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Comparison of long term vertical dimension changes using pea and begg mechanotherapy in extraction and non-extraction orthodontic treated cases-a cephalometric study

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Abstract

Background and Objectives: There exists a controversy regarding the effect of extraction and non-extraction treatment protocol on the facial vertical dimension change. The purpose of this study was to examine cephalometrically the dentofacial vertical changes in Class I subjects undergoing extraction of all four first premolars or no extraction between the preadjusted edgewise appliance (PEA) and the Begg appliance from pre to immediate post treatment and immediate post treatment to minimum 2yr post treatment.

Method: This study was carried out on 48 patients who were divided into 2 groups- Begg and PEA. Pre-treatment, immediate post treatment and minimum 2 years follow up lateral cephalograms of 24 patients treated with Begg mechanotherapy and 24 patients treated with pre adjusted edgewise appliance were used. Unpaired t- test was employed to compare the difference in facial vertical dimension change between the groups. Repeated measures ANOVA was used to compare the difference in facial vertical dimension change in extraction and non-extraction groups at pretreatment, immediate post treatment and minimum 2 years after treatment.

Results: No significant differences were observed when intra group and inter group comparison was made for Begg mechanotherapy and PEA mechanotherapy in vertical dimension.

Conclusion: Thus, regardless of mechanotherapy used there is no vertical dimension change in either extraction or non-extraction group. The insignificant change observed from pretreatment to post treatment tends to revert back to pretreatment during post retention period.

Keywords: Vertical dimension, long term, non-growing, Begg mechanotherapy, PEA mechanotherapy

1. Introduction

Stability following orthodontic treatment continues to be a great challenge [1]. The ability to maintain long-term changes following orthodontic treatment involving the extraction of premolars have been shown unpredictable. Therefore, in the recent years the debate over the extraction and non-extraction decision continues to be a controversial issue [2].

According to occlusal wedge hypothesis, dentoalveolar apparatus is assumed to take the form of an occlusal wedge so that bite is opened when molars or premolars are extruded or distalized or it is closed when molars are moved forward after the extraction of premolars [3]. But this line of treatment to decrease vertical dimension is a subject of controversy.

Moreover, control on vertical dimension also varies according to the technique and/or type of appliance employed in treating the malocclusion. Begg and Kesling stated that bite opening with the Begg technique was due to intrusion of the mandibular incisors in response to anchorage bends and the light forces used with minimal or no extrusion of the posterior teeth. On the contrary, Swain and Ackerman reported considerable molar extrusion under the use of Class II elastics. Pre adjusted edgewise appliance has been attributed to cause significant molar extrusion with the use of comparatively heavier class II elastics in extraction patients and use of sliding jig in non-extraction patients, both leading to backward rotation of mandible and increasing the vertical facial dimension [4].

Hence, the present study is designed to evaluate the vertical dimension changes in the extraction and non-extraction orthodontically treated non growing patients using Begg and pre-adjusted edgewise appliance and whether this change is stable 2 years after the treatment.

Methodology

1. Data Collection

This study was carried out on 48 patients who were divided into 2 groups- Begg and PEA.

Group I: 24 non growing patients treated with Begg mechanotherapy.

Group Ia- 12 with extraction of all first premolars

Group Ib- 12 with non-extraction
Lateral cephalograms were taken at following three points of time:
Pre-treatment- T1
Immediate post treatment- T2
Minimum 2 years post treatment- T3

Group II: 24 non growing patients treated with pre adjusted edgewise appliance.
Group IIa- 12 with extraction of all first premolars
Group IIb- 12 with non-extraction
Lateral cephalograms were taken at same three points of time:

2. Criteria for Selection of Patients

a) Class I skeletal base
b) Angle's class I molar relationship bilaterally.
c) Patient's age should be more than 18 years with no active growth remaining.
d) Presence of all teeth till 2nd permanent molar.
e) Moderate anchorage in both the arches
f) Average growth pattern

Exclusion Criteria

1. Incomplete pretreatment, immediate post treatment and 2yr post treatment records
2. Congenitally missing teeth (except third molars).
3. Patient's with previous orthodontic treatment
4. Patient's treated with functional or removable appliance
5. Patient's with craniofacial anomalies

