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Comparison of Facial Patterns and Extraction Versus Non-Extraction Treatment Mechanics on Growth During Orthodontic Treatment

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Comparison of Facial Patterns and Extraction Versus Non-Extraction Treatment Mechanics on Growth During Orthodontic Treatment.

by

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DEDICATION

I would like to dedicate this thesis to a very special person, my wife Ana Rosa who brought light into my life with her love, support, constant encouragement and personal sacrifice. Because of that I attribute my success.

To my parents who have taught me the value of high personal, academic and professional goals and have provided me with the support and education by which to attain them.

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VITA

Sergio Francisco Navarro was born on December 12, 1957 in Guadalajara Jalisco, Mexico, to Dr. Pedro Navarro and Dr. Carmen Legoff, being the second of four children. He graduated from Esc. Sec. No. 5 P.V. High School in 1973.

He studied College in Esc. Prep. de Jalisco of Guadalajara University where he obtained the Bachelor Degree in july 1975.

After College, he entered Guadalajara University School of Dentistry in September 1975, and obtained the degree of Doctor in Dental Surgery in July 1979, graduating as a Class Valedictorian.

Upon completing his dental education, Dr. Navarro served his Social Service, which consisted of one year at Guadalajara University School of Dentistry, Endodontics department.

He began Graduate studies in the department of Oral Biology and Postgraduate studies in the Orthodontics department at Loyola University School of Dentistry in Maywood Ill. in July 1981, leading to a Master of Science degree in Oral Biology and a Postgraduate Certificate in Orthodontics.

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CHAPTER I

INTRODUCTION

The problem in the assessment of any malocclusion is to find the causative factors that are involved. The entire plan of treatment and the patient's future dental health depend on the detailed recognition of the existing abnormalities.

An accurate diagnosis still remains as the very venerable corner stone in building function and stability into the correction of malocclusions.

Each malocclusion must, of necessity, be evaluated individually. There are, however, certain guidelines that can and must be utilized as a basis for each specific evaluation.

In the early years of orthodontics we can find that the orthodontist directed his attention only to the teeth and the manner of their interdigitation. Through the process of diagnostic maturation, he has come to realize that the teeth are an integral part of the craniofacial complex and nowadays the orthodontist develops his treatment planning base upon the facial pattern of growth present as well as the dental component, the age, sex, etc. He is able to detect extreme types of mandibular rotation that are occuring during growth. He is now aware that the more extreme the rotation of the mandible during growth the greater the clinical problems that the case presents. Therefore, it is important to predict such rotations and their effect on the profile and on the occlusion prior to beginning orthodontic treatment.

The orthodontist bases his treatment planning on the pattern of facial growth and on the possibility of closing down or opening the bite considering the skeletal component. But, to what degree is the inherited facial pattern important in affecting growth during the period of orthodontic treatment?

The purpose of this investigation is to compare the effect of the patients facial growth patterns and the effect of extraction versus non-extraction treatment mechanics on growth during orthodontic treatment in patients 1 standard deviation dolichofacial and 1 standard deviation brachyfacial. Ricketts dolichofacial-brachyfacial index was used to define the facial growth patterns.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

> The growth and development of the human face provides us a fascinating interplay of form and function. The mosaic of the morphogenetic pattern, as it is influenced by epigenetic and environmental forces, requires an understanding of various factors if we are fully appreciate the phenomenon. An understanding of differential growth per se has a vitally important clinical implication for succesful treatment. Surveys have shown that two thirds of the cases seen for orthodontic therapy involve types of malocclusion in which growth and development play a significant role in the success or failure of mechanotherapy. Equally important in the study of growth, orthodontists must also take into consideration the time. This is of vital importance to the orthodontist who must schedule his therapy so that it coincides with the most favorable growth period. Bjork (1954)

Bjork (1954, 1955, 1966, 1972) has studied facial growth in man with the aid of metallic implants. Up to 1955 analysis of the general growth pattern of the cranium as a whole was carried out with reasonable accuracy in the sagittal and vertical directions from a line joining nasion with sella and employing the center of sella as a fixed landmark, in accordance with widely used radiographic cephalometric procedures. He pointed out that radiographic techniques employed at that time were unable to reveal the mechanism governing the growth of the individual bone elements in the facial skeleton, and that the growth of each separate bone such as the mandible or the maxilla, is bound up with a change in form which to a greater or lesser degree embraces all bone surfaces.

This regeneration is effected by a process of periosteal bone growth and through resorption. Hence it is not possible to use radiographic methods for analysing the growth mechanism of individual bones in humans on the basis of comparisons from the external bone countour (Brash 1924, Weinmann and Sicher 1947, Moore 1949, Gans and Sarnat 1951, Baer 1954).

For that reason and in order to facilitate radiographic studies of the growth mechanism of the maxilla and mandible in man, Bjork introduced a new method based on the use of metallic implants. These markers remain in position serving as reference points with the aid of which the radiographs may be orientated so that the growth pattern of each jaw may be analysed.

The sample comprised normal, healthy children with different types of malocclusions from slight rotation of individual teeth to severe disharmony. All children were summoned for annual observation on the date of enrollment. Vitallium pins were used as radiographic markers at the beginning of his experiment. Application of the pins in the jaw bone was effected with a pencil shaped instrument which hammered the pins under facial anesthesia, a short distance into the bone, through the periousteum. The indicators were located in the right hand side of each jaw, the side close to the film and X ray exposures were made with the patient's head orientated in a cephalometer under controlled conditions.

By that implant study Bjork has shown that growth in the length of the mandible was found to occur chiefly at the condyles. On the anterior aspect of the chin there was no appreciable growth and in most cases this area was unaffected. In a few cases, however, resorption or apposition on the anterior surface of the chin was observed.

Thickening of the symphysis occured by periosteal growth on the posterior surface. On the lower border there was also apposition which contributes to the increase in height of the symphysis. As the endosteal resorption in this area does not occur at the same rate as the apposition on the outer surface a pronounced apposition will be reflected in an increase in the thickness of the cortical substance.

The periosteal apposition below the symphysis is extended posteriorly, to the anterior part of the lower border of the mandible, and when it is marked, this area is characteristically rounded. Below the angle of the mandible there is normally resorption which may be very pronounced, but in some cases, there is, instead apposition on the lower border at the angle of the jaw. These appositional and resorptive processes result in an individual shaping of the lower border of the mandible, which characterizes the type of growth the individual exhibits. The shape of the basal arch and the mandibular angle depend on the direction of growth of the condyles. The direction of condylar growth in relation to the posterior tangent to the ramus of the first radiograph was found to average 6 degrees, which means that the average direction of growth at the condyles was slightly forward in relation to the posterior tangent to the ramus and not occuring backwards as it is commonly imagined. Related to the tangent to the lower border of the mandible, the mean direction of growth was 123 degrees which was less than the mean jaw angle at 129 degrees that was measured at the first radiographs.

It was this evidence that the mandibular base was generally curved with growth, which was accompanied by a reduction in the gonial angle. The decrease in the gonial angle was, however, generally not pronounced, as it was compensated for by resorptive modeling below the angulus of the madible and periosteal growth below the symphysis.

The direction of the condylar growth was not necessarily linear and in many cases, there was a distinct curvature. The individual variation in the condylar direction of growth was great and fairly symmetrically distributed. In some cases it took place in a vertical direction which considerably increased the curvature of the mandibular base, the gonial angle decreased, the compensatory resorption beneath the angulus region was extremely great and the apposition under the symphysis seemed to be greatest. In other cases it was directed sagittally-posteriorly where the mandibular base was flattened, the gonial angle was increased, the compensatory resorption beneath the angulus was moderate, or an apposition could even occur, and the apposition under the symphysis was less. The lower border of the mandible therefore is unsuitable as a reference line, so he suggested that radiographs be superimposed at the tip of the chin and the three following internal structures: inner cortical structure of the inferior border of the symphysis, detailed structures from the mandibular canal, and the lower contour of the third molar germ from the time that mineralization of crown is visible until the roots begin to form. He found out that from the onset of mineralization of the crown to the time when the roots start to develop the lower border of the germ is apparently stationary.

