone. This approach consists of implementing a conservative, i.e. non-extraction treatment plan and re-evaluating the patient after 6 to 9 months. The skeletal Class II child is initially treated with suitable headgear or a functional appliance and if a poor response is observed, whether due to poor co-operation or poor growth, then the therapy may be dropped in favour of an extraction approach (Ackerman and Proffit, 1970; Lindquist, in Graber and Swain, 1985: p607).

4.2.2.4 Selection of mechanotherapy for the various extraction cases

Consider firstly the correction of Class II relationship by the distal movement of maxillary posterior teeth.

(i) Upper second molar extraction: here extraoral force is used to move upper first molars distally to both reduce the overjet and correct the Class II molar relationship. Proffit (1986: p421) states that without second molar extraction it is difficult to produce more than 2mm of distalization of upper first molars. However, with these extractions and good patient co-operation it is possible to simultaneously reposition all the maxillary teeth, with an archwire tying the teeth together. The force should be approximately 300 grams on each side; Class II elastics may be included to apply force directly against the upper molars via sliding jigs, the lower arch having been stabilized with a full dimension rectangular archwire to impede forward tipping of mandibular teeth. It should be noted that with the use of Class II elastics the lower archwire should be slightly constricted to resist the distobuccal forces and prevent expansion of intermolar width.

Once the molars are distalized the sliding jig is altered so that the force is applied against the second premolars and then the first premolars. This elastic force against the lower arch should be light, not more than 100 grams per side (Proffit, 1986:p421).

Indications: growth complete or almost complete, uncrowded lower arch; mild Class II jaw discrepancy; not a high angle case.

(ii) Upper first premolar extraction cases: the first premolar extraction space is closed by retracting the protruding incisor teeth. Treatment mechanics:

- * use intramaxillary elastics or closing loops between anterior and posterior segments.
- * reinforce posterior anchorage with suitable extraoral force or Nance holding arch on the palate.
- * retract canines individually to place less strain on anchorage.
- * alternatively, retract the protruding anterior teeth with extraoral force, e.g. the maxillary canines can be retracted with J-hooks from headgear: 200 grams of force per side to highpull headgear; the hooks fit directly to the anterior archwire and slide the teeth backward and upward.

Indications for extraction of upper first premolars: this has been recommended by Schudy (1965) in the treatment of high angle dolichofacial cases with a retrognathic mandible and with a short posterior ramus height. His advice is to treat these cases as if no growth is present and make no effort to gain Class I occlusion. The first premolar space enables overjet correction while any overbite or supraeruption is corrected by intrusive mechanics and vertical pull headgear for molar anchorage (Schudy, 1965; Proffit, 1986: p421).

(iii) Extraction of maxillary and mandibular premolars. In correction of the Class II "dentoalveolar" relationship, the buccal mandibular segments will be moved anteriorly, almost the entire extraction space, while the protruding maxillary anterior teeth will

be retracted without forward movement of maxillary buccal segments.

Light Class II elastics are used to assist in closing the extraction sites and anchor bends are placed in the upper archwire to counter the effect of the Class II elastics, providing a force system which intrudes incisors and elongates the molars. The round wire will tend to slide posteriorly through the molar tube, tipping the incisors distally. The mesiodistal width of the canine edgewise brackets tends to keep the canine teeth upright and there is some strain on the posterior anchorage, so that reinforcement of the maxillary anchorage with suitable headgear is often advisable (Proffit, 1986: p424).

If Class II elastics cannot be used, then space closure by retraction of the maxillary anterior teeth and protraction of the mandibular posterior segments is achieved with a segmented arch technique, generally with highpull (intrusive) headgear to limit molar extrusion (Burstone, 1966).

When differential space closure, with or without Class II elastics, is indicated, it is often preferable to extract maxillary first and mandibular second premolars, thus altering the anchorage value of the two segments enabling closing mechanics to move the lower molars forward while the upper posterior anchorage is effectively enhanced.

This upper first/lower second premolar extraction pattern greatly

simplifies the mechanics needed for differential space closure with the continuous arch edgewise technique. (Grabner and Swain, 1985: p94; Proffit, 1986: p425). This extraction pattern is ideal for Class II, Division 1 treatment and has been discussed in Chapter 2 with a view to root surface area ratios (Freeman's values).

4.2.3 Use of Class II Intermaxillary Elastics

Class II elastics are used to correct both the anteroposterior and vertical relationship in this malocclusion.

(i) **Non-extraction Cases:** Class II correction to a Class I relationship without extraction is achieved largely by mesial movement of the mandibular arch associated with forward growth and a small amount of distal maxillary positioning. The amount of force varies with the amount of tipping allowed in the mandibular arch. As mandibular tipping is rarely desired, then Class II elastics should only be used when a well fitting rectangular wire is placed with some posterior contraction. Large forces are used (300 grams per side) to displace one arch relative to the other when both arches have been stabilized with rectangular wire in edgewise brackets, the lower second molars are banded to aid anchorage and the Class II elastics are attached to them.

(ii) **Extraction Cases:** (upper and lower premolars) Here the Class II elastics produce differential movement of the arch segments while correcting the molar relationship. An anchor bend is placed in the upper archwire to tip maxillary teeth back and to resist the

extrusion force of the elastics on anterior teeth, while in the lower arch anchor bends control the mesial tipping of the molars. As with the Begg or Jarabak appliances, light elastic force is used on round wires (0.018" wire in 0.022" tube/slot). However, because of greater bracket friction, particularly from the mesiodistal width of the canine bracket and also the upper molar tube, it is often found that posterior maxillary anchorage reinforcement (with headgear) is needed especially if somewhat heavier elastic force is used. (Proffit, 1986:p424).

(iii) Side Effects of Class II Elastics: Apart from anteroposterior forces there are transverse and vertical force components.

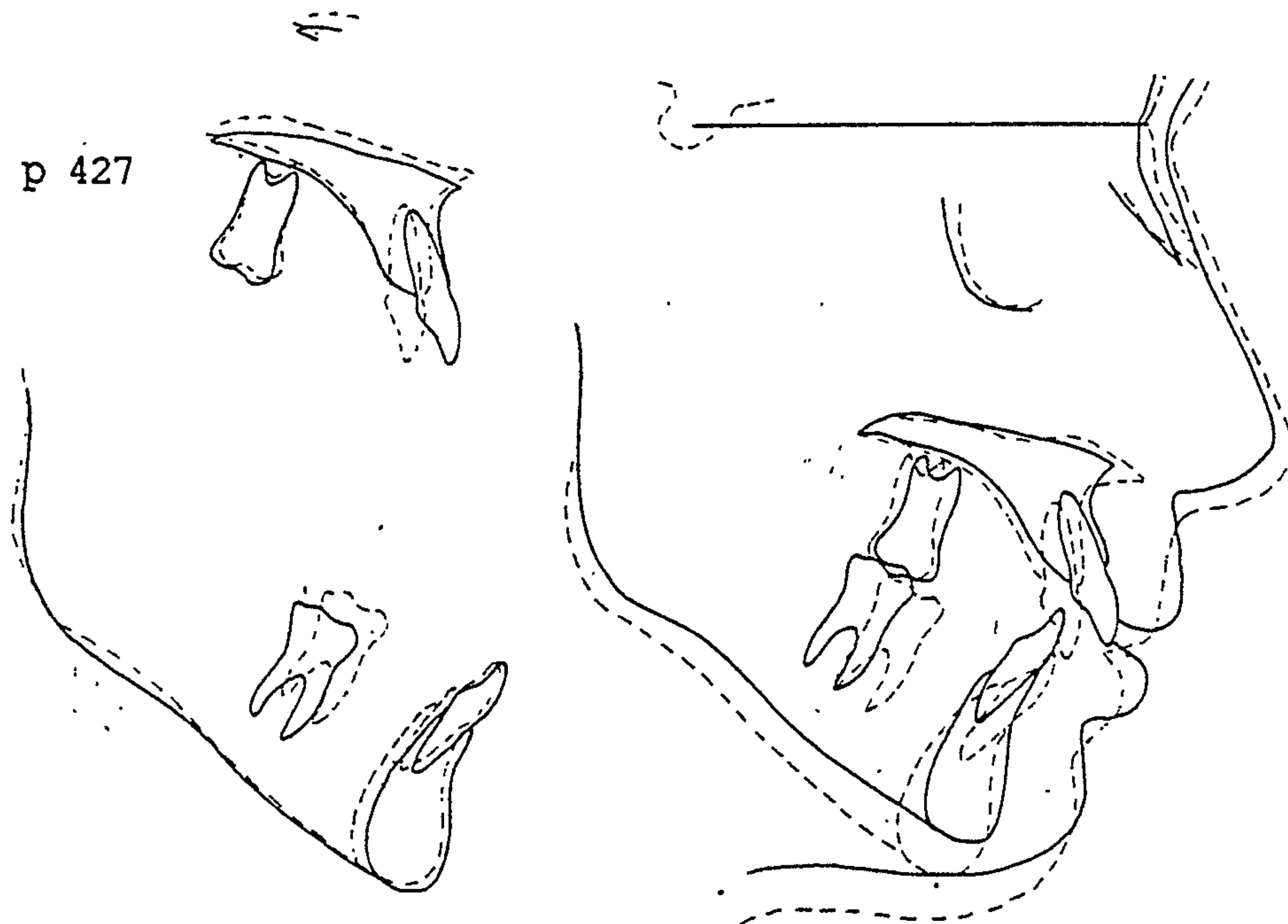
- (a) Transverse forces: elastic forces on lower molars will expand the intermolar width creating a molar crossbite; it is avoided by narrowing the posterior end of the lower rectangular archwire, or with "toe in bends" to the round wires.
- (b) Vertical forces: (See Figure 4.1B) there is elongation of the mandibular molars and the maxillary incisors, effectively producing rotation of the occlusal plane (up posteriorly and down anteriorly). (Proffit, 1986: pp424-427)

If molar extrusion is greater than the ramus growth, the mandible itself will be rotated downward. Class II elastics are therefore contraindicated in non-growing patients who cannot tolerate downward and backward rotation of the mandible (as in high angle cases - See

Figure 4.1A). The rotation of the occlusal plane, even when in brachyfacial cases, is contraindicated if the incisors are in supraocclusion; further extrusion of incisors will result in unsightly excess gum and tooth showing (Burstone, 1977) and this will be discussed fully in Section 4.3.1.

It is because of these vertical effects that prolonged use of Class II elastics, especially with heavy forces, is rarely indicated. Using Class II elastics for 3 to 4 months at completion of treatment of a Class II patient, to obtain good posterior interdigitation is often acceptable in the normal to brachyfacial patterns (Nanda, 1981; Proffit, 1986: pp425-427).

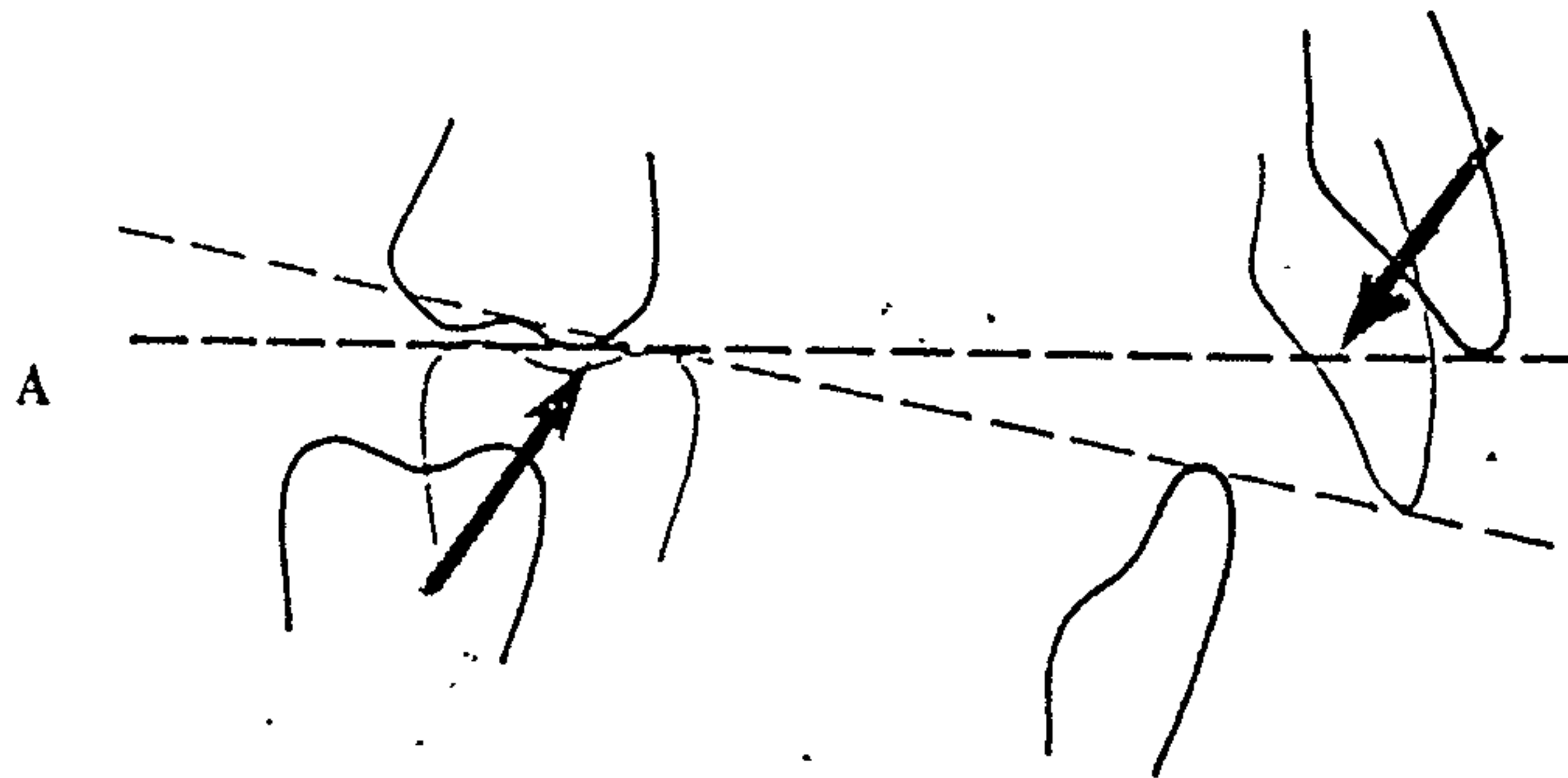
Figure 4.1A
Proffit 1986: p 427



Cephalometric superimposition showing the effects of Class II elastics in the correction of this Malocclusion. Note the elevation of the lower molar, extrusion and distal tipping of the upper incisor, rotation of the occlusal plane, and downward and backward rotation of the mandible.

Figure 4.1B

Rotation of the occlusal plane may occur with Class II elastics



(iv) Class II elastics combined with high pull J hook traction: In the brachyfacial patient, i.e. low mandibular plane angles that need as much vertical development as possible, the combination of highpull headgear and Class II elastics will provide both vertical development and horizontal correction. Although of most benefit to Class II, Division 2 therapy, it may also be used in Class II, Division 1 therapy to resist downward anterior tipping of the occlusal plane that may occur with extended use of Class II elastics (care is needed to prevent the occlusal plane tipping down posteriorly with highpull headgear) (Lindquist, writing in Graber and Swain, 1985: pp609-610).

(v) Short Class II elastics: Are recommended by Schudy (1973) and Roth (1985) to control the cant of the occlusal plane for interarch adjustment. Roth uses multiple, short Class II elastics 1/8" diameter with 4 to 8 oz of pull, from the mesial of the lower first molar to the mesial of the upper second premolar; from the

distal of the lower second premolar to the mesial of the upper first premolar and from the distal of the lower first premolar to the mesial of the upper canine. Their advantage is that they do not extrude the molars and do not change the cant of the occlusal plane. If they extrude teeth it is in the middle of the arch, helping to level the curve of Spee. The force is largely anteroposterior because of the difficulty in opening the mouth.

Use: for three to five months near the end of treatment when the lower arch has been levelled and rectangular arches are in place.

(Schudy, 1973; Roth in Graber and Swain, 1985: pp709-710).

4.2.4 Continuous Retraction Archwires (extraction cases)

These are used in the lower arch to close any residual space once the Class I molar relationship is gained and the occlusal plane is levelled. It is constructed of 0.017" x 0.025" stainless steel wire; it has vertical loops that are formed distal to the distal wing of the canine bracket, the loop is 8mm in length. The archwire is ligated and then activated by cinching back at the ends at the molar tube. The activation is 1mm and it is repeated at 3 week intervals.

In the upper arch, the upper canines should be completely retracted, the space left is between them and the laterals. The upper incisors are retracted with an 0.016" x 0.022" stainless steel, "Stoner T" loop archwire. Activation is also by cinching back distal to the upper buccal tubes. An appropriate headgear is used for posterior anchorage control.

Advantages of looped retraction archwires (rectangular)

- (a) further anterior intrusion can be obtained by placing a gingival curvature across the incisal portion of the archwire to intrude centrals while the retraction takes place.
- (b) reverse curve of Spee or accentuated compensating curves may be placed to further open the bite as retraction takes place.
- (c) torque can be added or the pretorqued bracket slots will provide torque control to upper or lower incisors along with the retraction. (Lindquist, in Graber and Swain, 1985: pp600-602; Proffit, 1986: pp428-433).

4.2.5. Maximum Incisor Retraction/Maximum Anchorage Cases

Where maximum retraction is required it becomes essential to both maximise posterior anchorage and to reduce strain on that anchorage by either:

- (i) reinforcing posterior anchorage by the use of extraoral and/or stabilizing transpalatal arches etc. or,
- (ii) with the reduction of strain on the posterior anchorage, which is achieved with various combinations of mechanics that eliminate friction from the retraction system, e.g. retracting canines and even laterals separately or tipping the incisors before uprighting them.

Anchorage reinforcement with intramaxillary anterior retraction.

With retraction forces to anterior teeth from intramaxillary elastics or archwire closing loops, the following steps to augment

anchorage and reduce anchorage strain are suggested by Proffit, (1986: pp434-435):

(i) add stabilizing palatal arches and proceed with en masse space closure, the resulting increase in anchorage, though only modest, will change the ratio anterior retraction : posterior protraction to 2:1.

(ii) reinforce maxillary posterior anchorage further with suitable extraoral force and, if needed, Class III elastics can be used off the face bow molar tubes to retract lower canines. Here a 3:1 or 4:1 ratio is achieved for anterior retraction : posterior protraction.

(iii) retract the canines separately

(iv) Ricketts' or Burstone's closing loops can be used to first independently retract the canines and then retract the incisors with a second closing loop archwire used with stabilizing lingual arches to control the posterior segment. This "frictionless" mechanotherapy provides a retraction ratio of 3:1 and when reinforced with headgear even better ratios are obtained. (Proffit, 1986: pp434-435).

Reinforcement with stabilizing lingual arches: (use rigid 0.036" steel wire).

* the lower lingual arch when used for posterior anchorage, should lie behind and below the lower incisors.

* the palatal arch should be rigid and Proffit (1986: p435) states that expansion loops should be avoided. However, Ricketts et al (1980: p159) recommends the use of a Nance holding arch on the

palate which may include an expansion helix to rotate the molars, placing their roots just in contact with the cortical bone to further improve their anchorage.

These lingual arches are removed after alignment and space closure is complete as they may interfere with final settling of the occlusion. (Ricketts et al, 1980: p159).

Reinforcement with headgear and interarch elastics: Extraoral force against the maxillary posterior segments is the most direct method for anchorage reinforcement. It is also possible to place extraoral force against the mandibular posterior segments and this is suggested by Roth (in Graber and Swain, 1985: pp708-709). However, Proffit (1986: p435) suggests that the use of Class III elastics and sliding jigs to transfer extraoral force from the upper to the lower arch is more practical.

Interarch elastics for anchorage reinforcement were part of Tweed's (1941) method for maximum retraction of protruding anterior teeth; his method of "anchorage preparation" in these cases was to tip the molars and premolars distally, firstly using Class III elastics off maxillary headgear and a lower sliding jig from the canine region to tip the lower buccal teeth distally, along with retraction of the lower incisors at which point the lower arch was stabilized with a heavy rectangular archwire. Following this, "preparation" of upper anchorage was started using Class II elastics and a sliding jig to

tip back the upper molars, before the upper incisors were retracted. Retraction of the upper canines and then incisors is achieved with either Class II elastics, if the facial pattern permits, or perhaps more commonly, with intramaxillary elastics or rectangular closing loop retraction archwires (Proffit, 1986: p435).

It should be emphasized again, that both Class II and Class III elastics are extrusive and require good vertical growth to avoid tipping the occlusal plane. (Schudy, 1965; Burstone, 1966).

Frictionless retraction: As in the Ricketts and Burstone bypass mechanics this will require an auxiliary tube on the molar. Firstly the canines are retracted with segmented canine retraction springs which require a root paralleling gable bend of 60° and an anti-rotation bend of 20° . Closing loops are then used for the second stage of incisor retraction. Anchorage stress is not as great as with sliding mechanics and is relatively free of the frictional drag, seen with continuous arches. Anchorage control, if needed, is provided by palatal and lingual arches. (Proffit, 1986: p435). High pull headgear to the maxillary molars is used to prevent reciprocal extrusion in high angle deep bite cases where upper and lower incisor intrusion mechanics may be needed. (Burstone, 1977; Ricketts et al, 1980: p253).

4.3 VERTICAL CORRECTION

Proffit (1986: p 171) states that deep overbite is corrected by

levelling an excessive curve of Spee in the mandibular arch and that this may be achieved in three ways:

- i) absolute intrusion of the mandibular incisors, by moving them into the alveolar process;
- ii) relative intrusion of the mandibular incisors, accomplished in the growing patient, merely by preventing their eruption while other teeth erupt normally (bite plate);
- iii) elongation (extrusion) of the canines and premolars while holding the incisors and end molars; this causes the mandible to rotate downward in high angle cases and also in the absence of any growth.