Skeletal Linear Parameters

- Posterior facial height (Distance from S to Go), Total anterior facial height (Distance from N to Me), Upper anterior facial height (Distance from N to perpendicular projection of the ANS on the N-Me line),Lower anterior facial height (Distance from a perpendicular projection of the ANS on the N-Me line to Me), Jarabak's ratio (PFH:AFH)

Dental Linear Parameters

- MxM – PP, MdM – MP

Skeletal Angular PARAMETERS

- SN to mandibular plane angle, FH to mandibular plane angle, Y-axis angle, Facial axis angle

Soft Tissue Linear Parameters

- G' to Me, Sn' to Me'

Statistical Analysis

- Unpaired t test was employed to compare the difference in facial vertical dimension change between the groups.
- Repeated measures ANOVA was used to compare the difference in facial vertical dimension change in extraction and non-extraction groups at pretreatment, immediate post treatment and after minimum of 2 years.

Results

Linear Measurements (Tables 1, 2, 3.4)

1. N – Me

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.543 and p value for post treatment to minimum 2 years post-treatment is 1. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.241 and p value for post treatment to minimum 2 years post-treatment is 0.225. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.659 and p value for post treatment to minimum 2 years post-treatment is 1. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.306 and p value for post treatment to minimum 2 years post-treatment is 0.174.

2. ANS-Me

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.399 and p value for post treatment to minimum 2 years post-treatment is 1. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.188 and p value for post treatment to minimum 2 years post-treatment is 0.193. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.346 and p value for post treatment to minimum 2 years post-treatment is 0.775. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.136 and p value for post treatment to minimum 2 years post-treatment is 0.123.

3. S – Go

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0.

4. Jarabak's ratio

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.727 and p value for post treatment to minimum 2 years post-treatment is 0.936. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.1300 and p value for post treatment to minimum 2 years post-treatment is 0.1115. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.370 and p value for post treatment to minimum 2 years post-treatment is 0.692. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.681 and p value for post treatment to minimum 2 years post-treatment is 0.270.

7. UAFH

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post

treatment to minimum 2 years post-treatment is 0. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0.

8. LAFH

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.385 and p value for post treatment to minimum 2 years post-treatment is 0.508. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.149 and p value for post treatment to minimum 2 years post-treatment is 0.151. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.640 and p value for post treatment to minimum 2 years post-treatment is 0.303. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.082 and p value for post treatment to minimum 2 years post-treatment is 0.062.

9. G'– Me'

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.533 and p value for post treatment to minimum 2 years post-treatment is 0.649. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.218 and p value for post treatment to minimum 2 years post-treatment is 0.195. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.720 and p value for post treatment to minimum 2 years post-treatment is 0.603. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.059 and p value for post treatment to minimum 2 years post-treatment is 0.055.

10. G'-Sn

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0 and p value for post treatment to minimum 2 years post-treatment is 0.

11. Sn-Me'

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.307 and p value for post treatment to minimum 2 years post-treatment is 0.508.

Intergroup of group Ia and IIa comparison: p value for pre-treatment to post-treatment is 0.218 and p value for post treatment to minimum 2 years post-treatment is 0.195. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.720 and p value for post treatment to minimum 2 years post-treatment is 0.603. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.059 and p value for post treatment to minimum 2 years post-treatment is 0.055.

12. MxM-PP

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.364 and p value for post treatment to minimum 2 years post-treatment is 0.167. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.131 and p value for post treatment to minimum 2 years post-treatment is 0.083. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.544 and p value for post treatment to minimum 2 years post-treatment is 0.482. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.298 and p value for post treatment to minimum 2 years post-treatment is 0.127.

12. MdM-MP

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.062 and p value for post treatment to minimum 2 years post-treatment is 0.093. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.151 and p value for post treatment to minimum 2 years post-treatment is 0.142. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.455 and p value for post treatment to minimum 2 years post-treatment is 0.427. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.069 and p value for post treatment to minimum 2 years post-treatment is 0.054.

Angular Measurement

13. FH – MP

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.118 and p value for post treatment to minimum 2 years post-treatment is 0.179. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.752 and p value for post treatment to minimum 2 years post-treatment is 0.482. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.264 and p value for post treatment to minimum 2 years post-treatment is 0.223. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.308 and p value for post treatment to minimum 2 years post-treatment is 0.193.

14. SN-MP

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.136 and p value for post treatment to minimum 2 years post-treatment is 0.207. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.482 and p value for post treatment to minimum 2 years post-treatment is 0.482. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.603 and p value for post treatment to minimum 2 years post-treatment is 0.143. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.052 and p value for post treatment to minimum 2 years post-treatment is 0.193.

