AN EVALUATION OF CHANGES IN THE VERTICAL POSITION OF INCISORS DURING VARIOUS STAGES OF REFINED BEGG MECHANOTHERAPY: ORIGNAL RESEARCH

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ABSTRACT

This retrospective cephalometric study assessed changes in the vertical position of upper & lower incisors during various stages of refined Begg mechanotherapy following four first premolar extractions.

Sample comprised of forty lateral cephalograms of ten post-pubertal patients (six females and four males with mean ages 16.6 & 17.5 years respectively) with skeletal class II malocclusion and deep overbite, taken at pre-treatment and end of different stages. Vertical position of incisor was measured as perpendicular distance from selected reference plane to an incisor centroid. Differences in vertical positions between various stages were calculated and Student's t-test applied to determine statistical significance of difference at $p < 0.001$.

Results indicate significant intrusion of both upper & lower incisors at end of stage I with minimal alteration in their position at end of stage II. At the end of stage III, significant extrusion of upper incisor results where as lower incisors demonstrate minimal change and remain intruded throughout treatment.

Within limitations of a retrospective cephalometric design, the study concludes that true incisor intrusion is attainable with refined Begg mechanotherapy and modifications in treatment mechanics are indicated, especially for maxillary anterior region to preserve this intrusion throughout treatment and translate it into clinically significant results.

Key Words: Begg mechanotherapy, cephalometric,overbite

INTRODUCTION:

Correction of a deep overbite is often one of the primary goals of comprehensive orthodontic treatment because of its potentially detrimental effects on the temporomandibular joint function, periodontal health as well as esthetic perceptions.[1,2] Though opinions have differed regarding the etiology of a deep overbite & its subsequent treatment; the difficulties encountered in its correction are well documented, especially in adults. There are many treatment modalities designed specifically to "open up the bite", however the relative contributions of tooth movement, skeletal changes & growth are yet to be fully comprehended.[2]

Four inter-related factors contribute to the non-surgical correction of an increased vertical overlap of teeth: molar extrusion, incisor intrusion, tipping of incisors & differential growth of maxilla & mandible. Varied treatment modalities & techniques have been employed for the correction of a

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deep overbite by achieving a combination of the above factors, the best options depending upon individual characteristics, treatment objectives & esthetic considerations.[2,3]

Since its introduction half a century ago, the 'pure' Begg technique has proved to highly effective in correction of alignment, overbite, and overjet & in most cases it can be used to position teeth in an excellent relationship to one another. [4] The anchor bends & class II elastics work together to extrude the molars & the anchor bends intrude the incisors. If the elastics & anchor bends are properly balanced, they serve to maintain the molars in an upright position. Though this mechanism produces nearly optimal effects in the mandibular arch of an average patient, the effects are considered less than ideal on the maxillary arch.[4]

The stage I appliance in Begg mechanotherapy opens the bite, this however can be the result of one or a combination of several occluso-gingival displacements & the exact manner of bite opening continues to be a subject of discussion.[5] Bite opening was attributed mainly to molar extrusion & some amount of intrusion of the lower incisors.[6]

The capability of Begg mechanotherapy to produce intrusion of the maxillary anterior teeth, particularly the incisors has been questioned; though support exists at least partially in its favour because of the potential for extrusion of these teeth during stage III mechanics. [5] Thus, whether the incisors, especially the upper, intruded, remained at the same level or actually extruded continues to be a matter of endless speculation, more so because the labio-lingual position of the incisor influences its vertical incisal edge and the subsequent clinical impression of a deep overbite correction.[1,2,6]

Studies carried out to evaluate the changes in the vertical position of incisors during Begg mechanotherapy hitherto have employed incisal edges or root apex as reference points for measurement of the changes but these can produce faulty results as they are influenced by changes in tooth inclination.[3] The centre of resistance or centroid of the incisor, defined as a point on the longitudinal axis of the tooth that is independent of any change in its inclination is the reference point of choice for evaluating these vertical changes.[3] A reference plane relative to the incisor centroid must also be used to evaluate the changes in its vertical position. [3]

Bearing these issues in mind, this particular study was designed to evaluate changes in the vertical position of upper & lower incisors during various stages of refined Begg mechanotherapy- a retrospective, cephalometric appraisal of clinical cases treated with four premolar extractions.