Kuhn (1968), Burstone (1977) and Nanda (1981) have also written on this subject and list several features, both soft tissue and skeletal in nature, that should be considered in order to select the appropriate mechanotherapy for the wide variety of soft tissue and skeletal patterns that may be present with Class II, Division 1 malocclusion.

4.3.1 Soft Tissue and Facial Pattern Considerations

- i) Consideration of the lip relationship: A relaxed mandibular position should display an interlabial gap between upper and lower lips of 2 - 4mm on average.

* If the case displays a larger than average gap and a deep overbite, then posterior extrusion will worsen the aesthetics by increasing lower face height.

* If a normal interlabial gap is present, with a deep overbite

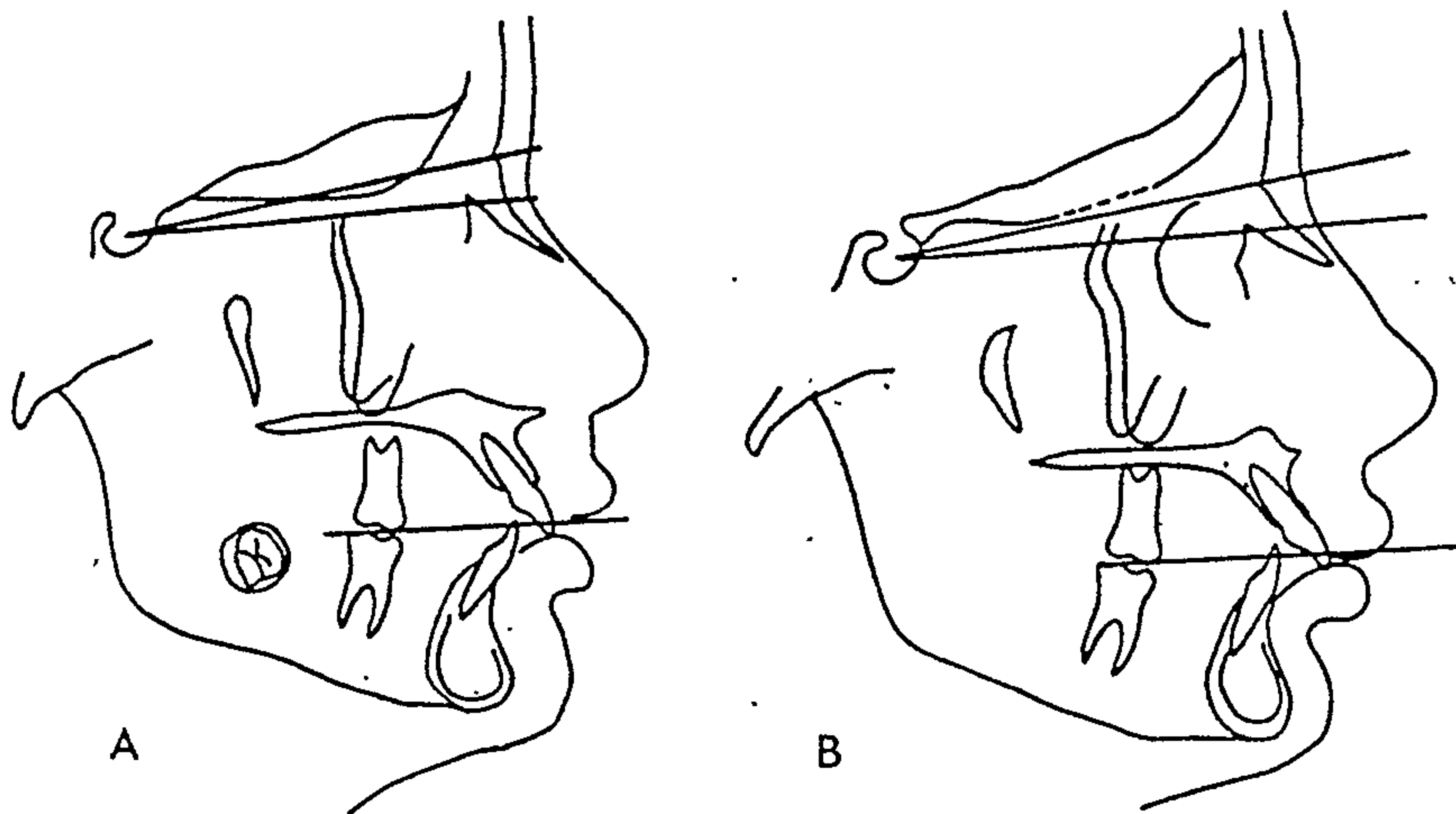
and large overjet, the treatment mechanics should prevent extrusion of posterior teeth and correct the overbite by incisal intrusion.

(See Figure 4.2A)

* If there is redundant lip or no interlabial gap then posterior extrusion mechanics may be selected. (Nanda, 1981) - (See Figure 4.2B).

ii) The upper incisal edge - stomion distance: With the lips in a relaxed position, it is the distance of the upper incisal edge to the lower border of the upper lip, and the average is 2 - 4mm. If normal, then intrusion is contraindicated because it may create an edentulous appearance. If a large amount of tooth is exposed, with a high smile line or "gummy smile", then intrusion mechanics are selected. (Kuhn, 1968; Burstone, 1977; Nanda, 1981).

Figure 4.2 (Nanda, 1981: p74).



A, lateral headfilm tracing of a patient showing normal interlabial gap with deep overbite and large overjet. The treatment objective in this patient will be to prevent an extrusion of posterior teeth. B, A lateral headfilm tracing of a patient showing no interlabial gap in a relaxed position but rather a lip redundancy. In this patient the correction of deep-bite can be accomplished by a combination of incisor intrusion and posterior extrusion. The extrusion of posterior teeth will help in reducing lip redundancy.

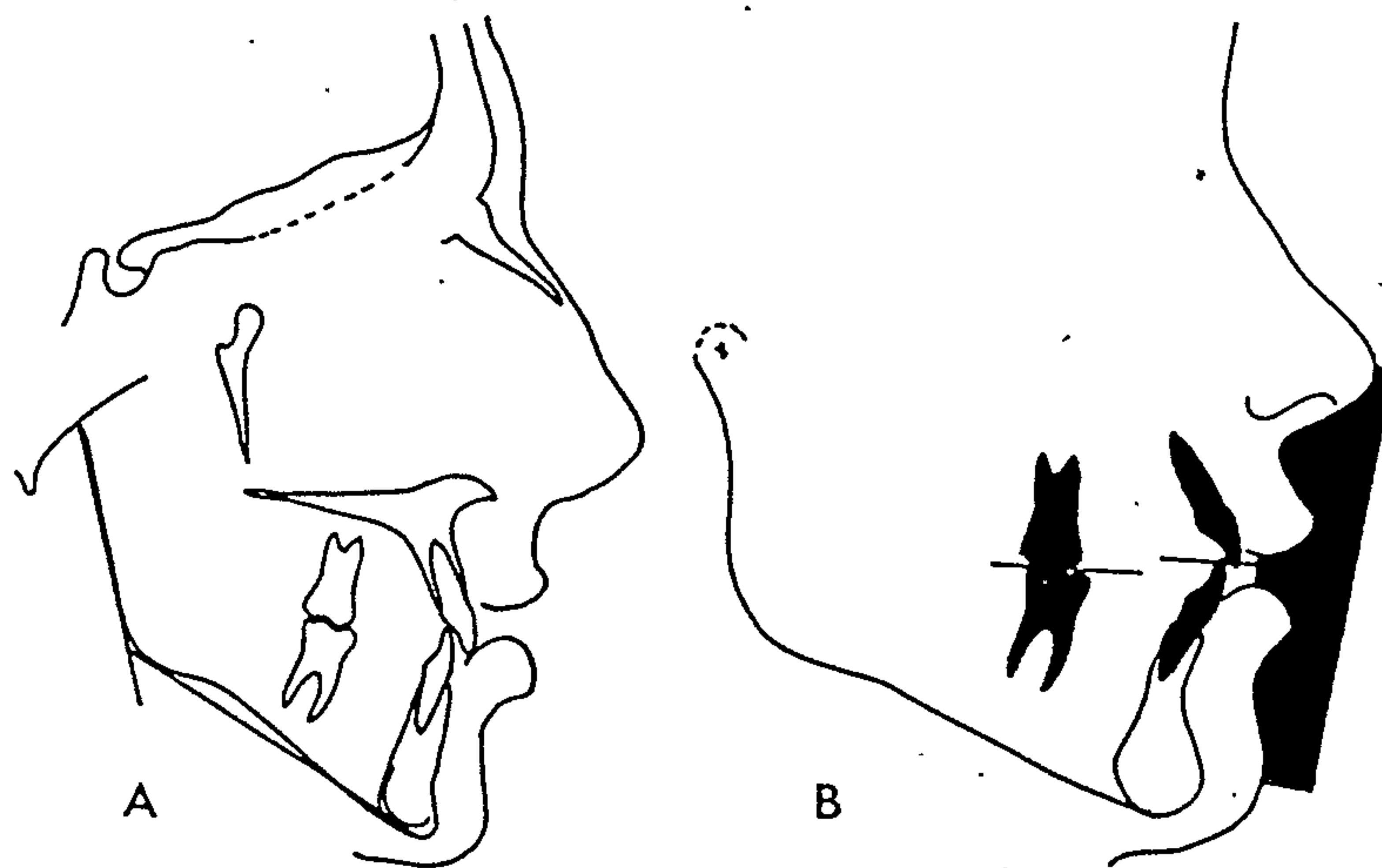
iii) Vertical facial relationships: In a Class II, Division 1 malocclusion with dolichofacial pattern and large vertical face height, extrusion of posterior teeth is contraindicated, because it would cause distal movement of the chin and an increase in lower face height. (Kuhn, 1968; Nanda, 1981).

iv) Occlusal plane considerations: Although the objective of treatment is to provide a flat occlusal plane this objective must be considered along with lip and vertical facial height. For example in a case where the vertical position of the posterior teeth cannot be changed (dolichofacial/high angle) and anterior teeth need intrusion because of lip-tooth imbalance (e.g. excessive gum showing) then

instead of levelling the posterior occlusal plane, it is left and the upper anterior teeth are intruded to correct the overbite, creating a step-type of occlusal plane between anterior and posterior teeth. (See Figure 4.3 A and B) (Burstone, 1977; Nanda, 1981).

Figure 4.3 (Nanda, 1981: p75)

DIAGNOSIS AND TREATMENT OF EXCESSIVE OVERBITE



A, A lateral headfilm tracing of a patient showing deep-bite with long anterior vertical height, large interlabial gap, and steep mandibular plane. The orthodontic correction of deep overbite needs intrusion of a maxillary incisor. An orthognathic surgical approach to improve the skeletal and dental malocclusion can also be considered. The use of a bite plate to correct the deep-bite in such a clinical situation is highly contraindicated. B, A lateral headfilm tracing illustrating the proposed treatment plan to correct a deep overbite. The correction can be done by maintaining the posterior occlusal plane and intruding the upper incisors. This decision is governed by the interlabial gap, incision-stomion distance as well as the relationship of points A and B to occlusal plane, steepness of the mandibular plane, and the anterior vertical facial height of the patient.

v) Interocclusal space or freeway space: That space between the occlusal or incisal edges of the maxillary and mandibular teeth when

the mandible is in physiological rest position. The average freeway space is 2 - 4mm. If this space is minimal, then extrusion of the posterior teeth may lead to relapse as a result of masticatory muscle forces and in these cases intrusion of anterior teeth may be the most stable mechanics for overbite correction. (Nanda, 1981; Berg, 1983).

vi) **Age of patient:** In an adult patient (no growth) with 100% overbite or more, with a high smile line, vertical height and alveolar problems, the length of orthodontic treatment may be prohibitive and Nanda (1981) suggests that the patient should be given a choice of orthognathic correction done in conjunction with orthodontic specialists and oral maxillofacial surgeons.

4.3.2 Deep Overbite Correction in the Normal to Brachyfacial/Low Angle Cases. If the Class II, Division 1 deep overbite case has a brachyfacial pattern with an average to low mandibular plane, then correction of the deep overbite may be achieved by selective extrusion of the posterior teeth along with some degree of anterior intrusion.

Burstone (1977) and Nanda (1981) both stress that in the correction of any deep anterior overbite there are several factors that should be considered:

(i) **Soft tissue considerations:** in the brachyfacial pattern cases it is mostly common to find the deep overbite associated with redundant lip and normal or no interlabial gap present. Here

extrusive mechanics are called for to achieve an increase in lower face height, while intrusive mechanics are contraindicated as they may produce an edentulous appearance. (Nanda, 1981).

(ii) Occlusal plane consideration: Occasionally the occlusal plane is tipped down anteriorly, with the upper incisors in supraocclusion and with a gummy smile line or large interlabial gap, then it is contraindicated to use Class II elastics as they would further tip the occlusal plane and worsen the facial aesthetics. Intrusion of the overerupted incisors is the treatment choice for the deep overbite correction and this is achieved with either the Ricketts intrusive utility arch or the Burstone intrusive arch. (Burstone, 1977). If the case has a normal facial pattern, posterior extrusion should be minimal, while if there is a brachyfacial pattern Class II elastics could be used in conjunction with J hooks to change the cant of the occlusal plane or to upper buccal sectional archwires. (Graber and Swain, 1985: p609).

The following list of treatment mechanics will provide extrusive forces to posterior teeth to aid in bite opening.

- * use of Class II intermaxillary elastics (Schudy, 1965).
- * cervical headgear, particularly if the outer bows are placed above the centre of resistance, when applied to the maxillary arch. (Schudy, 1965; Kuhn, 1968)
- * placing a reverse curve of Spee in the lower arch and an accentuated compensating curve to the upper arch. These curves can

be placed in all the archwires, from round to the rectangular finishing wires, until the occlusal plane is levelled. The force in ligating the archwires will extrude the premolars while the end molars and incisors are both intruded and tipped distally and labially respectively. This method of bite opening is greatly assisted by the banding or bonding of second molars, enabling first molar extrusion. (Burstone, 1977; Mulligan, 1979).

* placing the buccal brackets close to the gingival margin and the incisor brackets towards the incisal edges, to assist in the intrusion of incisors and premolar extrusion. (Mulligan, 1979).

4.3.3 Mechanotherapy selection for the dolichofacial/high angle

cases: The dolichofacial/high angle case has been described by Thurow (1982) as having a steep mandibular plane, long anterior lower facial height and weak masticatory musculature. Nanda (1981) adds that if a deep overbite exists in these cases then there is usually a large interlabial gap, the occlusal plane is tipped down anteriorly, the upper incisors being in supraocclusion and a gummy smile line may also show.

The literature clearly suggests that any extrusion of the molars in these cases may result in further deterioration of the facial aesthetics brought about by the downward and backward rotation of the chin point with an associated increase in the lower anterior vertical height, the midfacial convexity and the interlabial gap (or "gummy smile"). (Schudy, 1965; Burstone, 1966, 1967; Kuhn, 1968; Pearson, 1978; Nanda, 1981).

Burstone (1977) describes the following Class II, Division 1 malocclusion case with a typical dolichofacial pattern that requires careful selection of mechanotherapy, that will not extrude posterior teeth. The skeletal pattern is characterised by the following features (See Figure 4.4):

- * a large anterior vertical height with shorter posterior height
- * facial convexity
- * 100% overbite
- * a steep mandibular plane
- * short upper lip

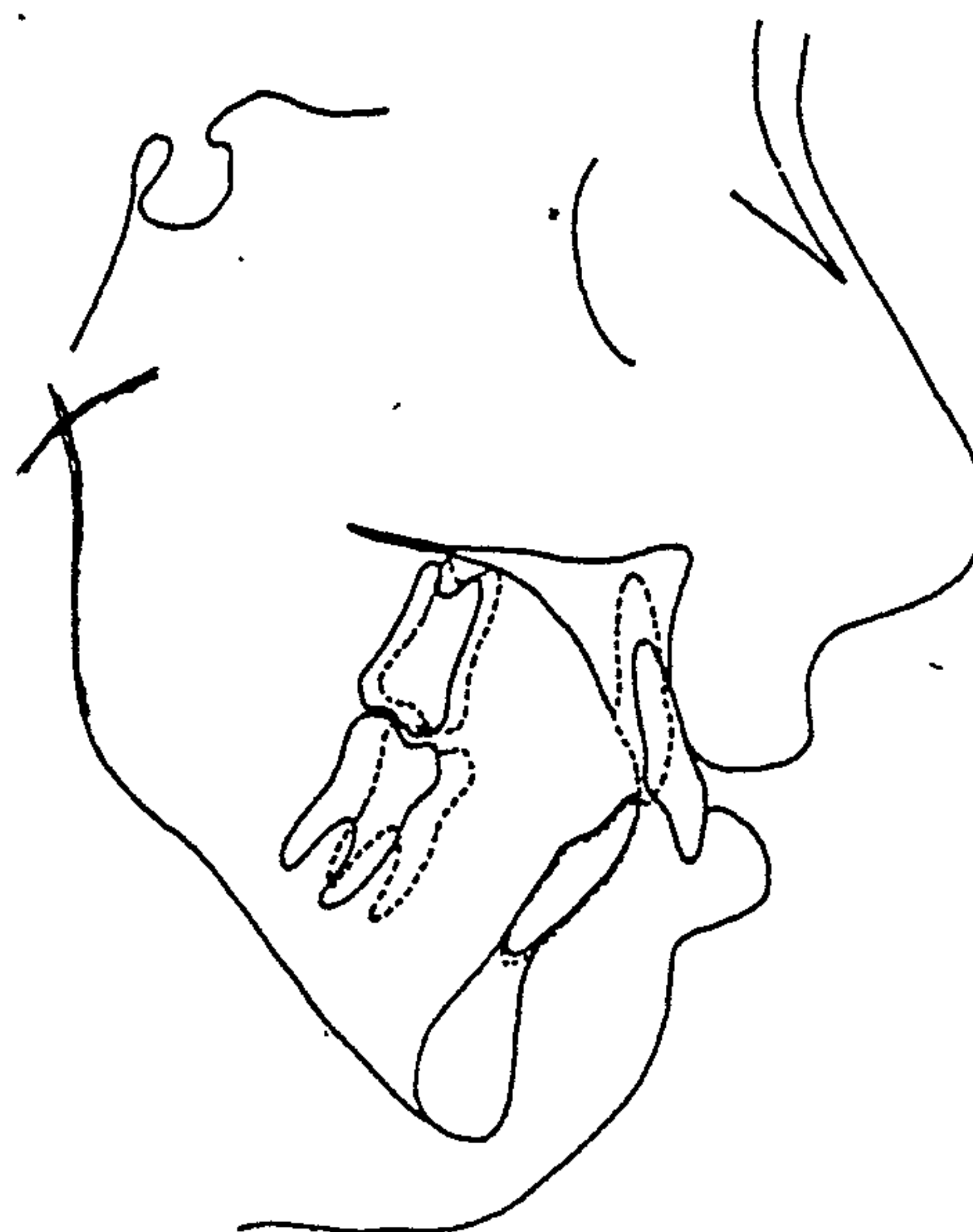


Figure 4.4
Burstone, 1972:p19

Patient M.M. Cranial base superposition (Dotted line - After treatment). No mandibular rotation or increase in vertical dimension has occurred during treatment.

Summary of mechanotherapy for the case in Figure 4.4 In this case, mechanotherapy that will maintain vertical dimension, but still correct the deep overbite, is called for. The steep mandibular plane precludes any buccal extrusion and the overbite is corrected by intrusion of the upper incisors. Because of the short upper lip, the curve of Spee was maintained in the lower arch with all the

intrusion occurring in the upper incisor region (Burstone, 1977).

Kuhn (1968), also describing treatment mechanics for these extreme hyperdivergent cases, writes that only a slight change in vertical movement of posterior teeth can markedly affect the chin point, moving it further backwards, while intrusion of the posterior teeth may result in some forward movement of the chin point. Headgear force to the molars should have a larger intrusive force component to neutralize any extrusive tendency in the mechanics. Kuhn adds that this intrusive force acting on maxillary molars will also assist by helping to restrict vertical maxillary growth.

Functional adaptations, such as prolonged mouth breathing and tongue thrust habits are sometimes associated with this dolichofacial pattern and they may exhibit a tendency to markedly increase their alveolar heights during orthodontic treatment. Intrusive forces to buccal segments may be useful in preventing unwanted facial height increase. The use of maxillary and/or mandibular headgear, vertical pull chin caps or mandibular bite blocks have been recommended by Pearson (1978).

4.3.3.1 Anteroposterior correction in dolichofacial/high angle cases: Burstone (1977); Ricketts et al (1980); Proffit (1986: p436) have all described the use of segmented arch mechanics for initial canine retraction independently, followed by its consolidation and the retraction of four incisors. This will conserve anchorage by the

use of light continuous forces which are relatively friction free, while the avoidance of Class II elastics for retraction eliminates further tipping of the occlusal plane and minimal molar extrusion. The retraction assemblies are equally adaptable to 0.022" and 0.018" slots. The posterior anchorage for both horizontal and vertical forces should be reinforced by lingual arches and upper intrusive headgear traction. As discussed earlier, Proffit (1986: p421) has also described the use of intramaxillary sliding mechanics with anchorage reinforcement from highpull headgear and the use of light force nickel and beta titanium archwires is recommended. Extraction of teeth to assist in rotating the mandible closed is suggested by Schudy (1964) and Roth (in Graber and Swain, 1985: p671).

4.3.4 Intrusive Mechanotherapy

(i) The Burstone intrusion arch (Figure 4.6) can be used to intrude one or any combination of maxillary or mandibular teeth. It was designed to use a 0.022" edgewise bracket slot, and the first molars are banded with a triple tube combination; a lingual sheath is added for replacement of palatal or lingual arches.

Preparation of posterior anchor unit: If intrusion of more than one anterior tooth is needed, it is advisable to band or bond the premolar teeth and even second molars to reinforce anchorage where needed. An 0.018" x 0.022" wire segment is used to join the posterior teeth on each side and they may be joined by a passive, removable transpalatal bar.

Preparation of the anterior unit: is done with successive wire thicknesses to gain bracket alignment.