15. Y-axis

Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.179 and p value for post treatment to minimum 2 years post-treatment is 0.179. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.482 and p value for post treatment to minimum 2 years post-treatment is 0.482. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.387 and p value for post treatment to minimum 2 years post-treatment is 0.223.

Intergroup of group IIa and IIb comparison: p value for pre-treatment to post-treatment is 0.127 and p value for post treatment to minimum 2 years post-treatment is 0.193.

16. Facial -axis
Intergroup of group Ia and Ib comparison: p value for pre-treatment to post-treatment is 0.118 and p value for post treatment to minimum 2 years post-treatment is 0.118. **Intergroup of group Ia and IIa comparison:** p value for pre-treatment to post-treatment is 0.149 and p value for post treatment to minimum 2 years post-treatment is 0.149. **Intergroup of group Ib and IIb comparison:** p value for pre-treatment to post-treatment is 0.338 and p value for post treatment to minimum 2 years post-treatment is 0.496. **Intergroup of group IIa and IIb comparison:** p value for pre-treatment to post-treatment is 0.193 and p value for post treatment to minimum 2 years post-treatment is 0.193.

Discussion

Changes in PEA group (IIa Vs IIb)

Effect on skeletal linear parameters

In all the groups, a statistically insignificant increase in nasion-menton that is anterior facial height, anterior nasal spine-menton that is lower anterior facial height and LAFH projected on true vertical plane was noted from pre to post treatment and statistically insignificant decrease from post treatment to minimum 2 years post treatment in both the groups respectively. When inter group comparison was done insignificant difference was observed [5].

In PEA group
Studies done by Gkantidis *et al* [6] and Lin *et al* [7] showed no significant increase in total and lower anterior facial height. Authors like Staggers [8], Kumari *et al* [9], Ismail *et al* [10], Klappers *et al* [11], Heravi *et al* [12], and Kocardeli [13] in their studies showed significant difference in the increase in lower anterior facial height between the extraction and non-extraction groups. However, studies done by Chua *et al* [14] showed that the increase in lower anterior facial height contributing to the increase in total anterior facial height was more in the non-extraction group. However, study done by Sivakumar *et al* [15] showed more increase in lower anterior facial height in the extraction group. This can be attributed to the fact that the use of class II elastics in extraction group to close down the extraction space had more extrusive effect than mesialisation which was absent in non-extraction group.

In Begg and PEA group
TFH increased in the Begg group and in the PEA group could be attributed to the extrusion of the molars with both techniques and is in accordance with the findings of Staggers [8], Kocadereli [1]3 and Kim and Kim [16].
LAFH increased for the Begg group and PEA group, could be attributed to molar extrusion. In the Begg group, this increase could be attributed to the use of Class II elastics having a vertical component of force causing the molar extrusion. The increase in the PEA group could possibly be attributed to the bite opening mechanics employed or the Class II elastics used during finishing and detailing.

In Begg group
Authors like Chua *et al* [14], Staggers [8] in their studies showed no significant difference in the increase in lower anterior facial height between the extraction and non-extraction groups. This increase in both the groups could be attributed to the use of anchor bend in both the groups and the negation of vertical component of class II elastics used in extraction group with its mesialisation [17]. On the other hand significant increase was found in study done by Alkumru *et al* [18].

Effect on Linear Dental Parameters

In all the groups, an insignificant MxM-PP from pre to post treatment and decrease from post treatment to minimum 2yr post treatment in both the groups has been noted. An insignificant increase in MdM-MP from pre to post treatment and decrease from post treatment to minimum 2yr post treatment in both the groups has been noted.

In PEA group
Klapper *et al* [11] showed that upper molars were more liable to be extruded because of relatively spongy bone in the maxilla. This extrusion of upper molars was seen more in the non-extraction group corresponding to a greater degree of maxillary molar distal movement.
Sivakumar and Valiathan [15] in their study have showed no significant extrusion of molars. On the other hand, studies done by Heravi *et al* [12], Al-Nimri [19], Kumari *et al* [9] and Staggers [8] signifies that fixed mechanotherapy is extrusive in general causing both upper and lower molars to extrude.