MATERIALS AND METHODS:

A. Sample

This study examined the lateral cephalometric records of 10 patients (6 females, 4 males) treated with four premolar extraction employing refined Begg mechanotherapy. All the subjects were treated by post-graduate students under the guidance of a single consultant. The mechanics were those normally used by faculty supervising the treatment. Inclusion criteria were as follows:

1. Age at the start of treatment: 14 or more for females & 16 or more for males (based on supposed puberty at 9-14 and 12-16 years respectively)[7]. Mean age was found to be 16.6 & 17.5 years for females & males respectively.

2. Angle's class I or class II malocclusion on a class II skeletal base relationship (as determined by ANB angle greater than 5°) with the presence of a deep overbite at the start of treatment. This was determined cephalometrically as overbite greater than 3.3 mm (STCA- Arnett et al[8]) and if necessary confirmed from the pre-treatment study models. Mean overbite at the start of treatment was found to be 4.63 mm.

3. Refined Begg mechanotherapy carried out after four first premolar extractions.

4. No extra oral appliances were used. Transpalatal & lingual arches were used wherever indicated.

5. Light elastics: yellow, 5/16 inches, $2\text{-}2^{1/2}$ oz (T.P. laboratories, USA) changed every 3-4 days were used throughout the treatment.

6. Satisfactory treatment results on completion.

7. Availability of lateral cephalometric radiographs of good definition & detail, taken at pre-treatment & at completion of each stage of treatment. All the cephalograms were taken from the same cephalostat with same exposure parameters.

B. Technical details

The cephalograms taken at pre-treatment, end of stage I, II & III were designated as T_0, T_1, T_2 & T_3 respectively. Cephalometric tracings were performed on sheets of matt acetate paper with 0.35 mm tracing pencil & the necessary structures were traced to allow identification of superimposition points.

The centroid or centre of resistance (C.R) of the upper and lower incisors was marked as a point at 50% of the root length from the cementoenamel junction to the root apex. The reference planes chosen were- palatal plane (line connecting the anterior and posterior nasal spine) and mandibular plane (line connecting anatomic gonion & menton) for evaluating changes in the vertical position of the upper & lower incisor centroid respectively.[2,11,12] Vertical position of the incisor was measured as the perpendicular distance between the incisor centroid & mentioned reference planes [2,11,12] (Fig. 1 & 2)

A calliper (Mercer precision instruments) which is accurate to the nearest 0.1 mm was used for conducting the measurements that were performed at all four stages (T_0 through T_3) for all 10 patients and the corresponding readings were noted as difference between any two stages (between pre-treatment & stage I, stage I & stage II and stage II & stage III & pre-treatment and stage III). The vertical change was defined as true intrusion or extrusion based on the apical or coronal movement of the centroid to its respective reference plane.[1] The magnitude of this movement was noted in millimetres and intrusion was connoted as by (-) sign.

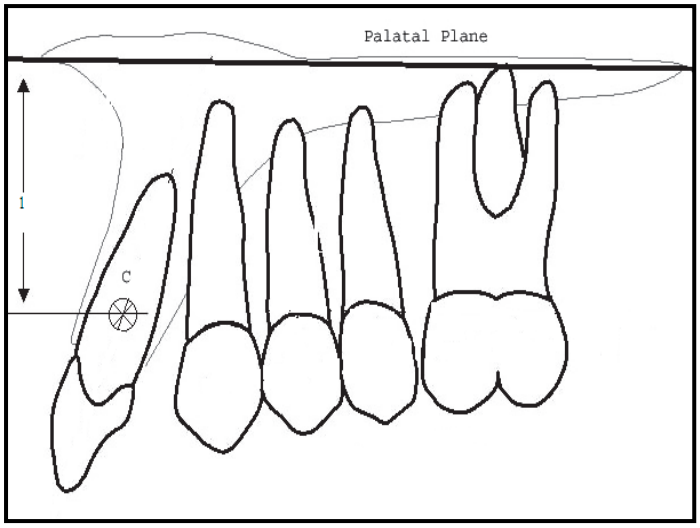

Fig. 1: Measurement of perpendicular distance (1) from Upper incisor centroid (C) to palatal plane

