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**THE SOFT TISSUE CHANGES AFTER CLASS II TREATMENT
WITH BIONATOR AND JASPER JUMPER APPLIANCES**

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DOCTORATE PROGRAM THESIS

DEPARTMENT OF ORTHODONTICS

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ISTANBUL - 2007

I. ACKNOWLEDGMENT

I dedicate this work to my parents, my wife, and my kids for their life-long love and support.

Many thanks go to my supervisor Associate Prof. Dr. Sibel Biren for his encouragement, patient and guidance throughout this thesis. Her consistent care and support is highly appreciated.

I would further thank my teachers Prof. Dr. Nazan Kuçukkeleş the head of the department, Prof. Dr. Nejat Erverdi, Associate Prof Dr. Ahu Acar, Associate Prof. Dr. Banu Çakırer, Assistant Prof. Dr. Arzu Demirkaya and Assistant Prof. Dr. Toros Alcan for their precious advices, guidances, and support .

Special thanks go to my friends in the department especially Dt. Musa, Dt. Sanam and Dt. Seniz for comfortable and caring.

Finally, I would like to thank all my friends and colleagues who were great help to me.

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III. ABBREVIATIONS

1. SD : Standard deviation
2. D : Difference
3. P : Probability
4. mm : Millimeter
5. cm : Centimeter
6. ° : Degree
7. % : Percentage
8. < : Angle
9. Fig. : Figure
10. JJ : Jasper Jumper
11. TBA: Twin Block Appliance

1. ÖZET

Bionator ve Jasper Jumper apareyleri ile yapılan Sınıf II tedavisinden sonra yumuşak dokuda görülen değişiklikler.

Ortodonti alanında yumuşak doku ile ortodontik tedavinin ilişkisini araştıran oldukça az sayıda çalışma mevcuttur. Bionator ve Jasper Jumper dizayn ve etki şekli olarak oldukça farklı aygıtlardır. Bu iki tedavi yöntemi karşılaştıran bir çalışma gösterilecektir. Bu çalışmanın amacı, Bionator ve Jasper Jumper ile tedavi edilen bireylerin elde edilen yumuşak doku değişikliklerinin kontrol grubu ile karşılaştırılmasıdır.

Grubumuz 43 iskeletsel ve dental Sınıf II, bölüm 1 hastadan oluşmaktadır. Her iki cinsiyet de çalışmaya dahil edilmiştir. Jasper Jumper ile tedavi edilen hastalardan elde edilen 22 seri sefalometrik röntgen, Bionator ile tedavi edilen hastalardan elde edilen 11 sefalometrik röntgen Sınıf II malokluzyona sahip tedavi edilmemiş 10 hastadan alınan seri röntgenlerle karşılaştırılmıştır.

Aşağıdaki sonuçlar elde edilmiştir:

1. Kontrol grubuyla karşılaştırıldığında tedavi edilmiş grupta yumuşak doku profilinde gelişme olmuştur. Tedavi edilen grup Z açısında, H açısında, yumuşak doku yüz açısında, yumuşak doku açısında, alt dudak sulcus açısında istatistiksel olarak anlamlı değişiklikler göstermiştir.
2. Bionator ve Jasper Jumper uygulanan hastalarda tüm açılarda önemli değişiklik elde edilmemiştir.
3. Yumuşak doku açısı, H açısı ve Z açısı artışında bionator ve kontrol grupları arasında istatistiksel olarak anlamlı fark bulunmuştur.

4. Her iki grupta da alt dudak açısında kontrollere göre önemli artış olmuştur.

Anahtar kelimeler: Jusper Jumper, Bianator, Profil, H açısı, Z açısı

2. SUMMARY

The Soft Tissue Changes after Class II treatment with Bionator and Jasper Jumper Appliances

Few studies are found in the orthodontic literature in which an attempt has been made to relate orthodontic treatment to the soft-tissue profile. As the Bionator and the Jasper Jumper are quite different appliances in design and, possibly, mode of action, a study comparing the two treatment methods would be warranted (23). The purpose of this study was to examine and compare the soft tissue changes that occur as a result of treatment with the Bionator and Jasper Jumper with the comparison of control group.

The samples have 43 skeletal and dental Class II Division 1 malocclusions. Both sexes included in the study. Serial cephalometric radiographs from 22 patients who had been treated with the Jasper Jumper appliance and from 11 patients who had been treated with the Bionator appliance were compared with serial radiographs of 10 untreated persons with Class II malocclusions.

The following results were obtained:

1. There was improvement in soft tissue profile in the treated group when compared with the control group. Treated group showed statistically significant changes in the Z angle, H angle, soft tissue facial angle, soft tissue angle and Inferior labial sulcus angle.
2. There was no significant difference in the changes in all the angles between bionator and jasper jumper groups.
3. The increase of Soft tissue angle, H-angle and Z-angle between the bionator and the control groups was insignificant.

4. The two treatment groups showed significant increase in Inferior labial angle when compared with the control group.

Key word: Jasper Jumper- Bionator-Profile- H angle- Z angle

3. INTRODUCTION

Angle Class II division 1 malocclusions have been studied extensively regarding their skeletal and dental characteristics and timing and method of treatment. The main reason for the extensive research on this particular type of malocclusion is its high frequency in the population. This malocclusion is reported to constitute 12% to 49% of all orthodontic disorders. (118) A successful treatment of this malocclusion requires that the skeletal and dental basis of the disorder be investigated carefully. (35) The method of treatment is usually performed using orthopedic and orthodontic applications.

The soft-tissue profile plays an important part in our orthodontic considerations. As we correct malocclusions, we bring about changes in appearance that are pleasing to all concerned. We should determine beforehand that the proposed orthodontic treatment will not result in adverse facial change (186). Better treatment goals can be set if we quantitate the soft-tissue features which contribute to or detract from that "physical attractiveness" which has been ingrained into our culture (86). The need to improve treatment goals for our patients is the primary reason for this soft-tissue analysis (185).

Riedel (193) studied facial profiles of thirty persons by means of lateral cephalograms. He reported that the relation of the maxillary and mandibular apical bases, the degree of convexity of the skeletal pattern, and the relation of the anterior teeth to their respective apical bases have a marked influence on the soft-tissue profile.

Subtelny (223) published a longitudinal study of the soft-tissue facial structures and their profile characteristics, defined in relation to underlying skeletal structures. Subtelny (222) reported the effect of orthodontic treatment on the lip position.

Holdaway (110) proposed a method of analyzing the soft-tissue profile both as a means of diagnosis and as a method for determining changes in the soft-tissue profile induced by growth and treatment. He proposed the "H" angle, formed by a line drawn from the point of the soft-tissue chin tangent to the upper lip and the N-B line, as a measure of profile acceptability.

Burstone (43) presented a method to analyze the soft-tissue profile by means of angular and linear measurements. He described the average morphology and the variation of acceptable profiles and reported that desirable and undesirable alterations in the facial contour could be influenced by the underlying dentoskeletal framework.

Ricketts proposed a line which he called the "esthetic plane" to describe the relationship of the lips to the soft-tissues of the chin and the nose. In Caucasian adults the lips should be contained within this line drawn from the chin to the tip of the nose. Yogosawa (244) found that the anterior dental protrusion and lower-facial height are the two factors leading to strain on the lips.

In 1975, Huggins and McBride reported a study of thirty-three randomly selected Class II, Division 1 patients with overjet ranging from 3.0 to 12.0 mm. It was not reported whether the lips were relaxed or closed during the radiographic exposure. Their analysis showed that subnasale, labiale superius, and labiale inferius moved nearer to the facial plane as a result of the hard-tissue remodeling caused by orthodontic treatment. Roos (198) established a reference line perpendicular to the S-N line at Sella for all soft-tissue and hard-tissue measurements. He reported a relatively good correlation between the retraction of skeletal points and soft-tissue landmarks subspinale, incision inferior, and supramentale.

Appliances traditionally used to treat Class II malocclusion can be divided into two categories: extraoral and intraoral. The typical extraoral traction device used in the correction of Class II malocclusion applies forces to the maxillary dentition, either to retard forward movement or growth of the teeth and maxilla and/or to push the maxillary teeth posteriorly. The intraoral appliances can be categorized into two groups: appliances that pull and appliances that push (118). The most commonly used device that produces pulling interarch force vectors is intermaxillary elastics (9). The second category of intraoral appliances include various types of functional jaw orthopedic appliance. Those appliances that deliver a pushing force vector, forcing the attachment points of the appliance away from one another. This resultant force contrasts with pulling devices, such as intermaxillary elastics, that brings their insertions closer to one another (80).

In its early days, orthodontics was primarily concerned with skeletal and dental tissues because the objective of orthodontic treatment was the attainment of normal occlusion. Soft tissue measurements were introduced into cephalometric in the 1950s and were quickly recognized as an important factor in treatment planning. This was the result of clinical observations that a single skeletal and dental pattern could be associated with a wide variety of integumental profiles. Class II, Division 1, malocclusion is fairly common and the bionator has been widely used for its correction. The effects of treatment with the bionator on hard tissue have been well documented, although the conclusions have been mixed. Some studies have reported orthopedic effects as part of the correction, while others have found that the effects of the bionator are mostly dentoalveolar in nature. While the bionator affects the hard tissue, it also impacts the soft tissue profile. Proponents of the bionator claim that it improves soft tissue facial balance. However, the effects of bionator therapy on the integument and, consequently, esthetics, have not been quantified. The objective of this

study was, therefore, to determine the treatment effects of the bionator appliance on facial soft tissues.

Few studies are found in the orthodontic literature in which an attempt has been made to relate orthodontic treatment to the soft-tissue profile. Many investigations were performed to quantitatively evaluate skeletal and dental changes contributing to Class II correction in activator and Jasper Jumper treatment. As the Bionator and the Jasper Jumper are quite different appliances in design and, possibly, mode of action, a study comparing the two treatment methods would be warranted (196).

The purpose of this study is to examine and compare the soft tissue changes that occur as a result of treatment with the Bionator and Jasper Jumper with the comparison of control group.

4. LITERATURE REVIEW

4.1. History and Classification

Class II malocclusion is a commonly observed clinical problem, occurring in about 15% to 20% of the population in most regions of the world (1). Class II is a loose, subjective designation including an assortment of problems ranging from simple to the most difficult. Hippocrates included "crooked teeth" in his 6th book of epidemics as early as 24 centuries ago (112).

Dr. E.H. Angle, who is considered as "father of orthodontics" gave us the first indices of malocclusion which is based on key to occlusion. Later many classifications have been put forth; but tell today, Angle's classification is being used widely because of its simplicity (7).

1899, Angle divided the whole range of malocclusion into three main groups according to the antero-posterior relationships of the teeth. He used Roman numerals I, II, III to designate the three main classes. He employed Arabic numerals 1, 2 to denote the division of the classification. Unilateral deviations were termed as subdivision. In Class II, Angle required the mesiobuccal cusp of the upper first molar to be at least one cusp width distal to the correct relationship. Lischer used the Disto-occlusion term (Synonymous with Angle's Class II) to describe all cases of post-normal occlusion.

In 1912 a committee of the British Orthodontic Society chaired by Norman Bennett suggested that although the Angle an adequate classification of anteroposterior relationship, it did not include information about the transverse and vertical planes and should be extended to do so.

In the 1930s the German orthodontist Simon (212) proposed a new system of classification based on three dimensional relationships of the dental arches to the three anthropological planes namely:

- A) Frankfort Horizontal plane.
- B) Median sagittal plane.
- C) Orbital plane.

Only three of these terms are in frequent use-protraction, retraction and contraction. For example, an Angle Class II case may be due to maxillary protraction, mandibular retraction, or both.

In the 1960s, Ackerman and Proffit formalized the system of informal additions to the Angle method by identifying five major characteristics of malocclusion that should be considered and systemically described in classification. It is based on venn-digram (1).

In 1964, Ballard and Wayman described the incisor classification. It is based upon the relationship between the lower incisor edges and the cingulum plateau of the upper central incisors. In Class II, the lower incisor edges lie posterior to the cingulum plateau of the upper central incisors. There are two divisions of Class II:

Division 1 – the over jet is increased and the upper central incisors are usually proclined.

Division 2 – the upper central incisors are retroclined, the Overjet is usually minimal but may be increased.

Skeletal classification is used to know the various skeletal relationships. In Skeletal Cl II the lower apical base is placed relatively too far back. The lower incisor axis would pass palatal to the upper incisor crown.

Bishara illustrated that angle's original dental classification was extended by the next generation of orthodontists to describe

anteroposterior skeletal discrepancies or disproportions of the maxilla and the mandible. Skeletal discrepancies associated with Class II malocclusions have been termed skeletal class II relationships. This term indicates that the class II malocclusion is one resulting from an anteroposterior disproportion in size or discrepancy in position of the jaws rather than malposition of the teeth relative to the jaws (retrusion of the mandibular teeth or protrusion of the maxillary teeth or both). These skeletal class II relationships often are associated with class II dental malocclusions. Typically some natural dental compensation is observed in the presence of skeletal discrepancy.

4.2. Etiology of Class II Malocclusion

Malocclusions are usually clinically significant variations from the normal range of growth and morphology. Although it is difficult to know the precise cause of most malocclusions, we do know in general what the possibilities are, and these must be considered when treatment is considered.

It has always been thought that in the most civilized countries, and particularly in the young Caucasian population, these malocclusions are increasing. The skulls of soldiers belonging to the Austro-Hungarian army of the nineteenth century were compared to those of the current federal army of Austria. The groups were subject of occlusal and cephalometric analyses. The results showed an increase in the mesio-distal dimensions of the teeth, an increase in Class II occlusions, an increase in the "irregularity index", in the ANB angle and in overbite, while there was a decrease in intercanine diameters and arch length. All this can be interpreted as the long term result of steady Class II skeletal development increases with a multifactorial etiology.

The Etiologic Factors of Class II Malocclusions Fall Into These Headings:

4.2.1. Heredity

Heredity has long been indicted as a cause of malocclusion. Aberrations of genetic origin may make their appearance prenatally or they may not be seen until many years after birth. The role of heredity in craniofacial growth and the etiology of dentofacial deformities has been the subject of many studies, yet surprisingly, few specifics are really known. Interesting familial resemblances are seen frequently, yet the mode of transmission or even the site of gene action is not understood, except for a few clean-cut problems, for example, absence of teeth or the appearance of some gross craniofacial syndromes.

Nakasima did a comparison to assess the role of heredity in the development of Angle Class II malocclusion. He compared the craniofacial morphologic differences between parents with Class II offspring and analyzed the parent-offspring correlations. High correlation coefficient values were seen between parents and their offspring. Thus, there appears to be a strong familial tendency in the development of Class II malocclusions (160).

4.2.2. Developmental Defects of Unknown Origin

Developmental defects of unknown origin are a term applied to gross defects of a rare type probably originating in failure of differentiation at a critical period in embryonic development. Examples sometimes cited include congenital absence of some muscles, micrognathia, facial clefts, and some instances of oligodontia and anodontia (24).

4.2.3. Trauma

Both prenatal trauma to the fetus and postnatal injuries may result in dentofacial deformity.

4.2.3.1. Prenatal Trauma and Birth Injuries

- Hypoplasia of the mandible can be caused by intrauterine pressure or trauma during delivery.
- Inhibited growth of the mandible due to ankylosis of the temporomandibular joint may be a developmental defect or may result from trauma.
- Asymmetry. A knee or a leg may press against the face in such a manner as to promote asymmetry of facial growth or retardation of mandibular development.

4.2.3.2. Postnatal Trauma

- Fractures of jaws and teeth.
- Trauma to the temporomandibular joint has been reported to impair growth and function leading to asymmetry and temporomandibular dysfunction.

4.2.4. Physical Agents

4.2.4.1. Premature Extraction of Primary Teeth

Any decrease in the mesiodistal width of a primary molar may result in the forward drifting of the first permanent molar. When a primary tooth is lost before the permanent successor has started to erupt (crown formation completed and root formation begun), bone may re-form atop the permanent tooth, delaying its eruption.

When the eruption is delayed, more time is available for other teeth to drift into space that would have been occupied by the delayed

tooth. Any decrease in the mesiodistal width of a primary molar may result in the forward drifting of the first permanent molar.

Ronnerman (197) in Sweden and Northway (166) in Canada found that the space occupied by the primary molars closed as a consequence of caries or loss of the primary teeth. Davey (59) in a study of the loss of maxillary primary molars, concluded that the factors related to migration of the first permanent molar after loss of the second or first and second primary molars were (1) the amount of leeway space-more drift occurred in arches with less leeway space, (2) cusp height-high permanent molar cusps inhibit drifting, and (3) age when the primary teeth are lost-the greatest loss occurred when the primary molars were lost prior to the eruption of the first permanent molars.

4.2.4.2. Loss of Permanent Teeth

The loss of a permanent tooth results in a major upset in the physiologic functioning of the dentition, since the break in mesiodistal contacts permits shifting of the teeth (133).

4.2.5. Habits

All habits are learned patterns of muscle contraction of a very complex nature. Abnormal habits which may interfere with the regular pattern of facial growth must be differentiated from the desired normal habits that are a part of normal oropharyngeal function and thus play an important role in craniofacial growth and occlusal physiology. Concern here is with those likely to be involved in the etiology of malocclusion.

4.2.5.1. Thumb-Sucking and Finger-Sucking

Popovitch and Thompson (181) have reported a high association of abnormal sucking habits with the malocclusion sample at the Burlington Orthodontic Research Centre in Ontario, Canada. Cook (53)

measured the forces of thumb-sucking, finding three distinctly different patterns of force application during sucking, all utilizing forces sufficiently strong to displace teeth or deform growing bone. Melsen et al. (151) found that both digital sucking and pacifier sucking increased the tendency toward abnormal swallowing.

Sucking habits were related to an increase in severe malocclusion symptoms apart from the type of swallow presented. These habits were strongly correlated with distocclusion and open bite and with crossbite and maxillary overjet. Mandibular postural retraction may develop if the weight of the hand or arm continually forces the mandible to assume a retruded position in order to practice the habit. Concomitantly, the mandibular incisors may be tipped lingually (224).

4.2.5.2. Tongue-Thrusting

Tongue-thrust swallows that may be etiologic to malocclusion are of two types: (1) the simple tongue-thrust swallow, which is a tongue-thrust associated with a normal or teeth-together swallow; and (2) the complex tongue-thrust swallow. The child normally swallows with the teeth in occlusion, the lips lightly closed, and the tongue held against the palate behind the anterior teeth.

Melsen et al., (29) in one of the most definitive studies yet reported, state that both tongue-thrust swallow and teeth-apart swallow favor the development of disto-occlusion, extreme maxillary overjet and open bite.

4.2.5.3. Posture

Persons with faulty body posture frequently demonstrate undesirable mandibular postural positioning as well. Both may be expressions of poor general health. On the other hand, those who hold themselves straight and erect with the head well placed over the spinal

column will almost reflexly hold their chins forward in a preferred position. Body posture is the summated expression of muscle reflexes and, therefore, is usually capable of change and correction (214).

4.2.6. Disease

Nasopharyngeal disease and disturbed respiratory function may produce mouth breathing and alter craniofacial morphology. Disturbance of nasal respiratory function undoubtedly is etiologic to some skeletal Class II malocclusions (23).

Bluestone pointed out that upper-airway obstruction can be caused by tonsils and/or adenoids and can result in serious cardiorespiratory complications. However, he felt that the effects of respiratory obstruction on craniofacial and occlusal development remain to be shown (37).

4.3. Characteristics of Class II

Using Angle's classification as their criteria, several authors have attempted to describe the cephalometric characteristics of the Class II, Division 1 malocclusion. Since Broadbent's introduction of radiographic cephalometric in 1931, a number of different lateral headfilm analyses have been devised. There are many method of cephalometric evaluation that has been used in the diagnosis and treatment planning of patients undergoing orthodontic, orthopedic and orthognathic surgical treatments. This cephalometric analysis is but one of many diagnostic tools used to determine the type and focus of therapy for an individual patient. Therefore, we perceived a need for a method of cephalometric analysis that is sensitive not only to the position of the teeth within a given bone, but also to the relationship of the maxilla, mandible, and cranial base structures, one to another (36, 37).

The diagnosis is achieved by comparing the patient's values of specific measures to nonnative standards. Comparison of mean values is the most commonly employed analytical procedure. Skeletal Class II cases show values above the mean. . If the patient falls above of this value, he or she is assumed to be in skeletal Class II. When analyzing a patient exhibiting skeletal Class II, it is useful to determine which anatomic regions are the principal contributors to the dysplasia.

Many investigators have pointed out that a Class II molar relationship occurs in a variety of skeletal and dental configurations. The data available from the literature indicates that there is notable disagreement. McNamara indicates mandibular retrusion as a common characteristic of nearly all Class II cases. Amoric, on the other end, sustains that protrusion of the upper jaw is predominant. Blair proposes an intermediate view essentially saying that the two percentages are similar. Literature review indicates that Class II malocclusion may or may not be accompanied by a skeletal discrepancy (204).