In Begg and PEA group
The extrusion of the upper molars in the Begg group was caused primarily due to the anchor bends which tend to tip and extrude the molars. This finding is claimed by Begg and Kesling.
The lower molar to mandibular plane showed extrusion in the Begg technique and PEA, indicating that both systems were similar in the extrusion of the molars.
The extrusion of the lower molars in the Begg group was caused primarily by the vertical component of the force of the Class II elastics and the anchor bends which tend to tip and extrude the molars. In the PEA group, this extrusion could probably be attributed to the bite opening mechanics employed as seen by Hayasaki and Henriques [2].

In Begg group
The increase in both the groups could be attributed to the use of anchor bend. Even Klapper *et al* [11] showed that upper molars were more liable to be extruded because of relatively spongy bone in the maxilla.

Effect on Linear Soft Tissue Parameters

A statistically insignificant increase in glabella-soft tissue menton, subnasale-soft tissue menton was observed in both the groups' pre to post treatment and statistically insignificant decrease from post treatment to minimum 2yr post treatment. When inter group comparison was done insignificant difference has been observed. This can be said to have accompanied the increase in skeletal lower anterior facial height due to extrusive mechanotherapy.

In PEA group
Kumari *et al* [9], Ismail *et al* [10] and Staggers [8] in their study obtained no significant difference in the increase of soft tissue facial height between extraction and non-extraction groups. However study done by Chua *et al* [14] showed

significant increase in vertical dimension accompanying the skeletal increase in lower anterior facial height due to distalization of upper molars.

In Beggs and PEA group

TFH increased in the Begg group and in the PEA group could be attributed to the extrusion of the molars with both techniques and is in accordance with the findings of Staggers [8], Kocadereli [13] and Kim and Kim [16].

In Beggs group

When inter group comparison was done insignificant difference was observed. This can be said to have accompanied the increase in skeletal lower anterior facial height due to extrusive mechanotherapy.

Effect on Skeletal Angular Parameter

In all the groups, a statistically insignificant increase in mandibular plane angle, Y-angle axis and facial axis angle from pre to post treatment and subsequent decrease from post treatment to minimum 2yr post treatment was observed.

In PEA group

The results were obtained by Kocadereli [13], Heravi *et al* [12], Klappers *et al* [11] and Staggers [8] who attributed it to the extrusive mechanotherapy leading to backward rotation of the mandible.

However, authors like Heravi *et al* [12], Sivakumar *et al* [15] and Bishara *et al* [20] noted no increase in mandibular plane angle. Sivakumar *et al* [3] also mentioned that the mesial movement of the maxillary and mandibular posterior teeth was coincidental with the extrusion to such an extent that it increased the vertical dimension, although the mandibular plane angle remained unchanged during treatment.

In Beggs and PEA groups

Though statistically insignificant, increase in mandibular plane angle, Y-angle axis and facial axis angle from pre to post treatment and subsequent decrease from post treatment to minimum 2 years post treatment was more in Begg mechanotherapy in comparsion to PEA. This can be attributed to the vertical component of class II elastics and the anchor bend used in Begg mechanotherapy leading to opening of the mandible as quoted by Begg and Kessling.

On the other hand the study done by Kim and Kim[16] showed *Y* axis reduced in the Begg sample indicating a very mild closing of the mandibular plane angle. In contrast, in the PEA group, again though statistically insignificant, the *Y*-axis increased indicating a mild opening of the mandibular plane angle.

In Beggs group

Authors like Heravi [12], Sivakumar *et al* [15] and Bishara *et al* [20] noted no increase in mandibular plane angle. Sivakumar *et al* [3] also mentioned that the mesial movement of the maxillary and mandibular posterior teeth was coincidental with the extrusion to such an extent that it increased the vertical dimension, although the mandibular plane angle remained unchanged during treatment.

Similar results were obtained by Klapper *et al* [11] who mentioned that there were indications of greater degree of facial axis angle opening also denoting backward rotation of the mandible with greater degrees of maxillary molar distal movement in non-extraction group.

Limitations of the study

- The sample size in the present study was 14 patients in each group. Hence the results obtained should be confirmed using a larger sample.
- Gender based comparison could not be done from study as there was no uniform distribution between male and female patients.
- Lateral cephalograms were used in the study which is a two dimensional representation of a three dimensional object and has its own errors like landmark identification and tracking.

Scope for the future study

- Increasing the sample size could facilitate better results.
- A prospective study could be planned by uniformly considering the gender.
- A three dimensional representation like Computed Tomography (CT) scan could give better results and less errors.

