European Journal of Orthodontics 33 (2011) 712–720
doi:10.1093/ejo/cjq176
Advance Access Publication 24 March 2011

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Cephalometric comparison of vertical changes between Begg and preadjusted edgewise appliances

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SUMMARY The purpose of this retrospective study was to quantify and compare the vertical dimensional changes in bialveolar dental protrusion patients undergoing extraction of all four first premolars between the preadjusted edgewise appliance (PEA) and the Begg appliance. The cephalometric records of 55 patients (14 males and 41 females) with Class I bimaxillary protrusion were selected and divided into two groups based on the appliance used, i.e Begg or PEA mechanotherapy. To minimize the effects of growth, the subjects were at least in stage VI of skeletal maturation. The mean age was 18.25 ± 3.2 years for the Begg group and 18.03 ± 3.5 years for the PEA group. Skeletal and dental changes were analysed in both groups on lateral cephalograms taken pre- (T1) and post- (T2) treatment. A Student's *t*-test was used to analyse the treatment changes.

Within group results showed a significant increase in face height and extrusion and mesial movement of the upper and lower molars for both groups. However, no significant differences were observed when the groups were compared. A significant correlation was found between the change in lower molar to mandibular plane angle and lower anterior face height for both groups. No significant difference was found when the Begg mechanotherapy was compared to the PEA technique on vertical dimensional changes. It can be speculated that mesial movement of the molars tended to keep pace with their extrusion and negated any bite opening effect with both mechanotherapies.

Introduction

Extraction of teeth has always been the primary method of gaining space for either correction of severe crowding or retraction of proclined teeth. It also helps in closing the bite in open bite subjects and has therefore been suggested as a method of controlling the vertical dimension of the face. It has been suggested that the dentofacial apparatus is in the form of an occlusal wedge. According to Roth (1972) and Pearson (1978), when the posterior teeth are brought forward, the wedge closes and the vertical dimension decreases. On the other hand, when the posterior teeth are distalized or extruded, the vertical dimension increases. Tulley (1959), Isaacson (1971), Pearson (1973), and Garlington and Logan (1990) appear to support this hypothesis by identifying that extraction was associated with mesial movement of posterior teeth with a reduction in face height.

However, these claims have been disputed (Sims, 1964; Bijlstra, 1969; Parker, 1969; Swain and Ackerman, 1969; Williams, 1977; Kocadereli, 1999; Ahn and Schneider, 2000; Reddy and Kharbanda, 2000; Kashani and Neishabori, 2003). Those authors showed that the vertical dimension of the face increased following orthodontic treatment as the molars were extruded because of interarch mechanics, which consequently caused clockwise rotation of the mandible. Further fuelling this controversy, Cusimano and McLaughlin (1993) and Upadhyay *et al.* (2008) suggested that occlusal movement of the posterior teeth tends to keep pace with the increase in anterior face height, thus maintaining the mandibular plane angle and nullifying any bite-closing effect of protraction of the posterior teeth. In other words, even though the molar moves forward in premolar extraction patients, the vertical dimension of the face is maintained by extrusion of the posterior teeth similar to the observations of Staggers (1990). Hans and Groisser (2006) evaluated changes in overbite and vertical face height after removal of four first molars or first premolars in open bite patients to test the 'wedge' hypothesis. The results of that study did not support the wedge hypothesis as the change in the vertical dimension after extraction of first premolars or first molars was not significant.

The results on the control of the vertical dimension have also shown considerable variation according to the technique and/or type of appliance employed in treating the malocclusion. Begg and Kesling (1977) 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. Swain and Ackerman (1969) and Williams (1977) reported considerable molar extrusion under the

influence of Class II elastics. However, James (1968) and Thompson (1972) found that with the Begg appliance, the deep bite was corrected primarily by simultaneous extrusion of the mandibular molars and intrusion of the lower incisors. It was suggested that molar extrusion might lead to a backward rotation of the mandible increasing the vertical facial dimension with a potentially detrimental effect on facial aesthetics.

Kottraba (1971), Barton (1973), and Fischer (1974), who compared the Begg technique with the edgewise technique, found no difference in the vertical dimension. In view of these conflicting claims and as no study has compared the Begg technique with the preadjusted edgewise appliance (PEA), the aim of this research was to evaluate and compare the changes in the vertical facial dimension in Angle Class I bimaxillary dentoalveolar protrusion subjects on an underlying Class I or mild Class II skeletal base treated with first four premolar extractions with the Begg or PEA technique.