Fisk et al described six possible morphologic variations in the dentofacial complex: (1) The maxilla and teeth are anteriorly situated in relation to the cranium. (2) The maxillary teeth are anteriorly placed in the maxilla. (3) The mandible is of normal size but posteriorly positioned. (4) The mandible is underdeveloped. (5) The mandibular teeth are posteriorly placed on an adequate base. (6) The final variation comprises various combinations of the aforementioned factors (79, 80).

4.3.1. Mandibular Position

Mandibular deficiency can be either an absolute Deficiency (because of size) or relative (because of position). In several cephalometric studies it has been observed that the relationship of the

maxilla to the cranial base shows no significant differences between the Class II Division 1 and the normal groups, whereas the mandible is significantly retrusive. (6, 8) Craig, (56) Blair and Gilmore (93) found minor differences in the mean skeletal patterns of individuals with Class I and Class II Division 1 malocclusions and concluded that a high degree of variability is seen in each class of malocclusion.

Varrela (234) compared cephalometric values of children at the deciduous dentition stage with Class II occlusal development with those of children at the same developmental stage with normal occlusal development. He found that children with distal occlusion had a shorter mandibular corpus and a larger gonial angle relative to those with normal occlusion.

McNamara (144) evaluated the variation in the position of the mixed dentition mandible relative to the cranial base and cranial structures by way of two cephalometric measures: pogonion to the nasion perpendicular (145) and the SNB angle (215). These measures indicate that a deficiency in the anteroposterior position of the mandible is a common finding in Class II malocclusion, with about 60% of the patients demonstrating mandibular skeletal retrusion. Similar findings were noted in an adult Class II sample (60).

Maj, Luzi and Lucchese (134) found total mandibular length in 96% of Class II subjects to be similar to that of normal subjects of corresponding age. They concluded that the differences in the bony bases were not the result of abnormal development of any specific part but, rather, an abnormal relationship of the parts.

McNamara reviewed the available literature and observed that of 16 studies, the findings of 12 supported the notion that the mandible is retrognathic in Class II Division 1 malocclusions. In the other four

studies, the mandible was found to be normal. McNamara's own findings indicated that most individuals with Class II Division 1 malocclusion have mandibular skeletal retrusion, with a smaller percentage showing maxillary protrusion.

Adams (3) and Rothstein (199) stated that the absolute length of the mandibles in Class II patients did not differ from those of Class I subjects. Most other investigators, however, noted a mandibular deficiency in Class II individuals for both sexes. For example, Craig (56) noted that the mandibular body was shorter in Class II subjects. Most investigators did not differentiate between the absolute size and the position of the mandible, but Renfroe (188) and Henry (105) noted that, whereas certain Class II patients could be characterized as being deficient in mandibular size, other Class II patients had mandibles that were well formed but were retruded due to a posterior position of the glenoid fossa. All concluded that the mandibles of Class II individuals were retrognathic relative to other craniofacial structures.

4.3.2. Maxillary Position

Maxillary excess frequently may be the underlying skeletal cause of a Class II malocclusion. Maxillary excess may present as overdevelopment in the vertical or anteroposterior dimension or in both (23).

In the case of vertical maxillary excess; the excess may be more localized to the posterior area, associated with maxillary posterior teeth being in an inferior position with a normal vertical position of the incisors. This condition is associated with anterior open bite but with a normal display of the maxillary incisors relative to the upper lip both in repose and upon smiling.

It is possible, although less common, to have maxillary excess in anteroposterior dimension or midface protrusion. Drelich (42) and Rothstein (44) report this to be the case. On the other hand, Hunter (114) state that in their samples the maxilla was normally positioned in both sexes. Further, Harris and coworkers (50) reported that, on average, the maxilla was in a slightly retrusive position, and Henry reports that the SNA angle of his Class II sample averaged 1.5° less than the Class I mean.

McNamara, analyzing the components of Class II malocclusion in 277 children 8-10 years of age, found that protrusion of the maxilla was noted in only a small percentage (10-15%) of the patients studied. On the other hand, 23-39% of the Class II sample had a retrusive position of the maxilla relative to cranial base structures, a skeletal relationship that often is reflected in an obtuse nasolabial angle (41).

4.3.3. Dentoalveolar Position

The dental aspects of Class II largely are adaptations to the skeletal and muscular pattern, although they may exist alone sufficiently exaggerated to produce Class II dental relationships in a balanced facial skeleton. The dental features must be studied in the cephalogram, and the dental casts, as well as in the patient.

The early identification of the Class II sample was based on the presence of three concomitant occlusal features in the deciduous dentition: a distal-step relationship of the second deciduous molars, Class II deciduous canine's relationship, and excessive Overjet. Arya and coworkers (8) observed that all patients presenting with a distal-step relationship of the second deciduous molars ultimately demonstrated a Class II relationship of the permanent molars.

Dental Class II is characterized by a normal skeletal profile and normal AP position of the jaws. The mandibular dentition is placed normally on its base but the maxillary dentition is protracted, resulting in a Class II molar relationship and greater incisal overjet and overbite than normal.

Riedel (45) noted that the maxillary incisor in his Class II, division 1 sample was twice as far anterior to the facial plane as that in patients having normal occlusions. Hitchcock (108), reported maxillary dental protrusion relative to the A-Po line. In contrast, Henry (105) noted that, relative to a line from nasion to Point A, only 11 of 103 patients exhibited maxillary dentoalveolar protrusion.

Altemus stated that the posterior dentition was mesially located in the maxilla, whereas Baldrige (12,13) and Elsasser and Wylie (73) noted no difference in maxillary molar position between groups of Class II and Class I individuals. Renfro (48) reported that the maxillary first molar in his Class II sample was located posterior relative to the Class I group.

Less attention has been paid to the position of the mandibular dentition relative to the structures of the mandible. Generally, the investigators who considered the position of the mandibular dentition reported that, on average, the mandibular incisors were related normally to basal structures (157).

Elman (72) reported no difference in the position of the mandibular molars relative to Class I individuals. On the other hand, Craig (56) and Altemus reported that the mandibular molars in the Class II individual were located more posteriorly; Gilmore (57) found the anteroposterior position of the mandibular molars was variable.

4.3.4. Transverse Dimension

Many Class II Malocclusions, when evaluated clinically, have no obvious maxillary transverse constriction. When study model of the patient are coordinated into Class I canine relationship, however, a unilateral or bilateral crossbite is produced. In fact, Tallaro and co-workers (225) have shown that a Class II what appears to be a normal buccolingual relationship of the posterior dentition usually has a 3-5 mm transverse discrepancy between the maxilla and mandible. This underlying transverse discrepancy can be unmasked clinically by having the patient posture the mandible in an anterior position so that the canines are positioned in a Class I relationship. More pronounced transverse discrepancies are evidenced by unilateral or bilateral posterior crossbites in centric occlusion.

4.3.5. Vertical Dimension

Although Class II malocclusion usually is perceived as a sagittal problem, the vertical dimension of the patient also must be considered. As has been shown by Schudy (208, 209) variations in facial height may conceal or intensify the clinical appearance of the malocclusion. Many other authors have recognized the importance of excessive or deficient vertical development in the determination of occlusal relationships, yet few of the cephalometric studies of Class II malocclusion specifically mention anterior or posterior facial height (152).

As is well known in prosthodontics and orthognathic surgery, a decrease in vertical dimension causes the mandible to rotate upward and forward. This same phenomenon occurs in the Class II orthodontic patient, in that a short lower anterior facial height can camouflage a mandible that is structurally small relative to the midface. These patients typically have a low mandibular plane angle, a deep overbite

with a strong chin point, and either retruded or flared maxillary incisors. Mandibular dentoalveolar retrusion also occurs.

A patient with an increased lower anterior facial height often is characterized by a retruded mandible (and occasionally the maxilla as well), a poorly defined chin point with a hyperactive mentalis muscle, and a tendency toward or an anterior openbite. A bump on the nasal contour ("dorsal hump") often is observed clinically in patients with both maxillary and mandibular skeletal retrusion and a Class II malocclusion.

Drelich (68) noted that the Y-axis in Class II patients was directed more downward than in Class I individuals, and that the ratio of anterior to posterior face height was greater in Class II individuals than in Class I individuals. Henry (49) noted a larger mandibular plane angle in his Class II sample, Altemus and Hunter (114) showed a slight increase in anterior face height.

McNamara (16) examined two measures of vertical dimension; approximately 40% of the sample had a neutral vertical dimension, whereas an increased mandibular plane angle was observed in nearly 50% of the children. Only 10% of the sample had a short lower anterior facial height, and this decrease in facial height often is associated with Class II, division 2 malocclusion

4.3.5. Soft Tissue Characteristics

The position of the maxilla can be evaluated best at the time of the clinical examination, but it also can be evaluated while analyzing the lateral cephalogram. In particular, the nasolabial angle and the cant of the upper lip should be examined both clinically and cephalometrically.

The nasolabial angle is formed by the intersection of a line tangent to the base of the nose with a line tangent to the upper lip.

Scheideman and co-workers (41) reported that the nasolabial angle was approximately 110° in their sample of so-called "dentofacial normals. The upper lip should be evaluated relative to the vertical orientation of the face. A vertical or retruded upper-lip orientation is a contraindication for any mechanics that would distalize the maxilla or the maxillary dentition.

Miyajima and co-workers (42) support the premise that a single standard of facial esthetics is not appropriate for application to diverse racial and ethnic groups. In fact, European Americans in general have a straighter facial profile than do Asian Americans and African Americans, indicating the necessity of using standards that are racially and ethnically specific for the population group being studied.

The patient with mandibular deficiency typically presented with facial appearance characterized by a normal nasolabial angle, relative protrusion of the maxillary anterior teeth and a relative deficiency in the chin caused by the small size or retruded position of the mandible. The lower lip tends to be more everted or redundant, resulting in a pronounced labiomental fold this is the result of the lingual contact of the maxillary incisors with the lower lip, which prevents it from being supported by the mandibular incisors. If the deficiency is great enough; the lower lip will be positioned lingually to the maxillary incisors at rest (everted lower lip); resulting in lip incompetence. The consequence of this resting lip position is further protrusion of the maxillary incisors. This lip posture also prevents the lower lip from providing adequate vertical support for the maxillary incisor; promoting overeruption of these incisors (23).

If the decreased size of the mandible is localized more to the mandibular body and mandibular rami is normal or increased length typically the patients have a short lower anterior face height, often resulting in both upper and lower lips having a more everted position at rest.

In the case of vertical maxillary excess; the excess may be more localized to the posterior area, associated with maxillary posterior teeth being in an inferior position with a normal vertical position of the incisors. This condition is associated with anterior open bite but with a normal display of the maxillary incisors relative to the upper lip both in repose and upon smiling.

The excess maybe overall excess; there will be no open bite, but there will be an excessive vertical display of the maxillary incisors relative to the upper lip in repose as well as a gummy smile. In either of the two presentation of the vertical excess; the mandible is rotated downward and posteriorly.

4.4. Progressing Of Class II

Most investigators noted that all Class II subjects maintained full Class II molar and canine relationships, and mean overjet increased when compared to mean overjet in the deciduous dentition.

Fröhlich (90) reported that no improvement of Class II occlusal relationship occurs from 5 to 12 years of age. This observation was confirmed by Bishara and colleagues (24) who concluded that Class II malocclusion, when diagnosed on the basis of the occlusal features, never is "self-correcting" in growing patients.

On the basis of the results of Arya and coworkers (8), it may be stated that Class II occlusal relations are never self-correcting in the

transition from the deciduous to the mixed dentition in the absence of treatment or a change in an existing etiologic factor (e.g., habit, airway obstruction).

Moyers and Wainright (158) stated that a distal step in the deciduous dentition likely reflects an underlying skeletal imbalance and typically results in a Class II malocclusion occurring in the permanent dentition.

Baccetti and co-workers (10) evaluated two groups of untreated subjects (a Class II group and a normal occlusion group) during the transition from the deciduous to the mixed dentition. They noted that the transverse discrepancy that existed in the Class II group in the deciduous dentition persisted into the mixed dentition.

Bishara and co-workers, who have shown that in the absence of therapeutic intervention or a change in the orofacial environment (for example, the elimination of a habit or an airway obstruction), Class II malocclusion generally is not self-correcting. Only after the transition of the second deciduous molars to the second premolars is an improvement in molar relationship sometimes noted. Thus, Class II occlusal relationships tend to be self-perpetuating and continue to be associated with constricted transverse occlusal relationships (70, 71).

Harris and Behrents (98) evaluated the long-term stability of the dental relationship on 61 orthodontically untreated cases. They observed that, when the molars were malrelated at the initial observation, they did not self-correct at the end of the observation period, rather the relationship became progressively worse.

Bishara et al. (25) evaluated cephalometric and dental arch changes in 35 untreated normal subjects from early adolescence to early

adulthood. They observed that the tooth size-arch length discrepancy (TSALD) tended to increase with time in both male and female subjects.

4.5. Treatment Time Of Class II

In support of early intervention, it should be noted that somatic and craniofacial growth rate is more intense in young juveniles (deciduous dentition) than in later developmental stages (e.g., mixed dentition) at which time generally a steady low growth rate is observed until pubertal growth spurt occurs (32).

According to Petrovic and Stutzmann, (178) the possibility of stimulating increments in condylar cartilage growth is quite effective between 5 and 7 years of age. In addition, the experimental primate studies of McNamara (143) demonstrated that the most significant experimentally induced increments in condylar growth occur in animals with full deciduous dentitions, when compared with juvenile, adolescent, or adult animals. Also, Melsen (150) has shown that the midpalatal suture is more amenable to orthopedic expansion during the juvenile age period than at later stages of development.

West (239) stated that intervention in patients with Class II malocclusion in the deciduous dentition generally is overlooked in terms of benefits from early treatment. Therefore, in patients presenting with concomitant Class II occlusal signs in the deciduous dentition, it is possible to start treatment at that stage of dental development. As Class II subjects in the deciduous dentition almost always present with a deficiency in maxillary arch width, an initial goal of treatment might be the early correction of interarch transverse discrepancy by means of rapid maxillary expansion (RME) (21).

Wieslander (240) has proposed to correct distocclusion in the early mixed dentition with a headgear-Herbst appliance, and Fränkel and Fränkel (84) recommend the treatment of Class II malocclusion associated with significant skeletal and neuromuscular imbalances early in the mixed dentition by means of the function regulator (FR-1 or FR-2).

As a rule, the more severe the skeletal dysplasia, the more advantageous is early treatment. The vertical skeletal aspects of Class II, difficult to compensate for with tooth movements alone in adolescence, are improved in earlier years by controlling the basal skeletal growth and by differential management of the alveolar processes and occlusal plane (125).

Significant differences in severity of the several types of Class II are often not appreciated by the inexperienced (159). The diminished growth potential and the arrival of the permanent teeth significantly change the tactics of Class II treatment from those used earlier.

Since there are distinct sexual differences in the onset of the pubescent growth spurt and in the cessation of craniofacial growth, the rationale for skeletal Class II therapy varies with the sex: that is, girls generally ought to be treated earlier, in which case results are achieved sooner. Obversely, the tendency for craniofacial growth in men to continue past the second decade of life is a complicating factor irrespective of the time treatment was begun. Logic and the clinical research evidence now available support the use of early skeletal Class II treatment, since achieving a balanced skeletal profile prior to the eruption of most permanent teeth minimizes tooth movements, is less taxing to anchorage, diminishes actual treatment time, and reduces some kinds of relapse tendencies.

Account also must be taken of differential growth between the upper and lower jaws, since as Bjork's studies have shown, the upper jaw ceases its growth from 18 to 24 months before the lower jaw. The clinician should carefully consider this factor both during active therapy and during the retention period (29 , 30).

4.6. Treatment Of Class II

Depending on the diagnosis and time, different treatment methods can be used for correcting Class II malocclusion;

- 1) Dental
- 2) Orthognathic surgery
- 3) Growth modification

4.6.1. Dental Treatment

In Class II there often is disharmony between the upper and lower arch forms. Accordingly, a second dental aim is widening the maxillary arch form, thereby aiding incisal retraction, improving occlusal function, and easing anteroposterior correction and improving occlusal relations. A most interesting (and somewhat surprising) observation following our initial efforts to expand Class II patients in the early mixed dentition was the occurrence of a spontaneous correction of the Class II malocclusion during the retention period. Such patients had either an end-to-end or full cusp Class II molar relationship. Generally, these patients did not have severe skeletal imbalances but typically were characterized clinically as having either mild-to-moderate mandibular skeletal retrusion or an orthognathic facial profile (38).

McNamara and Brudon (141) hypothesize that expansion of the maxillary dentition may create an "endogenous functional appliance" in that lingual cusps of the maxillary dental arch, overexpanded after RME

relative to the mandibular dental arch, will encourage the growing patient to posture his or her jaw in a more protrusive position when establishing comfortable contact in maximal intercuspation, ultimately leading to a stable occlusal change.

The types of dental camouflage for class II problems can divide conveniently according to whether or not the treatment requires extraction of teeth, this decision is usually related to patient's profile and acceptance.

4.6.1.1. Extraction

Complex crowding necessitating extractions draws attention to the selection of teeth to be extracted. Combinations to be considered are a bicuspid in each quadrant, or maxillary second molars and mandibular bicuspid. The choice of which tooth in the lower arch to extract is dependent on restoration present and the site of the principal crowding. When there is no crowding in the maxilla, the extraction of maxillary second molars may be considered, for this greatly aids the dorsal movement of the maxillary dentition. Absence of crowding in the mandible may permit the consideration of extraction of maxillary first bicuspid, where there is maxillary crowding, or second molars, when there is none (24).

Bishara, in the extraction groups as compared with the nonextraction groups, during the retention period, found that lip prominence decreased further among the extraction groups and increased among the nonextraction groups accentuating earlier trends. Skeletal relationships, During treatment, there was a significantly greater decrease in the facial skeletal convexity and an increase in chin prominence in the extraction groups as compared with the nonextraction groups in both male and female subjects. These findings suggest that

during treatment planning if such outcomes are desirable, an extraction approach might enhance these changes (26).

Bowbeer on the other hand suggested that the extraction of four first premolars results in a decrease in the mandibular plane angle (40).

Unfortunately, the debate is still ongoing, and some clinicians still suggest, without providing much evidence, that four first premolar extractions will compromise posttreatment esthetics by "dishing in" the profile, whereas others have an unfounded belief that a nonextraction approach places the teeth in an unstable position (230).

4.6.1.2. Molar Distalization Devices

Nonextraction treatment plans for Angle Class II malocclusions often require the distal movement of maxillary molars. The Appliances creating molar distalization can be divided as following:

4.6.1.2.1. Head Gear

Typical extraoral appliances include face-bows that attach to tubes on the upper first molar bands and headgears that attach directly to the arch wire or to auxiliaries connected to the arch wire. According to vertical vector of related force the head gears are divided into cervical, occipital and combined. Occipital face bow produces an intrusive force vector, whereas a cervical pull face bow tends to produce an extrusive force vector.

Oppenheim (54) pointed out that when the molars were moved distally no spaces were obtained in the region of the bicuspid provided that correct force was applied. With correctly measured force it would develop neither tipping of the molars nor risk for retention of the maxillary wisdom teeth.

Baalack and Poulsen concluded that the prognosis of the distal movement of the maxillary first molars appears to be good if the treatment with occipital anchorage is started prior to the eruption of the maxillary second molars.

Firouz et al. (78) stated that , by directing the force of the headgear approximately through the center of resistance of the maxillary molars, it is possible to accomplish simultaneously a substantial distal movement of molars (2.6 ± 0.6 mm), as well as significant intrusion (0.54 ± 0.54 mm).

4.6.1.2.2. Magnets

Itoh et al. (30) concluded those Molar distalizations ranged from 5mm to 3.7mm, with an overall mean of 2.1mm were achieved by using repelling force.

Bondemaik and Kurol (7), in the study of the magnets were attached buccally in the premolar and first molar area to a fixed orthodontic appliance, concluded that the mean distal crown movement was 4.2mm, and the maxillary first molars tipped disto-buccally by 80 and 85 degrees, respectively. The reciprocal forces resulted in increased inclination of the upper incisors.

4.6.1.2.3. Pendulum Appliance

The pendulum appliance introduced by Hilgers relies on 0,032 TMA springs, which deliver a continuous force against the maxillary first molar. Four occlusal rests extending from the anterior acrylic are either banded or bonded to the first and second premolars or primary molars and a large palatal Nance button is used for anchorage. Hilgers (34) has stated in his study that distal movement of the molars appears to be most efficient before the upper second molars have erupted.

Ghosh and Nanda (23) determined the effects of the pendulum appliance on distalization of maxillary molars and the reciprocal effects on the anchor premolars and maxillary incisors. The mean maxillary first molar distalization was 3.37 mm, with a distal tipping of 8.36°. The mean reciprocal mesial movement of the first premolar was 2.55 mm, with a mesial tipping of 1.29°. The same results were achieved by Byloff (12) and Bussick (11).