Table 1: Comparison between Group Ia and Group Ib

	Group								
	IA				IB				p- value
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	
N-Me_T2-T1	12	1.08	0.9	0.26	12	1.33	1.073	0.31	0.543
N-Me_T3-T2	12	-1.08	0.9	0.26	12	-1.08	0.9	0.26	1
ANS-Me_T2-T1	12	1.08	0.9	0.26	12	1.42	0.996	0.288	0.399
ANS-Me_T3-T2	12	-1.08	0.9	0.26	12	-1.08	0.793	0.229	1
S-Go_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
S-Go_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
JRB_T2-T1	12	-0.647	0.6162	0.1779	12	-0.729	0.5229	0.1509	0.727
JRB_T3-T2	12	0.605	0.6077	0.1754	12	0.587	0.4238	0.1223	0.936
UAFH_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
UAFH_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
LAFH_T2-T1	12	1	0.853	0.246	12	1.33	0.985	0.284	0.385
LAFH_T3-T2	12	-1	0.853	0.246	12	-1.25	0.965	0.279	0.508
G'Me'_T-T1	12	1.17	0.937	0.271	12	1.42	0.996	0.288	0.533
G'Me'_T3-T2	12	-1.08	0.9	0.26	12	-1.25	0.866	0.25	0.649
G'-Sn_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
G'-Sn_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
Sn-Me'_T2-T1	12	1	0.953	0.275	12	1.42	0.996	0.288	0.307
Sn-Me'_T3-T2	12	-1	0.953	0.275	12	-1.25	0.866	0.25	0.508

MxM-PP_T2-T1	12	0.33	0.651	0.193	12	0.58	0.669	0.188	0.364
MxM-PP_T3-T2	12	-0.25	0.452	0.193	12	-0.58	0.669	0.131	0.167
MdM-MP_T2-T1	12	0.58	0.793	0.229	12	1.25	0.866	0.25	0.062
MdM-MP_T3-T2	12	-0.58	0.793	0.229	12	-1.17	0.835	0.241	0.093
FH-MP_T2-T1	12	0.75	0.622	0.179	12	1.25	0.866	0.25	0.118
FH-MP_T3-T2	12	-0.75	0.622	0.179	12	-1.17	0.835	0.241	0.179
SN-Md_T2-T1	12	0.75	0.622	0.179	12	1.25	0.866	0.25	0.118
SN-Md_T3-T2	12	-0.75	0.622	0.179	12	-1.25	0.866	0.25	0.118
Y-axis_T2-T1	12	0.75	0.622	0.179	12	1.17	0.835	0.241	0.179
Y-axis_T3-T2	12	-0.75	0.622	0.179	12	-1.17	0.835	0.241	0.179
Fa-Ax_T2-T1	12	0.67	0.492	0.142	12	1.08	0.793	0.229	0.136
Fa-Ax_T3-T2	12	-0.67	0.492	0.142	12	-1	0.739	0.213	0.207

a. t cannot be computed because the standard deviations of both groups are 0.