The intrusion arch: 0.018" x 0.022" rectangular wire with a 3mm diameter helix just mesial to the molar tube on both sides (2 1/2 winds on the gingival side).

Activation: place a bend in the archwire near the helices and the labial wire is pulled down to the level of the anterior brackets, or tied into the stabilizing arch (a force of 25 grams/tooth).

(ii) The Ricketts (bioprogressive) utility intrusion archwire. Like the Burstone spring the utility arch will bypass the premolars and frequently the canines (if normal or in infraeruption) by the use of step down bends between the first molars and lateral incisors. Usually it is 0.016" x 0.016" wire when used in a 0.018" slot, and is placed in the brackets with slight labial root torque to control the inclination of the teeth, since the incisors will move labially while they intrude. Although preformed 0.019" x 0.019" utility arches are available for the 0.022" slot, Proffit advises that the utility arch should not be stiffer than 0.016" square steel wire, even in 0.022" slots. Activation is by 30° tip back bends, while pretorqued brackets are advised the centrals having 22° of torque. (Burstone, 1977; Ricketts et al, 1980: p281).

In both these bypass intrusion arches, reciprocal molar extrusion

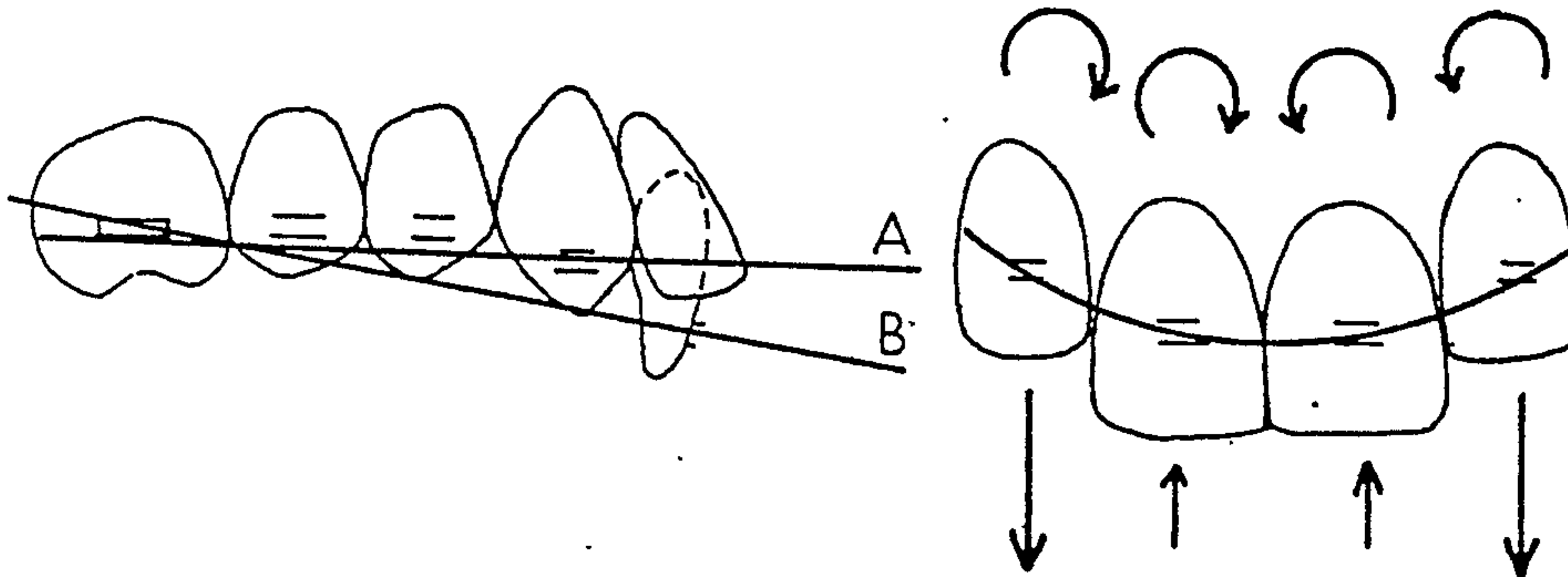
will occur. This extrusion, while not significant in growing patients with suitable facial patterns, becomes critical in the hyperdivergent or non-growing cases where extrusion must be avoided; it is necessary to combine the premolars and second molars to enhance the posterior anchorage unit. Highpull headgear can be added to the upper molars to improve posterior anchorage and prevent extrusion. (Kuhn, 1968).

Ten Hoeve et al (1977) write that it is wise to intrude the maxillary incisor to a significant degree prior to any retraction; this will achieve bite opening by moving the incisors into the alveolus, the incisors can be moved through central cancellous bone, diminishing the risk of root resorption. If teeth are retracted first it may result in the root apices approximating cortical bone which makes intrusion impossible and increases the risk of root resorption.

4.3.4.1 Control of unwanted extrusive forces

(i) If the centrals and laterals are in supraocclusion, while the canines are normal or in infraocclusion, then those canines should not be attached to either a continuous archwire or a segmental archwire. Instead the central incisors (and laterals) are firstly intruded, bypassing the canines. Burstone (1977) adds that the geometry of the anterior segment should always be considered and many canines may be left in their original position while the incisors are intruded to the canine level. (See Figure 4.5).

Figure 4.5 Burstone, 1977: p12.



A straight wire placed in brackets of a Class II, Division 2 case, instead of producing intrusion (line A), tends to steepen the plane of occlusion (line B).

A straight alignment arch, instead of intruding incisors, will erupt lateral incisors and tends to converge the incisor roots mesially.

(ii) Control reactive units: join as many posterior teeth together as possible to form the posterior anchorage unit, using a buccal segment wire of 0.018" square for an 0.022" bracket slot and 0.016" square wire for an 0.018" slot.

(iii) Join segments with a transpalatal bar or a low lingual arch in the mandible for anchorage and to prevent buccal roll.

(iv) As an added precaution use occipital headgear with the line of force, anterior to the centre of resistance of the posterior anchorage unit, this will counteract the moment of the anterior intrusive force and prevent steepening of the maxillary plane of occlusion by limiting molar extrusion.

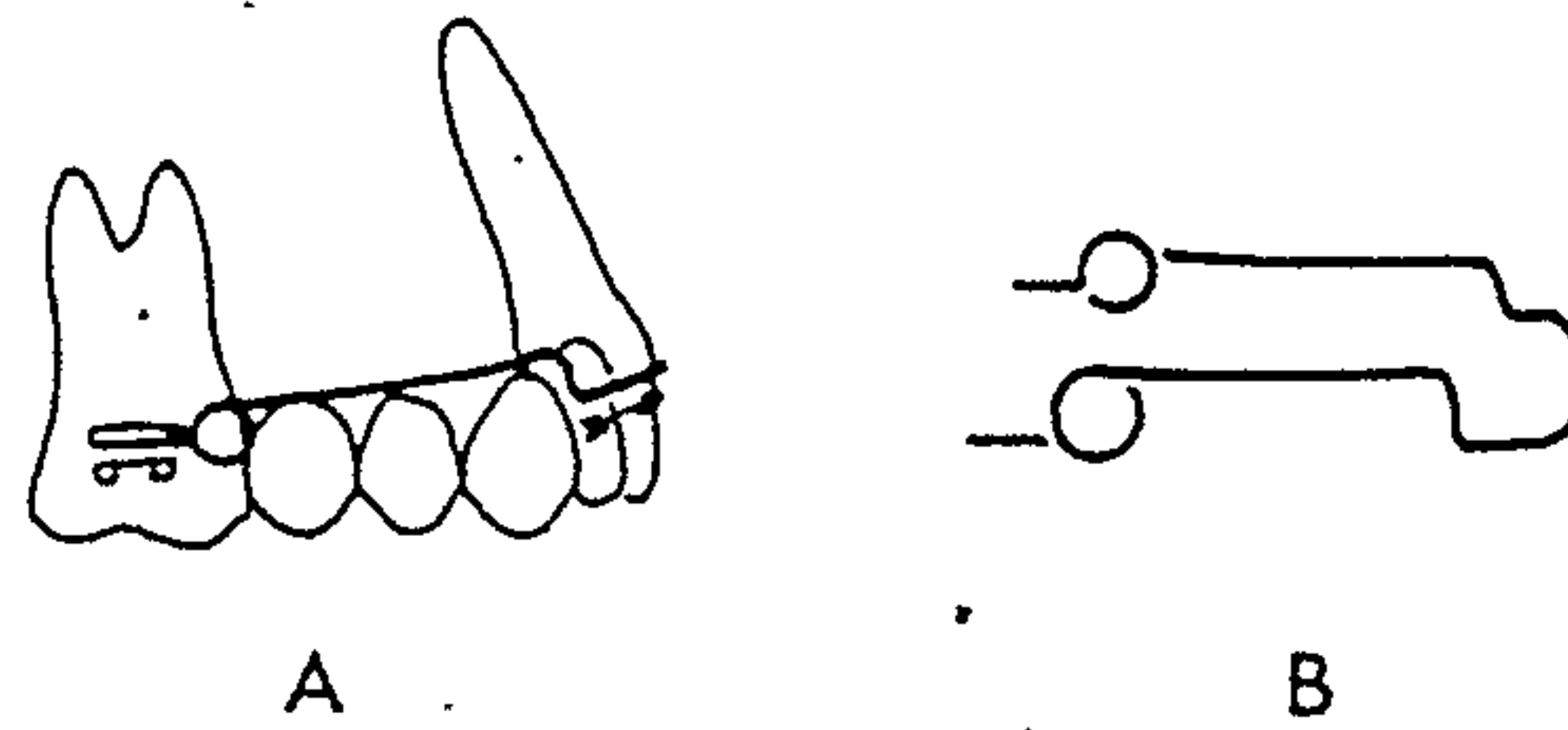
(v) The inadvertent placement of a continuous archwire with or without loops will erupt already intruded incisors. (Burstone, 1977).

(vi) Inhibition of posterior eruption by the use of either

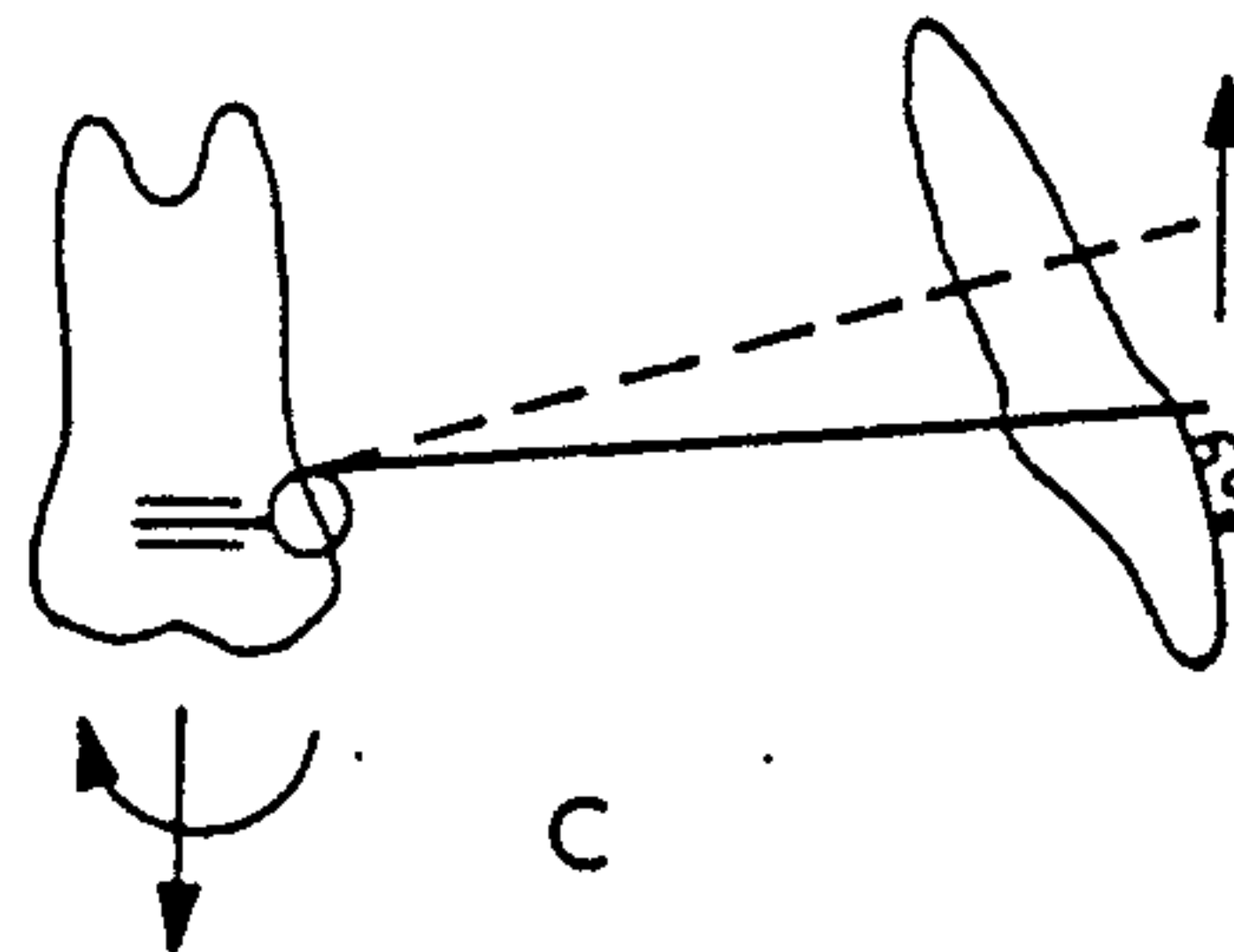
occipital headgear to the upper arch, and cervical headgear with high outer bows to the lower arch, or even chin caps to inhibit posterior eruption (Burstone, 1977; Pearson, 1978).

(vii) Incisal intrusion forces should be kept low in high angle cases, this provides for optimal incisor intrusion and minimal reciprocal extrusive force on the molar bicuspid anchorage unit (Kuhn, 1968). (See Figure 4.6).

Figure 4.6 Nanda, 1981: p77.



INTRUSION MECHANICS



A, A base arch in an activated position. B, A base arch prior to activation. The steps in the anterior region are only "comfort bends", which prevent the wire from touching soft tissues and teeth that are malpositioned and/or erupting. C, The forces generated by activation of a base arch. The incisors experience an intrusive force, whereas molars experience an extrusive force and a moment that tends to tip the molar crown back and root forward. The side effects on the molar can be minimized or prevented by using lower force magnitudes, a lingual or palatal arch, and an appropriately activated occipital headgear.

4.4 CONTROL OF UNWANTED RECIPROCAL FORCES IN THE EDGEWISE

APPLIANCE (Anchorage Stabilization)

The following summary of the literature attempts to describe unwanted, often reciprocal forces, associated with the edgewise

archwire and its force systems and how it is best to overcome them in view of the patient's facial pattern and case requirements.

4.4.1 Tip Back Mechanics in the Continuous and the Bypass Arch:

molar tip back bends can produce unwanted forces, e.g.

- * molar extrusive forces (from the incisor intrusion)
- * molar mesial root tip
- * lower molar lingual crown tip (Mulligan, 1979).

Molar extrusive forces are not wanted in the more dolichofacial cases and are overcome by the use of occipital or high occipital headgear while they are useful in bite opening for the hypodivergent (low angle) cases. (Burstone, 1977).

Molar lingual crown tip is overcome by slight archwire expansion or torque to the rectangular wires. (Ricketts et al, 1980: p124).

4.4.2 Labial Crown/Lingual Root Torque Bends: will create intrusive forces to the molar tubes and a degree of extrusive force to the incisors. This negative force on bite opening correction can be countered by molar tip back bends. This means torque and bite opening should be done separately. (See Figure 4.8A). (Mulligan, Part 2, 1979).

In the normal to brachyfacial pattern cervical traction with the hook placed level to the molar trifurcation (or higher) will maximize molar anchorage extrusion and an incisal spur, if added,

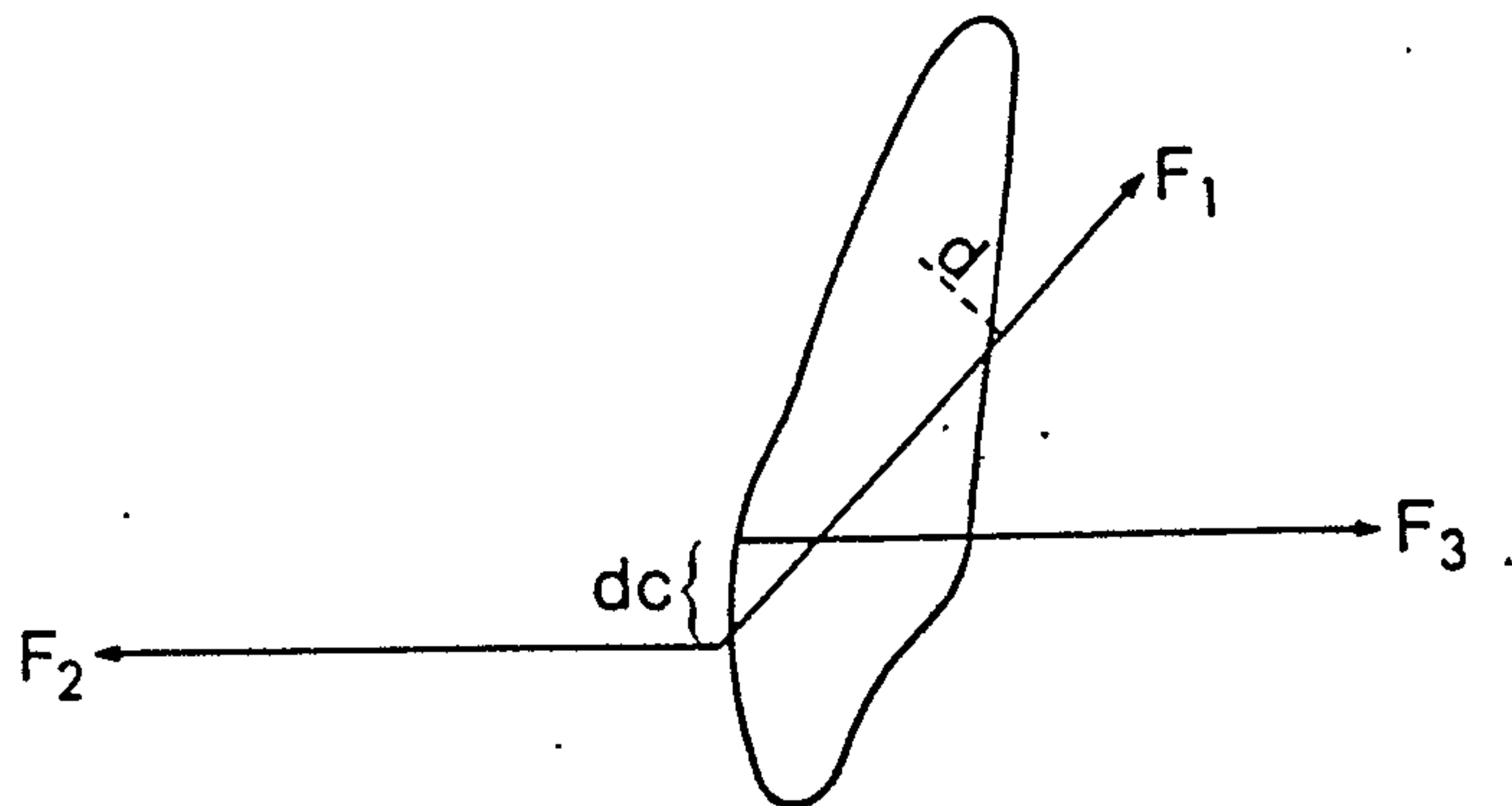
should provide intrusion of the incisal end. (Kuhn, 1968).

Control of forward incisor movement from a torque couple to produce "real" lingual root torque. Hocesvar (1981) writes that for lingual root torque on maxillary incisors to be effective, both a couple to produce the torque rotation and a force to prevent the bracket moving anteriorly will be needed. (See Figure 4.7) This force will effectively translate the C.R. of the incisor, posteriorly giving a genuine root torque. The posterior force is provided:

- (i) externally by headgear traction
- (ii) with Class II elastics or
- (iii) a force generated from within the arch if the wire is cinched back distal to the molar tube.

(See Figure 4.7)

Figure 4.7 Hocesvar, 1981: p463.



A torque couple is set up at the bracket, i.e. two forces in opposite directions at different points of application, this results in a moment inducing rotation about C.R. The moments produced are equal in magnitude but opposite in direction and cancel out, leaving the tooth to move anteriorly, the force F_1 is provided by headgear, Class II elastics and cinching back of the archwire.

4.4.3 Reverse Curve of Spee Added to the Archwire With full

ligation of the arch, reciprocal moments are set up at either end of the "curve", producing anterior lingual root torque (labial crown torque), while at the molar end the mesial root torque (distal crown torque) is set up. Both these moments are controlled by molar cinch back bends. In this fully ligated arch the extrusive force at the middle of the arch is countered by the intrusion forces at the anterior and posterior ends (Mulligan, Part 2, 1979).

However Thurrow (1982: p116) states that this method of overbite correction gives the superficial impression that the incisors have been intruded. The rapid overbite correction is due mostly to the extrusion of buccal teeth.

4.4.4 Conflicting Force Systems in Class II Division 1

Mechanotherapy. It has been noted previously that mechanisms such as

molar tip back bends produce incisor intrusion and molar extrusion; this applies to both the continuous arch and the bypassing arch, while most mechanisms for torquing incisor roots lingually induce incisor extrusion and molar intrusion which tend to reverse the bite opening. (See Figure 4.8B) (Mulligan, Part 2, 1979; Hocevar, 1981).