As far as maxillary growth pattern Bjork pointed out that growth in length is sutural toward the palatine bone and is accompanied by periosteal apposition at the maxillary body. The ventral displacement is accompanied by a posterior lowering of the maxillary corpus along with the growth between palatine bone and the pterygoid processes. Growth in length of the maxilla has not been found to occur on the anterior surface of the maxilla, apart from the alveolar process. The nasal floor is lowered through resorption combined with periosteal apposition of the hard palate, and the anterior nasal spine is also lowered through resorption and remodeling processes. On the floor of the orbits this process occurs in the opposite direction, with apposition on the upper surface and resorption on the lower. Again individual variations are found to be in both directions so that in some cases the vertical growth can have a forward or backward component.

Bjork (1969) published "Prediction of mandibular growth rotation". In this paper Bjork regards the mandible from a stand point of growth as a more or less unconstrained bone, for it may change its inclination in several ways. A critical factor in this respect is the site of the center of rotation, which may be located at the posterior or anterior ends of the bone or somewhere in between. The center therefore may not necessarily lie at the temporomandibular joints, as is usually imagined. Bjork points that we may have a forward rotation of the madible which may occur in three different ways, and a backward rotation of the mandible which is less frequent and may occur in two different ways.

Forward rotation (brachyfacial growth pattern), Type I: in this type there is a forward rotation about centers in the joints which give rise to a deep-bite, in which the lower dental arch is pressed into the upper, resulting in underdevelopment of the lower anterior face height. The cause may be occlusal imbalance due to loss of teeth or powerful muscular pressure of the masticatory muscles. This lowering of the bite may occur at any age.

Type II: forward rotation of the mandible about a center located at the incisal edges of the lower anterior teeth.This is due to the combination of marked development of the posterior face height and normal increase in the anterior height. The posterior point of the mandible then rotates away from the maxilla. The increase in the posterior face height has two components. The first is the lowering of the middle cranial fossa in relation to the anterior one, as the cranial base elongates, the condylar fossa then being lowered. The second component is the increase in the height of the ramus, which is pronounced in this case with vertical growth of the mandibular condyles being great. With the vertical direction of the condylar growth the mandible is lowered more than it is carried forward. Because of the muscular and ligamentous attachments, the lowering takes place as a forward rotation in relation to the maxilla with the center at the incisal edges of the lower incisors.

Type III: in anomalous occlusion of the anterior teeth, the forward rotation of the mandible with growth changes its character. In the case of a large maxillary overjet or mandibular overjet, the center of rotation no longer lies at the incisors but is displaced backward in the dental arch, to the level of the premolars. In this type of rotation the lower anterior face height becomes underdeveloped when the posterior face height increased, the dental arches are pressed into each other and basal deep-bite develops.

Backward rotation (dolichofacial growth pattern), Type I: here the center of the backward rotation lies in the temporomandibular joint. As a result we have an increase to the lower anterior face height. This is the case also when the vertical dimension is increased by orthodontic treatment, by a change in intercuspation or by a "bite-raising" appliance. This can also occur in connection with growth of the cranial base as in the case of flattening of the cranial base, raising of the middle cranial fossa and consequent raising of the mandible posteriorly. It can also occur in other cases,such as in incomplete development in height of the middle cranial fossa.

Type II: backward rotation here occurs about a center situated at the most distal occluding molars. This occurs in connection with growth in the sagittal-posterior direction at the condyles. The explanation remains to be proven according to Bjork but it is evident that muscular factors play an important role. With the position of the center of rotation at the molars, the symphysis is swung backward and the chin is drawn back below the face. Basal open-bite may develop. This type of backward rotation has been found to be characteristic also in cases of various forms of condylar hypoplasia. It is important to detect therefore extreme types of mandibular rotation occuring during growth. Seven structural signs of extreme growth rotation must be considered in relation to the condylar growth direction. Not all of them will be found in a particular individual but the greater the number that are present the more realiable the prediction will be: inclination of the condylar head; curvature of mandibular canal; shape of lower border of the mandible; inclination of the symphysis; interincisal angle; interpremolar or intermolar angles and the anterior lower face height.

Creekmore (1967) following the work of Schudy, and Ricketts further developed the concept of vertical growth of the maxilla and its detrimental effects on high angle cases. He took a variety of male and female patients in their growing stages with high mandibular plane angles, and children with average mandibular plane angles. Showing that high angle cases are more susceptible to vertical development than average faces, the high angle cases tended to become even higher unless he attached high pull headgear to these children which pulled up and back on the maxilla in the

maxillary molar region to inhibit their growth in the vertical dimension.

Schudy (1964, 1965, 1966) stated that "the rotation of the mandible resulting from an inharomy between vertical growth and anteroposterior or horizontal growth has important implications in orthodontic treatment". It is well recognized that the mandible rotates both clockwise and counterclockwise as the growth processes unfold. This is particularly true during the pubertal growth acceleration. This rotation indeed affects orthodontic treatment. Clockwise rotation of the mandible is a result of more posterior vertical maxillary growth than condylar growth, the point of rotation being the condyles. When vertical growth exceeds horizontal growth, (condylar growth) pogonion cannot keep pace with the forward growth of the upper face and the mandibular plane must become steeper. Obviously this condition would not help reduce the ANB angle (facial convexity), and it would not aid in correction of a Class II molar relation. However, it would tend to help correct the vertical overbite of the incisors. Many such growth patterns actually do reduce the vertical overbite, perhaps the majority do not. This is ample evidence to show that a predominance of vertical growth of the face facilitates the correction and retention of vertical overbite. Counterclockwise rotation of the mandible, on the other hand, is a result of more condylar growth than combined maxillary vertical growth. This type of rotation is nearly always accompanied by a forward movement of pogonion and an increase in the facial angle. The point of rotation is the most distal mandibular molar in occlusal contact. This flattening of the mandibular plane tends to increase the vertical overbite and renders vertical overbite correction and retention more difficult.

Vertical growth at the mandibular condyles produces a forward component of the chin, not a downward, nor a downward and forward component. It is only when the vertical increments of facial growth begin to assert their influence on condylar growth through occlusal contact that a downward and forward direction of the chin is produced. Thus, it can be stated that condylar growth is pitted against the combined vertical elements of growth. The final vector of growth of the chin is a resultant of the struggle between horizontal growth and vertical growth, in other words, between condylar growth and vertical growth of molars. Those vertical elements are: 1- growth at nasion and in the corpus of the maxilla which produces an increase in the distance from nasion to anterior nasal spine and causes the maxillary molars and posterior nasal spine to move away from the sella-nasion plane; 2- growth of the maxillary posterior alveolar processes causing the molar teeth to move away from the palatal plane; and 3- growth at the mandibular posterior alveolar processes causing the molar to move occlusally. The vertical growth of the anterior alveolar processes does not seem to have an appreciable effect on facial height. It is merely expressed in varying degrees of overbite. The dorsal migration of the glenoid fossa is a very real factor in many cases and tends to cancel out the growth of the condyles. The size of the gonion angle, has an important influence upon the number of degrees of resultant counterclockwise rotation. The smaller the gonion angle, the greater the rotation produced for each mm of forward movement of pogonion. The correct gonion angle helps to compensate for inharmonies of facial proportions. The degree of facial divergence (measured by the angle sella-nasion mandibular plane) also has a significant bearing on mandibular rotation. The larger the sella-nasion mandibular plane angle, the more the mandible tends to become steeper and the more the chin moves backward. The smaller the angle, the greater the tendency of the mandible to become flatter and the chin to grow forward.

Schudy stated that the molar height not only controls the vertical position of the chin, but also to a considerable extent the anteroposterior position. This principle has a very definite application to the treatment of Class II malocclusions. Obviously too much vertical growth of the molar teeth would prevent the forward positioning of the chin and thereby render Class II correction very difficult.