Table 2: Comparison between Group Ia and Group IIa

	Group								
	Ia				IIa				p value
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	
N-Me_T2-T1	12	1.08	0.9	0.26	12	0.83	0.835	0.241	0.488
N-Me_T3-T2	12	-1.08	0.9	0.26	12	-0.67	0.778	0.225	0.238
ANS-Me_T2-T1	12	1.08	0.9	0.26	12	0.67	0.651	0.188	0.207
ANS-Me_T3-T2	12	-1.08	0.9	0.26	12	-0.58	0.669	0.193	0.137
S-Go_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
S-Go_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
JRB_T2-T1	12	-0.647	0.6162	0.1779	12	-0.45	0.4503	0.13	0.382
JRB_T3-T2	12	0.605	0.6077	0.1754	12	0.325	0.3864	0.1115	0.192
UAFH_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
UAFH_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
LAFH_T2-T1	12	1	0.853	0.246	12	0.58	0.515	0.149	0.161
LAFH_T3-T2	12	-1	0.853	0.246	12	-0.5	0.522	0.151	0.097
G'Me'_T2-T1	12	1.17	0.937	0.271	12	0.75	0.754	0.218	0.243
G'Me'_T3-T2	12	-1.08	0.9	0.26	12	-0.5	0.674	0.195	0.086
G'-Sn_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
G'-Sn_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
Sn-Me'_T2-T1	12	1	0.953	0.275	12	0.75	0.754	0.218	0.484
Sn-Me'_T3-T2	12	-1	0.953	0.275	12	-0.5	0.674	0.195	0.152
MxM-PP_T2-T1	12	0.58	0.669	0.193	12	0.25	0.452	0.131	0.167
MxM-PP_T3-T2	12	-0.58	0.669	0.193	12	-0.08	0.289	0.083	0.026
MdM-MP_T2-T1	12	0.58	0.793	0.229	12	0.5	0.522	0.151	0.764
MdM-MP_T3-T2	12	-0.58	0.793	0.229	12	-0.33	0.492	0.142	0.364
FH-MP_T2-T1	12	0.75	0.622	0.179	12	0.67	0.651	0.188	0.752
FH-MP_T3-T2	12	-0.75	0.622	0.179	12	-0.58	0.515	0.149	0.482
SN-Md_T2-T1	12	0.75	0.622	0.179	12	0.58	0.515	0.149	0.482
SN-Md_T3-T2	12	-0.75	0.622	0.179	12	-0.58	0.515	0.149	0.482
Y-axis_T2-T1	12	0.75	0.622	0.179	12	0.58	0.515	0.149	0.482
Y-axis_T3-T2	12	-0.75	0.622	0.179	12	-0.58	0.515	0.149	0.482
Fa-Ax_T2-T1	12	0.67	0.492	0.142	12	0.58	0.515	0.149	0.689
Fa-Ax_T3-T2	12	-0.67	0.492	0.142	12	-0.58	0.515	0.149	0.689

a. t cannot be computed because the standard deviations of both groups are 0.

Table 3: Comparison between Group Ib and Group IIb

	Group								
	Ib				IIb				p value
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	
N-Me_T2-T1	12	1.33	1.073	0.31	12	1.17	0.718	0.207	0.659
N-Me_T3-T2	12	-1.08	0.9	0.26	12	-1.08	0.669	0.193	1
ANS-Me_T2-T1	12	1.42	0.996	0.288	12	1.08	0.669	0.193	0.346
ANS-Me_T3-T2	12	-1.08	0.793	0.229	12	-1	0.603	0.174	0.775
S-Go_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
S-Go_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
JRB_T2-T1	12	-0.729	0.5229	0.1509	12	-0.533	0.5263	0.1519	0.37
JRB_T3-T2	12	0.587	0.4238	0.1223	12	0.517	0.4407	0.1272	0.692
UAFH_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
UAFH_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
LAFH_T2-T1	12	1.33	0.985	0.284	12	1.17	0.718	0.207	0.64
LAFH_T3-T2	12	-1.25	0.965	0.279	12	-0.92	0.515	0.149	0.303
G'Me'_T2-T1	12	1.58	1.24	0.288	12	1.42	0.996	0.358	0.72

G'Me'_T3-T2	12	-1.25	0.866	0.25	12	-1.08	0.669	0.193	0.603
G'-Sn_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
G'-Sn_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
Sn-Me'_T2-T1	12	1.58	1.24	0.288	12	1.42	0.996	0.358	0.72
Sn-Me'_T3-T2	12	-1.25	0.866	0.25	12	-1.08	0.669	0.193	0.603
MxM-PP_T2-T1	12	0.5	0.674	0.188	12	0.33	0.651	0.195	0.544
MxM-PP_T3-T2	12	-0.25	0.452	0.131	12	-0.42	0.669	0.193	0.482
MdM-MP_T2-T1	12	1.25	0.866	0.25	12	1	0.739	0.213	0.455
MdM-MP_T3-T2	12	-1.17	0.835	0.241	12	-0.92	0.669	0.193	0.427
FH-MP_T2-T1	12	1.25	0.866	0.25	12	0.92	0.515	0.149	0.264
FH-MP_T3-T2	12	-1.17	0.835	0.241	12	-0.83	0.389	0.112	0.223
SN-Md_T2-T1	12	1.25	0.866	0.25	12	1.08	0.669	0.193	0.603
SN-Md_T3-T2	12	-1.25	0.866	0.25	12	-0.83	0.389	0.112	0.143
Y-axis_T2-T1	12	1.17	0.835	0.241	12	0.92	0.515	0.149	0.387
Y-axis_T3-T2	12	-1.17	0.835	0.241	12	-0.83	0.389	0.112	0.223
Fa-Ax_T2-T1	12	1.08	0.793	0.229	12	0.83	0.389	0.112	0.338
Fa-Ax_T3-T2	12	-1	0.739	0.213	12	-0.83	0.389	0.112	0.496

a. t cannot be computed because the standard deviations of both groups are 0.