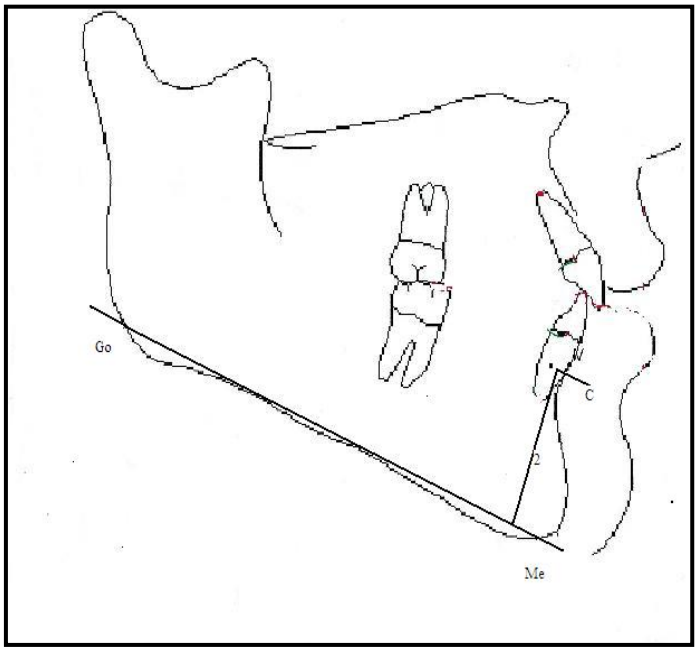

Fig. 2: Measurement of perpendicular distance (2) from Lower incisor centroid (C) to mandibular plane

C. Statistical methods

Data analysis was performed using the Microsoft Excel software (Microsoft Office 2007). The readings obtained as differences between two stages were analyzed by computing their average, standard deviation & standard error. Two tailed Student's t-test was used to determine statistical significance of difference between each of the stages. A value of '$p < 0.05$' was considered to be statistically significant where as 'p-values' lesser than 0.001 were considered as highly significant.

D. Measurement of error

Twenty lateral cephalograms (half of the sample) selected randomly were retraced and the measurements were repeated. Mean, standard deviation and standard error of repeated measurements was

calculated. The combined error of tracing and measurement was not significant at $p < 0.05$.

All the cephalometric tracings & measurements were performed and repeated by the same operator. (Corresponding author)

RESULTS:

A. For measurement of upper incisor centroid to the palatal plane:

1. All ten patients included in the study demonstrated intrusion of the upper incisors at the end of stage I (T_1), an average intrusion of 1.84 mm was noted that was highly significant at $p < 0.001$
2. At the end of stage II (T_2) a mean extrusion of 0.11 mm was noted that was not significant.
3. At the end of stage III (T_3) an extrusion of upper incisor was noted in all ten patients, mean value 1.23 mm that was highly significant at $p < 0.001$
4. Comparison between pre-treatment (T_0) and end of treatment (T_3) values showed that an average 0.5 mm intrusion persisted at the end of treatment that was not statistically significant.
5. Compared to the pre-treatment position, five patients each demonstrated intrusion & extrusion of the upper incisors at the end of stage III.
6. Among the five patients who demonstrated intrusion at the end of treatment, mean intrusion was 1.46 mm.
7. Among the rest five patients who demonstrated extrusion, mean extrusion was 0.575 mm

Table I & II summarize the measurements of upper incisor centroid to the palatal plane and descriptive statistics for upper incisor position respectively.

Table I: Measurement of upper incisor centroid to the palatal plane.