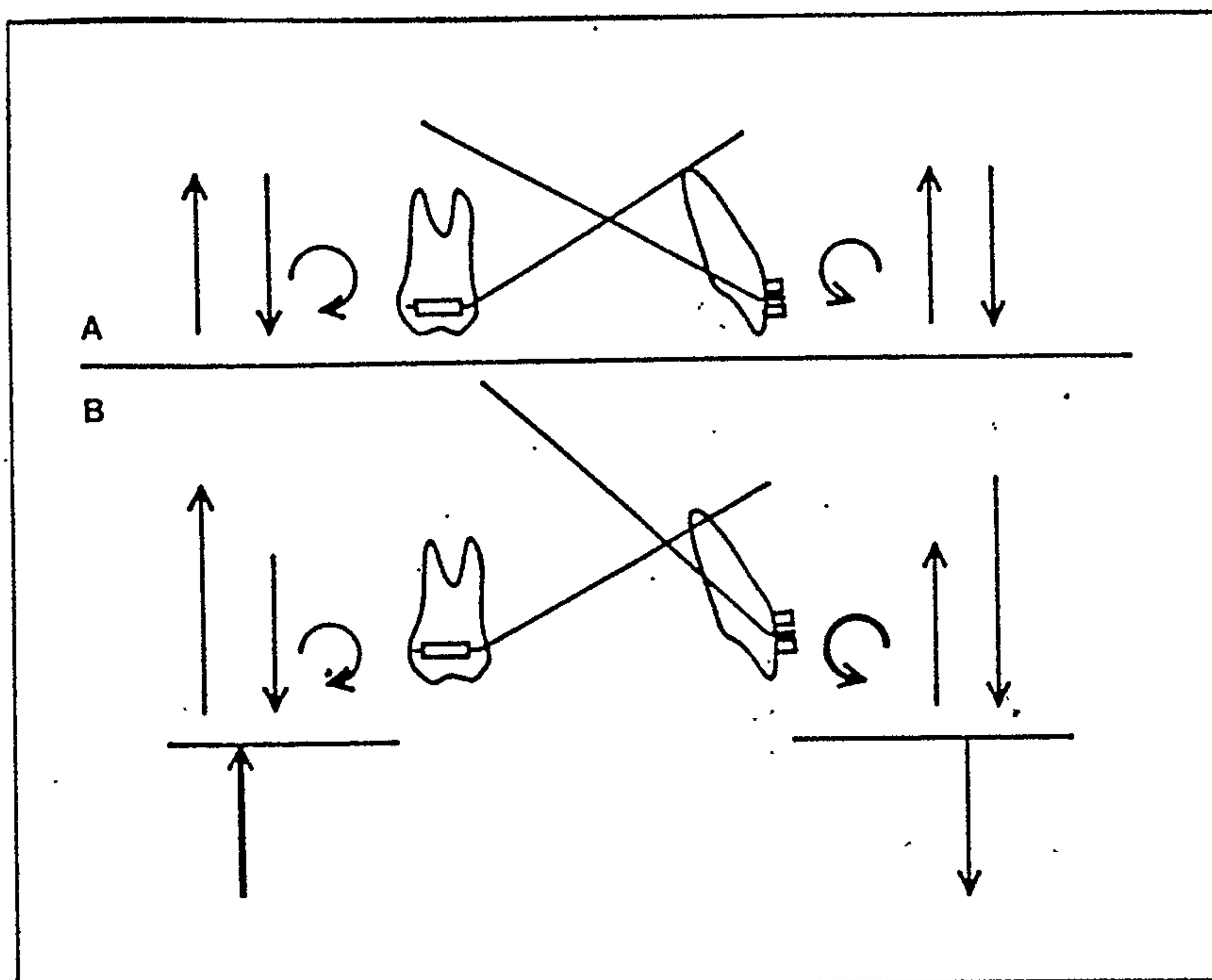
With tip back mechanics

In Class II, Division 1 cases with proclined incisors either:

(i) retract the incisor crown by simple tipping or combined tipping and translation; once the incisors are upright or somewhat retroclined, intrude them by adjusting the force vertically to pass through the centre of resistance. After intrusion beyond the desired level, lingual root torque is applied: or alternatively,

(ii) apply a force and couple together, the couple producing a moment of lingual crown torque greater than the moment of facial crown torque, then over-intrude and apply final root torque (Hocevar, 1981).

Figure 4.8 Mulligan, Part 2, 1979 p.683



If the tipback and torque ends produce equal angular relationships (A), the net forces are zero. If unequal (B), net forces occur.

With the continuous arch much of the correction of the deep overbite is achieved with buccal extrusion and minimal incisor intrusion. The fully engaged archwire levelling the curve of Spee (Thurrow, 1982: p116). Torque moments to the incisors being applied, in conjunction with Class II elastics or cervical headgear, will also help maintain the bite opening.

4.5 SUMMARY - SELECTION OF EDGEWISE MECHANICS

Class II, Division 1 malocclusion exists in a wide variety of facial patterns and mechanotherapy must be altered to suit the requirements of the individual case.

Treatment mechanics have been described for the low angle brachyfacial pattern which normally displays a forward mandibular growth tendency. These cases are treated with continuous arches, Class II elastics and often with cervical or horizontal pull headgear to control posterior anchorage. The deep overbite is corrected by levelling the curve of Spee and posterior extrusion, or by a combination of buccal extrusion and anterior intrusion depending on incisal geometry and soft tissue or lip considerations.

Kuhn (1968), Burstone (1977) and Nanda (1981) have listed several considerations of the lip incisor relationship, including interlabial gap (either excessive tooth showing or redundant lip), anterior vertical face height, lip strain. Other considerations should include freeway space available, the facial musculature and occlusal plane angle. All of these factors help determine whether intrusion of incisors or buccal extrusion is the treatment of choice for the deep overbite correction. It was noted by all three authors that indiscriminate levelling of the curve of Spee with continuous arches is to be avoided.

The less common combination of the dolichofacial/high angle pattern with deep overbite has been discussed and requires mechanotherapy that will not cause buccal extrusion as this rotates the chin point further backwards worsening the already convex profile. In these cases suitable intrusive mechanics include the Burstone intrusion

(bypass, spring) archwire or the Ricketts' utility (bypass) arch to intrude incisors. Both arches will need control over the vertical reciprocal forces on the posterior anchorage units. High angle cases will need buccal segmental and lingual or palatal arches with highpull occipital headgear to the maxilla. The anteroposterior correction can be achieved with light archwires and intramaxillary sliding mechanics or alternatively with low friction retraction springs. Retracting the canines and then the incisors separately is also advised to place less strain on posterior anchorage and the importance of low incisal intrusive force as has been mentioned previously to limit unwanted reciprocal forces. (Burstone, 1977; Ricketts, 1980: pp281-289; Nanda, 1981).

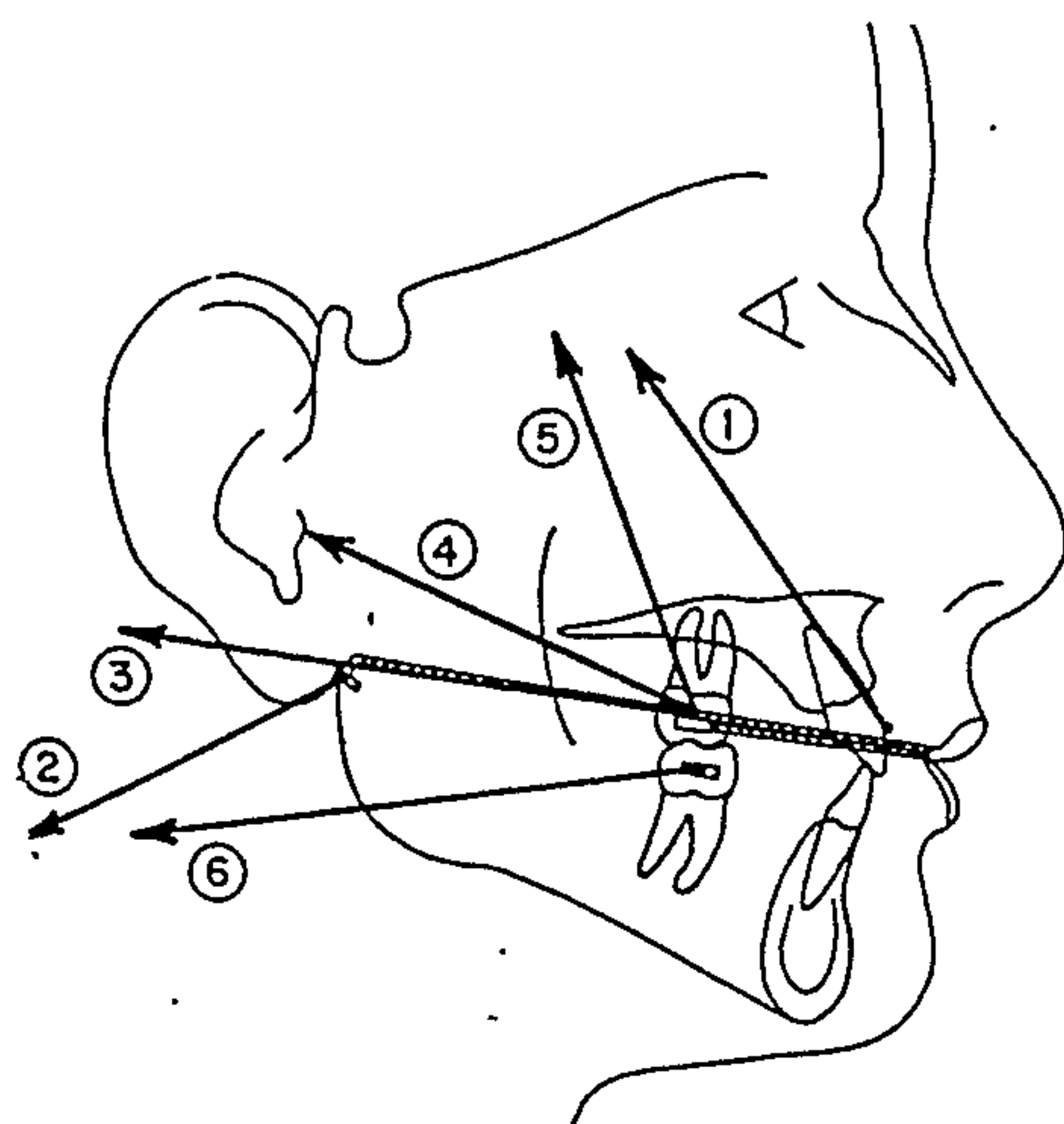
Headgear traction has been recommended to provide a restraining force in growth modification treatment, to enhance posterior anchorage or to distalize buccal or anterior teeth. The direction of the line of force is crucial to successful edgewise treatment of Class II, Division 1 cases with its varied facial patterns. (Kuhn, 1968; Jacobson, 1979).

The selection and mechanotherapy of the headgear appliance is discussed in the next sub-section. Although it may be used by itself to treat mild Class II, Division 1 cases in the pre-pubertal child, it is more often associated with the edgewise appliance as part of the total force system for the treatment of this malocclusion.

4.6 SELECTION OF HEADGEAR

Theoretically, any direction to the line of force is possible with headgear traction and its selection is dependent only on the needs of the orthodontic case. (See Figure 4.9) Headgear traction should be considered as part of the total force system of the edgewise appliance, it may be designed to effect movement of teeth or it may primarily be a stabilizing role, providing anchorage enhancement designed to cancel a force which tends to displace the teeth disadvantageously. (Kuhn, 1968) It is also used in correction of the Class II relationship by growth modification which is begun during the mixed dentition period just before puberty. (Proffit, 1986: p354).

Figure 4.9 Kuhn, 1968: p345.



1. High occipital headgear to the incisal area of the archwire.
2. Cervical gear to a face bow.
3. High cervical (low pull) headgear to a face bow.
4. Occipital headgear to a face bow.
5. High occipital headgear to a face bow.

4.6.1 Biomechanics of the Extraoral Force System

The extraoral force applied to a molar is the resultant force with a direction following the line connecting the point of origin of the force (occipital, cervical etc.) to the hook on the outer bow. The centre of resistance (C.R.) near the trifurcation of the maxillary molar roots (if no archwire) remains constant, the variables being:

(a) the perpendicular distance of the line of action of the force from C.R.

(b) the inclination or steepness of the line of action.

(a) Perpendicular distance of the line of action of force from centre of resistance (C.R.)

* If the line of action passes through C.R. then translation occurs (no tipping).

* If the line of action does not pass through centre of resistance then tipping occurs because a moment of force is set up around the centre of resistance (or rotation), the two centres being the same location for maxillary molars provided there is no archwire in place. (Godfrey, 1985)

The simple formula $\text{Moment} = F \times D$, indicates that as the line of force moves farther away from C.R. then the tipping moment is increased. Thus the control of a tipping force to a molar can be achieved by adjusting the outer bow hook distance to C.R.

* If the line of action of the force passes occlusally to C.R. then the crown will tip distally from a clockwise moment about the C.R. when viewed from the patient's right.

* If the line of force is moved apically to C.R. then a counterclockwise moment is set up, viewed from the patient's right, producing mesial crown tipping or distal root tipping moments.

(Jacobson, 1979)

(b) Inclination (steepness) of a line of action of the force will depend on two factors:

- (i) point of origin of the force (occipital, cervical etc.).
- (ii) the point of attachment of the force (i.e. level of hook of outer bow.

The inclination or steepness of the line of action of the force is an important consideration as it is related to the size of the vertical force component on the molar or arch.

Intrusive versus extrusive forces

* If the line of force originates below the C.R. of the molar then an extrusive component of force will occur.

* If the origin of force is above the C.R. then the vertical component of force will be intrusive.

* The steeper the line of action of the force, the greater the vertical component of force (intrusive or extrusive).

* The more horizontal the line of force to C.R. the less extrusion/intrusion occurs, with a greater distalizing force

(Jacobson, 1979).

4.6.2 The Use of Headgear with a Maxillary Rigid Archwire Fully Ligated. Here the C.R. lies in the region of the apices of the maxillary first and second premolar teeth.

* A line of force through this maxillary arch C.R. will result in translation of the arch along the line of action of the force.

* A line of force above and posteriorly in direction to the C.R. of the arch will set up a moment, tipping the arch posteriorly as well as moving it in the direction of the applied force, i.e. the posterior part of the rigid arch will tip inferiorly and the anterior part will tip superiorly effectively rotating the maxillary occlusal plane upward. (Godfrey, 1985).

If the rigid archwire mechanics are changed by, say, using a flexible rather than a rigid archwire, the C.R. will be more anteriorly located and vertical force action would be best concentrated in the region of the J hook attachment to the archwire rather than in the region of the premolar apices. (Nicholai, 1985: p353).

4.6.3 Force Direction

(See Figure 4.7 to clarify force line of action.)

4.6.3.1 Cervical traction to a face bow connected to the maxillary molars - consider the following positions for the outer face bow:

(a) outer bow level with or below the inner bow level (below

C.R.) the force components are in a distal and downward direction (extrusive). A moment of force on the molar crown will rotate the crown distally. This is useful in cases where extrusion of molars will assist in bite opening and therefore may be used in the normal to brachyfacial pattern. (Kuhn, 1968) The distal tipping is achieved where bodily translation may be extremely slow. (Godfrey, 1986).

(b) outer bow placed at the level of trifurcation towards the apex. This will provide distal bodily movement plus a high vertical component of force extruding the molar. If the hook is higher towards the apex a moment is set up on the molar which will tend to move the crown mesially and roots distally.

(c) with the addition of an incisal spur to give greater eruption to the molars there is also depression of the incisors and a net result of occlusal plane tipping or rotation of the maxilla and could be used in conjunction with Class II elastics in the brachyfacial cases and with torque archwire (Kuhn, 1968).

4.6.3.2 High cervical (low pull) headgear is designed to move the molar teeth distally with minimum intrusive force or extrusive vectors present.

(a) With the outer bow just above the occlusal plane: The result is a force through the centre of resistance and maximal distal bodily movement.

(b) With the outer bow lower than the C.R. or below the occlusal plane: As well as the distal force component there is a minor

intrusive force. A moment around C.R. is set up which tips the crown distally. This is ideal for use in Class II correction where there is a normal vertical facial pattern (Kuhn, 1968; Jacobson, 1979).

4.6.3.3 Occipital headgear to the molar area will give a distal and slightly intrusive force to the maxillary posterior teeth. It provides just as great a distal force component as that of cervical headgear but without the extrusive force vector. It is more suitable in the higher mandibular plane angle/dolichofacial cases where extrusion of molars is not wanted but distalization of the molars is still needed in the Class II correction or for anchorage reinforcement while anterior retraction is proceeding.

Hook position of the outer face bow for occipital headgear: In order to accomplish the desired root tipping, bodily movement or crown tipping, it is necessary to direct the line of traction above the C.R., through C.R. or below C.R. (See Figure 4.10). For example:

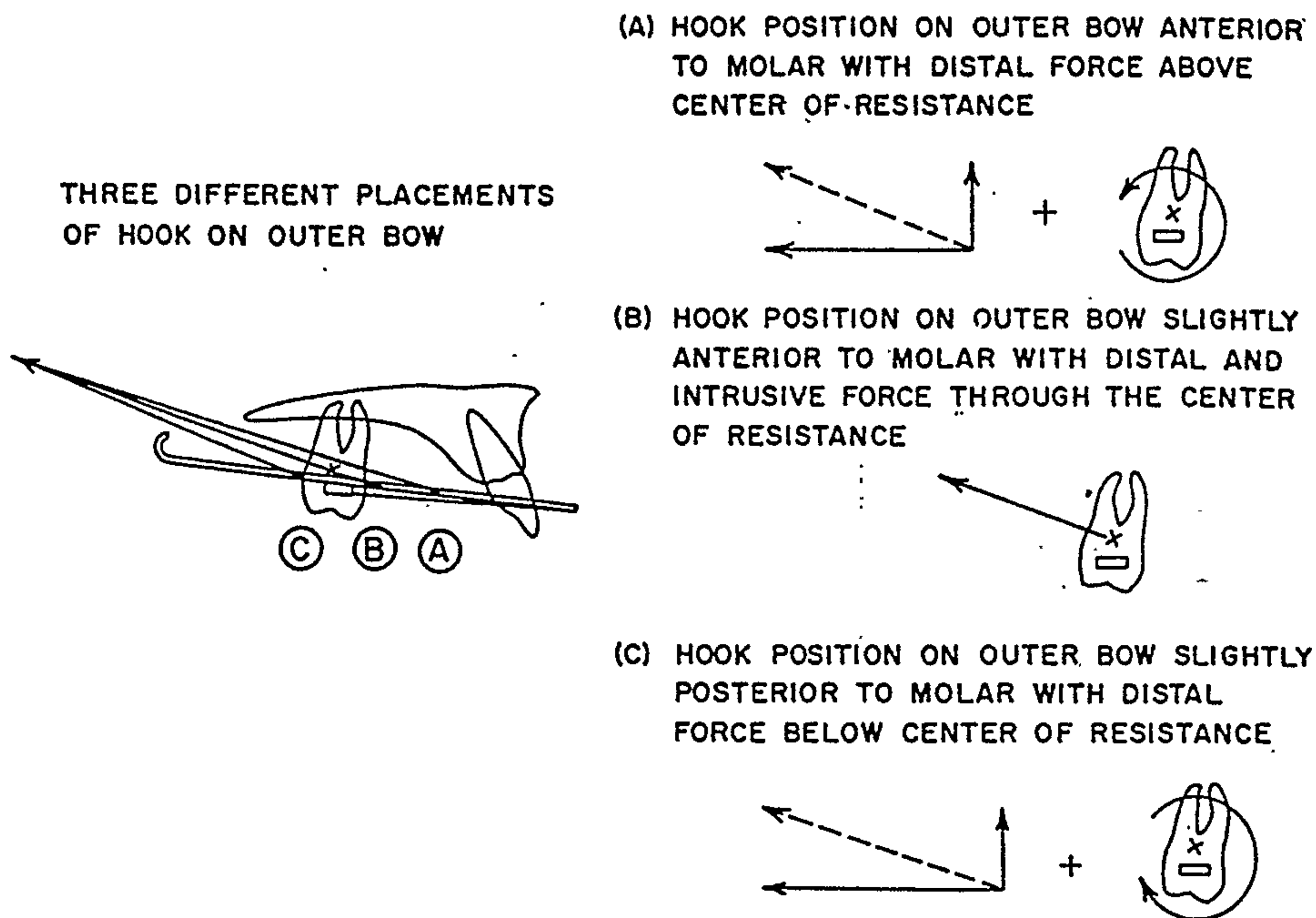
(A) If outer bow hook is anterior to the molar tube, the line of force is above the C.R. of the molar and will result in the following: distal and intrusive force vectors and a moment moving molar roots distally.

(B) If the outer bow hook is just anterior to the molar tube, the distal force will pass through the C.R. resulting in translation of the molar in line with the force.

(C) If the outer bow hook is distal to the molar tube it will result in: distal and intrusive force vectors and a moment which tips the crown distally (Kuhn, 1968).

Figure 4.10 Kuhn, 1968: p346.

OCCIPITAL HEADGEAR TO FACE BOW RESOLUTION OF FORCES PLUS MOMENTS



4.6.3.4. High occipital headgear: A large component of intrusive force is possible with this force direction. It should be noted that a buccal roll moment is set up in the molars and a transpalatal bar may be needed; this will give a bodily intrusive force to the molars and maxilla (Jacobson, 1979).

It is useful in high angle cases where retraction springs and/or intrusive bypass arch mechanics are used to negate reciprocal extrusive force on their posterior anchorage units. (Kuhn, 1968; Burstone, 1977).

4.6.3.5 Cervical traction to the mandibular molar is used in maximum anchorage cases, possibly providing some molar intrusion. (Roth, in Graber and Swain, 1985: p709).

Variation in hook position:

- (a) level with the occlusal plane: provides an intrusive force, a distal force and a moment which rotates the molar crown distally.
- (b) hook just below the buccal tube
 - * a net translatory movement
- (c) hook very low:
 - * distal force
 - * slight intrusive force (or extrusion if very low)
 - * a moment rotating the molar roots distally.

(Kuhn, 1968).

4.6.3.6 High-pull headgear with J hooks to the incisal area is used:

- * to produce an intrusive and retractive force to the upper anterior teeth, correcting an anterior overbite
- * to counteract the downward vector of force produced by Class II elastics
- * if just retraction force is needed a high cervical headgear is used providing retractive force to reduce overjet in the critical anchorage case. (Roth in Graber and Swain, 1985: p688).