All investigators are agreed that orthodontic treatment does not stimulate growth at the mandibular condyles. If this is true we have only the vertical increments that we may possibly change to serve our purposes. If we can inhibit vertical growth it will have the same effect horizontally as stimulating growth at the condyles. We are quite certain that we can stimulate the vertical growth of the alveolar processes, and we think we can inhibit this growth. If vertical growth is deficient we try to stimulate it, and if vertical growth is excessive we try to inhibit it. It has been said that the growth of the mandible is the principal determining factor of facial morphology. Schudy stated "however, it is not the growth of the mandible per se which primarly determines its posture but instead the vertical growth of the maxilla".

Schudy was the first who pointed out that orthodontists must come to consider, understand and appreciate the value of vertical growth as it relates to anteroposterior growth. While it is true that growth of the dentofacial complex does not proceed strictly vertically and anteroposteriorly perhaps it can be best understood when simplified by considering it in this manner.

Credit shoud be given also to Downs (1956) for a recognition of the importance of the vertical dimensions of the face. The "y" axis angle is a general expression of the relationship of facial height to facial depth. However, this angle merely tells us where the chin is situated with relation to the cranium but does not tell us by what route it travelled to arrive there, as a result an increase of this angle may accompany normal growth as well as abnormal growth depending upon the case. The same is true for the angle Ba-Na and the facial axis of Ricketts.

Charles Tweed (1954) also deserves credit for calling attention to the importance of the inclination of the mandibular plane angle.

Wylie and Johnson (1952) also made a study dealing specifically with dysplasia in the vertical dimension, being concerned primarly with the anterior facial region and Wylie (1946) made a comparison study between ramus height, dental height, and overbite. Nevertheless others completely ignored the vertical dimension like Moyers (1957) who believed that the clinician biggest problem is the anteroposterior discrepancies and Krogman (1957) also considered the horizontal dimension as the most important one.

Poulton (1967) stated that extraoral force application should be selected according to the particular requirement of each case, taking into account the malocclusion and the facial type. He showed many cases that had a poor facial esthetic result because of the use of cervical headgear which extruded the maxillary molars and increased the mandibular plane, thus elongating the patients facial esthetics. One method of avoiding this unwanted effect is to use a highpull headgear and facebow to the maxillary molar. The results of his patients with a highpull headgear showed a retraction and intrusion of the maxillary molars, along with an improvement of facial esthetics.

Isaacson (1977) stated that "in order for translatory mandibular growth to occur, vertical growth at the condyles (and fossa) has to exactly equal the sum of the vertical growth at the maxillary sutures and the maxillary and mandibular alveolar processes". This holds true irrespective of the anteroposterior components of growth present. When disproportions of vertical condylar or alveolar growth occur, the disproportions create a rotation. The center of rotation is anteroposteriorly located by the proportionality between vertical condylar growth and the sum of the vertical growth of the maxillary sutures and the maxillary and mandibular alveolar processes.

Odegaard (1970) studies of mandibular rotation with the aid of metallic implants. He stated that the degree of rotation is related to the direction of condylar growth and the magnitude of mean condylar growth.

Ricketts (1979) stated that, for many years orthodontists have lived with the concept of upward/backward growth of the condyle as the norm in mandibular development. The supposedly stable mandibular plane and points on the symphysis were used as superimpositional references to delineate an upward and slightly backward eruption of the teeth.

Early research by Hunter (1955) using the pig mandible and a wire circumferential to the ramus, indicated that there was resorption on the anterior portion of the ramus and apposition on the posterior aspect of the ramus. Later Brash (1956), repeating Hunter's investigations and, using the same type of experimental animal, came to a similar conclusion. Brodie (1951) referred to cartilaginous proliferation on the superior-posterior aspect of the condyles giving the mandible the same downward and forward growth exhibited by the maxilla. Bjork (1955) demonstrated that the mandibular plane was resorbing during normal growth (lower border of mandible),in many cases the condyles were not growing upward and backward but were proceeding to grow in either a straight upward or an upward and forward direction. Moffet (1965) at the University of Washinghton using tetracycline staining techniques on human mandibles, showed that there is a preponderance of appositional cartilaginous growth on the upward/forward portion of the condyle.

Ricketts (1979) concluded that the lower dentition normally erupts in an upward and forward direction. The mandibular plane is not a reliable reference point for long term evaluation of change. In all but the dolichofacial growth patterns, the condyles grow in a straight upward or an upward and forward direction. Protuberance menti and internal mandibular reference points are our most sound areas of superimpositional evaluation.

CHAPTER III

MATERIALS AND METHODS

A random selection of 60 finished cases with good initial and final lateral cephalometric roentgenograms was made from the retention files of the orthodontic department of Loyola University School of Dentistry.

The age range of those selected cases was from 12 to 15 years old (in order to have evidence of growth). The racial extraction of all patients considered in this study was caucasian.

All the selected cases were males. 30 being greater than 1 standard deviation dolichofacial and 30 being greater than 1 standard deviation brachyfacial according to the Ricketts facial index. Each group was subdevided in 15 cases treated with extraction mechanics and 15 cases treated with non extraction mechanics.

The cases selected had a range of lenght of orthodontic treatment from 24 to 30 months.

A total of 120 lateral headfilms (initial and final) were used.

These random sample was representative of the Loyola Orthodontic patients.

The roentgenographic technique employed was that described by Broadbent in 1931, in that the relation between the source of radiation, subject and film was standardized. The lateral headfilms of the patients, with their teeth in habitual occlusion, were traced on acetate overlays. Nine landmarks were located and 4 angles were drawn and measured on these tracings. Only headplates with clearly defined landmarks were considered. If double images occured, such as frequently occurs at the posterior border of the ramus, the mean difference between the two images was marked and used.

All craniometric points and constructed points were located and remeasured in 10 randomly selected cases to eliminate and judge the element of human error. All linear measurements were recorded to the nearest 0.25 mm and angular measurements to the nearest 0.25 degrees.

Landmarks and Constructed Points

Points selected by inspection.

Nasion (Na): a point at the anterior limit of the frontonasal suture.

Anterior Nasal Spine (ANS): tip of the anterior nasal spine.

Pogonion (Pg): the most anterior point of the anterior border of the mandibular symphysis.

Protuberance Menti (Pm): point selected at the anterior border of the symphysis between point B and pogonion where the curvature changes from concave to convex.

Menton (Me): a point located at the lowest point on the midline curve of the symphysis.

Orbitale (Or): a point located at the lowest point on the external border of the orbital cavity, tangent to the Frankfort plane. If double images occured, the mean difference between the two images was marked and used.

Pterygoid Point (Pt): the intersection of the inferior border of the foramen rotundum with posterior wall of pterygo-maxillary fossa as viewed in lateral head film.

Porion (Po): a point located at the most superior point of the external auditory meatus, tangent to the Frankfort plane. Left structure was selected; if double images occured, the mean difference between the two images was marked and used.