4.6.1.2.4. Coil Spring and Other Devices

In this group of appliances, the active component of force include coil springs on a continuous arch wire, super elastic nickel-titanium arch wires (46), coil springs on a sectional arch wire (Jones jig, distal jet, Keles slider, Wilson biometric arch) (61,51). All of these appliances use the Nance type acrylic button connected with either deciduous molars or premolars, as an anchorage component.

The distalizing plate can be used to obtain bilateral or unilateral dental movement (48). the plate must only be removed at meal times, in order to obtain molar body movement without loss of anchorage by mesial movement of the anterior teeth. It may be used in combination with nocturnal extraoral headgear

Locatelli et al (46) in their study showed that superelastic NiTi archwires is comparable to that with magnets and superelastic NiTi coils. If the second molars are unerupted, the first molars can be distalized 1-2 mm per month with little loss of anchorage.

Jones and Michael (32) reported that the Jones Jig produces distal maxillary molar movement to a Class I relationship with second molars erupted or unerupted, in the mixed or permanent dentition, unilaterally or bilaterally, and in growing or non-growing individuals.

Muse et al. (51) calculated the magnitude and direction of maxillary and mandibular molar and incisor changes that occur during Class II molar correction with Wilson "rapid molar distalization". The mean change in molar relation measured at the occlusal plane was 4.1 mm. The mean maxillary molar distalization was 2.46mm with 7.8° of tip.

Erverdi et al.(22) found in their study about a comparison between NiTi coil springs and repelling magnets that although nickel-titanium open coil springs were found to be a more effective means of molar distalization, both procedures were clinically acceptable.

Keles (35) carried the point of the distal force application towards the level of center of resistance of the maxillary first molar. Lateral cephalograms were taken and analyzed before and 2 months after molar distalization. The class II molars were distalized bodily, 4.9mm. mesial migration of the class II first premolars was 1.3mm, and incisor protrusion was 1.8mm and incisor proclination of 3.2 degrees.

Ngantung and Nanda et al. (13) made a study to analyzed molar distalization with the distal jet appliance. The results of their study showed that the distal jet appliance distalized the maxillary molars, but there was significant loss of anchorage.

Kucukkeles et al evaluated molar distalization by hyrax screw used in conjunction with lip bumper as an anchorage unit. Their cephalometric analysis showed that the upper first molars were distalized in an average of 4.17 mm, tipped 4.61° distally and intruded by 1.11 mm. The upper central incisors were proclined by an average of 1.72 mm and tipped 5.89° labially.

The cephalometric study of Toros et al was designed to evaluate molar distalization by compact R.P.E screw used in conjunction with

modified Nance. Their cephalometric analysis showed that there were no significant skeletal changes. The significant changes achieved were as follows: the upper first molars were distalized in an average of 2.68mm, tipped 2.62 distally. The upper central incisors were proclined by an average of 2.5 mm and tipped 4.9 labially.

Bernstein discussed ACCO appliance in his study. The ACCO (Acrylic Cervical Occipital anchorage) appliance is a removable acrylic appliance, which is used in conjunction with a Northwest headgear.

Recent developments in osseointegration have made it possible to use implants for orthodontic anchorage. Erverdi and keles (21) concluded that Palatal implants can be used effectively for anchorage maintenance and space gaining procedures in orthodontics. No cooperation was required (no headgear), except good oral hygiene. Noninvasive techniques ease the surgical procedure and reduce operation time.

4.6.2. Orthognathic Surgery

On occasion the skeletal dysplasia is so severe that orthodontic treatment alone cannot correct the problem, and orthognathic surgery is then employed in conjunction with orthodontic treatment. Such surgical procedures are usually carried out in adulthood after growth is mostly completed.

Conventional attempts to compensate for severe mandibular deficiency with orthodontic or facial orthopedic techniques have met with limitations and compromise. Clinicians appreciate that orthodontic or orthopedic treatment usually will only compensate for severe skeletal malrelationships but will not correct them (141). This conclusion has led clinicians to consider integration of surgical with orthodontic treatment. In addition, absolute mandibular deficiency is a frequent component of

dentofacial deformities. Therefore, mandibular-advancement surgery combined with orthodontic therapy has become a logical solution for correcting certain facial-skeletal deformities and their associated malocclusions.

The cephalometric evaluation was reported that for each 1 mm of posterior mandibular skeletal movement, the soft tissue lip fell back 0.6 to 0.75 mm while the soft tissue chin moved posteriorly 0.9 to 1.0 mm (121).

Mandibular advancements have also been evaluated, and investigators have found that although the soft and hard tissue chins predictably advanced in a 1:1 ratio, the lower lip changes were more variable with soft/hard tissue ratios ranging from 0.38:1 to 0.75:1(183).

The soft tissue changes associated with maxillary surgery have also been evaluated, and several investigators noted that as the maxilla was posteriorly displaced, the upper lip moved back, with ratios varying from 0.33:1 to 0.76:1(184).

The wide range of soft tissue responses seen has been attributed to the type of soft tissue surgical manipulation employed. This is evident in the studies of soft tissue responses to maxillary advancement in which the early reports, which did not involve soft tissue manipulation, showed upper lip advancement ratios of from 0.4:1 to 0.82:1.23-27 In contrast, a more recent group of studies in which the V-Y closure technique and the alar base cinch suture procedure were employed demonstrated consistent soft/hard tissue ratios of approximately 0.9:1(137).

Scheideman, Legan, and Bell (207) studied soft tissue changes with combined mandibular setback and advancement genioplasty in six subjects. They reported a 1:1 ratio at the level of pogonion, higher

than previous ratios possibly because a concomitant setback reduces tension on genial soft tissues.

Gallagher, Bell, and Storum (75) reported on soft tissue changes associated with advancement genioplasty performed in conjunction with superior repositioning of the maxilla in 10 subjects. The mean ratio at the level of pogonion was 0.87:1.

There are many skeletal Class II problems in individuals with little or no remaining growth potential that can not be treated with orthodontic treatment alone, surgical realignment of the jaw or repositioning of dentoalveolar segments is the only possible treatment option (23). In addition, for patients whose orthodontic problems are so severe that neither growth modification nor camouflage offers a solution, but surgery can be the only treatment method.

For surgical correction of Class II skeletal patients, the maxilla can be moved posteriorly, the mandible can be advanced, or both the maxilla and the mandible can be moved to correct jaw discrepancy (182).

Ruf (201) reported that adult subjects who have skeletal Class II malocclusions due to mandibular deficiency, have traditionally two possible treatment options. The first option is camouflage orthodontics by extracting the maxillary premolars to allow retraction of the maxillary incisors to normalize the overjet and mask the underlying skeletal problem. The second option is orthognathic surgery to reposition the mandible anteriorly.

4.6.3. Growth Modification

Growth may be directed to obtain a correction Therapy aims at restraint of midface growth, promotion of mandibular growth, widening

of the maxilla, control of dentoalveolar adaptation, or planned combinations of these strategies.

The goal of growth modification is to alter the unacceptable skeletal relationship by modifying the patient's remaining facial growth to a favorable jaw relationship (23) Growth modification of the maxilla and mandible can be achieved by using different appliances:

A. Headgear: The most common treatment for true maxillary skeletal protrusion (256).

B. Combination of both (headgear plus functional appliance): The combined approach utilizes an occipital attachment connected to a facebow inserted into headgear tubes that are incorporated into inter occlusal acrylic in the premolar area (23).

C. Functional Jaw Orthopedics: Treatment of Class II malocclusion due to mandibular retrusion require functional jaw orthopedics (182).

4.6.3.1. Head Gear

A Headgear intended for use in growth modification is designed to deliver an adequate extraoral orthopedic force to compress the maxillary sutures; modifying the pattern of bone apposition at these sites. It inhibits anterior and inferior development of the maxilla; as well as inhibiting the mesial and occlusal eruption of the maxillary posterior teeth (23).

The use of a cervical face-bow in a patient with a short lower facial dimension may be indicated, but this type of appliance often is contraindicated in patients with a normal to long lower anterior facial height, due to the adverse vertical forces produced.

Class II characterized by Maxillary prognathism (midface protrusion) associated with a normal mandible. One attempts to reduce the midface prognathism and associated dentoalveolar protrusion, if

present, without altering the favorable mandibular relationship. Heavy orthopedic forces to the completely bracketed maxillary dentition are necessary. The direction of the force is determined by the steepness of the occlusal and mandibular lines. Although the mandible may be normal, it is necessary to bracket all the mandibular teeth to achieve ideal positions and arch coordination (159).

Investigations by Badell, Barton, Baumrind (18), Brown, Chaconas, Droschl, Mays, Schudy and Zingeser have focused on the effects of different types of extraoral forces on treatment response. The direction of extraoral force application has been shown to influence the orientation of the palatal plane, the occlusal plane, and the mandibular plane. It has been a common conclusion that the palate downward anteriorly, opened the mandibular plane angle, and encouraged increased vertical development. Merrifield, Poulton, Root, Schudy and Weislander have suggested that it is possible for the orthodontist to alter predictably vertical development in the growing face by using extraoral forces directionally (38).

Fischer evaluated occipital force for the correction of the anteroposterior malrelationship of Class II, Division 1 malocclusion. He noted that the maxillary arch was moved posteriorly and the marked improvement in facial balance. Again in other cases the corrected occlusion and facial change was the result of a combined posterior movement of the maxillary arch and a repositioning of the mandible. Rotations of the entire mandible were not unusual.

4.6.3.2. Combination Of Headgear And Functional Appliance

Extraoral forces can be applied anteriorly on the buccal arch between the lateral incisors and the upper cuspids, using functional appliances like those of Bass and Teuscher or with removable plates for

maxillary distalization, as indicated by H. Margolis (inventor of the ACCO Acrylic Cervicoccipital Anchorage).

Ricketts (189) have however shown that such use of extraoral traction has orthopedic effects as well as dentoalveolar effects. The slow down in maxilla growth in the sagittal direction is more accentuated when the force is orthopedic in nature (18, 32 oz per side) and when applied anteriorly, as compression on the three most active sutures for a forward and downward movement of the maxilla is more intense. For this reason extraoral headgear with orthopedic forces must be applied at an inclination relative to the occlusal plane of 30° to 40° so as to cross the center of resistance of the maxilla and avoid posterior leaning of the palatal plane (147).

To obtain a more direct effect it is possible to transmit strong forces on the upper jaw with anteroposterior extraoral traction applied to removal plates of various kinds of splints. In this case sutural remodeling is stopped while the smooth chewing surface eliminates occlusal interferences favoring growth in the mandible, which may spontaneously assume a more forward position.

4.6.3.3. Functional Jaw Orthopedics

Functional treatment is defined by Bimler (22) as treatment with some appliance that can be introduced into the relax system which controls mastication. In the early days it was thought that the muscle was doing the magic. Nowadays it has been known that the muscles only work through nervous stimulation. Its main force control is provided by the patient's own neuromuscular reflex system, which brings mastication to a high level of efficiency (182).

Duterloo (4) defines orthopedic effect in orthodontics as a change in the position of bones in the skull in relation to each other induced by therapy. Absolutely, this change in direction and amount of growth should be permanent in nature.

One of the primary purposes of functional appliances is to alter the reflex activities of the facial and jaw muscles. Myotherapy is often employed, adjunctively, in Class II treatment. Abnormal muscle function is a frequent and important aspect of the Class II malocclusion and is often a prominent etiologic factor in its development (74).

The orthopedic mechanism involved is based, among other things, on distraction of the condyle from the glenoid cavity and the resulting stimulation of condylar cartilage proliferation. It seems that the mediator for the proliferation response is the superior head of the lateral pterygoid muscle (95, 221) It appears that the forward and downward movement of the glenoid fossa is strictly dependent upon the condylar distraction, while that of the lower jaw as a whole is also influenced by the overall increase in length. (233) On the other hand, there are still some researchers who suggest that these represent only temporary remodeling changes rather than stimulation of condylar growth (218).

Many investigations (85, 104) approved that functional appliances are effective devices for the correction of certain types of Class II malocclusions. There is, however, no general agreement on how correction of the Class II occlusal relationship takes place. The following concepts have been advanced: (1) Hotz (111) believes that the retractive mandibular muscle pull is transmitted from the mandible through the appliance to orthopedically hold the upper jaw in position which, as growth occurs, effectively reduces the SNA angle while leaving SNB relatively unchanged. (2) Björk (31) and Softley state that dentoalveolar changes account for the occlusal correction. (3) Fränkel,

(88) and Haupl and associates, (187) and others believe that the correction is due mainly to occlusal plane changes with differential eruption.

Most of the functional appliance studies reported in the literature have these common findings regarding the Class II correction: (a) reduced forward growth of the maxilla, (b) retraction of the maxillary anterior teeth, (c) increase in height of the mandibular alveolar process, (d) no change or protraction of the mandibular teeth (depending on the design of the appliance), and (e) increase in lower face height. The one observation that is not consistently found is an increase in the amount of forward growth of the mandible. This is due partly to the lack of controlled human studies with their inherent difficulties in experimental designs, treatment procedures, and measuring methods.

In 1971 Harvold and Vargervik (102, 103) found no effect on mandibular growth along with an increase in lower face height. Other investigators have supported these findings. (116, 228) However, a number of clinical cephalometric studies (100-149) have shown significant increases in growth of mandibular length with corresponding forward movements of pogonion and point B in activator treatment.

Baumrind (19) and his co-authors compared samples of subjects treated with cervical face-bow, high-pull face-bow, and activator-type intraoral appliances as well as a control group of untreated Class II subjects. As compared to the control group, a statistically significant rate of increase in condyle-pogonion distance was found in the intraoral group.

Animal studies have suggested that protracting the mandible in young animals (218, 138) can stimulate mandibular condylar cartilage

growth, producing significant changes in mandibular morphologic features as well as major occlusal changes.

Patient compliance is always a concern when treating patients with functional appliances (107). Whereas the fixed functional appliance has the advantage of reducing patient cooperation as a factor in treatment success, the removable functional appliance has the advantage of being more tissue-born and therefore less likely to produce dental adaptive changes.

With regard to the long-term stability effects of functional appliance treatment, both DeVincenzo (66) and Pancherz and coworkers (97-172) report very disappointing findings with their respective appliances.

The effects of different functional appliances in growing patients with skeletal Class II malocclusions have been reported in several studies; however, the results have generally been controversial. Although some studies have reported significant skeletal changes, others, while indicating dentoalveolar changes, have failed to demonstrate such an effect. In an effort to increase the extent of orthopedic effects, changes in mode of action of appliances and/or combining the appliance with extraoral forces has been advocated. Progressive jumping of the bite had been recommended, (14, 45) depending on the results of experimental studies that suggest a continuous forward repositioning of the mandible in functional appliances treatment gives a better effect than a greater protrusion in one step. (107, 179)

Owen (170) stated that "a good diagnostic aid in determining whether functional jaw orthopedics (FJO) is indicated" is to have the patient posture the mandible forward. If the face looks better when the incisors are edge to edge, the maximum use of FJO appliances may be indicated. If a half-protrusive posture appears more ideal for the soft-

tissue profile, then a combination of a functional appliance and a headgear may be indicated. If the face appears protrusive in any forward mandibular position, then headgear therapy and/or extractions should be considered.

Caries and Linden (45) stated in a review that a variety of different functional appliances are available. The appliance selected for the treatment can be adapted to the type of anomaly and to the growth pattern. The growth direction, the growth amount, and the timing are relevant to the ultimate success of the treatment.

Muscular activity of the superficial masseter muscle and anterior portion of the temporal muscle before, during, and after treatment, with gradual advancement of the mandible, was evaluated by assessing the average integrated electromyogram (EMG) with the mandible in retruded position (RP) and incisal edge-to-edge (EE) position on 23 consecutive subjects with skeletal Class II malocclusion. In conclusion, it seemed that gradual advancement affected the anterior portion of the temporal muscle to a minor extent, whereas the effect on the masseter muscle was significant.

A prospective clinical study with a random allocation of 47 patients to three different functional appliance groups was established and compared with a slightly younger control group over a 9-month period. The cephalometric hard tissue changes were assessed in relation to the soft tissue changes produced and the patients were also assessed by three-dimensional (3D) laser scanning of the facial soft tissues. Statistically and clinically significant changes occurred in the group treated with the Twin Block appliance, and to a lesser extent in the group treated with the Bionator appliance. No statistically significant facial soft tissue changes could be demonstrated in the Bass appliance group. Upper lip position remained stable despite the significant overjet reduction attained in the three appliance groups. Lower lip protrusion

(up to 3.8 mm), lower lip length (up to 4.0 mm), and soft tissue lower and total face height increased significantly in all appliance groups by varying amounts (192).

In clinical terms, the orthopedic phase has the following intent:

- (1) Retardation of the forward and downward growth of the maxilla and maxillary dentition by means of extraoral traction of high force values to the maxillary splint.
- (2) Acceleration of the rate of forward and downward mandibular growth (15).
- (3) Relief of the effects of adverse soft-tissue forces on the dentition.
- (4) Achievement of the major sagittal correction early in the treatment period (rather than in the last stage before appliance removal).

Effects of the orthopedic appliance

Placing the mandible in the correct relationship with the maxilla allows the lip musculature to function in a more advantageous manner. Fränkel (87) has postulated that bringing the "sticky zones" of the lips into contact results in the establishment of a functional anterior oral seal, which is subsequently maintained as the patient spontaneously adds the side shields also seems to have a positive effect on the matrix in which the dentition is developing the functional reflex.

An improvement in the relative positions of the maxilla and mandible may be seen when orthopedic therapy is carried out, with no subsequent "rebound" and without the establishment of a "dual bite." The mandible often appears to take up a more downward and forward position in the face. The intent is to avoid a recessive mandible, a retropositioned maxillary dentition with retroclined or inadequately torqued incisors, an obtuse nasolabial angle, (88) and increased prominence of the nose. It is felt that at maturity patients thus treated exhibit pleasing and harmonious facial features with a generous smile.

4.7. Classification Of Functional Appliances

Functional appliances can be classified as:

- A. Removable functional appliances
- B. Fixed functional appliances

4.7.1. Removable Functional Appliances

4.7.1.1. The Activator

The activator is created by Andresen and developed by Häupl and Petrik. These authors have constructed moderately activated appliances, working through isotonic muscle contractions which produce intermittent forces transmitted to the teeth by small inclined planes. The elongated mandibular retractors are restraining maxillary growth. The mandibular protractors are contracted and are thought to induce cellular activity in the condyle through the interplay of the lateral pterygoid muscle as has been suggested by Petrovic and McNamara. (143-148) In addition to these basic orthopedic changes, the activator permits a selective influence on the eruption pattern of the teeth. It has been very clearly shown by Harvold (102) how this can affect the final sagittal and vertical position of the teeth. Finally, the activator can contribute to the correction of different muscle dysfunctions, inappropriate respiration, and pernicious habits.

In 1978 Teuscher (227) proposed a modification of original design when he advocated anchoring the extraoral forces directly on the activator. Two tubes are polymerized together with the activator, and a face-bow is inserted semipermanently into the tubes. The outer bows must be very short in order to allow the extraoral forces to pass as close as possible to the center of resistance of the maxilla. The extraoral forces are intended to redirect the vertical growth of the maxilla,

eliminate the anteroinferior tipping of palatal and occlusal planes, and maintain the activator in place. It should not be used in hypodivergent cases where the downward growth of the maxilla will be beneficial to the correction of the deep-bite and the improvement.

The use of combined activator-high-pull head gear appliance has been recommended (226, 217) as a means of reducing vertical and sagittal maxillary displacement, achieving autorotation, and increasing forward displacement of the mandible. Creekmore and Rodney, (57) DeVincenzo, (65) and Mills (153) have all pointed out the fallacy of enhanced mandibular growth when the growth increments are manifested in a vertical direction rather than a horizontal direction.

Some researchers (102, 116) stated that activators do not produce any alterations in mandibular form beyond that which would have occurred without treatment. However, others (138) note a significantly higher rate of mandibular growth in patients treated with activators than in untreated patients. Many researchers (156, 122) believe or hint that mandibular growth can be affected by activator treatment.

4.7.1.2. Twin Block

The Twin Block appliance may be attributed to the generally high level of patient acceptance of this type of appliance. Because it is smaller than other functional appliances, patients are able to adapt to it more easily and speech disturbance is minimized. The twin block appliance has the distinct advantage of being worn as a fulltime appliance, including during meals, although some clinicians have their patients remove their appliances while eating.

On insertion of the appliance there is an immediate change in the neuromuscular proprioceptor response. Structural changes gradually take place in the muscles followed by dentoalveolar adaptation (remodeling)

to restore the functional balance. It can therefore be hypothesized that the initial change in muscular equilibrium modifies the posterior condylar space and stimulates cell proliferation (99).

The study of Schaefer et. al. (205) compared the treatment effects of the Herbst appliance with those of the Twin-block appliance followed by fixed appliances. The stainless-steel crown Herbst and the Twin-block produced the same changes in Class II patients; these changes led to normalization of the dentoskeletal parameters at the end of overall treatment.

