Bionator Treatment in Class II, Division 1

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Twenty cases treated with a Bionator followed by fixed appliance therapy are compared to an untreated sample and a group treated with fixed appliances only. The most notable differences in Bionator effects are increased vertical dimension and mandibular plane angle. The first appliance used, whether Bionator or fixed, produced similar changes.

KEY WORDS: • BIONATOR • FUNCTIONAL APPLIANCE • TREATMENT

The Bionator is one of many removable appliances used today for correction of Class II, Division 1 malocclusions. Its design objectives include the alteration of maxillary and mandibular skeletal, dental, and muscular relationships. This clinical cephalometric study uses measurements of positions of bony landmarks before and after bionator therapy, and after follow-up fixed-appliance therapy, in an attempt to answer some of the many unanswered questions about the effects of these appliances.

Many past studies have described positive effects with various functional appliances. There is a general consensus that favorable growth is often attainable, but this is defined in various ways. KELSEY (1926) defines the effect as stimulation of "subnormal" growth during the growing years. J. P. Moss (1962) refers to removing "inhibitory" factors which retard the growth of the mandible.

GROSSMANN ET AL. (1965) state that the mandible sometimes fails to realize its full growth potential due to restraining environmental factors. They feel that functional appliances can aid the mandible in the attainment of its genetic potential. This explanation for functional appliance action may explain some of the great variability in the results that are achieved. Individual variation is probably the most frustrating aspect of functional appliance treatment, as it is in most ortho-

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dontic treatment. Some patients achieve rather quick and dramatic results, while others benefit little.

MARSCHNER AND HARRIS (1966) also suggest that genetic growth potential is important. They state that functional appliance therapy can only alter growth within the limits of the individual's genetic growth potential.

The types of effects achieved by researchers have also varied. BJÖRK (1951) found only dentoalveolar changes resulting from functional appliance therapy. A bionator study by JANSON (1977) revealed results similar to Björk's. He concluded that the effect of the bionator in the underlying skeletal areas was not significant.

Results published by WIESLANDER AND LANGERSTROM (1979) show "favorable" bite opening and an increase in the anterior facial height, but they do not show any significant increase in mandibular growth.

Many researchers and practitioners feel that the apparent flaring of mandibular incisors is a problem with this type of therapy. TRAYFOOT AND RICHARDSON (1968), HAUSSER (1969), AND JANSON (1977) all report this effect.

Many have also reported on condyle reactions, including BAUME ET AL. (1959), BAUME (1962), CHARLIER ET AL. (1969), ENDICOTT ET AL. (1947), MCNAMARA AND CARLSON (1979), MCNAMARA ET AL. (1982), PETROVIC ET AL. (1975), AND PETROVIC AND STUTZMANN (1982).

Whether the mandible will grow or not is really not in serious question; the concern of the clinician is how, and *how much,* it will grow — and whether any of that growth is actually a direct effect of the treatment.

This study relates appliance choice and management to treatment results.

— Methods and Materials —

Twelve males and eight females, ranging in age from 9yr to 14yr, were selected for bionator treatment. The mean age at the start of treatment was 11.8yr for the males, and 11.1yr for the females. Mean age at the end of the bionator treatment period was 12.9yr for the males, and 12.1yr for the females.

All experimental patients exhibited an Angle Class II, Division 1 malocclusion with a retrognathic or deficient mandible.

Two control samples are utilized. The first is cephalometric data from untreated males and females of comparable ages reported by Riolo et al. (1974)

The second control sample, also of comparable age, received only fixed appliance orthodontic treatment, with no bionator appliance therapy. The cephalometric data for this control sample was taken from the records of Rocky Mountain Data Systems of Van Nuys, California. These records were made available through the Foundation for Orthodontic Research.

— Procedures —

Treatment

All subjects in the experimental sample were treated with a bionator. Treatment time ranged from 8mo to 20mo, with a mean treatment time of 12.7mo. This treatment was then followed by a second treatment phase with fixed orthodontic appliancee for an average time of 15.9mo.