Highpull headgear to the incisal area with J hooks will set up a moment that acts on the incisors producing lingual root torque, plus a rotational effect on the maxilla. If the archwire is rigid, a

greater rotational moment to the maxilla results, and this could be detrimental causing a downward tipping of the maxillary occlusal plane posteriorly (Kuhn, 1968).

Thurrow (1982: p285), recommends that J hooks should not be applied to an archwire smaller than 0.018" and that the teeth on either side of the arch hooks be banded, because extraoral forces can distort small diameter archwires or long spans distorting the shape of the dental arch. Thurrow adds that with all the intrusive forces adequate space must exist between the incisor apices and the nasal floor. The mechanics he selects for incisor intrusion of supraerupted maxillary incisors are as follows:

- i. the utility arch (bypassing arch) 0.016" or 0.018" square engaging the molar area and the incisors to be moved.
- ii. if other levelling mechanics have left the occlusal plane tipped downwards, highpull headgear and J hook mechanics may be used to provide anterior intrusion to level the occlusal plane.

Thurrow adds that all apical movements should be attained with very light continuous forces, so that wherever possible the utility arch should provide the primary activation to the incisors, along with the highpull headgear to the posterior anchorage units especially in high angle cases. Torque control is essential in all apical movements either through rectangular arches (for both utility arches and J hook application) or through torquing loops attached to round archwires. (Thurrow, 1982: p285).

4.6.3.7 Summary of headgear selection

The role of headgear traction in the treatment of Class II, Division 1 malocclusion falls into two basic categories; firstly to apply force to maxilla in growth modification treatment of the Class II jaw relationship which is started before puberty, and secondly as an integral part of the force system of the edgewise appliance to control anchorage and/or move teeth. Its action on teeth can be in all three planes of space. However, in Class II correction the main force direction is in the sagittal plane and in a distal direction, the other force vector will either be intrusive or extrusive to the molar or dental arch (Jacobson, 1979). (Slight arch expansion to distalizing molars is also needed.)

The facial pattern determines the headgear mechanics that are used in each case:

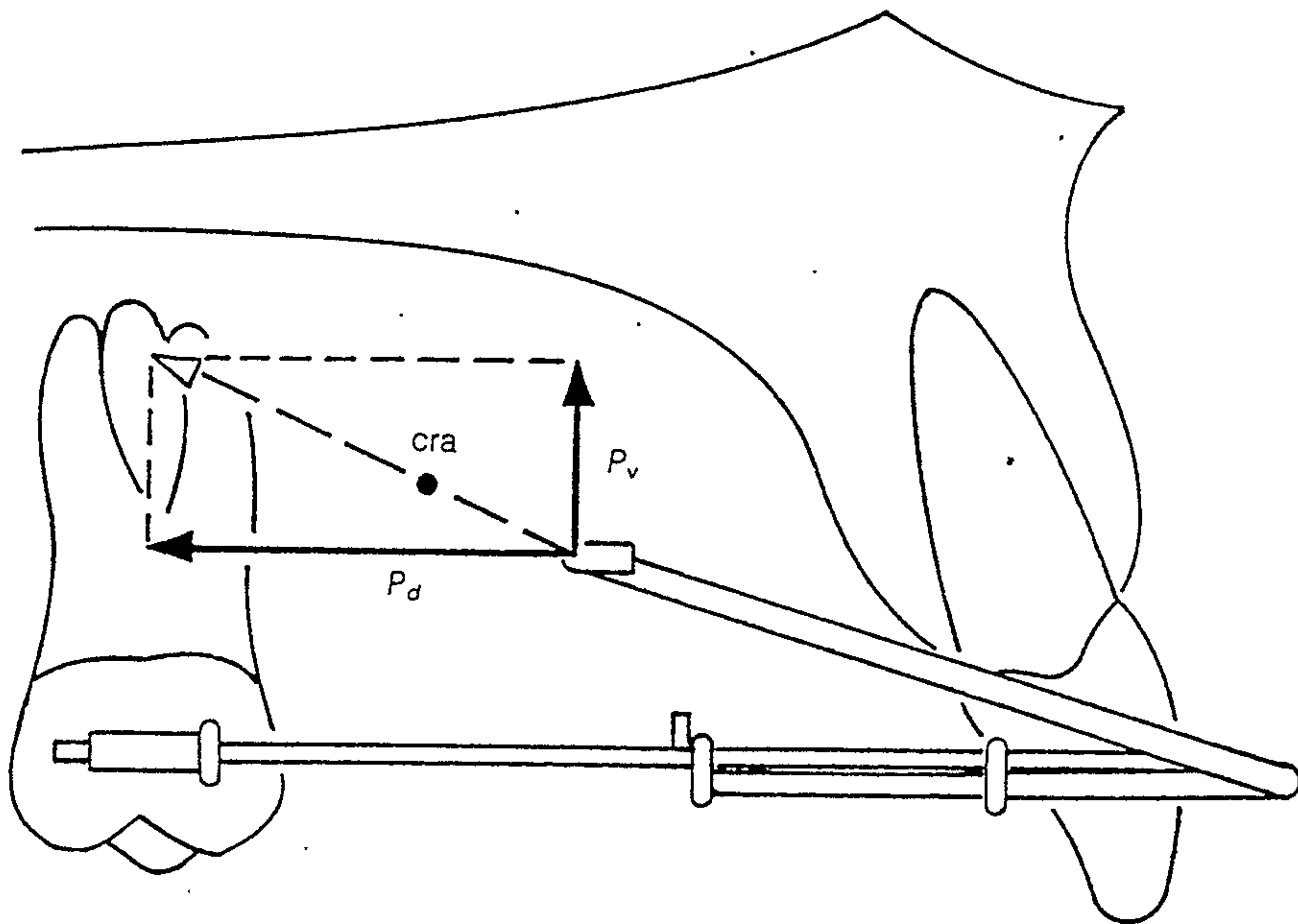
* in the normal to brachyfacial pattern extrusion of posterior teeth will be an advantage in bite opening and cervical headgear is selected with the outer bow, level with or just below the inner bow, if distal tipping of the molar crown and extrusion is required. If the archwire is ligated the outer bow may be placed higher towards the level of the molar trifurcation or premolar apices to achieve bodily movement in the direction of the line of force. (Kuhn, 1968; Godfrey, 1986).

* in the normal facial pattern neither extrusion nor intrusion is wanted (good lip and facial balance exist); then high cervical or

horizontal pull is used to give maximum molar distalization.

* in the normal to dolichofacial patterns extrusive force to the buccal teeth must be avoided to prevent backward rotation of the mandible, and occipital headgear will provide a substantial intrusive component of force as well as some distalizing force to the molars or maxilla to control posterior anchorage and/or to modify its growth. The hook position will provide distal tipping of the molar if placed below the C.R. of the molar. If an archwire is ligated then the hook if placed so that the line of action passes through the centre of resistance of the maxilla (premolar apices) then bodily movement upwards and backwards (with no rotation of the maxilla) should occur. Nikolai suggests that any overjet should be reduced and any intrusion of a previously levelled arch would help to diminish existing deep bite (See Figure 4.11). If straight pull is used (high cervical) a reduction of overjet would occur, but a moment producing clockwise rotation of the maxilla would occur, deepening the bite. (Nikolai, 1985: p353).

Figure 4.11. Nikolai, 1985: p353.



A buccal view of highpull extraoral force delivered to the maxillary arch.

* in the extreme high angle cases no molar distalization or extrusion can be tolerated as the slightest change will rotate the mandible backwards (Kuhn, 1968). High occipital pull headgear is used and this will often need a transpalatal bar to prevent buccal roll of the molars; and aid in the distribution of the highpull intrusive force to the maxilla where resistance to the vertical growth is an advantage. If intrusion bypass arch is being used in these cases to correct a deep overbite (usually over-eruption of

upper centrals) then the highpull headgear is advised to prevent reciprocal extrusion forces (Kuhn, 1968; Burstone, 1977; Nanda, 1981).

CHAPTER 5

STABILITY GOALS, POST-TREATMENT RELAPSE STUDIES

AND

METHODS OF RETENTION

CHAPTER 5STABILITY GOALS, POST-TREATMENT RELAPSE STUDIESAND METHODS OF RETENTION5.1 STABILITY GOALS FOR CLASS II, DIVISION 1 MALOCCLUSION, DEEP
OVERBITE TREATMENT

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5.1.1.1 Static goals of occlusion

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STABILITY GOALS, POST-TREATMENT RELAPSE STUDIES
AND METHODS OF RETENTION

5.1 STABILITY GOALS FOR CLASS II, DIVISION 1 DEEP OVERBITE
TREATMENT

Introduction:

Stability of the end-result is the prime objective of orthodontic therapy and without stability neither proper function nor aesthetics can be maintained. The desired stability of treated cases is dependent on corrected occlusion which must be within the bounds of normal muscle balance, which, in turn is dependent upon the relationship of the apical bases to one another. (Riedel, 1960). The concept of ideal occlusion - stable in both the static (centric) relationship and functional relationship - is described in the literature. (Andrews, 1972; Ricketts et al, 1980; Roth, 1981; Williams, 1985).

Overcorrection is also supported as a treatment goal in the literature. This concept is especially important in correction of Class II, Division 1 malocclusion and should be considered in both the anteroposterior and vertical planes. (Riedel, 1960; Graber, 1966; Ricketts et al, 1980; Proffit, 1986: p458).

Muscle balance is a necessary treatment goal in this malocclusion where circumoral muscle dysfunction may be a factor, associated with proclined or collapsed anterior dental arches. (Ballard, 1957; Williams, 1969). The position of the lower incisor and lower arch

form is important in achieving stability of both occlusion and the aesthetics and function of the soft tissue profile. (Subtelny, 1970; Schulhof et al, 1977; Ricketts et al, 1980; Zachrisson, 1984; Williams, 1985).

5.1.1. Description of Ideal Occlusion

As I have mentioned in the introduction, good occlusion is an integral factor in attaining post-treatment stability. In this subsection I have included an overview of ideal occlusion and arch form in both the static (or centric) relationship and in functional relationship.

5.1.1.1 Static goals of occlusion: In 1972, Andrews recognized the need to enumerate the various components of good occlusion and he found that six significant characteristics were consistently present in a collection of 120 sets of models of teeth with naturally excellent occlusion (non orthodontic normal models); his findings are summarized as follows:

Key 1 Molar relationship

- (a) The distal surface of the distal marginal ridge of the upper first molar contacts and occludes with the mesial surface of the mesial marginal ridge of the lower second molar.
- (b) The mesiobuccal cusp of the upper first molar falls within the groove between the mesial and middle cusp of the lower first molar.

(c) The mesiolingual cusp of the upper first molar seats in the central fossa of the lower first molar.

Key 2 Crown angulation: (The mesiodistal tip; here the gingival position of the long axis of each crown is distal to the occlusal position of that axis. The degree of tip varies with each tooth type.

Key 3 Crown inclination: The labio/buccal-lingual torque: with upper incisors the gingival position of the crown's labial surface is lingual to the incisal position. In all other crowns, including lower incisors, the gingival position of the labial or buccal surface is labial or buccal to the incisal/occlusal position.

Key 4 Rotations: teeth should be free of rotations.

Key 5 Tight contacts are advised (in the absence of abnormalities, e.g. tooth size discrepancies).

Key 6 Curve of Spee: should be no more than a slight arc. Flatness is a desirable treatment goal because of relapse tendencies (the deepest curvature in the models of ideal occlusion was 1.5mm).

Andrews suggests that the "Keys" are applicable to appraisal of both treatment progress and of treatment results. The clinician should aim at achieving the maximum number of keys. Roth (in Graber and Swain 1985: p666) declared the six keys to be consistent with desirable functional occlusal goals provided that the occlusal

interdigitation occurs with the mandible in centric relation, i.e. maximum intercuspation with the condyles seated in a centric relation position. (Figure 5.1 A, B and C).

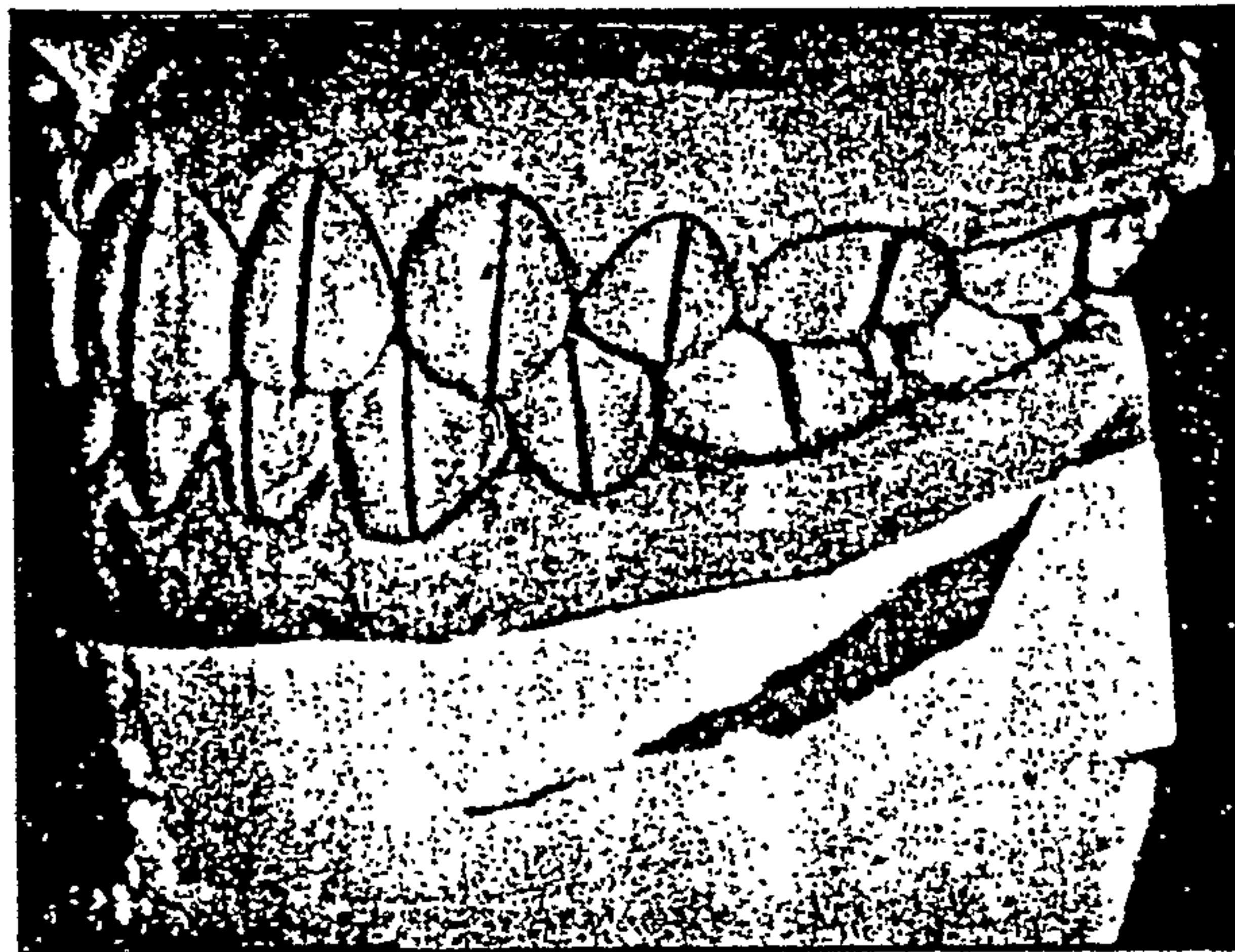


Figure 5.1A

Mounted study models, postorthodontics showing a centrically related occlusion and exhibiting Andrews' six keys

(Graber and Swain, 1985: p666).

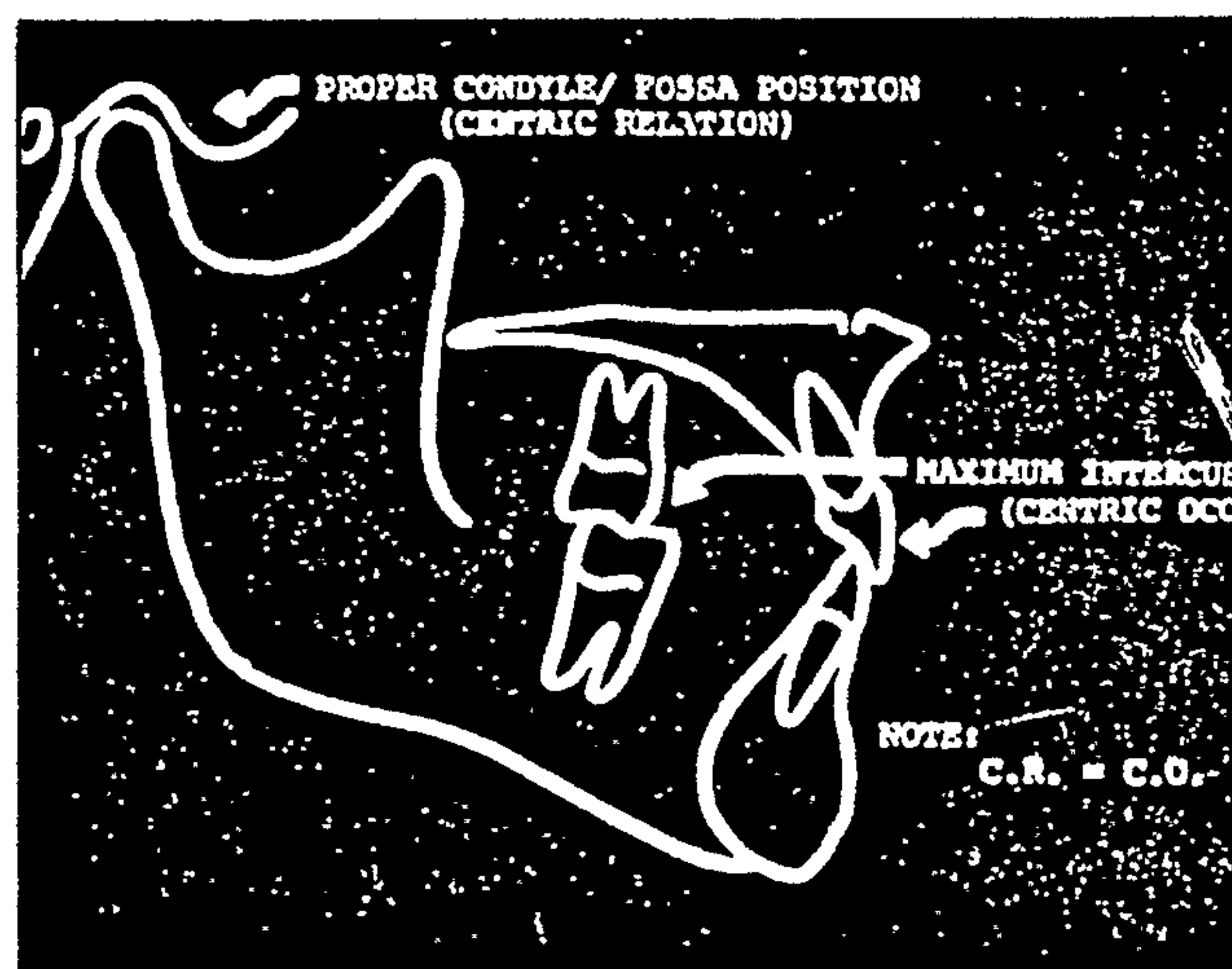


Figure 5.1B

Seated condylar position in centric relation

(Graber and Swain, 1985: p666)

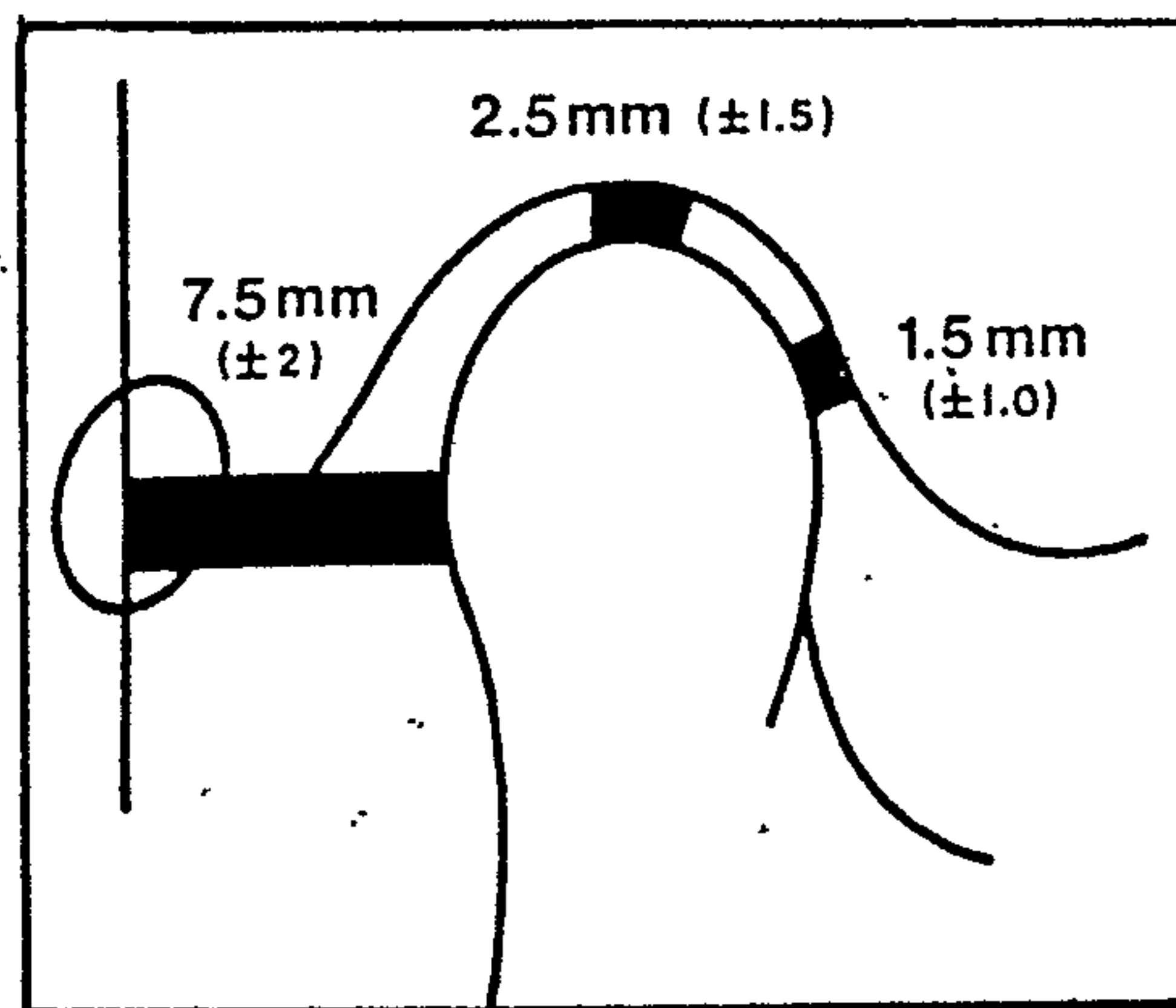


Figure 5.1C

Normal condyle-fossa relationship as it appears on a cephalometric tomogram. Norms established by Dr. R.M. Ricketts. Roth, 1981, Part 1: p35.