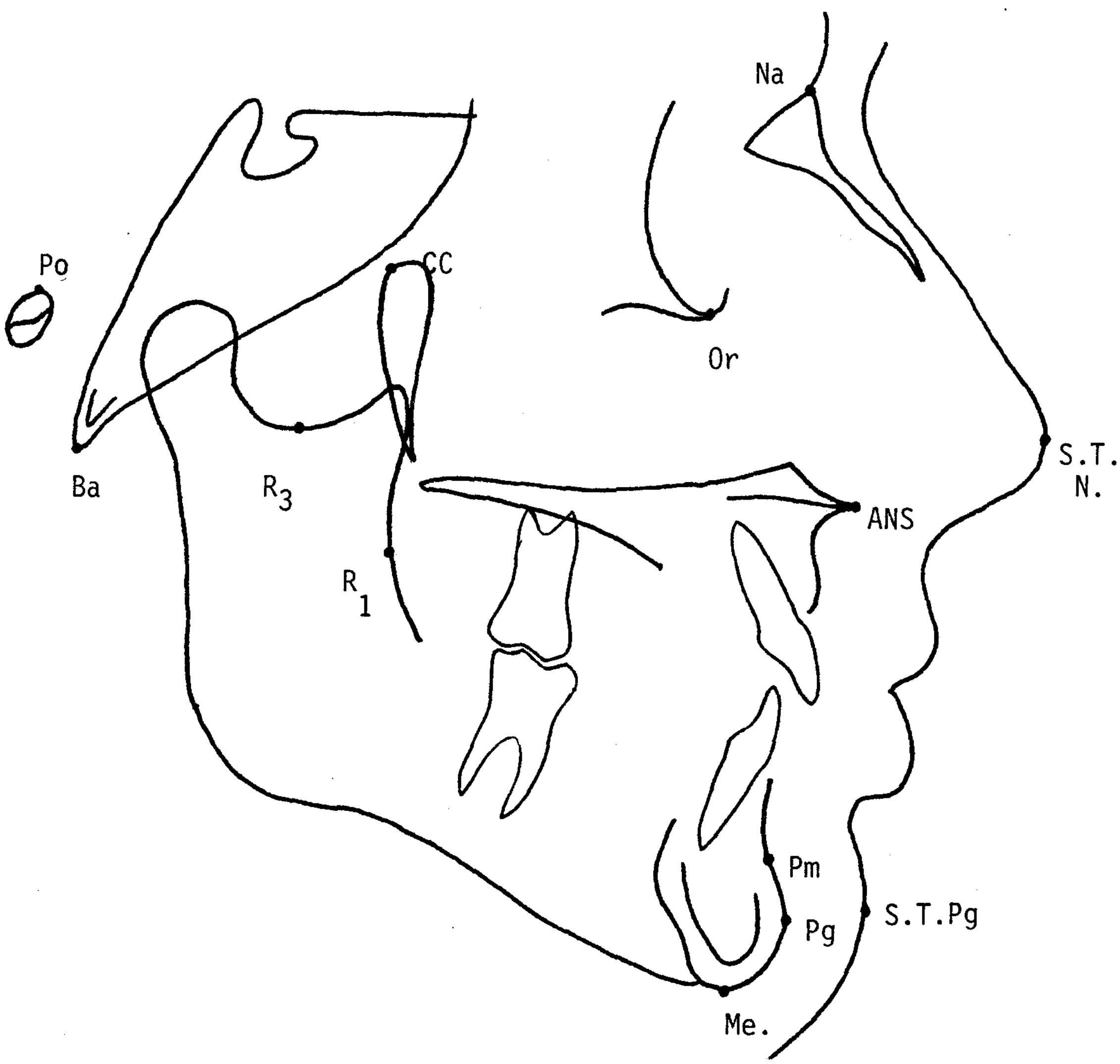
Basion (Ba): the most inferior point on the occipital bone where the exocranial and intracranial external cortical plates of this bone meet.

Point R1: the deepest point on the curve of the anterior border of the ramus. Left ramus was used;if double images occured, the mean difference between the two images was marked and used.

Point R3: a point located at the center and most inferior aspect of the sigmoid notch of the ramus of the mandible. Left ramus was used; if double images occured, the mean difference between the two images was marked and used.

FIGURE 1

Points selected by Inspection.



Lines and Planes

Frankfort Horizontal: from porion to orbitale.

Basion-Nasion plane.

Facial plane: nasion-pogonion.

Facial Axis: pterygoid-gnathion.

Pterygoid Vertical: Pterygoid vertical perpendicular to Frankfort horizontal thru distal of pterygopalatine fossa.

Mandibular Plane: a line from menton tangent to the lower border of the mandible.

Condylar Axis: Xi point to Dc point.

Corpus Axis: Xi point to protuberance menti.

Esthetic plane: tip of nose to soft tissue pogonion.

Points defined by planes:

Point CF (center of face): the intersection of pterygoid vertical with Frankfort horizontal.

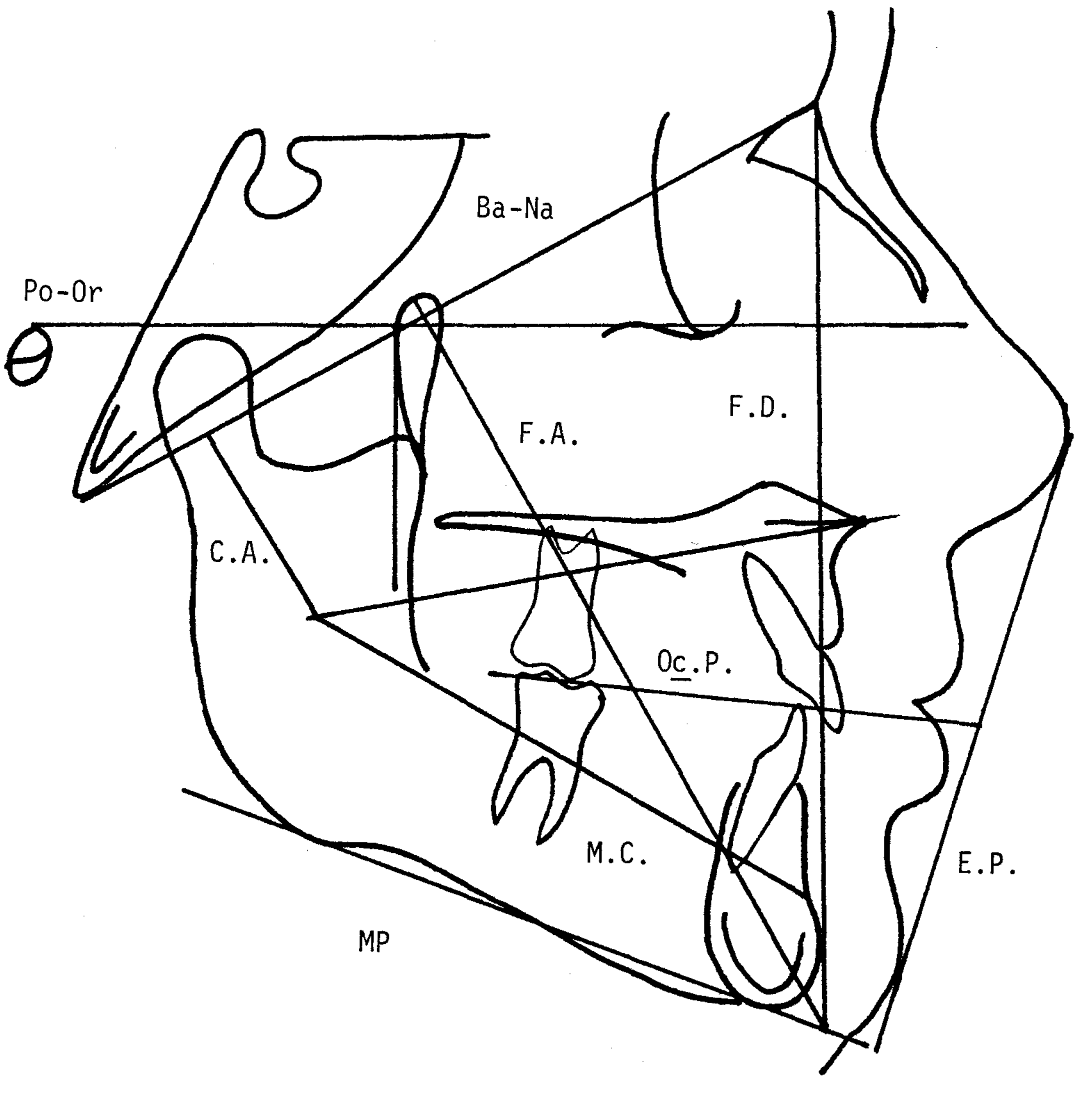
Point CC (center of cranium): the intersection of basion-nasion plane and facial axis.

Point Dc: a point selected in the center of the neck of the condyle on the basion-nasion plane.