Table 4: Comparison between Group IIa and Group IIb

	Group								p vlue
	IIa				IIb				
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	
N-Me_T2-T1	12	0.83	0.835	0.241	12	1.17	0.718	0.207	0.306
N-Me_T3-2	12	-0.67	0.778	0.225	12	-1.08	0.669	0.193	0.174
ANS-Me_T2-T1	12	0.67	0.651	0.188	12	1.08	0.669	0.193	0.136
ANS-Me_T3-T2	12	-0.58	0.669	0.193	12	-1	0.603	0.174	0.123
S-Go_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
S-Go_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
JRB_T2-T1	12	-0.45	0.4503	0.13	12	-0.533	0.5263	0.1519	0.681
JRB_T3-T2	12	0.325	0.3864	0.1115	12	0.517	0.4407	0.1272	0.27
UAFH_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
UAFH_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
LAFH_T2-T1	12	0.58	0.515	0.149	12	1.17	0.718	0.207	0.082
LAFH_T3-T2	12	-0.5	0.522	0.151	12	-0.92	0.515	0.149	0.062
G'Me'_T-T1	12	0.75	0.754	0.218	12	1.58	1.24	0.358	0.059
G'Me'_T3-T2	12	-0.5	0.674	0.195	12	-1.08	0.669	0.193	0.055
G'-Sn_T2-T1	12	0	.000[a]	0	12	0	.000[a]	0	
G'-Sn_T3-T2	12	0	.000[a]	0	12	0	.000[a]	0	
Sn-Me'_T2-T1	12	0.75	0.754	0.218	12	1.58	1.24	0.358	0.059
Sn-Me'_T3-T2	12	-0.5	0.674	0.195	12	-1.08	0.669	0.193	0.055
MxM-PP_T2-T1	12	0.25	0.452	0.131	12	0.5	0.674	0.195	0.298
MxM-PP_T3-T2	12	-0.08	0.289	0.083	12	-0.42	0.669	0.193	0.127
MdM-MP_T2-T1	12	1	0.739	0.151	12	0.5	0.522	0.213	0.069
MdM-MP_T3-T2	12	-0.33	0.492	0.142	12	-0.92	0.669	0.193	0.054
FH-MP_T2-T1	12	0.67	0.651	0.188	12	0.92	0.515	0.149	0.308
FH-MP_T3-T2	12	-0.58	0.515	0.149	12	-0.83	0.389	0.112	0.193
SN-Md_T2-T1	12	0.58	0.515	0.149	12	1.08	0.669	0.193	0.052
SN-Md_T3-T2	12	-0.58	0.515	0.149	12	-0.83	0.389	0.112	0.193
Y-axis_T2-T1	12	0.58	0.515	0.149	12	0.92	0.515	0.149	0.127
Y-axis_T3-T2	12	-0.58	0.515	0.149	12	-0.83	0.389	0.112	0.193
Fa-Ax_T2-T1	12	0.58	0.515	0.149	12	0.83	0.389	0.112	0.193
Fa-Ax_T3-T2	12	-0.58	0.515	0.149	12	-0.83	0.389	0.112	0.193

t cannot be computed because the standard deviations of both groups are 0
* p< 0.05, S (Significant)
** p< 0.001, HS (Highly significant)
p > 0.05, NS (Not significant)
T1: Pre-treatment
T2: Immediate Post-treatment
T3: Minimum 2 year post treatment
T2 – T1: Difference in immediate post-treatment and pre-treatment measurements
T3 – T2: Difference in minimum 2 year post treatment and immediate post treatment

Conclusion

The following conclusions were derived from the present study:-

1. Extraction cases treated by Begg and the PEA mechanotherapy were compared, no statistically significant differences were observed in all the parameters.
2. Non-extraction cases treated by Begg and the PEA

mechanotherapy were compared, no statistically significant differences were observed in all the parameters.
3. Relapse was observed in vertical dimension in both extraction and non-extraction group treated by Begg and PEA mechanotherapy.

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