Ricketts et al (1980) write that in treatment the upper arch is fitted to the lower arch and the upper teeth, when treated in patients with Class II malocclusion, are overtreated and positioned to simulate conditions that follow the normal pathways of eruption. The concept is that the natural forces of eruption and occlusion combine with those of physiology and growth to settle functionally into the best position for each individual. It is argued that no clinician can position teeth as delicately as can the functioning incline plane and cusp action.

Ricketts et al (op cit p204) also describe in a pictorial scheme the ideal orthodontic finishing occlusion for every single tooth and a very useful occlusal check list for the ideal finishing arch.

The Ricketts' occlusal checklist in finishing: the list covers eight areas in each arch and is used as a reference in the bioprogressive appliance system to establish the ideal finishing arch configuration and individualized tooth rotation in its overtreated orthodontic finishing occlusion. (See Figure 5.2).

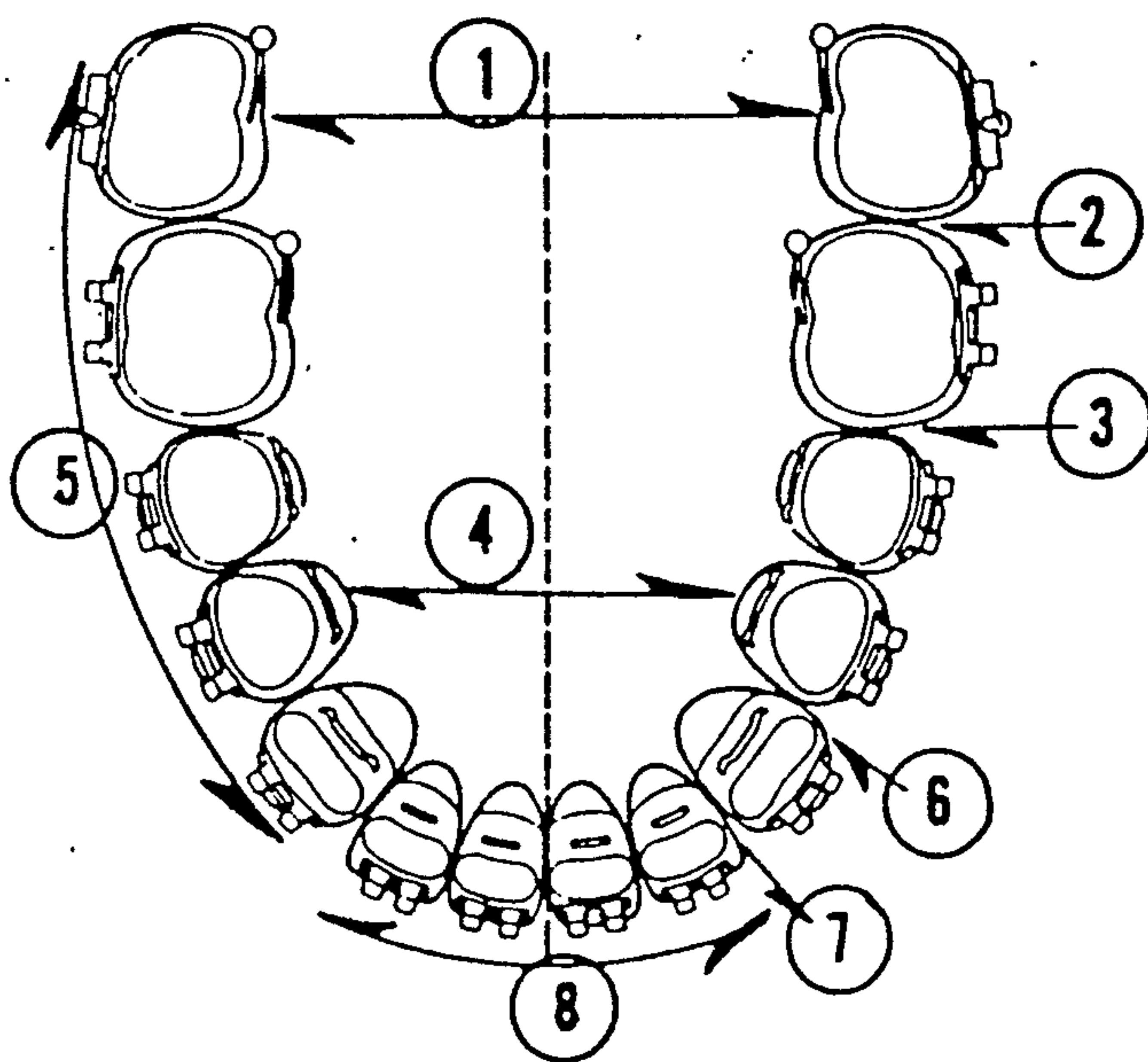
5.1.1.2 Functional goals of occlusion Ricketts et al (1980: p208) summarize the elements of normal physiology and function required in settling of an orthodontic case:

- * the proper location and function of the condyle in the temporomandibular joint is essential to the health and stability of the occlusion.
- * a normal airway is important, the respiratory process influences the tongue posture (and function) which is important to the stability of the dentition.
- * lip function and its variations have an influence upon the incisor alignment and stability. The muscles of mastication also influence the stability of overbite correction and may be a critical factor in the low angle case.

An analysis of functional occlusion has been made by Tuverson (1980); he states that with mandibular excursions, the anterior teeth work as a unit to restrict the horizontal movements of the posterior teeth during eccentric excursions (anterior guidance).

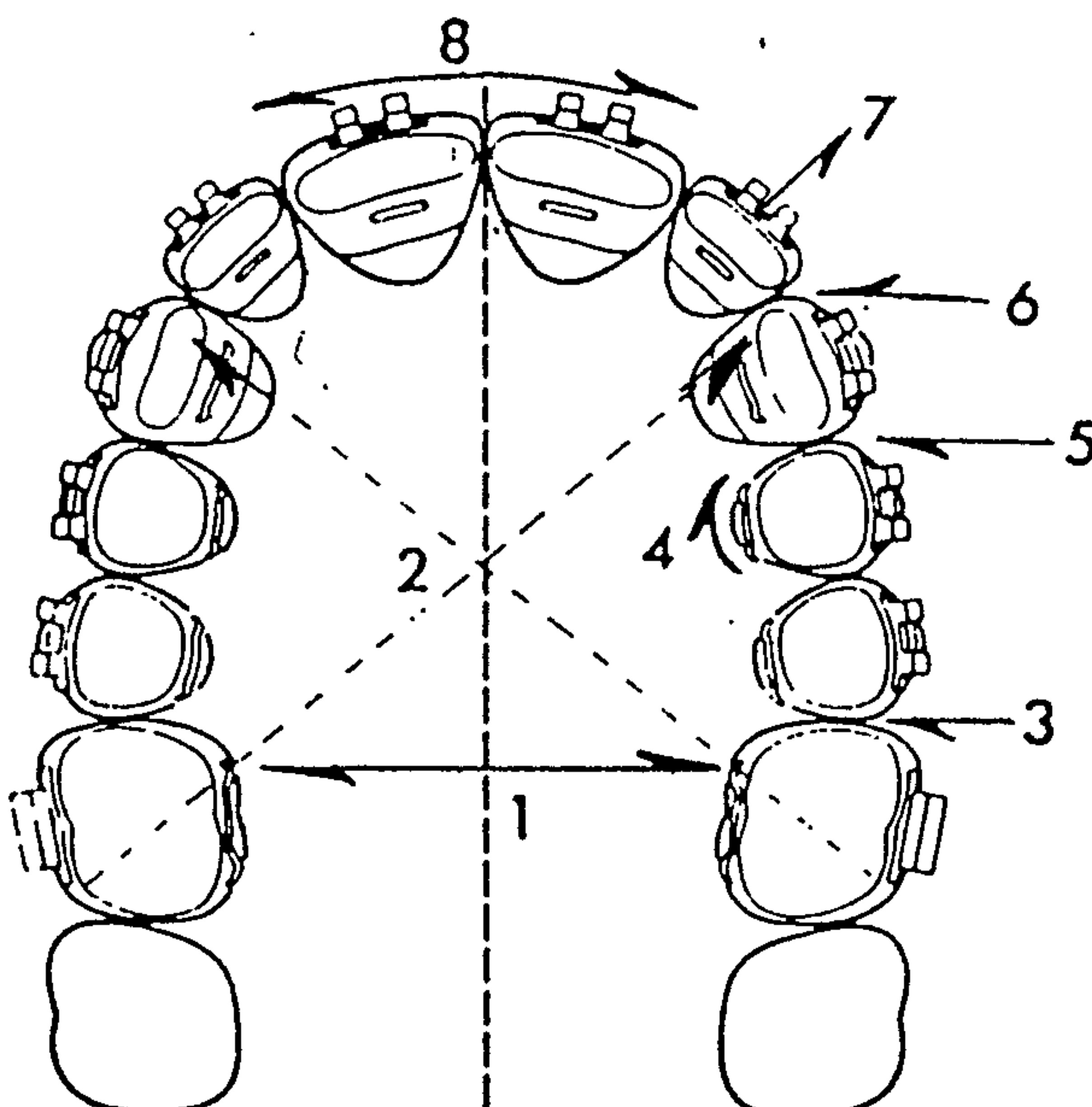
Figure 5.2
 Ricketts et al,
 Bioprogressive Therapy, 1980: p209.

OCCLUSAL CHECK-OFF FOR IDEAL FINISHING ARCH CONFIGURATION AND INDIVIDUALIZED TOOTH ROTATIONS



MANDIBULAR ARCH

1. Arch width across second molars.
2. Distal of first molar rotated lingually until the distobuccal cusp approximates mesial sluiceway on second molar.
3. Large buccal offset at mesial of first molar.
4. Check inter-bicuspid width for necessary expansion.
5. Proper buccal arch form and contour.
6. Premolar offset to bring it in contact with distal lingual incline of upper canine (2-3mm).
7. Mesial of cuspid tucked slightly behind lateral incisor, distal of the cuspid buccal.
8. Over-rotation of incisors; smooth arc.



MAXILLARY ARCH

1. Width across first and second molars.
2. Distal rotation of first molar so that line drawn through distobuccal and mesiolingual cusps points to the distal third of the opposite side cuspid.
3. Mesial offset (large) on molar.
4. Mesial rotation of lingual cusp of first bicuspid to seat in distal fossa of lower first bicuspid.
5. Premolar offset (2-3mm) to avoid first area of prematurity.
6. Cuspid brought into contact with lower cuspid and premolar to establish cuspid rise.
7. Lateral left labial (until retainer) to allow overtreatment of buccal segments; then tucked in.
8. Smooth arc across incisors.

When the posterior teeth are functioning properly, without mandibular slide, they protect the anterior teeth against excessive horizontal forces in the vertical closure position, to produce a mutually protected dentition.

Functional goals needed to provide a mutually protected occlusion:

- (i) minimal or no (less than 1.5mm) slide from centric relation to centric occlusion.
- (ii) even contact on both sides with no lateral slide and no forced mandibular movement.
- (iii) canine-protected occlusion on the working side.
- (iv) no balancing interference upon lateral movements (balancing contact may be acceptable).
- (v) disclusion of posterior teeth in protrusion.

(Tuverson, 1980).

The ideal functional occlusion is also described by Roth (1981) who writes that when the lower jaw is in its ideal or physiologic (rest) position, it may be closed from this position to a maximum intercuspation or mesh of the teeth without deviation of the condyle from its socket on either the right or left side; i.e. the teeth should intercuspidate upon closure when the jaw is in its ideal articular relationship and there should be no occlusal interference in this movement. Roth concludes that this "ideal" description of centric relationship with the condyles in the glenoid fossae with minimal change on closure to centric occlusion is basically in agreement with Tuverson who advises a minimal shift of no more than 1.5 mm.

5.1.2 Finishing Goals for Anteroposterior Stability

Instability or relapse has two major causes:

- (i) continued growth in an unfavourable pattern.
- (ii) tissue rebound after the release of orthodontic force.

(Proffit, 1986: pp450-451).

Overcorrection as a stability goal in Class II correction:

In Class II anteroposterior correction, once the headgear and/or Class II elastics correcting the occlusal relationship have been discontinued, it can be anticipated that the teeth will rebound up to 1-2mm and that this may occur within 2-4 weeks. (Proffit, 1986: p451). This is entirely different from the long term relapse tendencies associated with growth in Class II cases.

As a result of this phenomenon, an anteroposterior overcorrection of the occlusal relationships (about 1-2 mm) has been advised by several authors: (Riedel, 1960; Graber, 1966; Proffit, 1986: p458). Ricketts et al (1980: p203) also advise overtreatment in Class II correction and they emphasise that the teeth should be left in a position to follow the normal pathways of eruption when settling under physiological forces.

Joondeph and Riedel (writing in Graber and Swain, 1985: p881) also confirm that in Class II cases the maxillary buccal segments are not so much moved distally en masse, but more often tipped distally under the forces of headgear traction and/or Class II elastics. It may be undesirable to leave maxillary buccal teeth tipped distally, particularly if forward mandibular growth is not forthcoming, because, in most instances these distally tipped teeth will upright

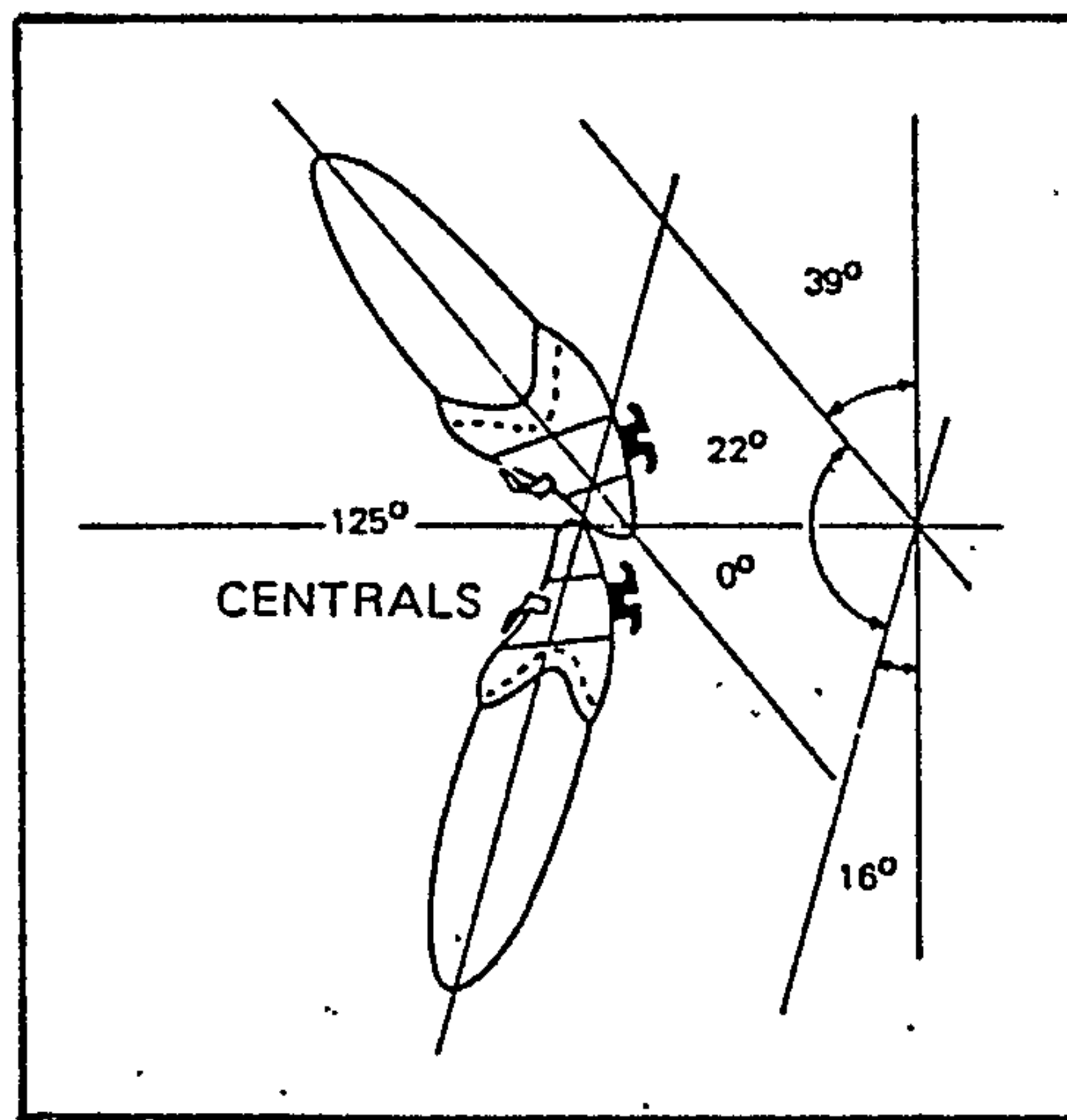
themselves with the crowns moving mesially towards the Class II relationship. This is balanced by either overtreatment to an incisal edge to edge relationship or attempting to upright them prior to deband.

5.1.3 Goals for Stability in the Vertical Plane

(i) Overcorrection: As in the horizontal plane overcorrection is advised in the treatment of deep overbite; the final treatment goal being to flatten the curve of Spee and compensating curve creating an almost edge to edge incisal relationship where possible. This is especially important in the low angle, brachyfacial cases. (Graber, 1966; Creekmore, 1967; Simons and Joondeph, 1973).

(ii) Interincisal angle: several authors agree that an interincisal angle at completion of treatment of about 125° - 130° is a desirable treatment goal. Ricketts et al (1980: p213) recommend 125° - 126° for finishing in Class II, Division 1 deep overbite cases and this is supported by Simons and Joondeph (1973) who state that the smaller interincisal angles will allow for some uprighting after retention and continue to provide a good articulation platform for the incisors.

Figure 5.3
Ricketts et al,
1980, p213.



Upper central incisors are placed at a 125° interincisal angle with 22° of lingual root torque in the bracket. This angulation allows for band space closure during retention.

The ideal finishing interincisal angle is set at 135° by Schudy (1964, 1973) and at 130° by Zachrisson (1984) who quotes studies conducted in Scandinavia of ideal stable occlusions which found the interincisal angle to range from 130.8° to 126.5° in adolescents and changing by age 25 years to 135° (Humerfelt and Slagsvold, 1972, Björk and Palling, 1974).

(iii) The lower incisor should contact the cingulum plateau of the upper incisor and this should be large enough to permit contact and balance for small lateral and forward movement. (Backlund, 1958).

(iv) Occlusal plane angle: Riedel (1960) writes that the occlusal plane probably cannot be permanently altered, except in a negative direction (sic) and that unless the occlusal plane is first prepared with Class III elastics, it will tend to tip down anteriorly with heavy or long term Class II elastics and return to its original level after retention with a relapse to the deep overbite.

Lindquist (writing in Graber and Swain, 1985: p609) also suggests

that the tipping of the occlusal plane should be avoided. It can be corrected or prevented with the use of J hooks where extended use of Class II elastics is required.

5.1.4 Lower Incisor Position

The importance of the lower incisor position has been recognized in orthodontic treatment planning for its effect on the profile aesthetics, stability and space availability in the mandibular arch. (Schulhof et al, 1977).

Views on the most stable positioning of the lower incisors vary, but two concepts predominate in the literature:

(i) that the lower incisors should remain approximately in their original position and that any protrusion or retraction will result in relapse. Weinstein (1963) supports this view, stating that the teeth are in a state of equilibrium as a direct result of muscle balance; Hixon (1972) also claims that any expansion anteriorly will lead to relapse.

(ii) others, such as Ricketts (1960) and Williams (1969) have supported diagnostic lines such as the APo (AP) plane as a guide for positioning the lower incisors, anteroposteriorly.

5.1.5 Soft Tissue Profile

The age of the patient must be considered in assessing the profile achieved by orthodontic treatment (as well as at the initial assessment). For example younger children will normally have relatively receding chins and convex profiles. As growth continues,

the hard and soft tissue chin becomes more prominent as does the nose. General proportions tend to be maintained with younger children with already "orthognathic" profiles developing prominent chins while those who are severely retrognathic in profile are likely to stay that way. (Steiner, 1960). Anchorage considerations and the desired amount of retraction of the incisor teeth require careful consideration. If patients with protrusion have too much incisor retraction at a young age their faces can look prematurely aged. (Graber and Swain, 1985: p69). Thus it is perhaps not desirable to create the ideal orthognathic profile in growing children and instead to retain at least the same convexity in the Class II profile cases, especially if good forward mandibular growth is predicted (more brachyfacial type).