Evaluation

Standard lateral cephalometric radiographs were taken of all subjects in the experimental sample at three different stages of treatment. The first was an initial pre-bionator treatment record, the

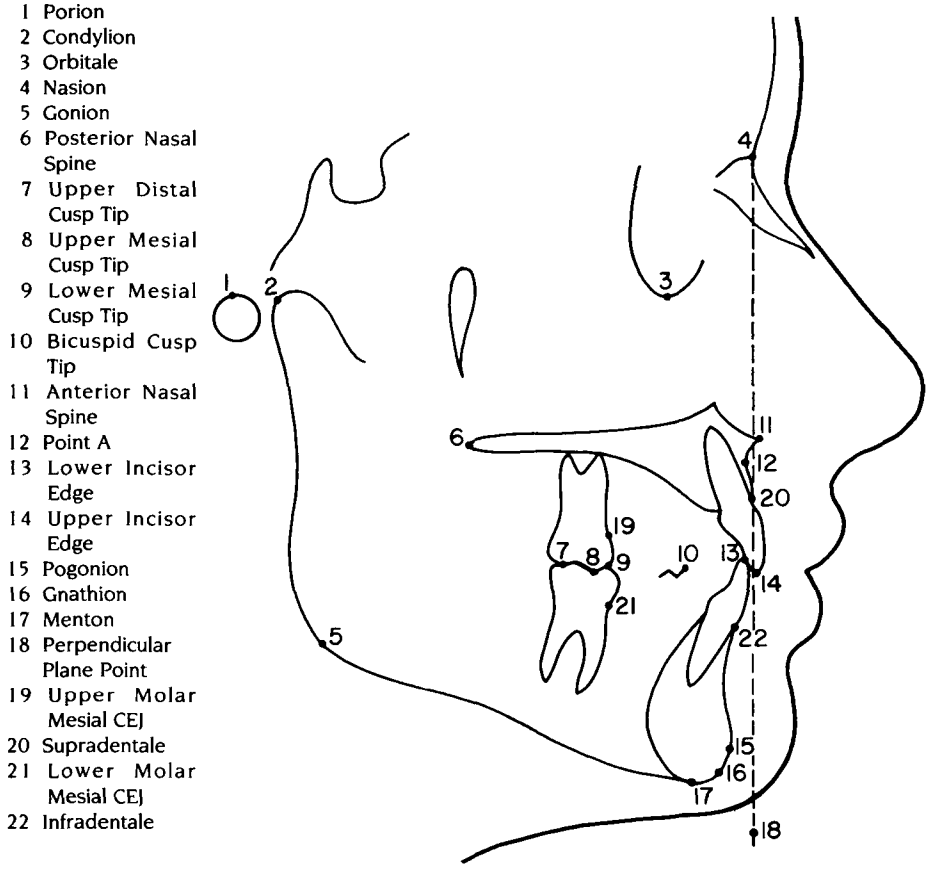

Fig. 1 Cephalometric Landmarks

second after the bionator treatment was completed, and a third following the fixed appliance phase of treatment. All radiographs were exposed with the mandible positioned in centric relation.

Reference points determining linear and angular measurements were recorded on a digitizer and translated into an X Y coordinate system.

The cephalometric landmarks that were used in this study are shown in Fig. 1. The thirteen linear and angular measurements used to analyze the cephalometric radiographs are used by RIDLO ET AL. (1974), MCNAMARA (1981), AND ISAACSON ET AL. (1971). These measurements are shown in Fig. 2.

Hypotheses

Thirteen null hypotheses were formulated to evaluate each of the thirteen parameters measured. The first phase of this study, the bionator appliance phase, includes thirteen hypotheses for the male values, thirteen for the female values, and thirteen for the combined total values.

The second phase of this study, the fixed appliance phase, also has three comparable sets of thirteen hypotheses.