Brien K. and Wright J. in the study evaluated the effectiveness of early orthodontic treatment with the Twin-block appliance for the developing Class II Division 1 malocclusion. A total of 174 children, aged 8 to 10 years old, with Class II Division 1 malocclusion were randomly allocated to receive treatment with a Twin-block appliance or to an untreated, control group. Results showed that early treatment with Twin-block appliances resulted in reduction of overjet, correction of molar relationships, and reduction in severity of malocclusion. Most of this correction was due to dentoalveolar change, but some was due to favorable skeletal change. The small change in the skeletal relationship might not be considered clinically significant (41).

To determine changes in soft tissue profile in patients with Class II division 1 malocclusions treated with Twin Block Appliances (TBA), Singh GD and Clark WJ. traced 99 pairs of lateral cephalographs and digitized 25 soft tissue landmarks. Procrustes superimposition was used to generate average soft tissue profiles scaled to an equivalent size. Statistical differences between prepubertal, pre- and post-treatment profiles were found using ANOVA ($P < 0.001$). Similarly, significant differences were found between adolescent, pre- and post-treatment profiles ($P < 0.001$). Using a colour-coded finite element scaling analysis

(FESA) programme to localize size change, male prepubertal post-treatment configurations revealed local increases in size at the labiomental groove (approximately 25%) with negative allometry (size-related form change approximately 5%) in the labial and symphyseal regions. For the female prepubertal post-treatment configuration, local increases in size were conspicuous also at the labiomental groove (approximately 6%). Male adolescent post-treatment configurations revealed increases in size in the nasal, mental, and labiomental groove regions (approximately 18%) with negative allometries associated with the upper and lower lips (approximately 20%). For the female adolescent post-treatment configuration, the labial fissure showed an increase in size (approximately 17%), whereas the upper and lower lips and symphyseal region exhibited negative allometries (approximately 5-15%). For shape change, all soft tissue post-treatment configurations were highly isotropic (uniform shape change) over the entire facial nodal mesh except in the areas of the labiomental region and the labial fissure. Thus, in children and adolescents treated for Class II malocclusions a less pronounced labiomental groove is associated with using TBAs, which may provide a more effective anterior lip seal (213-228).

The findings of the short-term cephalometric study, which is analyzed by Baccetti T. and Franchi L., indicated that optimal timing for Twin-block therapy of Class II disharmony is during or slightly after the onset of the pubertal peak in growth velocity. When compared with treatment performed before the peak, late Twin-block treatment produces more favorable effects that include: (1) greater skeletal contribution to molar correction, (2) larger increments in total mandibular length and in ramus height, and (3) more posterior direction of condylar growth, leading to enhanced mandibular lengthening and to reduced forward displacement of the condyle in favor of effective skeletal changes (9).

4.7.1.3. Frankel II Function Regulator

The functional regulator (88) is a removable orthodontic appliance developed by Professor Rolf Fränkel of the German Democratic Republic. This appliance is used during the mixed and early permanent dentition stages to effect changes in anteroposterior, transverse, and vertical jaw relationships. The Fränkel appliance, as it is more commonly termed, has two main treatment effects. First, it serves as a template against which the craniofacial muscles function. The framework of the appliance provides an artificial balancing of the environment, thereby promoting more normal patterns of muscle activity. The second effect of the Fränkel appliance is its influence on skeletal and dental development.

Unlike most other types of functional appliance, this appliance uses the buccal vestibule as its base of operation. The vestibular shields and the lower labial pads of the appliance restrain the musculature and remove restricting forces from the dentition (88) (86).

The Fränkel appliance has a distalizing effect both on the dentoalveolar component and on the whole jaw complex; such effect would seem to be even more important than the periosteal stimulation effect put forward by its creator. It would also seem to be able to produce elongation of the lower jaw together with that of the condyle, stimulating the normal growth processes (anterior resorption and posterior apposition of the ramus (126).

Creekmore and Radney (57) note reduced forward growth of the maxilla in patients treated with the Fränkel appliance, while Righellis, (194) Robertson, (195) and Bookstein report that there is no appreciable treatment effect on the position of the maxilla.

Schulhof and Engel (210) noted that in activator cases the upper molar was restricted in its downward and forward movement but observed little difference in upper molar movement between persons treated with the Fränkel appliance and normal persons. In contrast, Creekmore and Radney noted that the maxillary molars in their Fränkel sample moved forward significantly less than those of their untreated control sample. Righellis noted no statistically significant retardation of upper molar eruption in patients treated with either the Fränkel appliance or the activator, although both groups showed a little less vertical eruption than did the untreated controls. On the other hand, Björk, (31) Softley, and Freunthaller claim that the activator affects the dentoalveolar areas in many cases. Schulhof and Engel, Creekmore and Radney, and Robertson noted retroclination of the upper incisors during the course of Fränkel treatment.

Schulhof and Engel (210) indicated that Fränkel treatment involves additional mesial movement of the lower molar over what is expected during normal growth.

Creekmore and Radney (57) and Righellis reported significant additional vertical movement of the lower molars in Fränkel samples.

There seems to be agreement about the effect of Fränkel (2) therapy on lower incisor position; the incisors are proclined as compared to those of untreated controls.

Few studies have examined whether the functional regulator of Fränkel can cause an increase in mandibular growth that would not have occurred without treatment. Fränkel and Reiss and Righellis find that mandibular growth can be increased during Fränkel therapy, but Schulhof and Engel, (210) Creekmore and Radney, (57) and Robertson (195) have been unable to detect any increase.

Schulhof and Engel (210) note no significant change in the facial axis angle with either the activator or the bionator, but they do report an increase in the facial axis angle in patients treated with the Fränkel appliance. This indicates a larger increase in lower anterior facial height than in posterior facial height. Fränkel also reports an increase in the vertical dimension of the lower face after functional regulator treatment, while Righellis (194) reports no change in comparison to untreated controls. Bookstein (39) finds that the treatment effect on facial form involves considerable increase in both anterior and posterior facial height, together with some shrinking of growth anteroposteriorly; the combination of these effects leaves corpus length unaltered. Some downward and forward inhibition of maxillary dental movement may also occur.

In their study Creekmore and Radney (41) found that there was no significant difference in the forward growth of the mandible in the Class I Frankel, Class II Frankel, and untreated samples. Forward growth of the maxilla was significantly reduced in the Class II Frankel sample as compared to the untreated sample. Correction of the Class II malocclusion of the anterior teeth with the Frankel appliance was 37% from orthodontic retraction of maxillary incisors, 26% from orthodontic labial movement of mandibular incisors, 16% from orthopedic retraction of the maxilla, and 21% from normal forward growth of the mandible.

Woodside (242, 243) stated that Frankel appliances, have been shown to produce some remodeling effect on elements in the craniofacial complex. It restrict the forward growth of the midface (233), Stimulate the mandibular growth, (179) change the dentoalveolar position (203, 101)

Alberts and Dermaut (61) published a study that covered articles dealing with the orthopedic treatment and its long term effects. They

implied that on a long-term basis, only few studies provided scientific data, and all of them reported that orthopedic changes induced by Class II therapy fade away.

In ten patients who had completed one year of treatment with the functional regulator 2 (FR-2), Nielsen (165) concluded that facial growth changes in most patients were mainly in the vertical plane, the maxilla generally became more retrognathic during treatment and the improvement in sagittal occlusion was due more to changes in the vertical plane than to sagittal growth.

4.7.1.4. Bite Jumper Or Sander's Bite Jumping Appliance

This is one of many appliances derived from the activator, perfecting A. M. Schwarz's idea of splitting the activator into two separate plates, inserting into the upper part a W-spring to bring the mandible forwards. The split plate emerged from studies of sleeping patient behavior undergoing functional therapy, with its main purpose being to keep the mandible in the therapeutically effective position. The bite jumper consists of two plates connected by two clasps that force the mandible to remain in an advanced position. It has advantages over single base plate appliances as activator when the arches need different degrees of expansion or where dental rotation is present.

According to Sander's studies, the bite jumper's action on the slow down in maxillary growth in a sagittal direction (measured with the SNA, SNB and ANB angles) is comparable with that of the extraoral traction activator (the average intensity of the forces, especially at night, is 3 N) and more effective than that obtained with other functional appliances such as the activator and the Bionator.

4.7.1.5. Bite Jumper With Magnets –

This is a modification of the bite appliance invented by Schwarz and worked on by Schmuth and Sander. The inclusion of magnets brings with it a number of operational advantages but evaluation of results obtained are still at an initial stage. It seems, however, that distalization of the upper jaw is achieved as well as stimulation of mandibular growth and some dental effects.

4.7.1. 6. Bionator

Bionator an appliance that has been available for over 40 years and that has many devotees worldwide. Like the twin block, this appliance is much less technically demanding in its clinical management than the Frankel appliance, but it does not affect directly the orofacial musculature like the FR-2 appliance.

A major indication for the use of the bionator is in patients with extremely short lower anterior facial heights. The bionator appliance is used, not only to bring the mandible in a more forward position but also to increase vertical dimension through differential eruption of posterior teeth. In patients with excessive vertical, facial height, the bionator also can be used if the posterior teeth are prevented from further eruption by way of an interocclusal acrylic bite block (108).

A Class II malocclusion may also be corrected by the mesial migration of the lower dentition. While Janson (44) reports that this process is a principal effect of the bionator, Schulhof and Engel (210) come to the opposite conclusion about the bionator, although they notice a mesial movement of the mandibular molars during activator treatment.

William Lange and Varun Kalra found a significant change in the profile of patients treated with the bionator. Soft tissue facial convexity, as determined by G-Sn-Pg', decreased 2.22° more in the bionator group

than in the control group. Decrease in facial convexity was, to a greater extent, the result of soft tissue pogonion coming forward and, to a lesser extent, due to subnasale being restricted in its forward movement. As determined by cranial base superimposition, the soft tissue chin advanced about 1.0 mm, while subnasale came forward 0.5 mm less in the treated group than in the control group (58).

Forsberg and Odenrick (81) reported a significant increase in the advancement of soft tissue pogonion. Korkhaus (127) made the clinical observation that activator therapy decreases the convexity of the soft tissue profile. The inhibition of forward movement of subnasale and increased anterior movement of soft tissue pogonion are reflective of the amount of movement of the underlying skeletal structures.

Based on the studies, one can conclude that treatment with a bionator results in:

1. Decreased skeletal convexity;
2. Increased anterior and posterior face heights;
3. Reduced overjet and overbite;
4. Decreased facial convexity;
5. Uncurling and increase in length of the lower lip;
6. Minimal effect on the upper lip

4.7.2. Fixed Functional Appliances

4.7.2.1. Herbst Appliance

The Herbst appliance is a fixed bite-jumping device for treatment of Class II malocclusion. The appliance has several advantages when compared to removable bite-jumping appliances (functional appliances), such as the activator, bionator, and Fränkel appliance: (1) The Herbst appliance works 24 hours a day, (2) no cooperation from the patient is required, and (3) treatment time is short (approximately 6 to 8 months).

The appliance was originally introduced by a German professor, Emil Herbst, at the International Dental Congress in Berlin in 1905. Recently the Herbst treatment method has gained increasing interest, especially in the United States, and several articles on appliance design have been published (113, 106).

Erverdi and Kucukkeles (74) (33), explained treatment by the Herbst appliance and presented three cases that were treated by the Herbst appliance. They reported that the Herbst was very efficient non-compliant device in correcting the orthopedic malocclusions if it was used during the active growth spurt. Herbst appliance is a device that doesn't need patient's cooperation.

Pancherz evaluated the effects of the Herbst appliance on the occlusion and on dentofacial growth. The results presented are based on analyses of dental casts and profile roentgenograms from twenty-two consecutive Class II, Division 1 malocclusion cases treated with the Herbst appliance. Six months of treatment with the Herbst appliance resulted in Class I (or overcorrected Class I) molar relationships, normal overjet (mean, 3.0 mm) and normal overbite (mean, 2.5 mm) in all twenty-two subjects (174).

The Herbst appliance had a restraining effect on maxillary growth and a stimulating effect on mandibular growth. Apparent mandibular length increased about three times more in the Herbst group than in the control group.

Herbst appliance reintroduced by Pancherz (176) after originally having been described by Herbst. This type of pushing appliance is categorized as rigid in that the Herbst bite jumping mechanism is composed of two stainless steel "plunger" rod and tube assemblies that usually are attached at the upper first molar and lower first premolar

regions. This type of rigid pushing appliance produces vectors of force that are not only sagittal, but also have been shown to be intrusive. In addition, the forces tend to produce transverse expansion and are more oriented along the downward and forward direction of facial growth.

The treatment effects produced by the Herbst bite jumping appliance (banded, cast or acrylic splint design) have been well documented. The studies of Wieslander (240) and McNamara have shown that both skeletal and dentoalveolar effects are produced in patients with Class II malocclusions who have worn this appliance. In general, the treatment effects produced are divided about equally between skeletal and dentoalveolar adaptations. The most common skeletal adaptation reported is an increase in mandibular length (approximately 2.0 mm) in comparison to untreated Class II controls. Little maxillary skeletal change has been noted. The most pronounced dentoalveolar change has been a relative posterior movement of the upper buccal segment, with about 2.5 mm of distal maxillary first molar movement noted in comparison to untreated controls. Forward movement of the lower molars and proclination of the lower incisors also have been reported.

One of the major advantages of the Herbst appliance is the relative speed at which treatment effects are achieved. Traditional approaches to treating a Class II malocclusion (e.g., extraoral traction, Class II elastics) often are hampered by problems with patient compliance. By anchoring the device intraorally, the need for patient cooperation is reduced substantially.

One of the disadvantages of the Herbst appliance is the rigidity of the Herbst bite jumping mechanism itself. Although every attempt is made to allow freedom of movement by enlarging the attachment holes of the tube and plunger to the axles, the bite jumping mechanism restricts lateral movements of the mandible.

Herbst therapy results in both skeletal and dental changes. The skeletal changes include: restrained anteroposterior maxillary growth, (232) enhanced mandibular growth, remodeling of the anterior glenoid fossa, and proliferation of the posterior aspect of the fibrous articular disc. The dental changes associated with Herbst therapy include: lateral expansion of maxillary molars, distalization of maxillary molars leading to increased maxillary arch length and slight proclination of mandibular incisors.

The amount and direction of condylar growth, glenoid fossa displacement, and "effective" temporomandibular joint (TMJ) changes (a summation of condylar growth, glenoid fossa displacement, and condylar position changes within the fossa) were analyzed in 35 Class II, Division 1 malocclusions (23 boys and 12 girls) treated with the Herbst appliance. Lateral head films in habitual occlusion and with the mouth wide open from before (T1) and after 7.5 months of Herbst treatment (T2) as well as 7.5 months (T3) and three years (T4) after treatment were evaluated. As a control group, a sample of 12 untreated male Class II Division I malocclusions was used during a 7.5-month time period corresponding to the treatment period (T2-T1) of the Herbst cases. The results revealed that during the treatment period (T2-T1) condylar growth was directed posteriorly about twice the amount as in the control subjects, and the fossa was displaced in an anterior inferior direction. The effective TMJ changes showed a pattern similar to condylar growth but were more pronounced. During the first posttreatment period (T3-T2), all TMJ changes reverted. The glenoid fossa was displaced backward; the amount of condylar growth and effective TMJ changes was reduced, and the changes were more superiorly directed. During the second posttreatment period (T4-T3), all TMJ changes were considered physiological. Conclusion: During Herbst treatment, the amount and direction of TMJ changes (condylar growth, fossa displacement, and effective TMJ

changes) were only temporarily affected favorably by Herbst treatment (172).

O'Brien K. and coworker evaluated the effectiveness of Herbst and Twin-block appliances for established Class II Division I malocclusion. There were no differences in treatment time between appliances, but significantly more appointments were needed for repair of the Herbst appliance than for the Twin-block. There were no differences in skeletal and dental changes between the appliances; however, the final occlusal result and skeletal discrepancy were better for girls than for boys. Because of the high cooperation rates of patients using it, the Herbst appliance could be the appliance of choice for treating adolescents with Class II Division 1 malocclusion (167).

Du X, Hagg U and Rabie AB. compared dental and skeletal treatment changes in Class II division 1 malocclusions with two modes of maxillary control and two modes of bite-jumping. One sample treated with a headgear Herbst appliance and step-by-step advancement (HHSSA) of the mandible, and the other sample treated with a 'conventional' Herbst appliance with maximal jumping (HMJ) of the mandible. Treatment with HHSSA seems to result in a greater effect on the sagittal jaw relationship, improved vertical control and more maxillary molar movement. Mandibular anchorage loss was not reduced with step-by-step advancement of the mandible (70).

Leung DK and Hagg U. monitored the effects of the progressive activation of the Herbst appliance on the activity of the masseter and temporalis elevator muscles of the mandible using surface electromyography. Results showed great individual and inter- and intrasessional differences in electromyographic activity of the muscles before and during treatment. At the retruded position, the masseteric activity increased by the sixth month while temporalis activity remained

at the same level. Following treatment, the masseteric imbalance was reduced, but the temporalis imbalance was unchanged. At the edge-to-edge position, masseteric activity increased by the sixth month, while temporalis activity remained unchanged. The masseteric imbalance was reduced by the sixth month, while the temporalis imbalance was reduced from the fourth month into treatment. The results imply a favorable muscular response to a progressive regime of Herbst appliance activation (131).

Ruf S, Pancherz H. analyzed the sagittal dental and skeletal changes contributing to Class II correction in young and adults groups treated with the Herbst appliance. Additionally, the alteration in skeletal and soft tissue convexity occurring during treatment was assessed. In both groups the improvement in sagittal incisor and molar relationships was achieved more by dental changes than by skeletal ones. The amount of skeletal change contributing to overjet and molar correction was smaller in the young adult group (22% and 25%, respectively) than in the early adolescent group (39% and 41%, respectively). Skeletal and soft tissue facial profile convexity was reduced in adults and adolescents. Facial profile improvement did not differ between the two groups. The results of this study revealed that the Herbst appliance is most effective in the treatment of Class II malocclusion in young adults (200).

4.7.2.2. Mandibular Protraction Appliance (MPA)

Coelho Filho developed the MPA with two applications (7) which resemble to Herbst. The mandibular protraction appliances seem to work similarly to the Herbst appliance and, perhaps, other mandibular propulsion devices. They are easily fabricated at chair side with ordinary, inexpensive wires.

The treatment effects of the MARA with an untreated Class II control group were compared. The annualized 5.8-mm Class II molar correction was obtained by a 47% skeletal change (2.7 mm) and a 53%

dental change (3.1 mm). The 2.7-mm skeletal change was completely due to growth of the mandible. The skeletal changes indicated that the MARA produced increases in mandibular length and in posterior and anterior face heights but had no headgear effect on the maxilla.

Its disadvantages appear to be potential breakage, arch wire distortion, and a limitation in mandibular movements. The study of Kulbersh, et al (128) showed that the MARA is effective in treating patients with Class II malocclusions through dental and skeletal changes in the craniofacial complex.

4.7.2.3. Biopedic

The Biopedic, designed by Jay Collins and manufactured and sold by GAC, was introduced in 1997 (48). It consists of buccal attachments soldered to maxillary and mandibular molar crowns, the attachments contain a standard edgewise tube and a large 0.070-inch molar tube. Large rods pass through these tubes. The mandibular rod inserts from the mesial of the molar tube and is fixed at the distal by a screw clamp. By moving the rod mesially, the appliance is activated. The short maxillary rod is inserted from the distal and fixed by a similar screw at the mesial of the maxillary first molar. The two rods are connected by a rigid shaft and have pivotal regions at their ends.

4.7.2.4. Adjustable Bite Corrector

In 1995 West introduced a variation of the Jasper Jumper (129) which was termed as the Adjustable Bite Corrector (ABC). It had swivel adjustments at its ends, thereby eliminating the need for left and right models and thus reducing inventory by half. The push force is not generated from the coil spring as in the Jasper Jumper but rather from a nickel titanium wire in the center lumen of the spring.

The length of the ABC can be increased as much as 4 mm by simply turning the ends of the spring. This very desirable adjustable

feature permits the clinician to alter the applied force by merely rotating the end(s) of the spring. Repair of a broken spring is both quick and inexpensive. It is not even necessary to remove the end caps of the ABC from the arch wire. The broken parts are unscrewed from the end caps and replacement parts can be cut to order from stock material.

The most notable attractive feature was the ability of the clinician to repair the broken appliance. Because the nickel titanium wire placed in the center of the coil is subject to breakage, it is doubtful that the ABC would break less frequently than the Jasper Jumper. This is probably its most significant disadvantage.

4.7.2.5. Klapper Superspring II

In 1997 Lewis Klapper introduced the Klapper Superspring for the correction of Class II malocclusions (49). On first glance it resembles a Jasper Jumper with the substitution of a cable for the coil spring. In 1998 the cable was wrapped with a coil and the Klapper Superspring II was the result.