Sr. No	T_0	T_1	T_0 to T_1 Diff.	T_2	T_1 to T_2 Diff.	T_3	T_2 to T_3 Diff.	T_0 to T_3 Diff.	Final upper incisor position
1.	16.8	13.1	-3.7	13.4	0.3	13.7	0.3	-3.1	Intrusion
2.	13.3	11.7	-1.6	11.9	0.2	14.4	2.5	1.1	Extrusion
3.	12.3	11.3	-1.0	11.0	-0.3	12.2	1.2	-0.1	Intrusion
4.	14	12.3	-1.7	12.7	0.4	14.2	1.5	0.2	Extrusion
5.	18.4	15.7	-2.7	16.7	1.0	17.0	0.3	-1.4	Intrusion
6.	13.7	13	-0.7	12.6	-0.4	14.0	1.4	0.3	Extrusion
7.	11.4	10.5	-0.9	10.8	0.3	11.2	0.4	-0.2	Intrusion
8.	10.5	9.4	-1.1	9.0	-0.4	10.6	1.6	0.1	Extrusion
9.	12.0	8.5	-3.5	9.0	0.5	9.5	0.5	-2.5	Intrusion
10.	14.0	12.5	-1.5	12.0	-0.5	14.6	2.6	0.6	Extrusion

Legend:

All values in millimetres

T_0: Pre treatment T_2: End of stage II

T_1: End of stage I T_3: End of stage III

(-) denotes apical movement of upper incisor centroid with reference to the palatal plane, signifying intrusion.

Table II: Descriptive statistics for results of measurements upper incisor centroid to the palatal plane measurements in various stages.

Parameter	T_0 to T_1 Difference	T_1 to T_2 difference	T_2 to T_3 Difference	T_0 to T_3 Difference
Mean	-1.84	0.11	1.23	-0.5
Standard deviation	1.08	0.49	0.86	1.37
Standard error	0.34	0.15	0.27	0.43
t-value	-5.36	0.49	4.51	-1.14
p-value	**	NS	**	NS

Legend:

**: p value < 0.001 considered to be highly significant

NS: p value non-significant

B. For measurement of lower incisor centroid to the mandibular plane:

1. All ten patients included in the study demonstrated intrusion of the lower incisors at the end of stage I (T_1), an average intrusion of 1.69 mm was noted that was highly significant at $p < 0.001$
2. At the end of stage II (T_2) an average extrusion of 0.19 mm was noted that was not significant.
3. At the end of stage III (T_3) no significant change in the vertical position of the lower incisor was obtained as compared to the end of stage II position.
4. Comparison between pre-treatment (T_0) and end of treatment (T_3) values showed that all ten patients demonstrated intrusion at the end of treatment that was highly significant at $p < 0.001$ with a mean value of 1.41 mm

Table III & IV summarize the measurements of lower incisor centroid to the mandibular plane and descriptive statistics for lower incisor position respectively. Table III: Measurement of lower incisor centroid to the mandibular plane.

Sr. No	T_0	T_1	T_0 to T_1 Diff	T_2	T_1 to T_2 Diff	T_3	T_2 to T_3 Diff	T_0 to T_3 Diff	Final lower incisor position
1.	30.5	28.3	-2.2	28.5	0.2	28.4	-0.1	-2.1	Intrusion
2.	31.4	30.0	-1.4	30.1	0.1	30.8	0.7	-0.6	Intrusion
3.	31.4	30.0	-1.4	30.2	0.2	30.2	0.0	-1.2	Intrusion
4.	30.3	28.4	-1.9	28.5	0.1	29.0	0.5	-1.3	Intrusion
5.	31.4	29.7	-1.7	30.7	1.0	30.7	0.0	-0.7	Intrusion
6.	29.5	26.4	-3.1	26.6	0.2	26.7	0.1	-2.8	Intrusion
7.	24.6	23.6	-1.0	23.7	0.1	23.6	-0.1	-1.0	Intrusion
8.	26.4	25.4	-1.0	24.5	-0.9	25.1	0.6	-1.3	Intrusion
9.	25.6	23.7	-1.9	24.2	0.5	23.2	-1.0	-2.4	Intrusion
10.	31.3	30.0	-1.3	30.4	0.4	30.6	0.2	-0.7	Intrusion

Legend:

All values in millimetres

T_0: Pre treatment T_2: End of stage II

T_1: End of stage I T_3: End of stage III

(-) denotes apical movement of lower incisor centroid with reference to the mandibular plane, signifying intrusion.