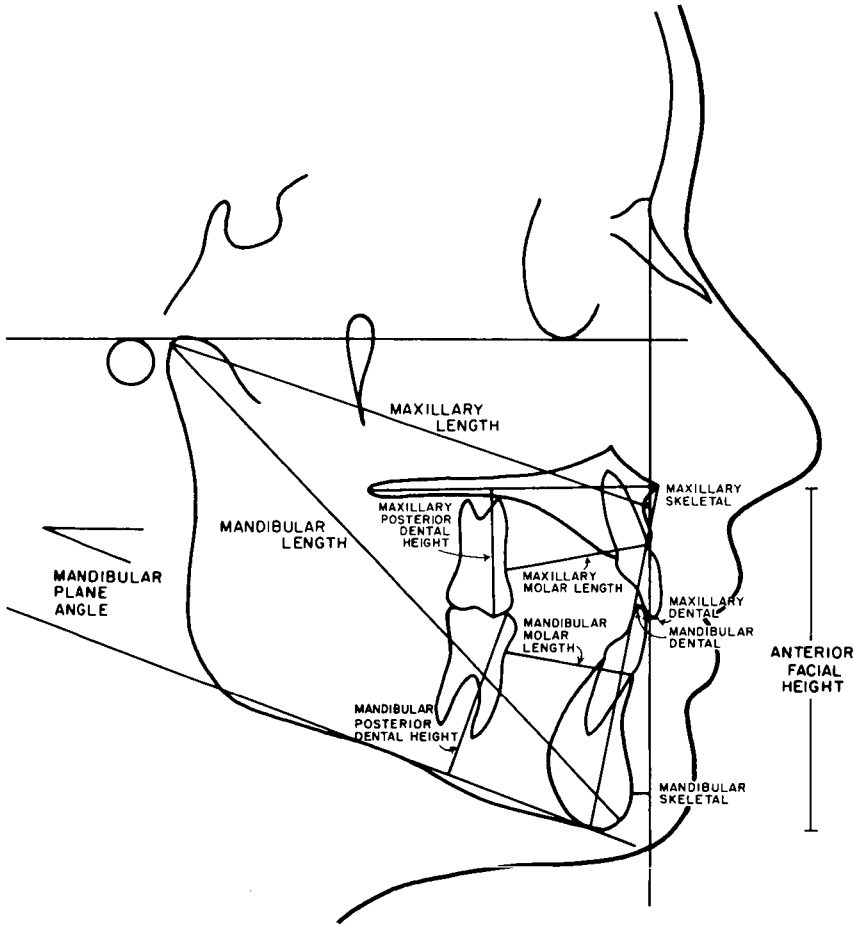

Fig. 2 Linear and Angular Measurements

A comparison must also be made between the differences between the raw data measurements and the control sample measurements. Twenty-six additional null hypotheses were needed to define these differences.

Statistical Analysis

A dependent "t" test was utilized to analyze the differences between the pre-bionator and post-bionator raw data measurements, and the post-bionator and post-fixed raw data measurements. This provides an evaluation of the significance of the effects of the bionator appliance and the fixed appliances on the patients in the experimental sample.

Independent "t" tests are utilized to analyze the differences between the experimental sample and the control samples. Difference values were computed, and the difference values were compared statistically. The difference values for the bionator phase of the experimental sample were compared with the difference values for the nontreat-

ment control norms. The difference values for the fixed appliance phase of the experimental sample were also compared with the difference values of the fixed-treatment control sample.

— Findings —

The dependent t test results reveal that changes do occur over time, but the most useful comparisons are found in the independent t tests.

No significant differences were found between the male and female patients.

Maxillary skeletal parameter changes show no statistically significant differences between groups, although a general pattern consistent with the anticipated bionator effect on the maxilla can be discerned in the mean values of the maxillary skeletal parameter —

- For the nontreatment control norm this value is +0.1mm.
- For the bionator experimental sample it is −0.4mm
- For the fixed appliance phase in the experimental sample it is +0.2mm
- For the fixed treatment control sample it is −1.2mm

This can be interpreted as indicating a retrusive or inhibitory effect on the maxilla during bionator therapy; since the proposed effect of the bionator therapy is to treat a mandibular deficiency, this slight retrusive effect is contrary to the desired effect, but nevertheless helpful in reducing the overjet.

The maxillary dental parameter is a measure of incisor position. The bionator experimental sample value of −2.22mm reveals an uprighting or retracting effect on the incisors, compared to −0.01 for the fixed treatment phase, −0.08 for the fixed treatment controls and +0.15mm for the untreated controls.

The mandibular dental parameter exhibited no significant differences for any of the four groups. The bionator design used in this study makes use of a mandibular incisal capping mechanism. If proper attention is given to the adjustment of this capping mechanism, very little mandibular incisor flaring should occur.

The Mandibular Skeletal parameter measures a complex of changes, in the sense that it is so closely related to several other dimensions. Because pogonion is one of the landmarks used in determining this parameter, any other dimension that has an influence on the position of pogonion has relational significance. The Mandibular Plane Angle and Anterior Facial Height can have significant effects. This value ranged from −10.7mm to +6.0mm in the bionator phase, with the mean of −0.05 showing a negligible difference from the +0.37mm control mean. The mean value for the fixed treatment phase on these patients was +1.91mm, and for the fixed-apliance controls it was +0.61mm.

The three patients showing the greatest negative change in Pogonion during the bionator phade also exhibited average increases of 6° in the Mandibular Plane Angle and 3mm in Anterior Facial Height. The effect of these changes means that pogonion moved down and back, masking and negating the effect of any actual mandibular growth.