To place the tip of the lower incisor on or in front of the AP line is a necessary goal in achieving the optimum in facial aesthetics and stability (Ricketts, 1960[b], Williams 1969). Williams (1969) states that the AP plane to lower incisal edge relationship is a common "cephalometric denominator" found in a wide range of facial types that have harmonious soft tissue profiles and lip balance. He suggests that the following factors be considered in achieving the ideal soft tissue profile:

- * if the lower incisor is positioned too far forward of the AP plane a protrusive lower lip results.
- * if the lower incisor is positioned too far back, a retrusive lip results.
- * to create well balanced lips, the optimum position of the

lower incisor is on or just in front of the AP plane (1-2mm).

5.2 POST-TREATMENT RELAPSE STUDIES AND THEIR SIGNIFICANCE FOR STABILITY GOALS AND RETENTION

Introduction: the literature contains the findings of many studies of the relapse of orthodontically treated cases. In this section I will attempt to discuss the significance of these findings and their relevance to the retention and stability of Class II, Division 1 deep overbite treatment.

5.2.1 Post-treatment Growth Changes

Long term relapse may occur after treatment of Class II, Division 1 cases in both the horizontal and vertical planes if these are fully or partly skeletal in origin. The amount of growth remaining after orthodontic treatment will depend on the age, sex and relative maturity of the patient. (Proffit, 1986:p456). When planning the retention period it must be remembered that condylar growth continues on after body growth is virtually complete and may continue in girls until 15-16 years of age and in boys until 18-20 years of age (Graber and Swain, 1985: pp38-39).

In the brachyfacial cases it has been reported by Björk and Skieller (1983: p26) that bite opening by orthodontic treatment influences the remodelling of the mandible as a whole, as does the effect of headgear on the maxilla. Both of these orthodontic procedures will induce a rotation of the corpus inside the matrix and this

intramatrix rotation may show a tendency towards relapse and will need consideration in retention selection and duration. The authors add that in this facial pattern (brachyfacial) there may be a post-treatment return to the original growth pattern, with excessive forward rotation of the mandible, due to both an increase in normal internal rotation and a decrease in external compensation resulting in a tendency for return to a nearly horizontal palatal plane, low mandibular plane angle and square gonial angle with deepened bite and crowded lower incisors (See Figure 5.4). (Björk and Skieller, 1983; Proffit, 1986: p86).

Tooth eruption patterns also vary in the brachyfacial type; the excessive rotation will result in the incisors being carried into overlapping (overjet) relationship with a tendency towards deep overbite. The lower incisors are uprighted progressively and may either be displaced lingually or they may become crowded (See Figure 5.5).

Björk and Skieller (1972) suggest the use of a bite platform in the retainer while Proffit (1986: pp463-466) suggests continued use of appropriate headgear (often cervical or straight pull), in cases which have a large basal overjet before treatment; a bite platform in the upper retainer and a lower lingual fixed retainer to prevent lingual tipping of lower incisors. Alternatively if patient co-operation is good and greater control of protruded lower incisors is needed then a Dohner or wrap-around lower splint is advised. (Proffit, 1986: pp433-436).

Figure 5.4
Björk and Skieller,
1972: p344

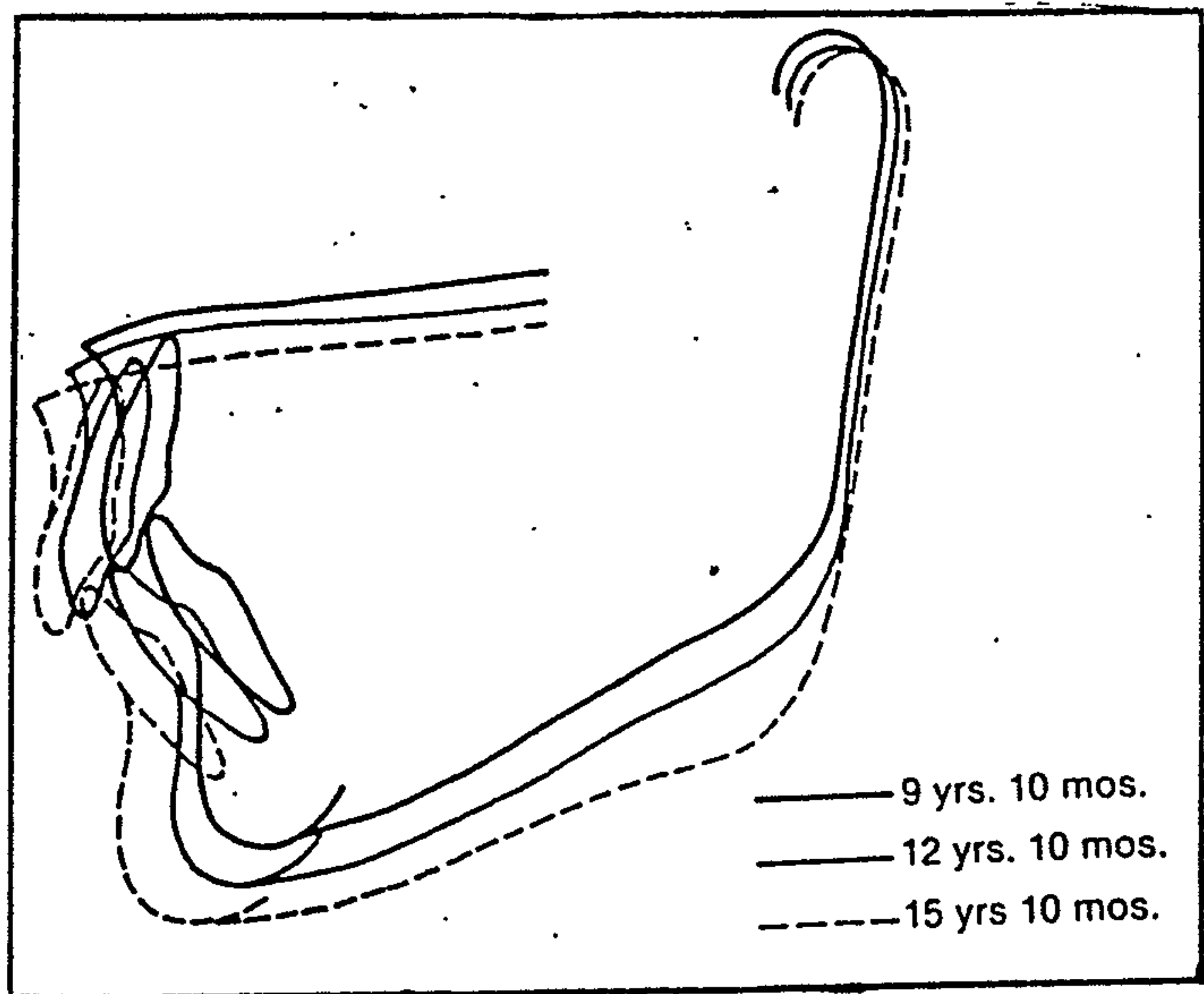


Figure 5.4 Cranial base superimposition shows the characteristic pattern of forward jaw rotation in an individual developing in the "short face" pattern. The forward rotation flattens the mandibular plane and tends to increase overbite anteriorly.

Figure 5.5
Björk and Skieller,
1972: p357.

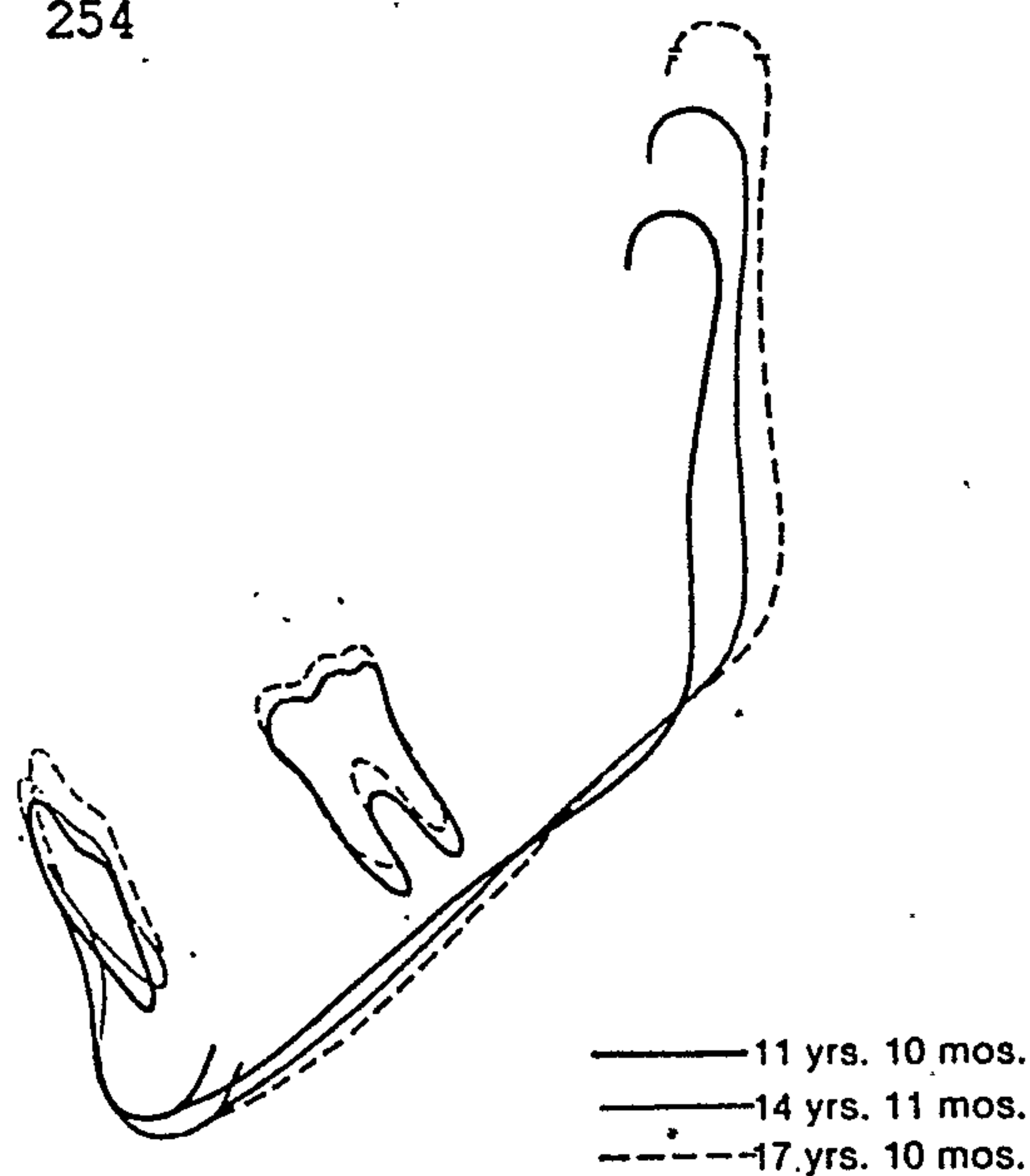


Figure 5.5 Superimposition on mandibular implants shows the lingual positioning of the mandibular incisors relative to the mandible that often accompanies forward rotation during growth.

Continued use of the retainers throughout the growth period is suggested, wearing them at night after six months "full-time" wear. (Graber and Swain, 1985: p536, p894; Proffit, 1986: p463). With growth in the more dolichofacial patterns the palatal plane tends to rotate down posteriorly and the mandible shows an opposite, backward rotation with an increase in the mandibular plane angle. This mandibular change results primarily from a lack of normal forward internal rotation - or even a backward internal rotation. The rotation is largely a matrix rotation (centred at the condyle), not intramatrix rotation. This results in an anterior open-bite tendency and mandibular deficiency, related to the chin moving back as well as downward. (Björk and Skieller, 1983).

The application of these findings to retention has been suggested in the literature as follows:

- (i) continue the use of highpull headgear; this would help limit the downward vertical growth of the maxilla and reduce molar eruption (traction to first molars only).
- (ii) the retention of the corrected deep anterior overbite is not critical and should remain stable in this facial pattern (Björk and Skieller, 1972; Engel, 1980; Proffit, 1986: p86).

5.2.2 Post-treatment Relapse Studies of Corrected Deep Overbite

A detailed cephalometric study of post-retention changes has been made by Simons and Joondeph (1973) and this indicated that patients with a deep initial overbite also had a deep overbite 10 years post-treatment; patients who had a large amount of overbite decrease during treatment also had the greater relapse. However, they were found to maintain the greatest amount of correction.

Several other authors such as Riedel (1960) and Graber (1966) have described a post-retention dominant tendency to relapse in the more brachyfacial cases despite levelling of the curve of Spee and compensating curve and over treatment to an edge to edge incisal relationship.

The method of bite opening has been accompanied by a level of controversy in that some authors advocate posterior extrusion to rotate the mandible open as being the most stable correction of deep overbite (Schudy, 1964; Creekmore, 1967). Others such as Burstone (1977) and Ricketts et al (1979) strongly advocate the treatment of deep overbite with intrusion of incisors as being more stable especially in the treatment of the more extreme brachyfacial cases.

The modern edgewise appliance may use intrusion or extrusion mechanics or a combination of the two depending on the demands of the facial pattern and incisor soft tissue relationship. (Burstone, 1977; Nanda, 1981)

5.2.2.1 Factors associated with the stability of deep overbite correction: this section will include a review of the literature on the stability of deep overbite correction and will attempt to compare the stability gained from various treatment goals and bite opening techniques.

(i) Relapse changes to corrected overbite: Berg (1983) in a study of 26 treated deep bite cases, found that the mean overbite reduction was 49%, during treatment, in the post-retention period a mean relapse of 18.8% occurred (when related to the pre-treatment situation the mean relapse was 9.2%). He also found that the long term post-treatment relapse was greatest in Class II Division 2, but this was only 3.2% greater than Class II, Division 1 overbite relapse. Simons and Joondeph (1973) also found that the deeper overbite cases also showed the greatest relapse but they also maintained the greatest amount of correction or overall net decrease in overbite.

(ii) Facial pattern and relapse of corrected overbite: Björk and Skieller (1973) report on relapse of deep overbite correction with continued growth in the brachyfacial cases has been outlined earlier. Several other authors have described studies which found a significant probability of relapse in the extreme low angle,

brachyfacial cases (Creekmore, 1967; Simons and Joondeph, 1973; Engel et al, 1980). Engel et al (1980) also suggest that, not only do the low angle cases show the greatest relapse tendency, they were also the most difficult to treat and the most likely to show 100% relapse. The more normal to dolichofacial cases undergo vertical growth of the jaws, manifested in a more downward movement of the chin; this facial pattern correlated with stable overbite correction, while the brachyfacial cases with strong horizontal growth vectors showed a correlation to relapse in anterior overbite. (Simons and Joondeph, 1973).

(iii) Anteroposterior position of lower incisors: Ludwig (1967) found that the lower incisor placed on the AP line correlated to stability of corrected overbite while protrusion beyond the AP plane correlated with its relapse. This correlation has been substantiated by Simons and Joondeph (1973) and Berg (1983).

(iv) Interincisal angle: Schudy (1964) and Simon and Joondeph (1973) have recorded that overbite relapse occurred concurrently with an increase in interincisal angle. Berg (1983) found that stable cases had interincisal angles under 140° , he suggests that post-retention changes in interincisal angle and overbite relapse, were partly due to relapse of tooth position and partly associated with individual growth trends; i.e. labial tipping of lower incisors in the retrognathic faces and lingual tipping in cases with extreme (brachyfacial) horizontal mandibular growth. Engel et al (1980) report that deep overbite cases finished at interincisal angles of between 125° - 135° showed greatest stability.

(v) **Mandibular plane:** Riedel (1960) states that changes in the mandibular plane induced by treatment are probably not permanent, tending to flatten with age, unless vertical growth occurs which may provide an increase in posterior face height and will result in stability of the corrected overbite and the opened mandibular plane. Schudy (1964) and Creekmore (1967) agree with this, but advocate extended use of a bite-plane retainer and fixed lower lingual retainer in cases where the mandibular plane has rotated open in treatment.

(vi) **Occlusal plane:** Simons and Joondeph (1973) found a correlation between a decrease in occlusal plane angle and a relapse in overbite. Berg (1983) states that occlusal plane tipping will relapse to its original level even within the retention period.

(vii) **Stability of intruded incisors:** Engel et al (1980) report on several studies that found intrusion of both upper and lower incisors with the Ricketts' utility arch provided about 2mm (on average) of incisor intrusion, the maximum intrusion being 5mm, there appeared to be no difference in the ability to intrude either in the upper or lower arch and approximately the same degree of intrusion was possible in children and adults. On average a 3mm incisor intrusion was found to be followed by a post-treatment relapse of 1mm, i.e. two-thirds of the intrusion held.

(viii) **Occlusion:** good continuity of both dental arches and ideal intercuspal relationship of all posterior segments are mentioned by Ludwig (1967) as a stabilizing factor for long term overjet and overbite correction. Backlund (1958) stresses the need for correct

interincisal angulation and a cingulum contact area for the lower incisors to the upper incisors that is large enough to allow small lateral movements.

5.2.3 Lower Incisor Position and Stability

I have discussed the use of AP plane as a cephalometric reference line for lower incisor stability and soft tissue (profile) aesthetics. In theory, the lower incisors would tend to adapt to and be reciprocally balanced between the dental bases and the natural drape and function of the facial and circumoral muscles. Posen (quoted in Schulhof et al, 1977) measured perioral musculature force and found a correlation with incisor position, e.g. Class II, Division 2 malocclusion had the strongest perioral forces, while Class II bi-maxillary protrusion had the weakest forces. It was also found by Subtelny (1970) that correction of the anterior Class II, Division 1 dental relationship was followed by a change in perioral muscle forces towards a more normal reading.

Several other studies have examined the relationship between the lower incisor position and the maxillary and mandibular basal bone. A study by Linder-Aronson et al (1976) found a significant correlation between angle ANB and the inclination of lower incisors, establishing a relationship between lower incisor and the basal jaw relationship. The AP plane had been suggested as a reference line for lower incisor position by Downs, (1956), Ricketts (1960[b]) and later by Williams (1969, 1985) who suggest that the tip of the lower incisor should be placed on or just in front of the AP line as a

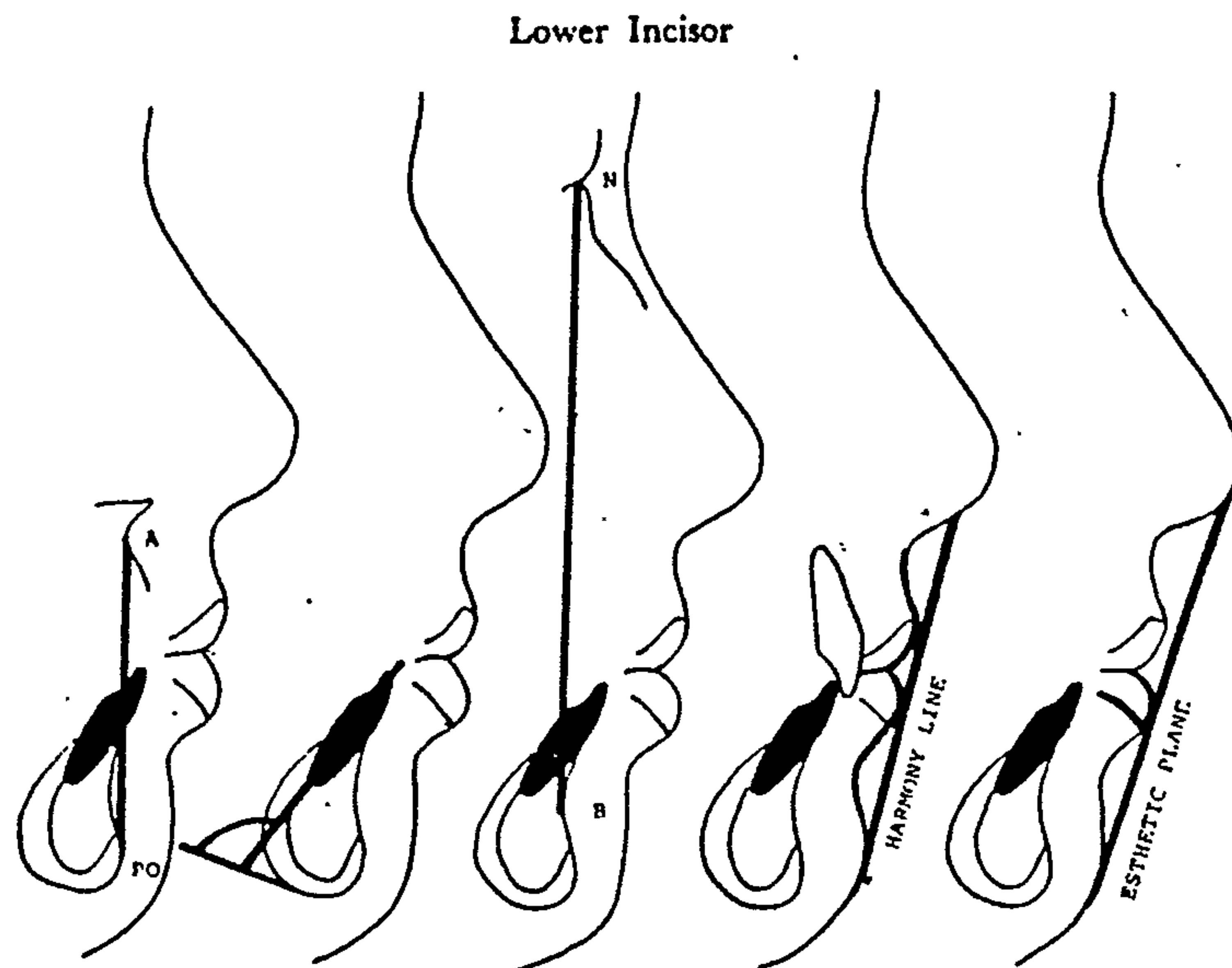
necessary goal for facial aesthetics and stability of the dentition. The use of the AP plane has been supported by a study carried out by Schulhof et al (1977) who conclude that:

- (i) the AP plane does adequately account for convexity of profile
- (ii) that the maxilla should be considered when placing the lower incisor and the AP line does this
- (iii) other cephalometric reference lines such as mandibular plane or facial plane do not assist stability (See Figure 5.6).
- (iv) the use of AP plane does not ensure post-retention crowding will not occur.