It has received a good reception over the Jasper Jumper because only two sizes are required (left and right sides are not interchangeable) and breakage may be less frequent. On closer examination it can be seen to differ considerably from the Jasper Jumper at the molar attachment. The Klapper Superspring II inserts from the mesial and is rigidly secured to the molar by an oval attachment tube. The Jasper Jumper inserts from the distal and has a swivel connection to the molar. The Klapper Superspring creates a moment on the molar, which is expressed clinically as distal root tip. This can be desirable in some patients, but extended wear of the appliance should result in excessive distal root tipping.

Because the Klapper Superspring inserts gingivally on the molar and cannot roll to the buccal as readily as a Jasper Jumper, there may be a greater vertical component to the force vector. If this were of clinical

significance, a patient with a pronounced curve of Spee would level more quickly with the Klapper Superspring. However, extended wear should produce excessive intrusions and may require removal before sagittal corrections have been completed.

The disadvantages of the Klapper Superspring include

1. The requirement of a special molar tube,
2. The lack of adaptability to correct Class III conditions,
3. Some limitation to maximal opening, and potential injury to the patient if breakage occurs
4. Extended wear may cause excessive distal root tipping to the maxillary molar and more intrusion to the molars and incisors than desired.
5. No statistical results of clinical trials are available to date.

4.7.2.6. Eureka Spring

The forerunner to the Eureka Spring was a system devised by Northcutt in 1974. The new device (35) incorporates significant changes to Northcutt's design, including triple telescoping action, flexible ball-and-socket attachments, a completely encased spring that remains intact even if the device becomes disengaged, and a shaft for guiding the spring. The main component of the Eureka Spring is an open-wound coil spring encased in a plunger assembly. The ram is made from a special work-hardened stainless steel that has been precision-machined with three different radii. At the attachment end, the ram has either a closed or an open ring clamp that attaches directly to the archwire. The plunger has a tolerance of .002" within the cylinder. A triple telescoping action permits the mouth to open as wide as 60mm before the plunger becomes disengaged. If this occurs, the system can easily be reassembled by the patient. The cylinder assembly is connected to a molar tube with an .032" wire that has been annealed at the anterior end. An .036" solid ball at the posterior end acts as a universal joint, permitting lateral and vertical movements of the cylinder.

4.7.2.7. Bass Appliance

In 1975 Bass (16) described an upper plate showing a looped torquing device for the upper incisors. He used this plate in conjunction with extraoral forces hooked directly to the loops of the torquing device to restrain growth of the maxilla in the anterior region.

4.7.2.8. Jasper Jumper

The Jasper Jumper, developed by Dr. James Jasper, is a fixed functional appliance that is designed to deliver light, continuous force to correct Class II malocclusion (37). It is purportedly capable of producing effects similar to those of headgear, activator, or a combination of the two, depending on how it is activated (American Orthodontics product brochure). The Jasper Jumper is also capable of moving single teeth, groups of teeth, or an entire arch. Functionally, it has an advantage over other fixed functional appliances, such as the Herbst, in that it is flexible, allows more lateral freedom of the mandible, and is easier for the patient to maintain (119).

First, the amount of force applied by the modules is more easily controlled by the clinician. The flexibility of the force module has been shown to increase patient comfort because greater lateral and sagittal movements are possible. In addition, the force module curves away from the dental arches in its activated position, thus making mastication and oral hygiene procedures easier to perform than with the Herbst appliance (146).

One of the treatment effects produced most easily by the force modules is the distalization of the upper posterior segment (i.e., the headgear effect). This type of movement is achieved by not cinching or tying back the maxillary arch wire but rather by allowing the arch wire to remain straight and slightly extended past the buccal tubes. Light

forces (e.g., 2 to 4 ounces) then can be expressed by the modules to distalize the upper molars. Because the forces are resisted by the entire lower dentition, minimal changes in mandibular dentition are noted. The headgear effect can be produced not only in actively growing patients, but also in some adult patients in whom maxillary molar distalization is desired (46-118).

As with any fixed force system, there are disadvantages associated with the use of these modules. The two most significant disadvantages are breakage and unwanted tooth movement. The fact that these modules often are used on "uncooperative" patients increases the concern of breakage. The appliance system has been improved over the last 10 years, so that now the modules are more resistant to fracture during appliance wear. Patients should be instructed not to chew on the appliance and also not to perform wide open movements. Strict dietary controls are mandatory. In addition, the patient should be cautioned repeatedly not to "pop" the modules after yawning or excessive wide opening.

Jasper Jumper therapy has been prescribed for Class II patients with deep bites it can be used with either extraction or nonextraction therapy. The hypothesized mechanisms of Class II correction with the Jasper Jumper include: basal restraint of the maxilla, dento-alveolar retraction of the maxillary dentition, dento-alveolar protraction of the mandibular dentition, increased growth at the mandibular condyle, downward/forward glenoid fossa remodeling, and lateral expansion of the maxillary molars.

In terms of appliance design and force vectors, the Jasper Jumper is most similar to the Herbst appliance. Both appliances:

1. Use pushing mechanics with intrusive force vectors as side effects, which are beneficial since intrusion of lower incisors is usually

necessary during the correction of Class II malocclusions. The upward pressure on the maxillary molars minimizes extrusion due to treatment mechanics or habits that interfere with normal breathing and tongue posture. Intrusive forces also tend to be expansive (37).

2. Minimize the need for patient compliance.
3. Produce forces that tend to parallel the normal downward and forward growth vector of the face.
4. Provide a continuous force 24 hours a day.

The Jasper Jumper not only holds, but actually displaces the maxilla backward; the anterior maxillary skeletal landmarks moved posteriorly and the posterior landmarks showed more than expected posterior movement. On that basis, we might expect SNA angle to decrease, which would compare favorably with previous reports of cervical traction, the Herbst and the activator appliance.

The Jasper Jumper does tend to rotate the mandible; the symphyseal landmarks moved downward and backward and condylion moved forward, suggesting backward rotation around a center between articulare and condylion. Backward or clockwise rotation of the mandible has also been reported for other functional appliances (63, 220).

The maxillary dentition of the JJ group was tied together as a unit. Both the molars and incisors displayed controlled posterior tipping around their apices. This indicates that the line of force application of the JJ is below and behind the unit's center of resistance. The posterior tipping of the JJ molar cusp is similar in direction, but of greater magnitude than found with the Herbst and cervical traction, which ranged between -1.4 mm to -2.6 mm. The maxillary incisor tip also showed approximately -5.4° of posterior tipping. Again, this is similar in

direction, but of greater magnitude than the posterior tipping reported for the Herbst appliance. The 4.8 mm of maxillary incisor retraction was reported by Derringer (64).

The mandibular dentition was also tied together as a unit, with both the molars and incisors affected by Jasper Jumper therapy. The mandibular molars underwent significantly more anterior bodily translation and tipping than observed for the controls, suggesting that the line of force is directed close to but slightly above the molar's center of resistance. The mandibular incisors were proclined approximately 6.37° , which parallels the proclination (6.6°), produced with a Herbst. Somewhat lesser changes, ranging between 2.9° - 5.2° , have been reported with lip bumper therapy (164-165).

Cope et al. (54) reported that the hypothesized mechanism for Class II correction by the Jasper Jumper is as follows: basal restraint of the maxilla, dentoalveolar retraction of the maxillary dentition, increased growth at the mandibular condyle, downward and forward remodeling of the glenoid fossa, and lateral expansion of the maxillary molars. Results of their study indicated that Class II correction using a Jasper Jumper occurred mainly through dentoalveolar movement and secondarily through restraint of maxillary growth. Furthermore, they reported that the mandible tended to rotate clockwise and showed little or no horizontal growth.

The clinical management of the Jasper Jumper is divided into three stages: Stage A: comprises essentially intrasegmental and intra-arch leveling and alignment of the teeth, treatment of vertical problems and correction of inadequate canine inclination.

Stage B is the actual jasper jumper therapy with establishment of Class I occlusion in canine region and/or its overcorrection.

Stage C concludes the process with precision adjustment (finishing and adjust settling) and retention.

Weiland and Bantleon (237) studied the effect of the Jasper Jumper appliance on the dentofacial complex in 17 consecutive growing patients who had Class II, Division 1 malocclusions. The following results were found:

- (1) Class I occlusal relationships were achieved in all patients in an average treatment time of 6 months.
- (2) The correction of the Class II malocclusion was a result of skeletal (40%) and dental (60%) changes.
- (3) Skeletal Class II correction was predominantly restricted to the mandible.
- (4) The dentoalveolar part of total molar relationship correction took place to the same extent in both jaws, whereas in overjet correction the maxillary dental changes outweighed the mandibular changes by far.
- (5) When compared with normal growth changes (Bolton standards), treatment with Jasper Jumpers distalizes the upper dentition and moves the lower teeth mesially. Mandibular growth seems to be increased to some extent.

Covell et al (55) evaluated the dental and skeletal effects of the Jasper Jumper appliance used in the correction of Class II Division 1 malocclusions. While the Jumpers were in place, maxillary incisors were retroclined and the molars were moved distally, tipped back, and intruded. The mandibular incisors were proclined and intruded, while the molars were translated mesially, tipped forward, and extruded. Skeletal

measures showed reduced forward maxillary displacement and no significant alteration of horizontal mandibular growth.

Although Dermaut and DeMunck (68) found no significant relationship between the amount of root resorption and achievable intrusion, others have demonstrated an association. Given the indicators of “resorption potential” which exist prior to treatment (140) (i.e., shortroots before treatment and bottleneck roots), it follows that individuals predisposed to root shortening should probably forego Jasper Jumper therapy.

Differences between activator-headgear (HG) combination to a Jasper Jumper (JJ) plus occipital HG were evaluated in Selcuk University. The Results suggested that ANB angle was decreased significantly in both treatment groups compared with the controls. Increase in total facial height was greater in the activator group than in the JJ group. Vertical growth inhibition of lower incisors was greater in the JJ group. The activator-HG appliance was more effective on the mandible, whereas the JJ appliance was mainly active on the maxilla. Thus, ideal cases for JJ-splinted appliance should be high-angle cases, particularly with maxillary excess and some mandibular deficiency (202).

Another cephalometric study investigated the dental and skeletal effects of the Jasper Jumper appliance used in the correction of Class II Division 1 malocclusions. A sample of 36 growing patients treated with the Jasper Jumper appliance was divided into two groups: (1) 24 patients with records obtained at the start and completion of orthodontic treatment, and (2) 12 patients with records available at the beginning and end of the Jumper phase of treatment. While the Jumpers were in place, maxillary incisors were retroclined and the molars were moved distally, tipped back, and intruded. The mandibular incisors were proclined and intruded, while the molars were translated mesially, tipped forward, and

extruded. Skeletal measures showed reduced forward maxillary displacement and no significant alteration of horizontal mandibular growth. During orthodontic finishing, molar tipping and maxillary incisor retroclination were corrected, although the mandibular incisors remained proclined. In summary, this study found that the Jasper Jumper appliance corrected Class II discrepancies largely through maxillary and mandibular dentoalveolar effects and, to a limited extent, by restraint of forward maxillary growth (55).

4.8. Soft Tissue Changes In Response To Treatment

Ricketts (23, 23) observed that prior to treatment the condyle in Class II malocclusion is in a relatively forward position in the fossa. Following treatment the condyle moves back into a normal position.

The effects of different types of appliances on the dentofacial relationships of individuals with Class II/1 malocclusions have been evaluated in several studies. In most of these studies the treated groups were compared with untreated Class II/1 samples. The findings suggest that a certain amount of normalization in the maxillary-mandibular relationship occurs with orthodontic/orthopedic treatment (231, 80).

Monahan found the correlation between upper incisor retraction and upper lip change to be improved in a subsample of high mandibular plane angle patients. Stromboni (220) concluded that in skeletal open bite cases extraction therapy resulted in better lip contour because of a smaller increase in anterior facial height than in nonextraction treatment.

Holdaway (109) and King (124) have suggested that initially thick lips may be self-supporting and undergo very little change when incisors are retracted. Holdaway also hypothesized that lips strained to obtain closure, as measured by lip taper, will thicken rather than retrude with

incisor retraction until a normal lip taper is obtained. The lip will then follow incisor retraction at a one-to-one movement ratio.

Anderson, Joondeph, Turpin (85) and Wisth (241) found less correlation between upper lip change and maxillary incisor retraction when initial overjet was increased, but Monahan reported no difference in correlation between the two variables in subsamples with increased and normal overjet. Anderson and Ricketts (190) have stated that the position of the lower lip may be influenced by changes in the position of the upper incisors in those cases that initially demonstrated increased overjet. However, Monahan¹⁰ found less correlation between lower lip change and upper incisor retraction in his subsample with increased overjet, and Lo and Hunter (132) and Roos (198) found low correlations between the two variables in Class II, Division 1.

In its early days, orthodontics was primarily concerned with skeletal and dental tissues because the objective of orthodontic treatment was the attainment of normal occlusion. Soft tissue measurements were introduced into cephalometrics in the 1950s and were quickly recognized as an important factor in treatment planning (191). This was the result of clinical observations that a single skeletal and dental pattern could be associated with a wide variety of integumental profiles (43). A number of articles have been published containing soft tissue cephalometric analyses (130, 200).

Polk et al. (180) stated, "Potential orthodontic patients will have varying profile preferences, and the orthodontist should elicit the patient's personal preferences when treatment is likely to alter the soft tissue "envelope," especially in borderline extraction/non extraction cases."

Berscheid, Walster, and Bohrnstedt (106) found that the face was the most important physical characteristic in the development of high self-esteem (male and female); that is, persons who are satisfied with their faces are more self-confident.

Burstone recognized that "analysis of both dental and skeletal patterns alone may prove inadequate or misleading, for marked variation exists in the soft tissue covering the dentoskeletal framework. Neger noted that anthropologists had previously documented a lack of uniformity of the soft tissue covering and concluded that one cannot depend on dentoskeletal analysis for accurate information on soft tissues (162).

Altman using Burstone's methodology compared the soft tissue profiles of North American Caucasian and African American children. His data supported the conclusion, reached by others that the soft tissue profile does not depend wholly on the underlying skeletal foundation (222). Merrifield analyzed a cross-sectional sample of 120 patients and concluded that the proportions of the lower face can be defined within a narrow range. Peck and Peck (177) also attempted to establish some population norms for a variety of soft tissue parameters. Establishing population mean values for soft tissue parameters may thus necessitate control of sample age, sex, racial background, and require a larger sample size.

Many studies have shown that significant differences exist between average Caucasian and African American profiles (11-115). Other research, however, has demonstrated the esthetic profile may be significantly different from the average profile for a given race. For example, the esthetic Caucasian female profile has been shown to have fuller lips than the average Caucasian female, while the preferred

African American face has been found to be flatter than the norm for that race (76).

Chaconas also assessed nasal changes with growth and recorded linear and angular changes of hard and soft tissue parameters, finding similar directional growth to that described by Posen, but also noting a differentiation in nasal the profile between skeletal patterns. Genecov et al. (92) found sex differences both in the amount and the timing of facial growth. Blanchette et al. (35) suggested that the skeletal extremes of long and short vertical face height subjects are compensated by the soft tissue.

Subtelny observed that soft tissue contours diverge from those of the underlying skeletal framework in certain areas, and suggested that a disproportionate rate of growth of the nose aided in the increase of soft tissue convexity with age. The alteration of nose and chin position results in the apparent recession of the lips within the facial profile with time (222).

Vig and Cohen (235) and Mamandras (136) discussed an important problem associated with soft tissue studies: the ability of voluntary and involuntary muscle activity to affect the contours being studied. One must be cautious of comparisons between different soft tissue studies because some include nasal changes while others do not. As profile convexity is largely affected by nasal changes, those studies that exclude nasal changes should be considered separately from those that include them (161-216). Studies that include nasal changes seem to report increasing soft tissue convexity with age, while those that don't include nasal changes report a relative flattening.

The relationship between nose, lips and chin can be altered by both growth and orthodontic treatment. It is imperative, therefore, that

the orthodontist have an understanding not only of the changes incident to orthodontic treatment but also of the amount and direction of growth expected in the facial structures. Several authors have indicated the importance of considering both growth and treatment in predicting post-orthodontic facial changes.

The development of the soft tissue profile is a result of complex changes within the hard and soft tissue structures of the face. Altemus found great variability in the soft tissue thickness of individual faces. Growth changes in the integument of the face have also been described by Subtelny, Burstone, Chaconas and Bartroff and Bishara et al. (27) The reference planes used in measuring growth changes were themselves subject to change and sometimes the data was cross-sectional or mixed longitudinal

Early studies suggested there was a constancy of the pattern of skeletal growth and assumed that the development of the soft tissue profile was coincident with the underlying hard tissue. However, a considerable body of evidence now exists which suggests that different components of the soft tissue profile have differing rates and timing of growth and that all parts of the soft tissue profile do not grow in direct proportion to their skeletal bases (53) (219). Increasing amounts of soft tissue convexity with age have been demonstrated, as has considerable sexual dimorphism with regard to soft tissue thickness, as well as the timing, amount, and direction of soft tissue growth in the post-pubertal period.

Battagel (24) evaluated the changes in soft tissue profile of 30 patients with a mean age of 12.7 at the start of treatment. These cases were treated with edgewise mechanics and the extraction of upper first premolars. Extractions in the lower arch were performed where necessary to relieve crowding. The mean changes reported were: 9.31° for the

nasolabial angle, 3.19° for the labiomentalar angle, -4.42 mm for the Ls to E line, and -2.39 mm for Li to E line. Clearly, the mean angular changes mentioned above are greater than ours, although the nasolabial angle and the labiomentalar angle were the two measurements in our sample with greater individual variability.

Finnoy, Wisth and Boe (241) analyzed the profile changes in 30 Class II, division I cases treated with an edgewise appliance after extraction of four premolars. They found mean changes of 6.5° for the nasolabial angle, -2.4 mm for the Ss to E line, -3.3 mm for Ls to E line, -2.5 mm for Li to E line, and -1.3 mm for Si to E line.

Drobosky and Smith (69) evaluated the profile changes in 160 cases, between 10 and 30 years of age at the start of treatment, who were treated with removal of four first premolars. Their sample was composed of five different treatment subgroups. The mean changes reported from the subgroup treated with an edgewise appliance in northern California (23 patients) were: 3.58° for the nasolabial angle, -0.64 for the labiomentalar angle, -2.60 mm for the Ss to E line, -2.84 mm for Ls to E line, -3.32 mm for Li to E line, -2.10 mm for Si to E line, -1.70 mm. for the protrusion of the upper lip to Sn-Pg', and -2.62 mm for the protrusion of the lower lip to Sn-Pg.

William et al. (58) studied the changes in the soft tissue profile in patients treated in the mixed dentition with a bionator. Two groups of 30 individuals, between 9 and 12 years old and with Class II, Division 1, malocclusion were matched for age, sex, observation time, and dentofacial characteristics. Patients in the first group were treated with a bionator for an average of 18.7 months, resulting in a Class I molar relationship and reduction of overjet. The second group acted as a control and individuals did not receive any form of orthodontic treatment. Pretreatment and posttreatment cephalograms were analyzed.

Compared with the control group, the treated group demonstrated 1.97° decrease in ANB, a 3.35 mm increase in anterior facial height, 2.22° decrease in soft tissue profile convexity, and 17.4° increase in mentolabial angle (more in the bionator group than in the control group).

The effects of treatment with the functional appliances on hard tissue have been well documented, although the conclusions have been mixed. Some studies (194, 135) have reported orthopedic effects as part of the correction, while others (58) have found that the effects of the functional appliances are mostly dentoalveolar in nature. While the functional appliances affect the hard tissue, it also impacts the soft tissue profile. Proponents of the functional appliances claim that it improves soft tissue facial balance. However, the effects of bionator therapy on the integument and, consequently, esthetics, have not been quantified.

The objective of this study was, therefore, to compare and determine the treatment effects of the bionator and jasper jumper appliances on facial soft tissues.

5- MATERIALS AND METHOD

Our study included 43 patients (21 males and 22 females), who were selected from the archive files of the Orthodontic Department in the Dental Faculty of Marmara University. The sample consisted of three groups of Class II division 1 patient. Group 1, consisted of 11 patients (3 males, 8 females) who were treated with Bionator. Group 2, consisted of 22 patients (12 males, 10 females) who were treated with jasper jumper. Group 3, consisted of 10 patients (6 males, 4 females) who were considered as control group. Both sexes included in the study.

The mean age of Jasper Jumper therapy at the start was 14.3 years; treatment lasted an average of 6 month. For bionator group the average age at the beginning of the treatment was 11,18 years; and the average duration was 20.91 months. For control group the average age was 9.3 years. Both appliances were used until Class I molar relationship was achieved.

Patient Selection

The patients were chosen based on the following criteria:

- 1) Class II dental and skeletal malocclusions.
- 2) Adolescents with growth potential.
- 3) Cephalograms had to have been taken immediately before and after treatment.
- 4) Good oral hygiene.
- 5) Cooperative.