Table IV: Descriptive statistics for results of measurements of lower incisor centroid to the mandibular plane measurements in various stages.

Parameter	T_0 to T_1 Difference	T_1 to T_2 Difference	T_2 to T_3 difference	T_0 to T_3 difference
Mean	-1.69	0.19	0.09	-1.41
Standard deviation	0.63	1.9	0.48	0.76
Standard error	0.20	0.60	0.15	0.24
t-value	-8.43	0.31	0.59	-5.81
p-value	**	NS	NS	**

Legend:

**: p value < 0.001 considered to be highly significant

NS: p value non significant

Table V: Summary of results

Measurement parameter	Mean difference between T_0 & T_1	Mean difference between T_1 & T_2	Mean difference between T_2 & T_3	Mean difference between T_0 & T_3
Upper incisor centroid to palatal plane	1.84 mm Intrusion **	0.11 mm Extrusion NS	1.23 mm Extrusion **	0.5 mm Intrusion NS
Lower incisor centroid to mandibular plane	1.69 mm Intrusion **	0.19 mm Extrusion NS	0.09 mm Extrusion NS	1.41 mm Intrusion **

Legend:

**: high statistical significance at p < 0.001.

NS: p-value not significant

DISCUSSION:

One of the principle tenets of the stage I Begg appliance was to obtain an edge to edge incisal relationship that involved the depression of the anterior teeth in their sockets.[13,14] This opened up the proverbial Pandora's Box that refuses to shut even after half a century. The entire concept of intrusion, particularly of the maxillary incisors using Begg mechanotherapy was deemed as controversial. Existing literature oscillates between describing this phenomenon as unstable and impractical to it being attainable in some of the cases.[15] Thus whether the incisors intruded, remained at the same level or actually extruded at the end of Begg mechanotherapy continues to be a perplexing issue.

The purpose of this study was therefore to evaluate the changes in the vertical position of the upper and lower incisors in various stages of refined Begg mechanotherapy. Similar studies performed previously have employed the incisal edge or root apex as a reference landmark for measuring the vertical changes.[13,19] This however is replete with the dangers of obtaining a biased result due to the influence of changes in tooth inclination on these landmarks. Our study utilised the centre of resistance or the centroid of the incisor defined as a point on the longitudinal axis of the tooth as a reference point since it is independent of any changes in the tooth inclination.[3] Different authors have proposed various definitions of the incisor centroid such as

50% [9,10], between 50-33% [16], 33% [17] and between 33-25% [18] of the embedded portion of the root between the cementoenamel junction and the its apex. This particular study utilised the incisor centroid as a point at 50% of the root length from the CEJ to the apex based upon the work of Proffit, Nikolai, Burstone & Edsard van steenbergen.[9-12] The reference planes used for evaluating the vertical changes in the centroid position were the palatal and the mandibular plane for the upper & lower incisor respectively.[1,2,3,11,19]

The subjects chosen for this study were post pubertal patients to minimize the effects of differential growth of the maxilla & mandible on the vertical position of the incisors. The presence of skeletal class II malocclusion with increased over bite in these post pubertal patients made them ideally suited for incisor intrusion mechanics.

The results obtained indicate that in all the ten cases upper incisors were intruded an average of 1.84 mm at the end of stage I. Their position remained more or less stable at the end of stage II before a significant extrusion of 1.23 mm resulted at the end of stage III. Compared with the pre treatment values, 0.5 mm of mean intrusion persisted at the end of treatment which is considered neither clinically nor statistically significant.