Gnathion (Gn): a point at the intersection of the facial plane and mandibular plane.

FIGURE 2

Planes used in this Research.



Angular Measurements

All angles measured are the result of the plotting of three points on the intersection of two planes. Every plane mentioned in this investigation is defined by two points.

Four angular relations were considered and they were as follows:

Mandibular plane to Frankfort horizontal.

Lower face height: Xi to Pm and ANS.

Mandibular Arc: Xi to Dc and Pm.

Facial Axis to Ba-Na plane.

Criteria used during the selection of points: in order to select certain specific points we followed these guidelines: for tracing the PtV line we used the left side but when two images were present we took the mean difference between them; the same holds true for the selection of the points located on the posterior and anterior borders of the mandibular ramus and for the lower border of the mandible. For the upper molar the left side one was traced.

It is understood that CC point can be selected on the 11 o'clock point of the inverted tear drop represented by the pterygopalatine fossa. For the purpose of reducing human error during the selection of this point it was recommended to use a template containing circles of different sizes each circle containing a vertical and a horizontal axis which was used to orientate the template taking as reference point to the Frankfort plane. The template was marked in the posterio-superior quadrant at 60 degrees from the horizontal line in such a way that it would be the equivalent of the 11 o'clock mark for the proper selection of the CC point. The circle that best fitted the superior image of the inverted tear drop was the one used and the 11 o'clock mark (60 degrees) was transferred to the tracing.

FIGURE 4

Showing how CC point was selected by using a circle template.

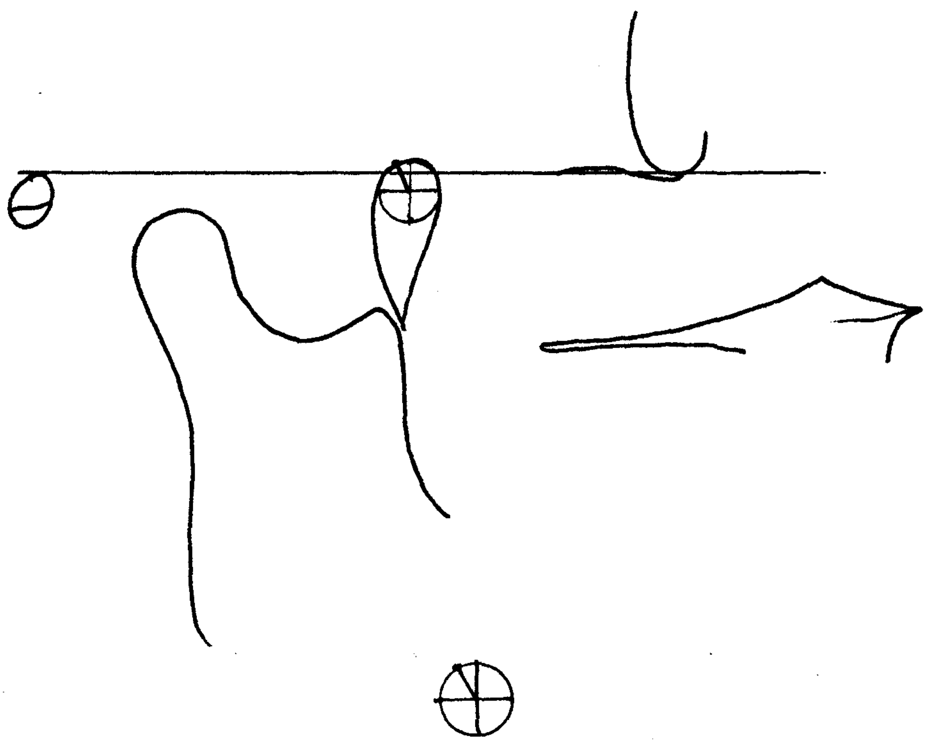
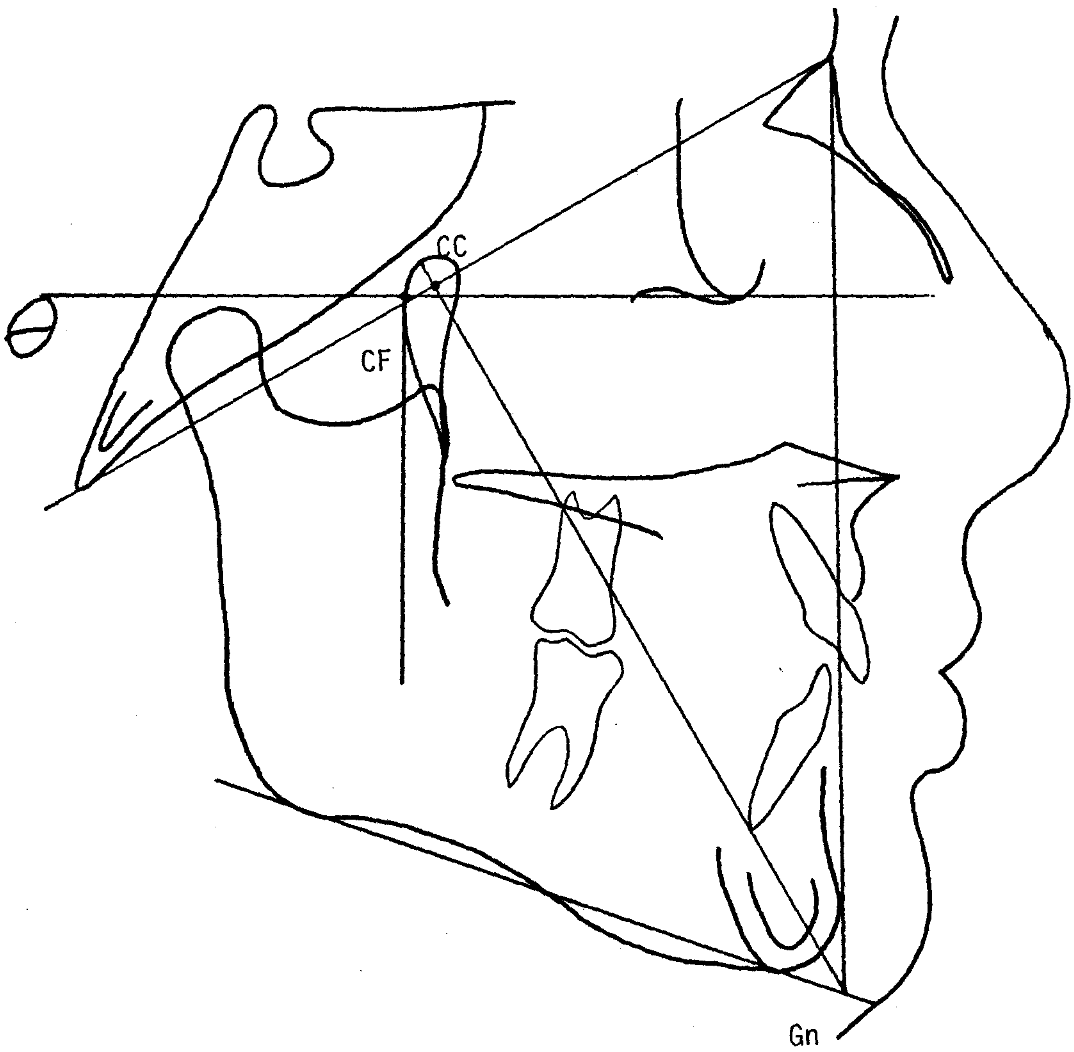


FIGURE 3

Points defined by Planes.



CHAPTER IV

FINDINGS

Table 1 presents the mean and standard deviation for facial axis value and molar movement, and the correlation values for each of the four groups studied (dolichofacial treated with extraction mechanics, dolichofacial treated with non extraction mechanics, brachyfacial treated with extraction mechanics, brachyfacial treated with non extraction mechanics). It should be noted that all the values shown in the facial axis value column were negative except for the brachyfacial group treated with extraction mechanics.