5.1. Appliance Design And Construction

5.1.1. Bionator

The bionator used in this study was designed by Balters (Figure 5.1). It is constructed of acrylic and wire, with its base of operation lingual to the dentition. The labial wire extended posteriorly into the vestibular region to function as the buccal shields. As with activator, lingual flanges were thought to stimulate forward posturing of the mandible and shelves or blocks between the teeth provided vertical control. The construction bite was taken with the incisors in an edge-to-edge relationship. The patients were instructed to wear the bionator at least 15 hours a day. For an orthodontic appliance to be worn 15 hours a day, it must be comfortable, with minimal interference with the tongue and soft tissues. First, the width of the acrylic body from the gingival margin to the border, in both the palate and the mandibular lingual regions, should be only 3-4mm in depth. This amount of acrylic is enough to maintain the bite registration and anchor the wire components. Second, the acrylic body should be as thin as possible. Third, the acrylic in the incisor region should extend from the lingual of the mandibular incisors to 2-3mm gingival to the lingual surfaces of the maxillary incisors. This provides an acrylic-free palatal area with more tongue space. Attention to these three details makes it possible for the appliance to be worn 24 hours a day. The appliance is strengthened with an .043" (1.1mm) palatal omega loop connecting the right and left acrylic components. In some cases— to expand contracted maxillary and mandibular arches— the omega loop is used in combination with an expansion screw incorporated in the lower anterior region of the appliance. A .030" (.8mm) labial arch wire extends to the mesial of the maxillary and mandibular first molars. The arch wire keeps the buccinator muscles and soft tissues away from the teeth and assists in expanding the buccal segments (Fig. 5.9). The labial arch-buccinator

wire enters the acrylic in the palatal area between the maxillary canines and first bicuspid. The wire must lie in the freeway space between the maxillary and mandibular buccal teeth, so it does not interfere with tooth eruption or appliance trimming (91).

5.1.2. Jasper Jumper

The basic design of the Jasper Jumper used in this study (Fig. 5.20-21) was an open-coil spring inside a plastic sleeve with metal offset plates on either end. It was fixed between the maxillary and mandibular arches, such that when activated, the appliance bowed away from the occlusal plane to deliver a bilateral force of 250–300 grams, pushing the maxilla and mandible apart. The Jasper Jumper was attached to the maxillary arch with a ball-pin attachment through the maxillary first molar band's headgear tube. It was attached to the mandibular arch using a $.017^2 \times .025^2$ stainless steel sectional arch wire with a ball stop (37). The distal end (which has an out-set bayonette bend just mesial to the mandibular first molar band's auxiliary tube) of the sectional arch-wire was inserted into the auxiliary tube of the mandibular first molar band (Fig. 5.22). The mesial end was looped over the main arch wire just distal to the mandibular canine bracket with enough separation for the Jasper Jumper to avoid occlusal interference and to clear the premolar brackets as it slides along the sectional wire (117). Jasper Jumper was placed in the mouth for 6 months. The treatment was continued until each patient achieved Class I occlusion. (Figures 5.23 to 5.37)



Fig 5.1 Frontal view of Bionator.



Fig 5.2 Superior view of Bionator.

Pre- and post-treatment intraoral and extraoral pictures of a Class II Div 1 patient who was treated with bionator for 10 months can be seen on Figures 5.3 to 5.19.



Fig 5.3. Pre-treatment Extraoral Frontal View



Fig 5.4. Pre-treatment Profile View



Fig 5.5. Pre-treatment Smiling View



Fig 5.6. Pre-treatment Intraoral Frontal View



Fig 5.7. Pre-treatment Right Lateral Intraoral View



Fig 5.8. Pre-treatment Left Lateral Intraoral View.



Fig 5.9. Intraoral View of Bionator Frontal.



Fig 5.10. Intraoral View of Bionator Right Side.



Fig 5.11. Intraoral View of Bionator Left Side.



Fig 5.12. Post-treatment Extraoral Frontal View.



Fig 5.13. Post-treatment Extraoral Lateral View



Fig 5.14. Post-treatment Extraoral Smiling View



Fig 5.15. Post-treatment Intraoral Frontal View



Fig 5.16. Post-treatment Right Lateral Intraoral View.



Fig 5.17. Post-treatment Right Lateral Intraoral View



Fig 5.18. Pre-treatment Overjet



Fig 5.19. Post-treatment Overjet



Fig 5.20 view of Jasper Jumper.



Fig 5.21 Different sizes of Jasper Jumper.



Fig 5.22 The J. J. attached to the arches

Pre- and post-treatment intraoral and extraoral pictures of a Class II Div 1 patient who was treated with Jasper Jumper can be seen on Figures 5.23 to 5.37.



Fig 5.23. Pre-treatment Extraoral Frontal View

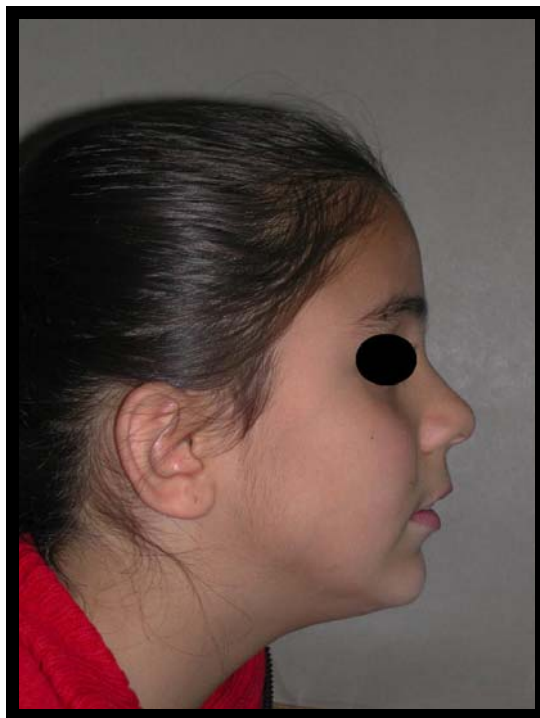


Fig 5.24. Pre-treatment profile view



Fig 5.25. Pre-treatment Smiling View



Fig 5.26. Pre-treatment Intraoral Frontal View



Fig 5.27. Pre-treatment Right Lateral Intraoral View



Fig 5.28. Pre-treatment Left Lateral Intraoral View.



Fig 5.29. Intraoral View of J J Frontal



Fig 5.30. Intraoral View of JJ Right Side.

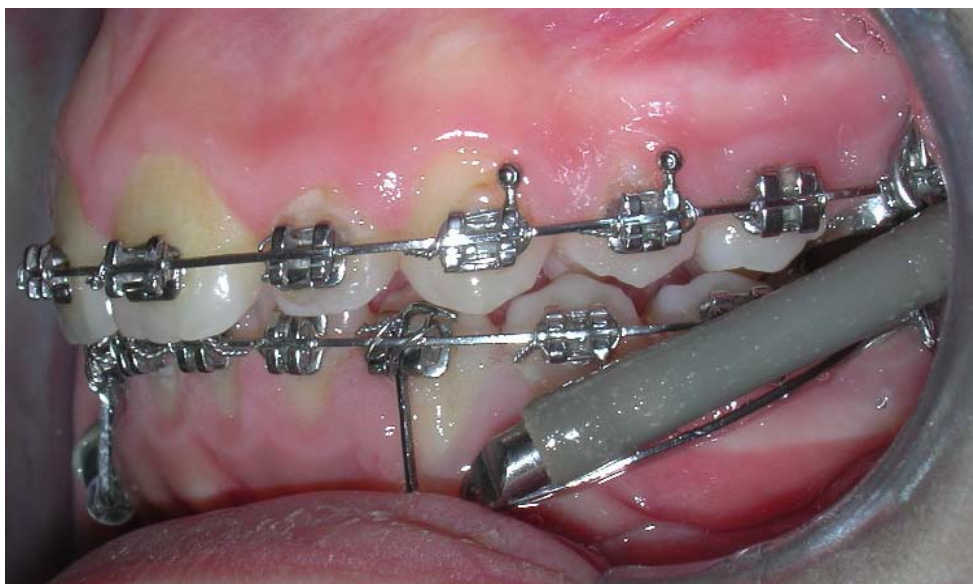


Fig 5.31. Intraoral View of JJ Left Side.



Fig 5.32. Post-treatment Extraoral Frontal View.



Fig 5.33. Post-treatment Lateral View of JJ Patient



Fig 5.34. Smiling View of JJ Patient



Fig 5.35. Post-treatment Intraoral Frontal View



Fig 5.36. Post-treatment Right Lateral Intraoral View.



Fig 5.37. Post-treatment Right Lateral Intraoral View

5.2. Cephalometric Method

Lateral cephalograms taken prior to and after treatment were chosen from the archive files of the Department of Orthodontic, Marmara University Faculty of Dentistry. All cephalograms were taken with patients in a standing position with relaxed lips. The relaxed lip position has been suggested as the best posture for cephalometric soft-tissue evaluation. Lateral cephalograms will carefully traced for each patient on 8 by 10 inch acetate paper. Each pair of radiographs of a patient will trace at the same sitting to minimize tracing errors. Since the x-rays evaluated in this study were taken by two different machines, during cephalometric analysis only angular measurements were used to exclude the magnification factor.

5.2.1. Cephalometric Landmarks

The following landmarks were identified on each cephalogram (fig. 5.38)
1- N (Nasion): The most anterior point of the frontonasal suture in the midsagittal plane.

2- N' (Soft-tissue nasion): The point of greatest concavity in the soft-tissue profile between glabella and pronasale.

3. Gl (Glabella): The most anterior point on the forehead, in the region of the supraorbital ridges.

5. B (B point): The most posterior midline point in the concavity of mandible between the most superior point on the alveolar bone overlying the lower incisors and pogonion.

6. B' (soft-tissue B point): The point of greatest concavity in the midline of the lower lip between labiale inferius and soft-tissue pogonion.

7. Pg' (soft tissue pogonion): The most anterior point of the soft tissue profile of the chin.

8. Prn (Pronasale): The most anterior point on the nasal tip.

9. Sn (Subnasale): The deepest point of the concavity at the junction of the lower border of the columella with the philtrum of the lip.
10. Po (Porion): The highest point on the roof of the external auditory meatus.
11. Or (Orbitale): The most inferior point on the lower border of the orbite
12. Li (Labiale inferius): The most anterior point on the lower lip.
13. Ls (Labiale superius): The most anterior point on the upper lip.
14. Si (Sulcus inferior): The point of greatest concavity in the midline between Labiale inferius and soft tissue pogonion.

5.2.2. Cephalometric Planes

These planes were used in the study (fig. 5.39)

- 1- FH (Frankfort Horizontal Plane): The horizontal line passing through the Porion (Po) and Orbitale (Or).
- 2- H line (Holdaway line): The tangent drawn from the tip of the chin (Pg') to the upper lip (Ls).
- 3- NB (Nasion-B point plane): Vertical line passing through the Nasion and B points.

5.2.3. Cephalometric Measurements

The following measurements will be used to examine changes in the soft tissue profile (fig 5.40)

1. Soft tissue facial angle: This is an angular measurement of a line drawn from soft-tissue nasion to the soft-tissue chin to the Frankfort horizontal plane
2. Soft tissue angle: This is the angle formed by the soft tissue glabella, subnasale, and soft tissue pogonion.
3. Total facial angle: This is the angle formed by the soft tissue glabella, tip of the nose, and soft tissue pogonion.

4. H-angle: This is the angle formed between the soft tissue facial plane line and the H line.
5. Z-angle: This is the angle formed by the Frankfort plane and a profile line formed by touching the Soft-tissue pogonion (Pg') and the most procumbent lip.
6. Nasolabial angle: This is the angle formed between the intersection of imaginary lines tangent to the columella and upper lip.
7. Inferior labial sulcus angle: This is the Angle formed by the intersection of the line drawn between Li and Si, and line drawn between Si and Pg' .

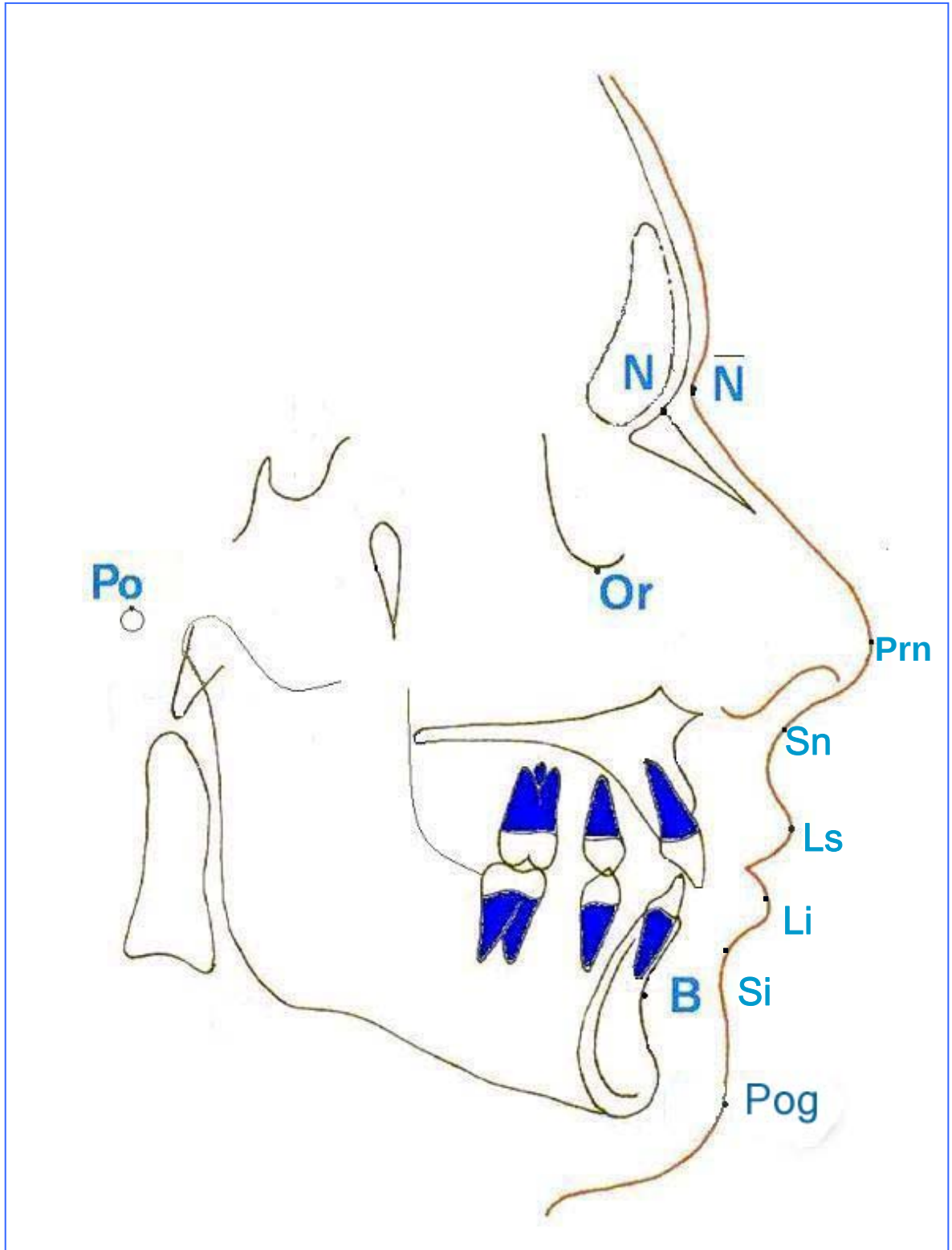


Fig.5.38. Lateral Cephalometric Landmarks.

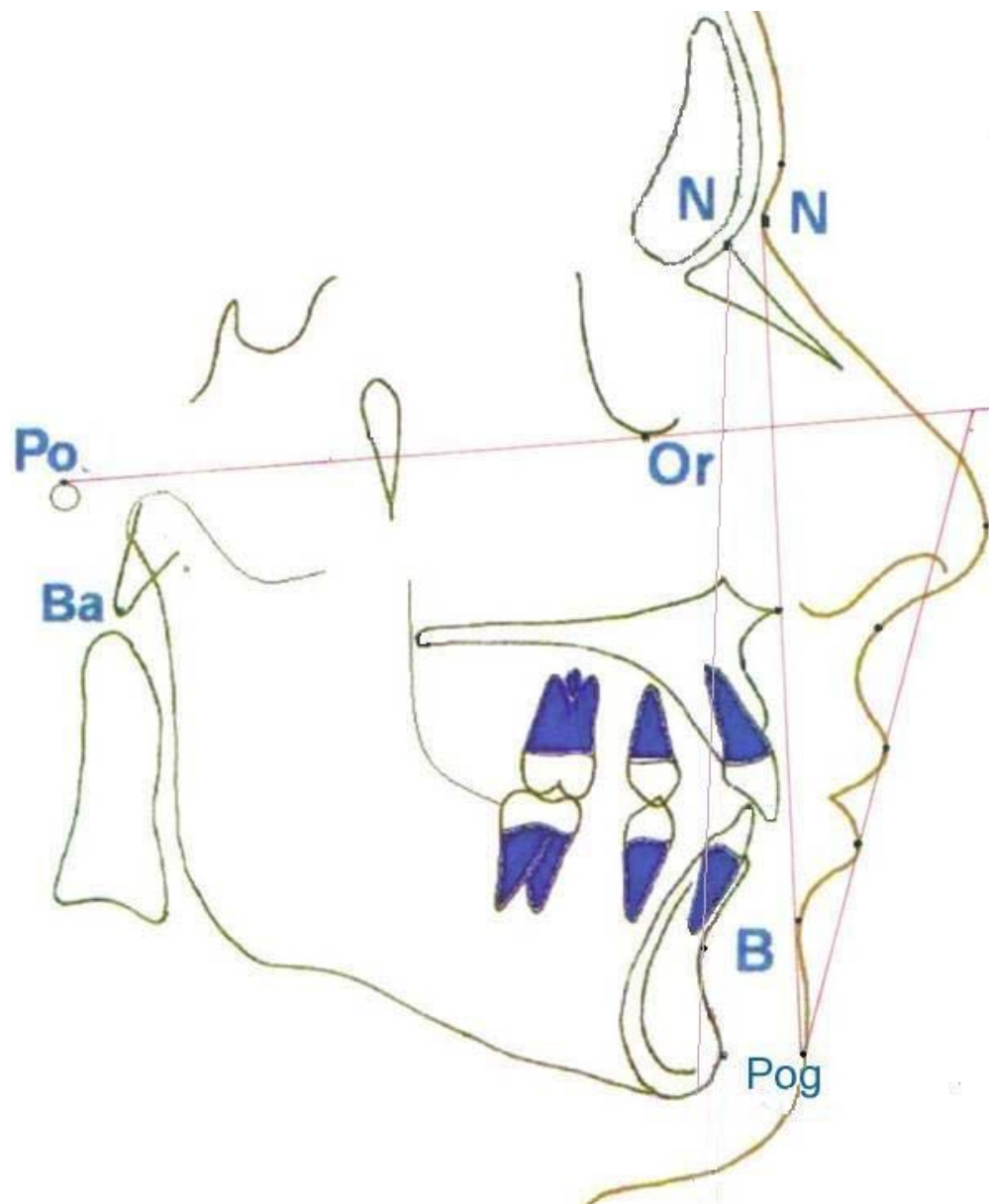


Fig.5.39. Cephalometric Planes.