An equal number of patients- five each demonstrated intrusion and extrusion at the end of treatment as compared to their pre treatment values. This attests the results obtained by other studies which imply that variable changes in the vertical position of upper incisors are obtained with Begg mechanotherapy.[4,5,6,19,20,21]

Similarly in all the ten patients, significant intrusion of the lower incisor was noted at the end of stage I, an average value of 1.69 mm. No significant vertical changes were noted at the end of stage II as in the case of upper incisors. However, contrary to the upper incisors, minimal vertical changes were obtained at the end of stage III so that 1.41 mm of mean intrusion of lower incisor persisted at the end of treatment in all the cases. This is synchronous with other studies that report the attainment of lower incisor intrusion with Begg mechanotherapy.[5,6,19,21,22]

The common highlight of the results is intrusion of the upper as well as lower incisors at the end of stage I as compared to their pre treatment values and the absence of any significant vertical changes in their position at the end of stage II compared to the stage I measurements. The principle difference arises at the end of stage III where the upper incisors experience significant extrusion where as the lowers remain unaffected.

These results pointedly mark out the fact that true intrusion, of both maxillary & mandibular incisors is attainable with refined Begg mechanotherapy and it is the torquing assemblage employed in the maxillary arch in stage III which is the chief culprit that results in a variable upper incisor vertical position at the end of treatment by causing their significant extrusion.

The study thus seeks to point out that, this intrusion must be preserved throughout the treatment particularly in the maxillary anterior region to translate into clinically significant results. The principles involved in the attainment and preservation of incisor would include augmenting the

intrusive potential of the first stage appliance and minimizing the undesirable consequences of the third stage. A brief overview of suggested modifications in mechanics utilised in Begg mechanotherapy is as follows: [4,5,6,15,23,24]

I. Augmenting the intrusive potential of the first stage:

This includes individualizing treatment mechanics during incisor intrusion & retraction by controlling the magnitude and direction of the resultant forces acting on the incisor. Use of 'power arms' or 'palatal elastics' or modifications in bite opening bends such as the use of gingival curves with concomitant vertical step up bends to augment intrusion and the use of judicious retractive force by light Class II elastics to reduce the extrusive component acting upon the incisors.

II. Minimizing the undesirable consequences of the third stage:

1. Minimizing the requirements of torquing and uprighting in the third stage:

This encompasses correct diagnosis and careful planning of the extraction decision, avoiding over retraction of the incisors, utilization of efficient 'brakes' for molar protraction wherever indicated as also controlled tipping of incisors in the first two stages by use of auxiliaries such as Mollenhauer's aligning auxiliary (MAA) or light uprighting springs right from the first stage.

2. Use of base wires of adequate strength such as premium plus grades.
3. Auxiliaries & uprighting springs of lighter diameters.
4. Reinforcement of the anchorage wherever indicated.
5. Modifications in the stage III base wire such as the re-introduction of the anchor bend in the stage III wire similar to the stage I wire. [24]

These modifications and refinements would help in augmenting and preserving the intrusive potential of the Begg appliance and would seek to imply what has been aptly stated that "it is not the appliance but 'the individual who thinks, understands and applies' the basic principles involved in this technique." [24]

CONCLUSION:

This retrospective cephalometric study was designed to evaluate the changes in vertical position of incisors during various stages of refined Begg mechanotherapy. The study concluded that

1. Significant intrusion ($p < 0.001$) of both upper and lower incisors occurs at the end of the first stage with mean values of 1.84 and 1.69 mm respectively.
2. There is no significant change in the vertical position of the upper and lower incisors at the end of stage two.
3. Significant extrusion of upper incisor results at the end of stage III, an average value of 1.23 mm.
4. When compared with pre treatment values, an average 0.5 mm intrusion of the upper incisors was

noted at the end of treatment that is neither clinically nor statistically significant.

5. On the contrary, the lower incisors did not demonstrate any significant change in their vertical position at the end of stage III and showed a mean intrusion of 1.41 mm at the end of treatment.

Within limitations of a retrospective cephalometric study involving a limited sample size, the discussion concludes that true intrusion of both upper and lower incisors is attainable with refined Begg mechanotherapy. Modifications in treatment mechanics are indicated to further augment and preserve this intrusion throughout the treatment, especially in the maxillary anterior region so as to translate into clinically significant results.

A randomized clinical trial involving greater number of patients with appropriately modified treatment mechanics would greatly facilitate further understanding of the subject.

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