In the table 2 the statistical analysis of the t comparisons are presented. The student t test was used in comparing molar movement observed in the dolichofacial group treated with extraction mechanics against the brachyfacial group treated with extraction mechanics; the same holds true for the dolichofacial group treated with non extraction mechanics against the brachyfacial group treated with non extraction mechanics; the dolichofacial group treated with non extraction mechanics against the dolichofacial group treated with extraction mechanics; and the brachyfacial group treated with non extraction mechanics against the brachyfacial group treated with extraction mechanics. It can be observed that a statistically significant difference was found only in the brachyfacial group treated with non extraction mechanics against the brachyfacial group treated with extraction mechanics and the dolichofacial group treated with non extraction mechanics against the dolichofacial group treated with extraction mechanics.

Chi square statistics were used to analyse the frequency of opening and closing of the facial axis in the experimental groups and the results are presented in the table 3. It should be noted that no statistically significant differences could be demonstrated between the groups.

Regression and correlation statistics were applied to determine if there was significant mathematical relationship between degree of opening or closing of facial axis and the amount of molar movement. The only significant correlations were found in the dolichofacial group treated with non extraction mechanics and the brachyfacial group treated with non extraction mechanics. These results are presented in Figure 5 for the dolichofacial group non-extraction and in Figure 6 for the brachyfacial group non extraction. In each plot the regression equation is presented.

TABLE 1

Summary of Measurements for the Different Groups

Mean and Standard Deviation of Facial Axis and Molar Movement and Correlation Values found in the different Experimental Groups

Classification	N	Facial Axis Value* $\bar{x} \pm 1$ S.D.	Molar Movement** $\bar{x} \pm 1$ S.D.	Correlation Value
Brachyfacial with no Extractions	15	-0.12 ± 1.25	1.27 ± 3.05	0.73
Brachyfacial with Extractions	15	0.59 ± 1.72	4.43 ± 2.27	0.30
Dolichofacial with no Extractions	15	-0.82 ± 1.94	1.03 ± 2.74	0.78
Dolichofacial with Extractions	15	-0.02 ± 1.55	4.50 ± 1.67	0.40

* (-) = Opened.
(+) = Closed.

** Positive values indicate forward movement.

TABLE 2

t Comparisons of Molar Movement in the Different Groups

Comparison Groups	t	P*
Brachyfacial Non-Extraction vs Brachyfacial with Extraction	-3.23	0.003*
Dolichofacial Non-Extraction vs Dolichofacial with Extraction	-4.19	0.0003*
Brachyfacial Non-Extraction vs Dolichofacial Non-Extraction	0.22	0.83
Brachyfacial Extraction vs Dolichofacial Extraction	-0.09	0.93

* = statistically significant.

TABLE 3

Chi Square Comparison

Frequency of Opening and Closing of the Facial Axis of Groups

Groups	X^2	P
Brachyfacial Non-Extraction vs Brachyfacial Extraction	0.54	0.46
Dolichofacial Non-Extraction vs Dolichofacial Extraction	0.13	0.72
Brachyfacial Non-Extraction vs Dolichofacial Non-Extraction	0.00	1.00
Brachyfacial Extraction vs Dolichofacial Extraction	0.14	0.71

FIGURE 6

Correlation plot for the Brachyfacial Non Extraction Group.

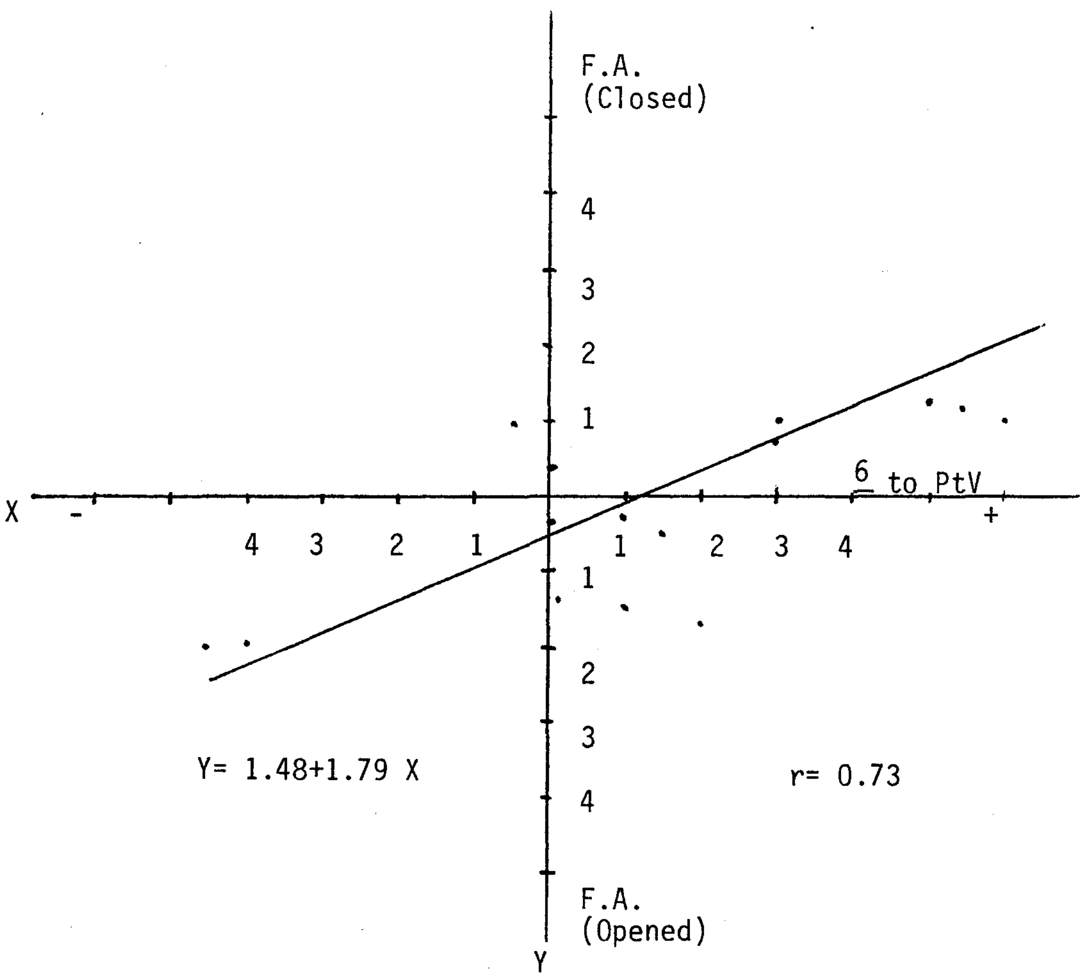
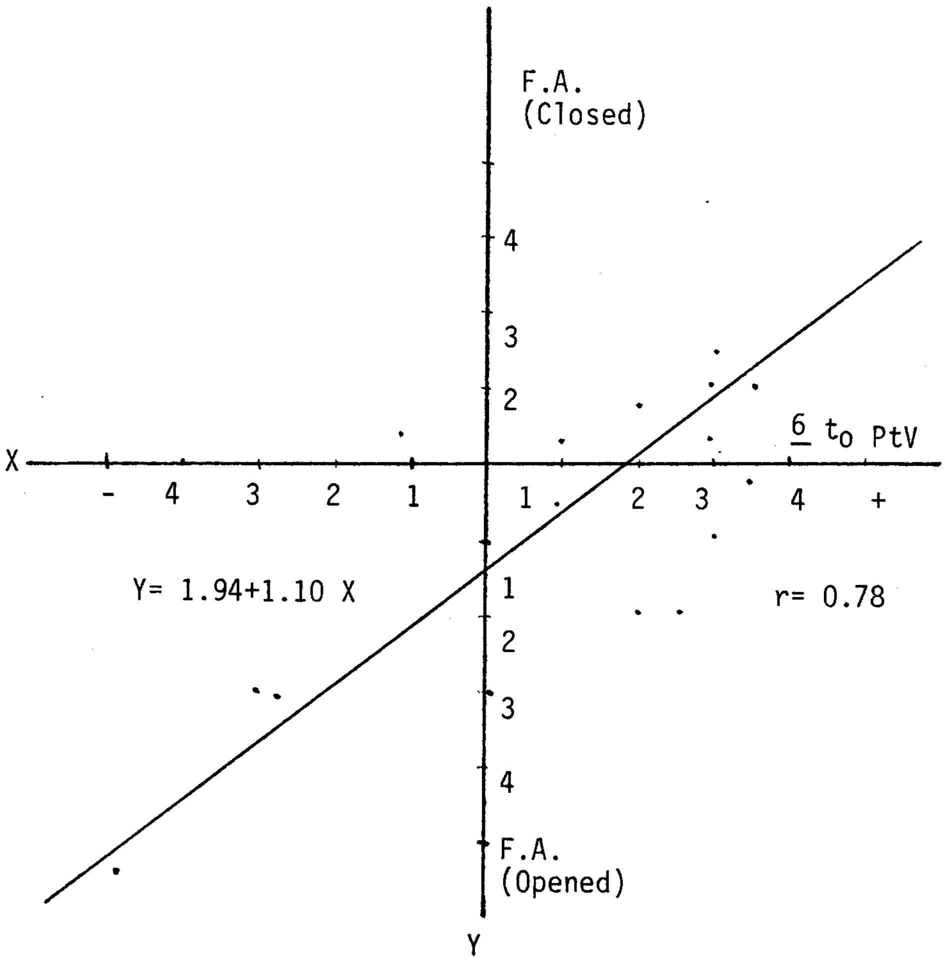