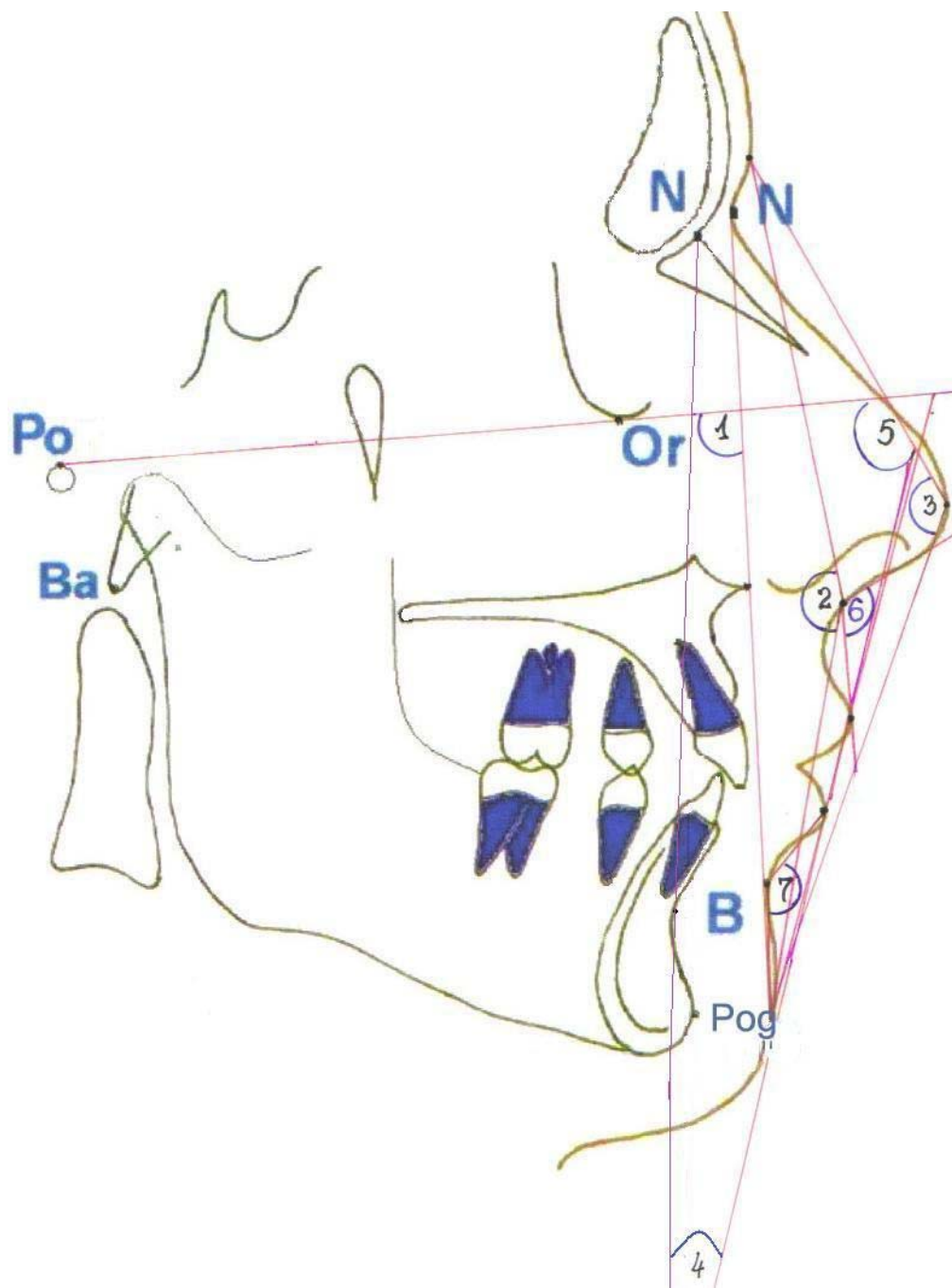


Fig.5.40. Cephalometric Angular Measurements.

5.3. Statistical Evaluation

Statistical calculations were performed with Paired t test used to compare before and after treatment for each group. One way Analysis of Variance (ANOVA) test also evaluated to compare differences of before and after between groups. Tukey HSD test was post-hoc multiple comparison for ANOVA. Significance level accepted as 0,05.

To evaluate the error of reproducibility of the method, 3 patients' cephalometric films from each group were randomly selected. Replicate tracings were drawn 3 times for 5 angular measurements from each film in different times. The standard deviation (SD) of the random error and the coefficient of reliability were calculated. For most measurements, the error coefficients were found to be close to 1.00 and within acceptable limits.

6. RESULTS

Table 6.1.Changes in Soft Tissue Facial Angle

	Before		After		Difference		p
	m	sd	m	sd	m	Sd	
Bionator	88,82	4,19	91,27	3,64	2,45	2,07	0,003
Jasper Jumper	87,18	4,02	88,95	2,84	1,77	3,50	0,027
Control	86,00	6,06	87,50	2,51	1,50	5,68	0,425

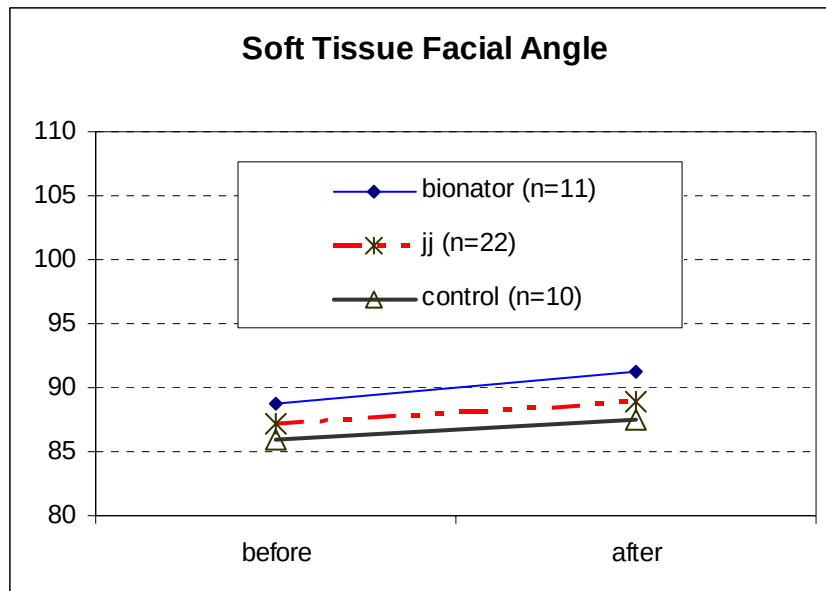


Figure 6.1. Soft Tissue Facial Angle

Soft tissue facial angle showed significant increase of 2,45 degrees in bionator group and 1,77 degrees in Jasper Jumper group while insignificant increase of 1.50 in control group.

Table 6.2.Changes in Soft Tissue Angle

	Before		After		Difference		P
	m	sd	m	sd	m	Sd	
Bionator	155,91	4,32	161,82	6,90	5,91	4,44	0,001
Jasper Jumper	160,00	4,86	162,86	5,45	2,86	2,93	<0,001
Control	161,10	5,13	161,50	4,45	0,40	4,03	0,761

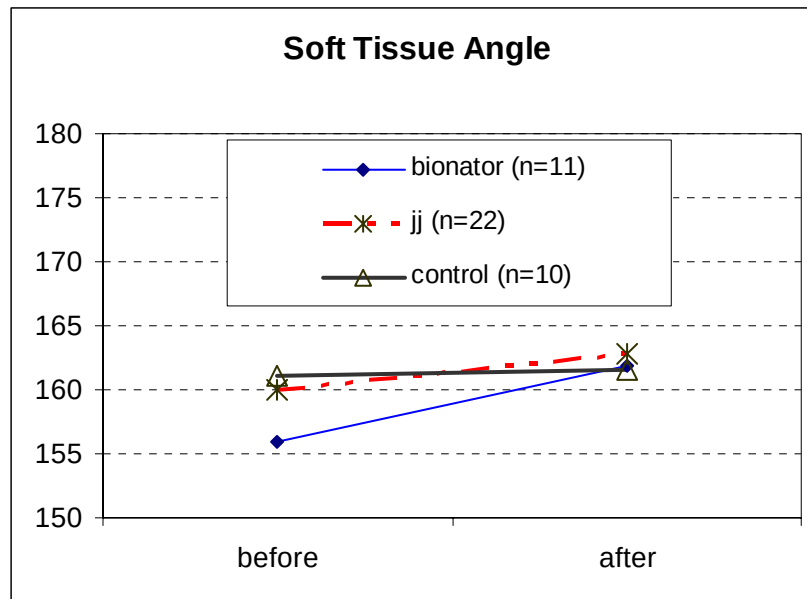
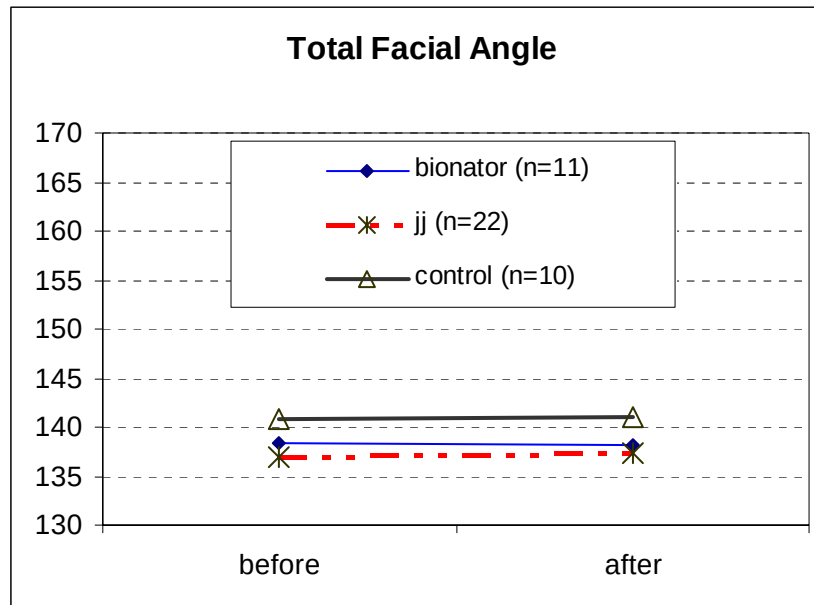


Figure 6.2. Soft Tissue Angel

The Soft tissue angel showed increase of 5.91 degrees in bionator group and 2.86 degrees in jasper jumper group. Both were significant changes. The increased in control group of 0, 40 degree was insignificant.

Table 6.3.Changes in Total Facial Angle

	Before		After		Difference		P
	m	sd	m	sd	m	sd	
Bionator	138,36	5,18	138,18	5,95	-0,18	2,79	0,833
Jasper jumper	137,00	5,03	137,36	5,74	0,36	2,52	0,505
Control	140,80	4,73	141,10	4,20	0,30	2,58	0,722

**Figure 6.3. Total Facial Angle**

The bionator group showed a slightly decrease in the total facial angle of -0, 18 degree and a slightly increase of 0, 36 degree in jasper jumper group and 0, 30 degree in control group. The changes in all groups were insignificant.

Table 6.4. Changes in H Angle

	Before		After		Difference		P
	m	sd	m	sd	m	sd	
Bionator	16,45	6,86	11,27	5,39	-5,18	4,33	0,003
Jasper Jumper	14,41	4,95	11,68	4,20	-2,73	2,77	<0,001
Control	14,40	4,40	13,00	3,68	-1,40	2,12	0,066

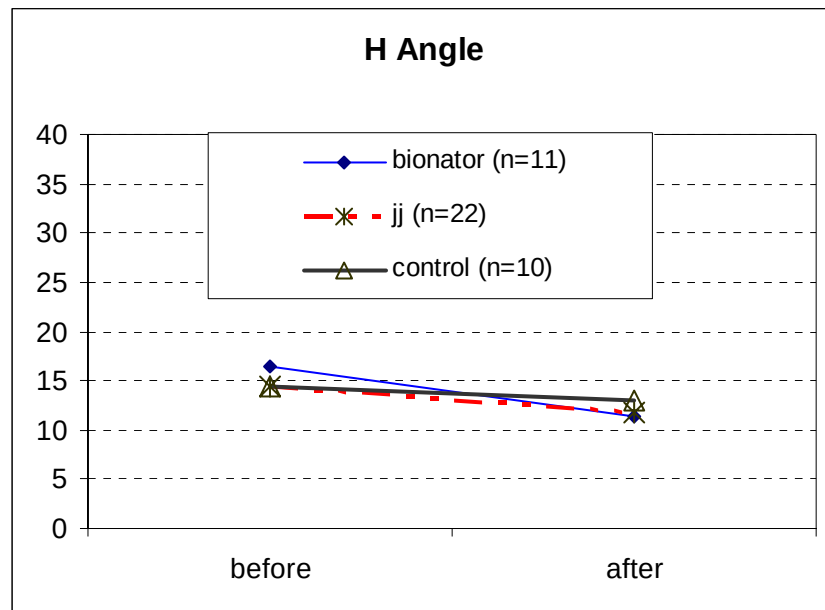


Figure 6.4. H Angle

The H angle showed decrease of -5,181 degrees in bionator group and -2,736 degrees in jasper jumper group. Both are significant changes. The decreased in control group of -1,40 degrees is insignificant.

Table 6.5.Changes in Z Angle

	Before		After		Difference		P
	m	sd	m	sd	m	sd	
Bionator	66,45	9,10	74,00	9,32	7,55	5,59	0,001
Jasper Jumper	67,41	6,73	71,68	6,39	4,27	4,37	<0,001
Control	67,30	5,89	69,20	5,14	1,90	5,13	0,272

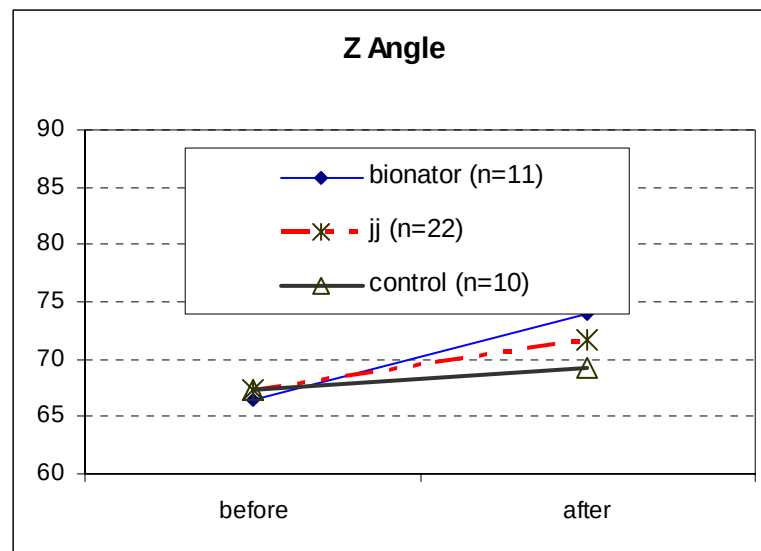
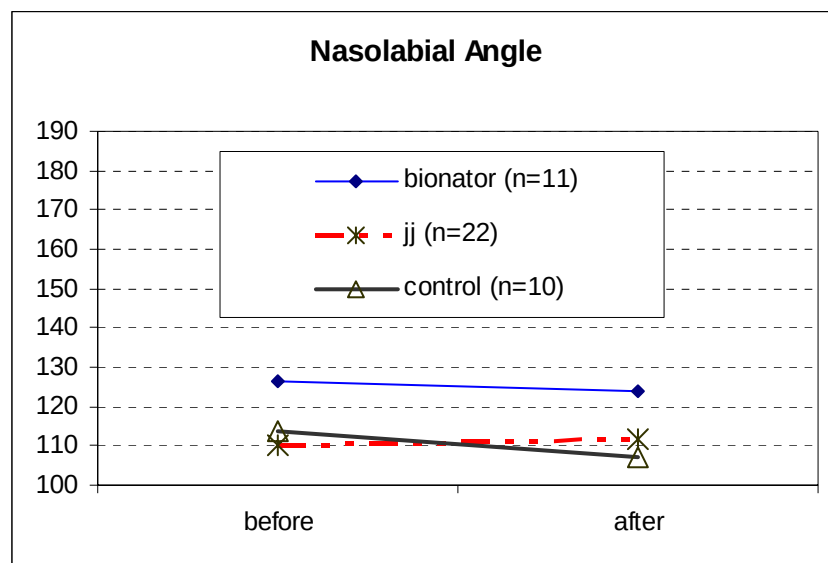


Figure 6.5. Z Angle

The Z angel showed increase of 7, 55 degrees in bionator group and 4, 27 degrees in jasper jumper group. Both were significant changes. The increased in control group of 1, 90 was insignificant.

Table 6.6.Changes in Nasolabial Angle

	Before		After		Difference		P
	m	sd	m	Sd	m	sd	
Bionator	126,55	9,84	123,82	7,72	-2,73	9,57	0,367
Jasper Jumper	110,09	11,24	111,86	9,53	1,77	8,92	0,362
Control	113,80	10,33	107,30	13,47	-6,50	14,94	0,202

**Figure 6.6. Nasolabial Angle**

The Nasolabial angle showed insignificant decrease of -2,73 degrees in bionator group and of -6,50 degrees in control group while it increased slightly by 1,77 degrees in jasper jumper group . All the changes were insignificant.

Table 6.7. Changes in Inferior Labial Sulcus Angle

	Before		After		difference		P
	m	sd	m	Sd	m	sd	
Bionator	93,73	24,31	115,73	16,06	22,00	26,31	0,020
Jasper Jumper	97,68	11,48	118,86	14,98	21,18	11,03	<0,001
Control	111,50	17,10	102,10	11,40	-9,40	18,11	0,135

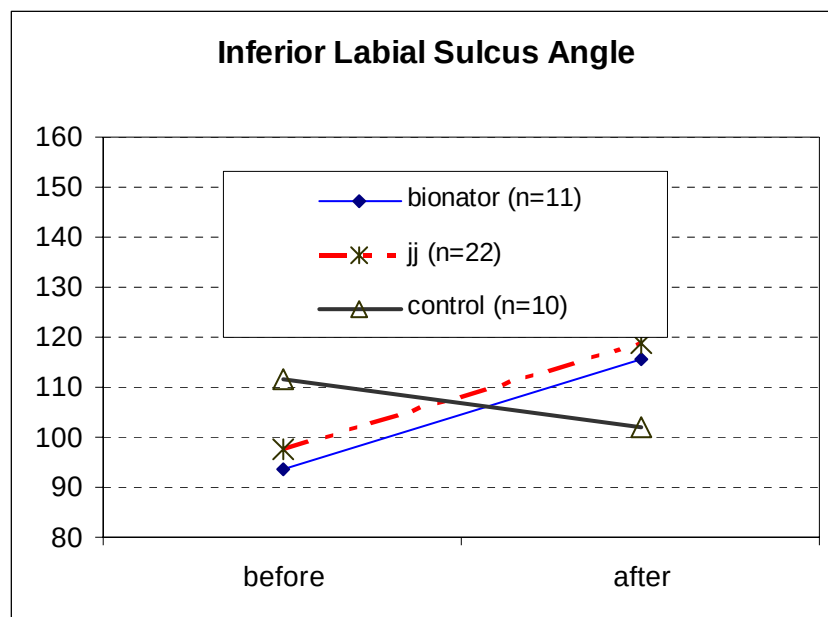


Figure 6.7. Inferior Labial Sulcus Angle

The Inferior labial sulcus angle showed a significant increase of 22,00 and 21,18 degrees in bionator and jasper jumper groups respectively while it decreased slightly by 9,40 degrees in control group . The decrease in the control group was insignificant.

Table 6.8. Intergroup Comparison of The Mean Differences.

	Bionator		Jasper jumper		Control		p
	m	sd	m	sd	m	Sd	
Soft Tissue Facial Angle	2,45	2,07	1,77	3,50	1,50	5,68	0,84
Soft Tissue Angle	5,91	4,44	2,86	2,93	0,40	4,03	0,005
Total Facial Angle	-0,18	2,79	0,36	2,52	0,30	2,58	0,84
H-Angle	-5,18	4,33	-2,73	2,77	-1,40	2,12	0,024
Z-Angle	7,55	5,59	4,27	4,37	1,90	5,13	0,037
Nasolabial Angle	-2,73	9,57	1,77	8,92	-6,50	14,94	0,12
Inferior Labial Angle	22,00	26,31	21,18	11,03	-9,40	18,11	0,001

There was no significant difference in the changes in Soft tissue facial angle between the three groups.

There was also no significant difference in the changes in Soft tissue angle between the two treatment groups, but bionator group showed significant increase than the control.

There was no significant difference in the changes in Total facial angle between the three groups.

There was no significant difference in the change in H-angle angle between the jasper jumper and control group, but there was a significant difference between the bionator group and the control group.

There was no significant difference in the increase in the Z-angle between the two treatment groups, but the increase in the bionator group was significantly differed from the control group.

There was no significant difference in the changes in Nasolabial angle between the three groups.

The two treatment groups both showed significantly increased in Inferior labial angle than the control group.

7. DISCUSSION

7.1. Discussion of Aim, Materials and Methods.

Improving facial aesthetics is one of the aims of orthodontic treatment. However, changes in the facial profile may occur due to many factors, such as dental movement or growth (185). The soft tissues reflect the changes that have occurred in the underlying hard tissues. However, functional appliances, besides improving the skeletal relationship, also alter the soft tissue profile. A Class II malocclusion may result from a mandibular deficiency, maxillary excess or a combination of both, but the most common finding is mandibular skeletal retrusion (119, 147). Functional jaw orthopedic appliances are designed to encourage adaptive skeletal growth by maintaining the mandible in a corrected forward position (50). Subjects presenting with a Class II division 1 malocclusion have specific clinical characteristics, such as an increased overjet, and an unfavorable profile which may produce negative feelings of self-image and self-esteem (211, 229). Patients with Class II malocclusions generally present with convex facial profiles and a retrognathic soft tissue pogonion associated with mentalis activity to achieve an anterior lip seal (236, 108).

Appliance therapy to correct such a malocclusion should ideally be directed towards addressing the dentoskeletal disharmony, in order to obtain a favorable facial aesthetic result. The literature contains a large number of studies investigating the mechanisms of action and the effects of different orthopedic appliances designed to correct Class II division 1 malocclusions. Most of these, however, have concentrated on recording the dentoskeletal changes (20) and have ignored the effects on the soft tissue facial profile (192).

The aim of the present study is to evaluate and compare the changes in the soft tissue facial profile, in subjects with a Class II

division 1 malocclusion, resulting from treatment two types of appliances the Bionator and Jasper Jumper with the comparison of control group.