The Mandibular Plane Angle, like the Mandibular Skeletal parameter, is dependent on other factors that may or may not be related to appliance therapy. Disproportionate eruption of molars will cause an increase in the mandibular plane angle. The bionator is designed for posterior eruption of teeth as the mandible is positioned forward. Such changes explain some of the changes seen in the mandibular plane angle.

The mean value for change in the mandibular plane angle in the nontreatment control sample is −0.26°, indicating a slight closing and forward shift of pogonion. Negative values are also seen in the fixed appliance phase in the experimental sample (−0.99°), and the fixed controls (−0.05°). The +1.46° average opening of this angle in the bionator treatment phase is the only positive mean change.

The Mandibular Length parameter is probably the most important measurement in this study in terms of identifying any true mandibular growth. It is also more subject to error than most measurements because of the difficulty in accurately locating the bilateral condylion points to eliminate mandibular positioning errors.

It is important to remember that the patient is growing throughout treatment; what is intended with the bionator treatment is to accelerate the growth rate.

Statistically significant differences were found in mandibular growth. The mean mandibular length increase for the nontreatment control sample is 2.52mm. This is the baseline normal growth against which other changes are judged. During the bionator treatment phase, mandibular length increased an average of 5.05mm, and during the following fixed treatment phase it was only 2.77mm. On the other hand, the fixed treatment control sample shows a 4.44mm increase that approaches that in the bionator sample. The difference in the two fixed appliance groups suggests that a mandibular growth response is more dependent on phase of treatment than appliance choice — in each case the maximum response occurred in the first phase.

Anterior Facial Height increase in the bionator experimental sample is over twice the mean value for the nontreatment control norms. One of the objectives of bionator therapy is bite opening, accomplished through molar eruption.

The bionator sample exhibited a statistically significant difference in Mandibular Posterior Dental Height increase, 1.88mm vs. 0.80mm for the controls. The mean value of 1.84 for the fixed appliance treatment controls shows a similar effect, while the 0.88mm mean change in the edgewise phase that followed bionator therapy shows little difference from the untreated controls. Again, the change appears to be more dependent on treatment phase than appliance choice.

No significant differences were seen in the Maxillary Posterior Dental Height. The reason why so much bionator phase extrusion is seen in the mandibular molars and not in the maxillary molars is because the acrylic is maintained on the mesial and lingual surfaces of the maxillary first molars, where it serves as a mesial and vertical stop.

The last two measurements to be discussed are the Maxillary Molar Length and the Mandibular Molar Length. These arch depth measurements are included to demonstrate that these are nonextraction cases, and that the overall dental effect of the bionator is minimal. The mean values for the bionator experimental sample and the nontreatment control norms are comparable, and the mean values for the fixed experimental sample and the fixed control sample are not significantly different.

— Discussion —

In review, the significant findings in this study show that the bionator affected the maxillary dental parameter (protrusion), mandibular length, the mandibulo-maxillary difference, and mandibular posterior dental height. Findings for the fixed appliance phase

following bionator treatment show that, aparently because the previous bionator treatment had already accomplished major changes, the changes in dental and skeletal parameters are near normal growth values.

These results compare favorably with much of the current literature. However, they results contradict some statements questioning bionator appliance effectiveness. This study shows that with the proper management, the skeletal changes can be more significant than dentoalveolar change, with correction of a Class II malocclusion involving some skeletal growth acceleration in the mandible. This study does not find maintaining the original lower incisor position to be a problem; no significant changes in incisor position occurred in this sample.

By following the experimental patients through the fixed phase of treatment, it becomes evident that the normalization of various skeletal and dental parameters occurs during the bionator phase of treatment, and that during the fixed phase the changes more closely resemble the changes expected for a Class I correction.

— Summary and Conclusion —

This study evaluates the action of the bionator appliance on patients with an Angle Class II, division 1 malocclusion. It is unique in that it also evaluates the effects of the follow-up fixed orthodontic treatment. Changes in these two phases of treatment are compared to changes in an untreated sample and a sample treated with fixed appliances only.

Significant findings for effects of Bionator treatment are:

- The Bionator treatment produced some maxillary incisor retraction and uprighting.
- Mandibular plane angle was increased.
- The increase in mandibular length was slightly greater than with fixed appliance therapy only.
- Increase in anterior facial height was more than with fixed appliances.
- Increase in mandibular molar eruption was similar to that with fixed appliance therapy.
- Changes with fixed appliance therapy only resemble the Bionator changes more closely than they resemble changes with fixed appliances following Bionator treatment.
- Similar major changes were accomplished by whichever appliance was used first, regardless of whether it was Bionator or fixed appliance.

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