FIGURE 5

Correlation plot for the Dolichofacial Non Extraction Group.



CHAPTER V

DISCUSSION

In assessing the information from this study the observation can be made that our treatment mechanics are indeed helping us in the achievement of our objectives during the treatment of the various facial patterns and malocclusions that we see in our practice every day. In a dolichofacial pattern of growth patient whose growth is characterized by a clockwise rotating mandible, in whom the possibility of opening the bite due to poor mechanics is tremendously great, our results confirm that our mechanics applied are working in our favor by avoiding an unwanted opening of the bite that would make the condition more severe. The same holds true for the brachyfacial pattern of growth patients characterized by a counterclockwise rotating mandibles in which the possibility of creating a severe close bite is greater due to the fact that our mechanics are in reality working against the inherited growth pattern of that particular type of patient.

Using chi square statistics no statistically significant differences could be demonstrated between all groups when the frequency of opening or closing of the facial axis was analysed.

The student t test statistics were applied to find out if there was a statistically significant relationship between the groups studied when considering the forward or backward molar movement. A statistically significant difference was found in the brachyfacial group treated with non extraction mechanics against the brachyfacial group treated with extraction mechanics. Also, the dolichofacial group treated with non extraction mechanics differed from the same group treated with extraction mechanics. In other words, we found a statistically significant difference in the same pattern of growth groups that were treated with different treatement mechanics (basically extraction versus non extraction). No statistically significant relationship could be demonstrated between the different growth patterns treated with the same treatment mechanics.

Therefore, it was demonstrated that the value of appropiate treatment mechanics for each facial type is more important in determining growth changes in the facial axis than is the existing facial growth pattern.

Also, the extraction versus non extraction choice produces significant different changes in the facial axis during treatment when combined with appropiate mechanics.

That is to say that the facial axis tends to open with distalization of the maxillary molars regardless of facial type.

Extraction treatment does not have a significant effect on closing the facial axis (dolichofacial or brachyfacial) and showed very low correlation. This may be explained by several things;

1. Reducing amount of high pull headgear wear, therefore, less heavy vectorial force to maxilla and maxillary molar in dolichofacials which would have helped closing of bite.

2. Use of more class II elastics in brachyfacials and more bite opening mechanics which extrude upper and lower molars and open the facial axis.

3. Resorting to class II elastics in dolichofacial late in treatment (when headgear cooperation is poor).

It should be noted that during the realization of this research lower molar movement was not taken into consideration.

It can be noted by studying figures 5 and 6 that appropriate use of orthodontic mechanics held the facial axis to a range of 0.75 to 1 degrees in 2/3 of the patients treated.

Also it can be observed that extreme change in the facial axis can occur when an inappropiate treatment plan for that face was used.

The information provided by this research has important clinical implications. For example, when considering extraction mechanics in brachyfacials a closing of the facial axis and therefore a deepening of the bite could be expected and it was showed that in 50% of the cases a opening of the facial axis occurred due puerly to the applied mechanics.

In dolichofacial patients treated with non extraction mechanics as it can be observed in figure 5 extreme opening of the facial axis was observed when the applied mechanics had driven the molar to far distally

Bjork (1955) regarded the mandible from a stand point of growth as essentially an unconstrained bone and that it may change its inclination in different ways, and he stated that the mandible can rotate forward or backward depending upon the location of its center of rotation.

Schudy (1965), Issacson (1977), and Odegard (1970) among others, also pointed out that the rotation of the mandible from an inharmony between vertical growth and anteroposterior or horizontal growth has important implications in orthodontic treatment.

Today the orthodontist is aware that the more extreme the rotation of the mandible during growth the greater the clinical problems that he will face.

Whenever the occlusal-mandibular plane angle is markedly low we have deficient alveolar height in comparison to the ramus height with a resultant counterclockwise rotation of the mandible, posterior facial height exceeding the anterior face height,anteroposterior growth exceeding vertical growth, in other words, we are dealing with a hypodivergent case, then, the overbite tends to be excessive. The opening of the bite in that case is difficult and when corrected (is usually corrected by depression of the anterior teeth as the molars are disinclined to move occlusally), will tend to return.

Schudy (1965) gives an explanation to that, he says that when the SN-MP angle is low and the O-M angle is low we can assume that there has been ample vertical growth of the rami and condyles, there has been no mechanical obstruction to the vertical growth of the alveolar process due to the force of occlusion we may further assume that the mandibular molars have already moved vertically to their full potential since they are already positioned high in the mandible when related to the mandibular incisors, and, therefore, we cannot induce them to move occlusally, in all those cases when the O-M angle is low molars should be moved occlusally as much as possible and the occlusal plane should be raised on the posterior end as much as possible. Thus, class II elastics are desirable. The mandibular incisors should not be markedly depressed if it can be avoided. In most instances maxillary incisors should be depressed as much as possible as they are often elongated due to large existing interincisal angle on those cases. Those cases should be treated without the extraction of teeth if at all possible. We must always keep in mind that molar teeth will stubornly resist movement occlusally and the retention will be very difficult and should be extended a long period.

On the other hand, whenever the O-M angle is high, the tendency is toward an open bite and should not be difficult to open and to remain corrected.That happens because when the O-M angle is high then the mandibular molars are positioned relatively low in the mandible, may not have reached their potential height and may be moved easily occlusally to aid in the bite opening. Beware however not to create an open bite with the applied mechanics because it is very easy on those cases during treatment to face such situation. However, the majority of those cases have deficient ramus height in comparison to the posterior alveolar height, with a resultant clockwise rotation of the mandible. Anterior face height is excessive when compared with the posterior facial height, vertical growth exceeding the antero-posterior growth, tending to reduce the vertical overbite, in other words, we are dealing with a hyperdivergent case which usually presents acute open-bite problems. The correction of the open bite on those cases will be difficult to retain.

On those cases with high O-M angle, tipping the occlusal plane appreciably upward on the posterior end is undesirable because it will tend, due to the extrusion of the molars, to open the bite more, so in our treatment planning we must be aware no to reduce that angle.

For this reasons we must not move the mandibular molars occlusally by applying class II elastics or by any other means. We must also try not to increase the S-N mandibular plane angle, and this is another reason for not applying class II elastics because the elevation of the lower molar not only open the bite but also causes point B and pogonion to go downward and backward increasing the ANB angle and making the class II problem more severe or even relapsing a corrected class II condition.