To ascertain the effects of treatment, it is essential to compare the effects with a matched or at least comparable control sample. Only a few studies have used persons with untreated Class II malocclusion as controls (141). Many other studies either refer to Class I controls or present no control data. Our study evaluates 10 patients, who had previously refused treatment, were selected as a control group.

The length of the observation period was longer in the bionator group. Therefore, 20–30 per cent of the differences observed between the control group and the treatment groups might be explained by difference in growth rather than the effect of treatment. All female and male subjects were pooled in the present study to increase the sample size.

The sample comprised 43 patients (21 males and 22 females) with a Class II division 1 malocclusion. Twenty two (12 males, 10 females; mean age 14.3 years) subjects were treated with a Jasper Jumper appliance and 11 patients (3 males, 8 females; mean age 11,18 years) were treated with a Bionator appliance while the remaining 10 (6 males, 4 females; mean age 9.3 years), who did not undergo any intervention, served as the control. As the activator and the Jasper Jumper are quite different appliances in design and, possibly, mode of action, a study comparing the two treatment methods would be warranted.

Bionator

The bionator used in this study was designed by Balters (Figure 5.1). It is constructed of acrylic and wire, with its base of operation lingual to the dentition. The construction bite was taken with the incisors

in an edge-to-edge relationship. The patients were instructed to wear the bionator at least 15 hours a day.

For an orthodontic appliance to be worn at least 15 hours a day, it must be comfortable, with minimal interference with the tongue and soft tissues. First, the width of the acrylic body from the gingival margin to the border, in both the palate and the mandibular lingual regions, should be only 3-4mm in depth (Fig. 2). This amount of acrylic is enough to maintain the bite registration and anchor the wire components. Second, the acrylic body should be as thin as possible. Third, the acrylic in the incisor region should extend from the lingual of the mandibular incisors to 2-3mm gingival to the lingual surfaces of the maxillary incisors. This provides an acrylic-free palatal area with more tongue space. Attention to these three details makes it possible for the appliance to be worn 15 hours a day. As with activator, lingual flanges were thought to stimulate forward posturing of the mandible and shelves or blocks between the teeth provided vertical control. The appliance is strengthened with an .043" (1.1mm) palatal omega loop connecting the right and left acrylic components.

An .030" (.8mm) labial archwire extends posteriorly into the vestibular region to the mesial of the maxillary and mandibular first molars to function as the buccal shields. The archwire keeps the buccinator muscles and soft tissues away from the teeth and assists in expanding the buccal segments (Fig. 3). The labial arch-buccinator wire enters the acrylic in the palatal area between the maxillary canines and first bicuspid. The wire must lie in the freeway space between the maxillary and mandibular buccal teeth, so it does not interfere with tooth eruption or appliance trimming. The labial wire extended.

Jasper Jumper

Jasper Jumper is a modification of the Herbst appliance. Instead of a rigid tube and piston mechanism, the Jasper Jumper uses a flexible force module that increases patient comfort by allowing greater lateral and sagittal movements of the mandible. Unlike bionator appliance which is removable, the Jasper Jumper appliance, is fixed to the teeth; the advantage is that it is worn 24 hours a day thereby obviating the problem of patient compliance.

The basic design of the Jasper Jumper used in this study (Figure 1) was an open-coil spring inside a plastic sleeve with metal off-set plates on either end. It was fixed between the maxillary and mandibular arches, such that when activated, the appliance bowed away from the occlusal plane to deliver a bilateral force of 250–300 grams, pushing the maxilla and mandible apart.

The Jasper Jumper was attached to the maxillary arch with a ball-pin attachment through the maxillary first molar band's headgear tube. It was attached to the mandibular arch using a $.017^2 \times .025^2$ stainless steel sectional archwire with a ball stop (37). The distal end (which has an out-set bayonette bend just mesial to the mandibular first molar band's auxiliary tube) of the sectional arch-wire was inserted into the auxiliary tube of the mandibular first molar band. The mesial end was looped over the main archwire just distal to the mandibular canine bracket with enough separation for the Jasper Jumper to avoid occlusal interference and to clear the premolar brackets as it slides along the sectional wire. (117) Jasper Jumper was placed in the mouth for 6 months. The treatment was continued until each patient achieved Class I occlusion (fig, 5.32-34).

Lateral cephalograms taken prior to and after treatment were chosen from the archive files of the Department of Orthodontic, Marmara University Faculty of Dentistry. All cephalograms were taken with patients in a standing position with relaxed lips. The relaxed lip position has been suggested as the best posture for cephalometric soft-tissue evaluation. lateral cephalograms will carefully traced for each patient on 8 by 10 inch acetate paper. Each pair of radiographs of a patient will trace at the same sitting to minimize tracing errors. Since the x-rays evaluated in this study were taken by two different machines, during cephalometric analysis only angular measurements were used to exclude the magnification factor.

A number of methods have been used to evaluate these facial changes including anthropometry, photogrammetry, computer imaging and cephalometry. Profiles have been evaluated by using both cephalometric or photometric linear and angular measurements, or combinations of metric, angular, and proportional measurements. In addition, the profile was also qualitatively evaluated by using silhouettes, probably the most simplified method for assessing facial esthetics because it specifically focuses on the overall outline of the profile (77, 169).

Burstone (44) presented a method to analyze the soft-tissue profile by means of angular and linear measurements. He described the average morphology and the variation of acceptable profiles and reported that desirable and undesirable alterations in the facial contour could be influenced by the underlying dentoskeletal framework.

Neger (163) reported a method for evaluating the soft-tissue profile in a quantitative manner with the help of profile photographs and cephalograms. He indicated that the straight profile does not necessarily accompany normal occlusion.

Subtelny (223) published a longitudinal study of the soft-tissue facial structures and their profile characteristics, defined in relation to underlying skeletal structures.

Ricketts (192) proposed a line which he called the "esthetic plane" to describe the relationship of the lips to the soft-tissues of the chin and the nose. In Caucasian adults the lips should be contained within this line drawn from the chin to the tip of the nose.

The nasolabial angle is a vital consideration in treatment planning for patients with dentofacial deformities. An arbitrary value of 90 to 110 degrees or less has been used to evaluate nasal base inclination(51-52, 43).

Soft-tissue facial angle (Fig. 5.38). This is an angular measurement of a line drawn from soft-tissue nasion, where the sella-nasion line crosses the soft-tissue profile, to the soft-tissue chin at a point overlying the hard-tissue suprapogonion of Ricketts measured to the Frankfort horizontal plane. This chin point is chosen because of the bony stability here during growth and because in cases in which there is hypermentalis activity resulting in an uneven distribution of the integumental covering of the bony chin it is a more realistic point at which to measure the chin prominence. It is a better measurement of chin prominence in a face than the hard-tissue facial angle because of the wide range of variations that we find in the thickness of the soft-tissue chin. A measurement of 91 degrees is ideal, with an acceptable range of ± 7 degrees (82).

Holdaway (110) proposed a method of analyzing the soft-tissue profile both as a means of diagnosis and as a method for determining changes in the soft-tissue profile induced by growth and treatment. He

proposed the "H" angle, formed by a line drawn from the point of the soft-tissue chin tangent to the upper lip and the N-B line, as a measure of profile acceptability. He believed that the H angle should be 7 to 9 degrees when the ANB angle is 3 degrees.

7.2. Discussion Of Soft Tissue Changes Due To Treatment

Soft tissue facial angle showed a significant increase of 2,45 degrees in bionator group and 1,77 degrees in Jasper Jumper group while insignificant increase of 1.50 in control group. Increase of Soft tissue facial angle was the result of forward movement of soft tissue pogonion. These finding correlate well with Forsberg and Odenrick, (194) who reported a significant increase in the advancement of soft tissue pogonion, and with Korkhaus, (127) who made the clinical observation that activator therapy decreases the convexity of the soft tissue profile. Frank J. and Bengt I. in their study, initial effects of treatment of Class II malocclusion with the Herren activator, activator-headgear combination and Jasper Jumper, found significant anterior movement of the pogonion (82, 83) . The inhibition of forward movement of subnasale and increased anterior movement of soft tissue pogonion are reflective of the amount of movement of the underlying skeletal structures (58). Forsberg and Odenrick (194) reported a significant increase in the advancement of soft tissue pogonion. Cátia and Ione (47) found a significant improvement in the facial profile, which closely followed the underlying dentoskeletal changes. Covell et al (53) evaluated the dental and skeletal effects of the Jasper Jumper appliance used in the correction of Class II Division 1 malocclusions. They reported that the skeletal measures showed reduced forward maxillary displacement.

Control group showed insignificant increase in our study. In agreement with this result, the data from the subnasale vertical reference

line would tend to suggest to the clinician that the relative positions of the upper lip and soft tissue chin are likely to remain constant with maturation of the child and that this should be taken into account in treatment planning. The absolute values seen at age 17 of the Class I and Class II cases were very similar to those seen in Spradley's study of ideal faces (120).

The Soft tissue angle showed increase of 5.91 degrees in bionator group and 2.86 degrees in jasper jumper group. Both are significant changes. The increased in control group of 0,40 degree is insignificant. The two treatment appliances were used in this study stimuli the forward movement of the chin in the same time have a head gear effect on the maxilla. Increase of Soft tissue angle was, to a greater extent, the result of soft tissue pogonion coming forward and, to a lesser extent, due to subnasale being restricted in its forward movement. William Lange and Varun Kalra (58) found a significant change in the profile of patients treated with the bionator. Soft tissue facial convexity, as determined by G-Sn-Pg', increased 2.22° more in the bionator group than in the control group. Facial convexity (without the nose) has been studied both cross-sectionally (42) and longitudinally. The findings from the different studies demonstrate much controversy. Longitudinal studies (139) have demonstrated relative stability in facial convexity after the age of 6 years. Bishara, used multiple regression analysis in his study, concluded that a significant increase in facial convexity occurs from age 5 to age 9. From age 9 to age 13 facial convexity remains relatively stable, and then it decreases from 13 years to adulthood. Lange et al. (58) and Morris et al. (155) reported lower lip protrusion and a decrease in soft tissue profile convexity by functional appliances treatment. Gögen and Parlar (94) evaluated the soft tissue profile of patients treated with an activator. They found decrease in convexity due to forward movement of chin. Hakan and Özgür (96) found a significant protrusion of the lower lip due to activator.

The total facial angle showed a slightly decrease in bionator group of -0,18 degree and a slightly increase of 0,36 degree in jasper jumper group and 0,30 degree in control group. The changes in all groups are insignificant. The findings of our study are in agreement with previous investigations. Chaconas and Bartroff (49) have shown that total facial convexity increases with age. This is equated by an angle (Gl'-Pr-Pog' or N'-Pr-Pog') that decreases with age. All male and female subjects demonstrated an increase in total facial convexity from the age of 5 years to adulthood. This increase in total facial convexity has been shown to be due primarily to a greater increase in nasal prominence relative to the rest of the soft-tissue profile with growth. Studies that include nasal changes seem to report increasing soft tissue convexity with age, while those that don't include nasal changes report a relative flattening. One of the first longitudinal cephalometric studies to include the soft tissue was by Subtelny, who found that despite the straightening of the skeletal profile with age, the soft tissue profile remained relatively convex. He observed that soft tissue contours diverge from those of the underlying skeletal framework in certain areas, and suggested that a disproportionate rate of growth of the nose aided in the increase of soft tissue convexity with age (222).

The H angel showed decrease of -5,181 in bionator group and -2,736 in jasper jumper group. Both are significant changes. The decrease in control group of -1,40 degrees is insignificant. Similar result was reported by other researchers. Robinson and Rinchuse have suggested that patients who begin adolescence with a Class II skeletal profile often continue to lack facial harmony as they mature. This lack of harmony is manifested by a greater tendency to develop disproportionate nasal size and an increased prominence of the nasal dorsum (206). Holdaway (82) suggested that, with a normal ANB angle of 1° to 3°, the Holdaway angle should be 7° to 9°. The larger the ANB angle, the larger Holdaway's soft-tissue angle, unless there is soft-tissue compensation.

The Z angel showed incese of 7,55 degrees in bionator group and 4,27 degrees in jasper jumper group. Both are significant changes. The increased in control group of 1,90 is insignificant . The changes in the treatment groups due to retraction of the upper lip and anterior movement of soft tissue pogonion. Such increase in the Z angle was achieved and reported by many operators who used functional appliances. Robsmar and Marco concluded that the twin block appliance significantly improved the Z angle ($P < 0.01$), reflected in reduced soft tissue facial convexity. Thus, the most significant effects were a total facial profile improvement, retraction of the upper lip and anterior movement of soft tissue pogonion ($P < 0.05$). Subjects treated with a twin block appliance achieved improved facial harmony, but such changes were not observed in the control group. Merrifield (152) found that, in the 11 to 15-year age group, the average Z angle was $78^{\circ} \pm 5^{\circ}$, with females demonstrating higher Z angle values than males. In the Bishara's study (217), no sexual differences were found. The average Z angle values were considerably lower than those reported by Merrifield. The average values found in his study ranged from a low of 66.5° to a high of 73.7° . The average values found in our study ranged from a low of $66,45^{\circ}$ to a high of $74,00^{\circ}$.

The nasolabial angle showed insignificant decrease of -2,73 degrees in bionator group and of - 6,50 degrees in control group while it increased slightly by 1,77 degrees in jasper jumper group . All the changes are insignificant. The result showed more decrease in the control than the treated groups which reflect the effect of head gear effect of functional appliances on the upper maxillary complex. The findings of this study agree with those of the nasolabial angle did not show any significant reduction in the treated group. The upper lip did retract about 1.0 mm more in the treated group than in the control group, relative to the Sn-Pg' line. However, this was in part due to the fact that Pg' came forward more in the treated group, thereby moving the Sn-Pg' line

forward. Overall, treatment with the bionator had minimal effect on the upper lip.

The inferior labial sulcus angle showed a significant increase of 22,00 and 21,18 degrees in bionator and jasper jumper groups respectively while it decreased slightly by -9,40 degrees in control group . The decrease in the control group was insignificant. The findings of this study agree with those of William and Varun. In their study two groups of 30 individuals, between 9 and 12 years old and with Class II, Division 1, malocclusion were matched for age, sex, observation time, and dentofacial characteristics. Patients in the first group were treated with a bionator for an average of 18.7 months, resulting in a Class I molar relationship and reduction of overjet. The second group acted as a control and individuals did not receive any form of orthodontic treatment. Pretreatment and posttreatment cephalograms were analyzed and paired t-tests were used to compare the significance of changes between the two groups. Compared with the control group, the treated group demonstrated 2.22° decrease in soft tissue profile convexity, and 17.4° increase in mentolabial angle (58). Bloom (36) stated that there was a definite relationship between the dentoskeletal framework and the soft-tissue profile around the mouth. The maxillary incisor movements were closely related to changes in the superior labial sulcus ($r = 0.89$). The upper lip changes are correlated closely with the mandibular incisor changes ($r = 0.87$). The inferior sulcus and the lower lip were also affected by dental changes. Nalbantgil et al evaluated soft tissue changes induced by the jasper jumper appliance used in late adolescence. They found that Straightening of the labiomental fold was significant.

7.3. Discussion Of Comparison Of The Mean Differences

There was no significant difference in the changes in Soft tissue facial angle between the three groups. The changes were greater in the bionator group than jasper jumper and control groups but the difference was not statistically.

There was no significant difference in the changes in Total facial angle between the three groups. There was also no significant difference in the changes in Soft tissue angle between the two treatment groups, but bionator group showed significant increase than the control. Subtelny stated that the bony facial profile tended to become less convex with age. The soft-tissue profile, including the nose, increased in convexity with growth and the soft-tissue profile, excluding the nose, showed a tendency to remain relatively stable in its degree of convexity.

There was no significant difference in the change in H-angle between the jasper jumper and control group, but there was a significant difference between the bionator group and the control group. However, no significant difference was found between the effects of the bionator and the jasper jumper on the H-angle. The reduction in H-angle was greater in the bionator group than in the jasper jumper group, but the difference was not statistically, and is unlikely to be clinically, significant. This may be due to the short treatment period of jasper jumper. On the other hand, there is a significant difference between the bionator group and the control group.

There was no significant difference in the average Z angel increased when the bionator was compared with the jasper jumper group. While, there was a statistically significant increased (7,55) in the bionator group relative to the increased in the controls (1,90). Similar findings on patients treated with the banded Herbst appliance were reported by Pancherz.

Nasolabial angle decreased an average of -6,50 degrees in the untreated Class II sample. It decreased an average of -2,73 degrees in the bionator group and slightly increased 1,77 degrees in the jasper jumper group. No significant differences were observed between either of the treatment groups or the control group. The slight differences between the groups may reflect the effect of the appliances on the maxillary complex. Katsavrias and Halazonetis (122) found posteriorly directed forces acting on the maxilla during activator wear. Öztürk and Tankuter (171) reported that restriction on sagittal displacement of the maxillary complex with the activator.

Treatment induced changes in Inferior labial angle were almost similar for the bionator and jasper jumper groups. The two treatment groups showed significantly increased in Inferior labial angle than the control group. Dentoalveolar effects (proclination of the lower incisors and retroclination of the upper incisors) and forward movement of pogonion played an important role in this correction. Both the appliances have an effect on dentoalveolar structure and the lip position. Such effect on dentoalveolar structure was achieved and reported by many operators who used jasper jumper and bionator appliances. Hakan and Özgür evaluated the soft tissue profile of patients treated with an activator. They found significant protrusion of the lower lip. (96) It was determined that the profile improvement in both the groups was because of the Changes observed in the lower lip, upper lip and soft tissue pogonion that were influenced from the forward displacement of the mandible and protrusion of the mandibular incisors (175). As the upper incisors retruded, the upper lip moved back and the lower lip was no longer captured behind the upper incisors. Moreover, the proclined lower incisors supported the lower lip. (206) Subtelny reported the effect of functional appliance on the lip position. He presented five patients who showed a change in lip position due to treatment and growth and concluded that lip posture was closely correlated with the posture of the

underlying dental and alveolar structures. Cope et al (54) used a Jasper Jumper in 31 Class II patients and evaluated the craniofacial changes. They reported that the changes were mostly dentoalveolar rather than skeletal. According to their results, the maxilla underwent significant posterior displacement, the maxillary incisors retroclined, whereas the maxillary molars tipped distally. Also, a clockwise rotation of the mandible was evident and the mandibular incisors proclined significantly, whereas the mandibular molars tipped mesially. Weiland and Bantleon (237) studied 17 consecutive growing patients with Class II division 1 malocclusions treated with Jasper Jumper appliances and reported that the correction of the malocclusion was achieved both by skeletal (40%) and dental (60%) changes. As with these findings, Kucukkeles and Orgun (128) showed that the appliance produced mostly dentoalveolar changes. David and Dennis reported that while the Jumpers were in place, maxillary incisors were retroclined and mandibular incisors were proclined and intruded. Skeletal measures showed reduced forward maxillary displacement and no significant alteration of horizontal mandibular growth. In summary, their study found that the Jasper Jumper appliance corrected Class II discrepancies largely through maxillary and mandibular dentoalveolar effects and, to a limited extent, by restraint of forward maxillary growth (60). Anderson (87) and Ricketts (86) have stated that the position of the lower lip may be influenced by changes in the position of the upper incisors in those cases that initially demonstrated increased overjet. However, Monahan found less correlation between lower lip change and upper incisor retraction in his subsample with increased overjet. Hunter (88) and Roos (198) found low correlations between the two variables in Class II, Division 1. O'Brien et al (168) used a modified Twin-Block and found that the overjet correction was due mostly to the dental changes (73%), which included retroclination of the upper incisors (44%) and proclination of the lower incisors (29%). Skeletal changes (27%) consisted of a slight maxillary retraction (13%) and mandibular advancement (14%).

Thus it can be concluded that when compared with the untreated Class II sample, both bionator and jasper jumper treatment improved the soft tissue profile. However, any superiority of the bionator over the jasper jumper in improving the facial convexity was not significantly. Further comparison studies are suggested to investigate the long term stability of our result.

8. CONCLUSION

8.1. Intra-group

1. The Soft tissue facial angle and Soft tissue angel showed significant increase in both treatment groups while insignificant increase in control group.
2. The Total facial angle showed insignificant increase in jasper jumper group and control group. The bionator group showed insignificant decrease.
3. The H angel showed significant decrease in bionator and in jasper jumper groups while decreased in control group was insignificant.
4. The Z angel showed significant increase in bionator group and in jasper jumper the increased in control group was insignificant.
5. The Nasolabial angle showed insignificant decrease in bionator and control groups while it increased slightly in jasper jumper group. All the changes were insignificant.
6. The Inferior labial sulcus angle showed significant increase in bionator and jasper jumper groups while it decreased slightly in control group . The decrease in the control group was insignificant.

8.2. Inter-group

1. There was no significant difference in the changes in the all angels between bionator and jasper jumper groups.
2. There were significant differences in increase of Soft tissue angle, H-angle and Z-angle between the bionator and the control groups.

3. The two treatment groups both showed significantly increased in Inferior labial angle than the control group.

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10. BIOGRAPHY

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