Proclination of lower incisors in Class II, Division 1 cases:

Zachrisson (1984: p82) states that in his view, proclination of lower incisors may be stable if it is possible to diagnose reasons for their retroclination. Lingual tipping of lower incisors associated with functional and environmental forces are sometimes seen in Class II, Division 1 cases. When treatment removes these muscle forces, the lost arch space may be regained with proclination of these lower incisors into a stable upright position.

Figure 5.6
Schulhof et al,
1977 p.283



Five different methods of determining the position of the lower incisor are shown above. (a) Relating the lower incisor to the AP plane. (b) Relating the inclination of the lower incisor to the mandibular plane. (c) Relating the lower incisor to the NB plane. (d) Determining the position of the lower incisor which gives optimum lip harmony (Holdaway). (e) Positioning the lower incisor such that the resulting lower lip will relate ideally to the aesthetic plane.

Environmental factors associated with retroclined lower incisors:

- * thumb sucking habits
- * mouth breathing often associated with large adenoids
- * premature extraction of deciduous canines or molars
- * very deep overbite; as the bite is opened, up to 10 mm of space has been demonstrated to become available for incisor alignment.

(Swain, quoted by Zachrisson, 1984: p82).

Zachrisson (1984: p83) describes cases that demonstrate good stability where lower incisors have been proclined even up to 10 mm; in these cases he notes that the interincisal angles were observed

to change from 170° to the more stable 124° . Zachrisson suggests the use of a suitable cephalogram analysis prior to decisions on proclination, to ensure a stable position for the lower incisor and to ensure adequate interincisal angles (by overtorque procedures).

5.2.4 Lower Incisor Crowding

It has been reported in the literature that success in maintaining satisfactory mandibular anterior alignment is less than 30% (Little, Wallen and Riedel, 1981). It was also found that after retention, arch dimensions of width and length decreased while crowding increased, irrespective of the maintenance of initial intercanine width or arch expansion. The study also found that increasing crowding normally occurs during late adolescence and early adulthood. The authors conclude that orthodontic therapy may only temporarily alter the course of physiological change and following retention the predetermined maturation process resumes.

Björk and Skieller (1972) report that a differential path of eruption between molars and incisors is a cause of lower incisor crowding often observed with growth in the late maturation stages, (see Figure 5.5). They describe a normal internal forward rotation of the mandible that carries the jaw upwards in front, altering the eruption path of the incisors, uprighting them while the molars migrate further mesially; this results in a net decrease in arch length.

A study looking at lower tooth size and crowding indicates that in the crowded groups, the mesiodistal diameter of the four lower

incisors was significantly greater than those in the normally aligned group. The study also noted that Bolton's Index was influenced by the excess of tooth material, being significantly higher in the group with crowding and interproximal reduction of the lower incisors was recommended to reduce this excess. (Nordeurval, Wisth and Boe, 1975). Williams (1985) lists six keys for lower incisor positioning which describe root position, incisal edge position and other considerations which the author claims eliminate the need for prolonged retention. Williams' keys are hard to find fault with and can be considered as an ideal goal in treatment.

5.2.5 Inter canine Width of the Mandible

The dominance of the lower arch in the stability of occlusion is suggested by Gardiner and Chaconas (1976) and there is general agreement in the literature that expansion of the inter canine width of the mandible leads to relapse towards the original pretreatment width. (Riedel, 1960; Graber, 1966; Gardiner and Chaconas, 1976; Little et al, 1981).

It has been reported that the inter-first premolar width does permit a degree of stable expansion in treatment (Gardiner and Chaconas, 1976) and Williams (1985) suggests that the distal movement of canines into premolar space may enable more stable expansion.

5.2.6 Third Molars

The role of third molars in the problem of lower incisor post-retention crowding has provoked considerable debate. The impaction

or crowding of third molars is symptomatic of general arch crowding. The use of non-extraction therapy with extraoral traction may also lead to third molar crowding. A recent study by Lindquist and Thilander (1982) of cases where third molars had been extracted on one side only found that there was less crowding on the extraction side in 70% of cases and the authors recommend extraction of third molars in cases of severe crowding. They also found that proximal contacts are an important factor in maintaining lower incisor alignment. A review of the literature however reveals little support for generalized extraction of third molars in order to alleviate or prevent lower incisor crowding. (Kaplan, 1974; Lindquist and Thilander, 1982; Graber and Swain, 1985: p877; Richardson, 1986). Kaplan (1974) in a cephalometric study of this subject found that the presence of third molars has no apparent influence on lower incisor crowding or rotational relapse any more than cases without third molars present.

5.2.7 Summary of factors relating to stability of corrected Class II, Division 1 deep overbite cases. Treated Class II, Division 1 cases clearly have particular goals for treatment stability. Anteroposteriorly a return to forward maxillary growth should be retained with continued use of the selective headgear, while vertical growers should be retained by continued use of highpull headgear to limit further backward rotation of chinpoint after treatment. (Proffit, 1986: p456). Alternatively in the normal or brachyfacial patients functional appliances may be used for retention in the growth period. It is noted that condylar growth is

not completed until 15-16 years of age in girls and 18-20 years for boys.

A high degree of relapse of corrected deep overbite is reported in the brachyfacial pattern cases and several authors suggest the extended use of retainers with suitable bite platforms (Björk, 1953; Riedel, 1960; Schudy, 1964; Creekmore, 1967; Skieller, 1967; Simons and Joondeph, 1973, Björk and Skieller, 1983). Overbite correction in the dolichofacial patterns were reported as stable. (Björk and Skieller, 1983; Engel et al, 1980).

The interincisal angle of between 125° and 135° is reported in the literature to correlate to stability of overbite correction. (Simons and Joondeph, 1973; Engel et al, 1980).

The use of the AP plane as a cephalometric reference line for lower incisor stability and soft tissue profile aesthetics has been found of value by several authors including Downs (1956), Ricketts (1960[b]) and Williams (1969), while several cephalometric studies have confirmed its value. (Linder-Aronson, 1976; Schulhof et al, 1977).

The proclination of lower incisors is sometimes necessary in Class II, Division 1 cases where habits or other circumoral forces have resulted in lingual retroclination of the lower incisors. Zachrisson (1984) states that this is usually stable provided factors such as suitable interincisal angles and cephalometric reference lines are used as finishing guides.

Expansion of the intercanine was usually found to result in relapse towards the original width with accompanying incisal crowding.

(Riedel, 1960; Gardiner and Chaconas, 1976).

Lower incisor crowding has also been related to large mesiodistal widths of the lower incisors and interproximal reduction has been advised by the authors Nordeurval et al (1975) and also by Williams (1969, 1985).

There is little support in the literature for generalized extraction of third molars in order to avoid incisor crowding. Lindquist and Thilander (1982) suggest that extraction of third molars in severe crowding cases is advisable, while several other authors suggest that there is no substantial evidence of a correlation between third molar presence and incisor crowding. Routine extraction of third molars is not justified. (Kaplan, 1974; Graber and Swain, 1985: p877).

5.3 METHODS OF RETENTION

The foregoing discussion on post-treatment relapse changes has established the role that ongoing unfavourable growth may play in skeletal or partly skeletal Class II, Division 1 cases.

5.3.1 Retention in the Normal to Low Angle Brachyfacial Pattern:

Here the ongoing growth pattern tends to result in excessive forward rotation of the mandible. This would tend to result in both closure of the corrected overbite and anterior incisor crowding (Björk and Skieller, 1983; Proffit, 1986: p86).

A Hawley or Begg type of removable retainer is used with a potential bite platform built into the retainer which the lower incisors will contact if the bite begins to deepen. The bite platform should not

separate the posterior teeth. This will need to be worn night and day for at least 6 months and then at night throughout the condylar growth period. (Schudy, 1973; Nemeth and Isaacson, 1974; Proffit, 1986: p458).

If marked forward maxillary development was initially diagnosed, it is advisable to continue the headgear traction to the upper molar bands in cases where considerable growth remains.

If headgear is not used in treatment another option would be an activator also used at night throughout the post-treatment growth period. A lower fixed lingual retainer is also advised in forward growing cases to prevent crowding of the lower incisors in the late maturation period of the mandible.

5.3.2 Retention in the Normal to High Angle Dolichofacial Patterns:

The very high angle cases will need vertical pull headgear continued to restrain further downward maxillary growth and to control eruption of the upper molars that would only result in further backward rotation of the chin in the post-retention growth period.

An upper Hawley or Begg retainer is also used. The Hawley can have a circumferential clasp that will fit under the headgear molar tube.

(Graber and Swain, 1985: p881; Proffit, 1986: p458). A bite platform should not be necessary as overbite is stable in this growth pattern. (Engel et al, 1980).

5.3.3 Types of Retainers

5.3.3.1 Removable retainers

(i) The Hawley retainer consisting of an acrylic plate and stainless steel round labial bow 0.036" wire formed to contact the labial surfaces of the four or six anterior maxillary teeth. Minimal occlusal interference is gained if the labial wire crosses palatally between the lateral and canine, rather than the conventional path between the canines and premolar; constraint can be added to the labial of the canines by a labial extension bend or the labial arch may be soldered to the molar clasps, extending from molar to molar. (Proffit, 1985: p462).

N.B. Working models should be articulated to ensure wires do not interfere with occlusion. (Graber and Swain, op cit p894).

(ii) The Begg retainer has no wires passing palatally through extraction spaces and no Adams clasps. The acrylic palatal base has wire extending buccally around the fully erupted teeth in a continuous arch which has vertical loops so that it may be gradually adjusted as spaces are closed. It is very useful where occlusal interference should be avoided and may include a bite platform. (Reitan, 1969).

(iii) The positioner in retention planning. The tooth positioner is a flexible one piece plaster appliance which fits over the crowns of teeth in both arches. Although basically retainers they can be constructed to produce limited tooth movement if needed.

Advantages: (Proffit, 1986: p463)

* aids the recovery of normal tissue tone where gingival

hyperplasia has developed during treatment.

- * works towards improvement of tooth position.

Disadvantages:

- * limited wear time - mainly when sleeping
- * may cause tooth mobility
- * contra-indicated in patients with blocked nasal airway.
- * because of limited time in use, it may not prevent relapse of deep overbite correction and a retainer with a bite platform is needed as well through the day. It is less effective in retaining growth than part-time headgear or functional appliances. (Proffit, 1986: p463).

Construction: positioner set-ups and fabrication should be done on an adjustable articulator with a facebow transfer, to allow the patient to function into the positioner without dislocation of the condyles. (Graber and Swain, op cit, p895). Taking a maxillary-mandibular relationship (MMR) is only valid if a small number of the teeth are to be adjusted by the positioner. (Godfrey, 1987; Personal communication).

5.3.3.2 Bonded lingual retainers

The most satisfactory bonded retainers are the flexible spiral wire (F.S.W.) types. Two types are currently being used:

(i) thick:

0.032" wire is bonded canine to canine or the canine and premolars are bonded at either end of the wire. If there is occlusal interference then Zachrisson (1984) suggests that a shallow slot can be cut into the enamel ridge of the premolars to accept the wire.

(ii) thin:

0.020" spiral wire, this thin F.S.W. retainer has all teeth bonded to the wire and will aid in retention of corrected rotations.

Advantages:

- * it replaces the conventional removable acrylic splint, when it is not likely to be worn by the patient.
- * it still allows slight movement of the bonded teeth in function
- * it is invisible
- * it can be placed out of occlusal contact (generally)

Disadvantages:

- * if a bite platform is needed it is contraindicated as a maxillary retainer (unless modified)
- * flossing and good oral hygiene are needed
- * wire must be totally passive when bonded to avoid undesirable tooth movement
- * it is subject to mechanical stress at the bond sites and may be less indicated in the maxilla if there is bite interference.

Zachrisson (1984) adds that it can be worn (reliably) on a semi-permanent basis, provided oral hygiene is good, up to two years or more.

Thin FSW Retainers:

Use:

- * prevention of space opening, e.g. median diastemas spaced anteriors, retention of closed large anterior spaces, mandibular incisor extractions
- * holding the correction of severely rotated teeth. (Zachrisson recommends this over a 6 year period), retaining the treatment of impacted canines or supporting apically resorbed incisors.
- * the thin F.S.W. retainers can be combined with Hawley retainers which may be needed for control of anteroposterior and vertical changes, while the F.S.W. retains incisal rotations.

Fixed cingulum bite platform retainer:

This is a bonded composite lingual bite platform attached individually to the incisors and joined by a thin spiral wire. It may be used to provide a long term bite platform for retention of corrected deep overbite cases of skeletal origin, with a brachyfacial growth pattern and where the post-treatment growth period can be expected to continue over a number of years.

Description.

The fine spiral wire 0.020" is first tack bonded to the lingual of the upper incisors and first premolars if space permits. The cingulum rest areas are then built up to form a small plateau-like platform, at approximately 90° to the long axis of the lower

incisors and varying in size: 3-6 mm mesiodistally x 1-2mm palatally depending on the tooth size. The build-up may be done in groups of 2-3 teeth at a time, checking that no incisal bite interference is present and reshaping prior to light curing. This bite platform should be only large enough to permit adequate contact and balance for small lateral and forward movement and a rest-spot may be added for centric occlusion or a guidance plane placed.

Advantages:

- * less reliance on patient co-operation which has considerable advantage with extended retention periods
- * extended wear 24 hours over several years may be possible
- * it is not visible.
- * it retains upper incisal rotation corrections

Disadvantages:

- * bond failure may be a problem (the retainer has not been tested adequately. However, lingual bracket bonds appear to last for several years).
- * special oral hygiene requirements, such as the use of super-floss to clean interproximally and under the F.S.W. is required.

Discussion/literature review:

The design follows on from the work of Zachrisson with bonded thin spiral wire retainers (in Graber and Swain, 1985: p538), theOrmco lingual orthodontic brackets which incorporate bite platforms and in particular from the work of Backlund (1958).

Backlund (1958) states that if lingual tooth anatomy and/or interincisal angulation allow gliding contact between upper and

lower incisors, then minimal axial stress is placed on the teeth, this permits over-eruption until vertical growth of the alveolus has ceased or is balanced, sometimes relapsing back to contact on gingival tissue with subsequent increase in overbite and overjet. Backlund concludes that upper front teeth with a natural cingulum plateau (nearly at right angles to the lower incisor, long axis) display favourable axial stress to both upper and lower incisors (see Figure 5.7), remaining stable.

Figure 5.7

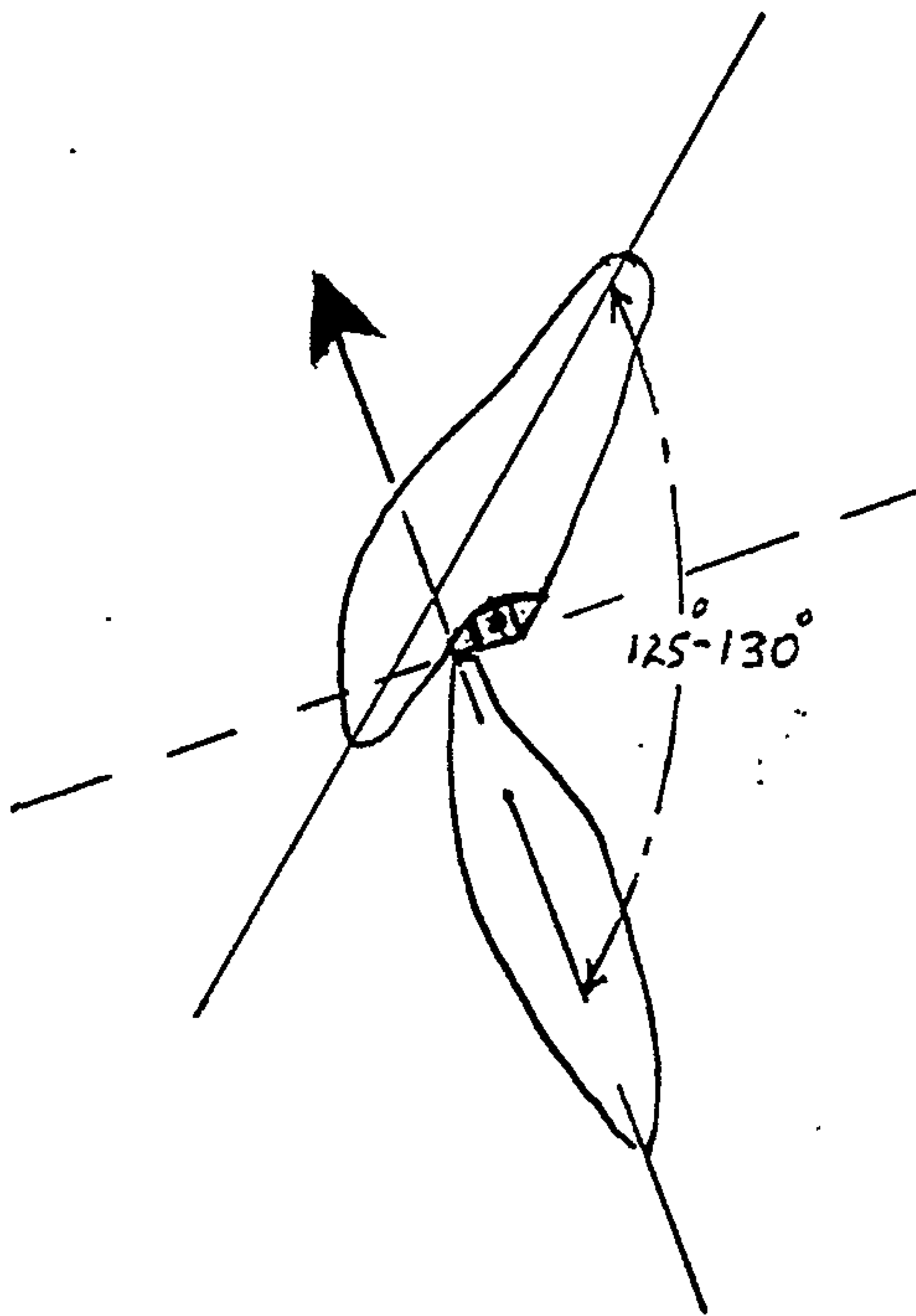


Figure 5.7
Fixed cingulum bite platform
retainer (light cured
composite with 0.020"
spiral wire).

Lower retention

(i) Fixed lower linguals: the lower incisor position is variable and only 30% of treated cases are likely to remain in a satisfactory alignment, out of retention.

The lower incisors are retained with a lingual round wire (0.036") or bonded flexible spiral wire (0.032") is recommended until the late teens or as long as significant condylar growth is still present. (Riedel, 1960; Schudy, 1973; Proffit, 1984: pp459-460).

In deep bite cases where extrusion of the lower premolars has occurred it is desirable to include at least the first premolar in the lower lingual retainer to prevent its likely intrusion. (Reitan, 1969).

(ii) Dohner Splint: or wrap-around retainer consists of a plastic

bar, wire reinforced, along the labial and lingual surfaces of the anterior and buccal teeth. A full arch wrap-around retainer firmly holds each tooth in position.

Advantage:

* it provides greater stability for the lower incisors and its use has been suggested for long term retention of lower incisors that have been proclined, with treatment, from a position of lingual collapse or retroclination often associated with the soft tissue disfunction seen in Class II, Division 1 cases or in patients who are thumbsuckers or have suffered early loss of deciduous teeth. (Godfrey, 1987: tutorial, Sydney University).

Disadvantages:

- * it does not hold corrections of Class II interarch relationships;
- * it needs excellent patient co-operation.

5.3.4 Rotations

The following summary outlines the approach taken to the treatment of rotated teeth. The retention of corrected rotations is vital and needs long term and sometimes individual retention long after removable retainers are finished with.

For Stability:

- (a) if possible correct prior to completion of root formation (Reitan, 1969).
- (b) over-rotation of the crowns - stretching the periodontal and

supracrestal fibres (Reitan, 1969).

(c) Pericision or Circumferential Supracrestal Fibrotomy (C.S.F.)

Pericision is the surgical severing of transeptal and supracrestal gingival fibres that are believed to cause the high incidence of relapse post-retention in rotated teeth.. (Edwards, 1970).

Note: The "papilla split" is an alternative to C.S.F. and acts by sectioning the gingival circumferential fibres. Vertical cuts are made in the gingival papillae, without separating the gingival margin. (Proffit, 1986: p453).

(d) post-retention rotation in lower incisors:

(i) interproximal reduction of lower incisors and premolars is recommended if there is any suspicion of excess mesiodistal width or over-expansion of the intercanine width (Nordeurval et al, 1975; Little et al, 1981). The interproximal preparation of lower incisors aimed at removing rounded surfaces or flattening narrow interproximal contact areas to gain a more stable abutment of the teeth is recommended by Williams (1985). (The keystoneing of lower incisors as suggested by Barrer (1975) has not received support).

(ii) in the lower or upper incisor area where rotations have been corrected, a spring aligner retainer may be placed for 6 months to allow for tissue reorganization and followed by thin F.S.W. bonded retainers for up to 6 years. (Zachrisson, 1984; Proffit, 1985: pp466-467).

5.3.5 Equilibration and Cosmetic Finishing

Equilibration: the emphasis placed on canine protected dentition by

periodontists has led to an abandonment of the belief that equilibration is an integral part of the retention phase. (Roth 1981: part 1). A more conservative approach has been adopted. Equilibration after orthodontic treatment may include removal of obvious (gross) interferences in centric occlusion and removal of cross-tooth and cross-arch deflective interferences. However, it is important not to try and achieve perfect functional balance soon after completion of treatment, only to find it distort after settling in during the immediate post-retention phase. (Roth, 1981; Graber and Swain, 1985: p890).

Cosmetic Finishing: restorations can be recontoured, cusps and incisal edges adjusted and teeth aesthetically recontoured where excessive function or lack of it has produced undesirable contours or morphology, (e.g. bell-shaped maxillary central incisors) or correcting individual variations in tooth size and shape. Pulp and dentine protection with grinding is achieved with abundant water cooling. The interproximal surfaces must be prepared to permit ready interproximal cleaning. (Zachrisson, 1984; Graber and Swain, 1985: p89).