Schudy (1955) specifies that when the SN-MP angle is above 45 degrees the use of class II elastics is disastrous and when the SN-MP angle is 40 degrees must be used sparingly. We must not also move the maxillary molars distally any appreciable amount because this will tend to open the bite due to the extrusion of the upper molars, if we must not extract teeth on those cases, and usually the extraction of 2 teeth in the maxillary arch will facilitate almost all aspects of the treatment problem, we must achieve any distal movement of the maxillary teeth with extraoral forces and not class II elastics and preferably with high pull or combination headgear which prevents the eruption of the upper molars, combined with palatal bar which due to the tongue pressure tends to intrude the upper molars. The high pull headgear with its upward and backward directional force inhibits also the downward growth of the maxillary alveolar process and possibly the body of the maxilla in growing patients. On those growing patients also we must be aware that due to the clockwise rotation, pogonion can not keep pace with the forward growth of the upper face and as the mandibular plane becomes steeper we will face an increase of the ANB angle. If we were lucky enough it will stay the same because usually it is increased and any improvement of that angle should be solely achieved by the posterior movement of point A through our mechanics. Schudy recommends that maxillary incisors should be retracted with headgear to avoid taxing our anchorage. All distal movement of the maxillary denture should be done principally with extraoral anchorage in most instances. We must also be aware in class II open bite cases not to move the mandibular incisors lingually because when this happens the resultant increase in overjet requires either more distal movement of the upper teeth which is difficult due to the limitations that are imposed (not to distalize the molars) or class II elastics which are disastrous. On these cases therefore, we must be aware not to increase the molar height by extruding the upper or lower molars with our various mechanics keeping in mind that not only do we open the bite by doing so but we also make the class II correction more difficult due to the resultant clockwise rotation of the mandible and backward movement of pogonion and point B.

Even though during the realization of this Research we did not use Schudy's cephalometric analysis, but Ricktetts cephalometric analysis; what Schudy established, however, in regards to vertical dimension still holds true and it has been the starting point of our investigation.

CHAPTER VI

SUMMARY AND CONCLUSION

The purpose of this investigation was to compare the influence of the patients facial growth pattern to the effect of extraction versus non extraction treatment mechanics on growth during orthodontic treatment in patients being 1 standard deviation dolichofacial and 1 standard deviation brachyfacial according to the Ricketts dolicho-brachy facial index.

The sample consisted of 60 finished cases with good initial and final lateral cephalometric roentgenograms that were randomly selected from the retention files of the Orthodontic Department of Loyola University School of Dentistry. Nine landmarks were located and 4 angles were drawn and measured on these tracings.

All craniometric points and constructed points were located and remeasured in 10 randomly selected cases to eliminate and judge the element of human error. All linear measurements were recorded to the nearest 0.25 mm and angular measurements to the nearest 0.25 degrees.

Chi square statistics were applied to find out the frequency of opening or closing of the facial axis in the groups involved in this research. Regression and correlation statistics were applied to determine if there was significant mathematical relationship between degree of opening or closing of facial axis and the amount of molar movement. The student t test statistics were applied to find out if there were statistically singnificant realationship between the experimental groups studied when condsidering the forward or backward molar movement.

The following conclusions were drawn from this investigation:

Chi square results pointed out that no statistically significant differences could be demonstrated between the groups involved in this research with respect to the frequency of opening or closing of the facial axis was analysed.

Student t test showed a statistically significant difference between the brachyfacial group treated with non extraction mechanics and the brachyfacial group treated with extraction mechanics. Also the dolichofacial group treated with non extraction mechanics differed from the same group treated with extraction mechanics.

Regression and correlation statistics showed that significant correlations between degree of opening or closing of facial axis and the amount of molar movement were found in the dolichofacial group treated with non extraction mechanics and the brachyfacial group treated with the same mechanics comparing molar movement with changes in the facial axis.

It is therefore concluded, that it was demonstrated that the value of appropiate treatment mechanics for each facial type is more important in determining growth changes in the facial axis than is the existing facial growth pattern. Also, the extraction versus non extraction choice produces significant different changes in the facial axis when combined with appropiate mechanics.

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APPENDIX A

SUMMARY OF DOLICHO'S NON-EXTRACTION

CASE #	FACIAL AXIS CHANGE		UPPER MOLAR to PTV			INDEX
	Opened	Closed	Start	Final	Total	
2		1.50	22	25	+3.0	1.39
10	3.00		18	15	-3.0	1.12
19	0.50		10	11	+1.0	1.84
32		1.00	19	22.5	+3.5	1.02
43	2.00		17.5	20	+2.5	1.01
16	5.50		15	10	-5.0	1.01
25		1.00	9.5	12.5	+3.0	2.02
69	1.00		12	15	+3.0	1.01
68	0.25		15	18.5	+3.5	1.18
23		0.25	19	22	+3.0	1.01
88	3.00		18	15	-3.0	1.01
89		0.25	18	17	-1.0	1.63
24	2.00		18	20	+2.0	1.02
34		0.25	15	16	+1.0	1.10
51		0.75	16	18	+2.0	1.01

APPENDIX B

SUMMARY OF DOLICHO'S EXTRACTION

CASE #	FACIAL AXIS CHANGE Opened	Closed	UPPER MOLAR to PTV Start	Final	Total	INDEX
18	1.50		17.5	20	+2.5	1.01
17		0.75	15	21	+6.0	1.01
3		1.75	20	25	+5.0	1.13
8	1.25		17	18.5	+1.0	1.01
20	0.25		17	19	+2.0	1.60
28	1.25		13	19	+6.0	1.54
26	2.00		9	14.5	+5.5	1.01
21	2.00		15	20	+5.0	2.09
79		2.00	20	25	+5.0	1.02
78		0.25	12	17.5	+5.5	1.25
77		0.50	19	22	+3.0	1.01
67		3.00	16	23	+7.0	1.18
76		1.00	16	21	+5.0	1.79
54		0.25	15	20	+5.0	1.96
201	1.50		19	23	+4.0	1.01

APPENDIX C

SUMMARY OF BRACHY'S NON-EXTRACTION

CASE #	FACIAL AXIS CHANGE Opened	Closed	UPPER MOLAR to PTV Start	Final	Total	INDEX
6		1.00	25.5	25	-0.5	2.59
14	1.75		16	18	+2.0	1.07
29		1.00	11	14	+3.0	2.05
38		1.25	12.5	18	+5.5	1.52
39	1.00		17	17	0.0	1.02
48	0.25		22	23	+1.0	1.39
53		1.25	18	23	+5.0	1.11
50	2.00		22	18	-4.0	1.54
66	0.25		15	15	0.00	1.01
12	2.00		14.5	10.0	-4.5	1.02
64		0.75	15	18	+3.0	1.01
22	0.25		17	17	0.0	1.02
15	1.50		26	27	+1.0	1.01
63		1.00	18	24	+6.0	1.69
89	1.00		15.5	17	+1.5	1.85

APPENDIX D

SUMMARY OF BRACHY'S EXTRACTION

CASE #	FACIAL AXIS CHANGE		UPPER MOLAR to PTV			INDEX
	Opened	Closed	Start	Final	Total	
7	0.75		13	19	+6.0	1.01
4		2.00	16	19	+3.0	1.15
13	1.00		24	22	+2.0	1.82
27	1.75		20	26	+6.0	1.01
30		2.00	14.5	21	6.5	1.01
35		2.00	13	15	+2.0	1.01
33		4.00	17	25	+8.0	1.30
31		1.50	20	23	+3.0	1.02
14		0.75	12	19	+7.0	1.01
40		0.75	16.5	24	+7.5	1.55
45	0.75		20	21	+1.0	1.01
11	1.00		15	18	+3.0	1.01
70	0.75		18	22	+4.0	1.01
73		2.00	17.5	20	+2.5	1.01
41		1.00	16	21	+5.0	1.19

APPROVAL SHEET

The thesis submitted by Sergio F. Navarro, D.D.S. has been read and approved by the following committee:

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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science.

3/22/80
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