Subjects and methods

The study design was retrospective in nature and the sample was randomly collected from the orthodontic records at the Department of Orthodontics, Manipal College of Dental Sciences, Mangalore, India. The patients were of a similar age and with a malocclusion. No specific criteria were set for prescribing the appliances and the patients were arbitrarily divided into two groups—Begg and PEA. The initial and final records of all patients who initially presented with an Angle Class I bimaxillary dentoalveolar protrusion and were treated with the Begg or PEA technique were obtained and every alternate patient from both groups was selected. The inclusion criteria were an Angle Class I bimaxillary dentoalveolar protrusion on an underlying Class I or mild Class II skeletal base (0 degrees < ANB <5 degrees), overbite 0–4 mm, with 2–3 mm of crowding or spacing. All permanent maxillary and mandibular teeth were present. Proclined upper and lower incisors as depicted by their pre-treatment cephalometric values. All patients had undergone therapeutic extraction of the four first premolars. No headgear or second molar banding or any other anchorage-reinforcing appliance was used. To minimize the effects of growth, only patients who were at least in stage VI of skeletal maturity as assessed using the method of Hassel and Farman (1995) were selected.

The exclusion criteria were incomplete pre- or post-treatment records, congenitally missing teeth (except third molars) or mutilated dentitions, periodontally affected cases where retraction of the teeth could be compromised, and those with congenital anomalies or significant facial asymmetry. The final sample comprised 55 Class I bimaxillary protrusive patients: Begg appliance group (N = 27) with a mean age of 18.25 ± 3.2 years (7 males and 20 females) and PEA group (N = 28) with a mean age of 18.03 ± 3.5 years (7 males and 21 females).

Treatment protocol

Begg mechanotherapy. Figure 1 depicts the Begg appliance treatment methodology. All teeth were bonded and the first molars were banded. Following initial alignment, stage I (bite opening) was carried on 0.016 inch Australian stainless steel archwire (A.J. Wilcock, Whittlesea, Victoria, Australia) with Class II elastics (TP Orthodontics, Inc., La Porte, Indianna, USA) delivering a force of 75 *g*. After achieving an edge-to-edge bite, stage II (space closure) was performed on a 0.018 inch Australian stainless steel archwire with Class I and II elastics, each delivering a force of 75 *g*. Stage III (torquing and root uprighting) was performed on a 0.020 inch premium Australian stainless steel base archwire with 0.014 inch premium plus Australian stainless steel torquing auxiliary, uprighting springs, and Class II elastics delivering a force of 75 *g*.

PEA mechanotherapy. For the PEA group, 0.022 inch slot Roth prescription was used. After initial levelling and alignment, individual canine retraction was carried out using an elastic chain on 0.018 inch stainless steel archwire (Australian A.J. Wilcock) with approximately 150 g of force at the time of initial activation. Bite opening, if necessary, was undertaken with a 0.017 × 0.025 inch stainless steel intrusion arch either in the upper or lower arch. Incisor retraction was undertaken using loop mechanics (0.019 × 0.025 inch stainless steel) in both arches. Short Class II elastics were used in some cases during the finishing and detailing phase. Figure 2 shows the PEA sample treatment protocol.

Cephalometric analysis

Cephalometric radiographs at the beginning (T1) and end (T2) of treatment were selected. All lateral cephalograms were taken on a Panex-EC (J. Morita Corporation, Kyoto, Japan) using high-speed polyester-based 18 × 24 cm Kodak X-Omat lateral head films with the exposure values set at 90 kVp; 10 mA, with a maximum exposure time of 2.5 seconds having a magnification factor of 1.2. The radiographs were exposed while the subjects had occluded their teeth in centric occlusion. All exposed films were developed and fixed under similar conditions to achieve uniformity. Since the T1 and T2 cephalograms were taken on the same machine, the magnification of the cephalograms was not considered. The lateral films were hand traced by one investigator (AC) under the same illumination and magnification on a single matte lacquered polyester acetate tracing paper of using a 3H lead pencil. Structures appearing as bilateral images were identified by bisecting the outlines of the images.

The 12 parameters studied were broadly divided into skeletal and dental parameters and are depicted in Figure 3. The skeletal parameters were further divided into linear and

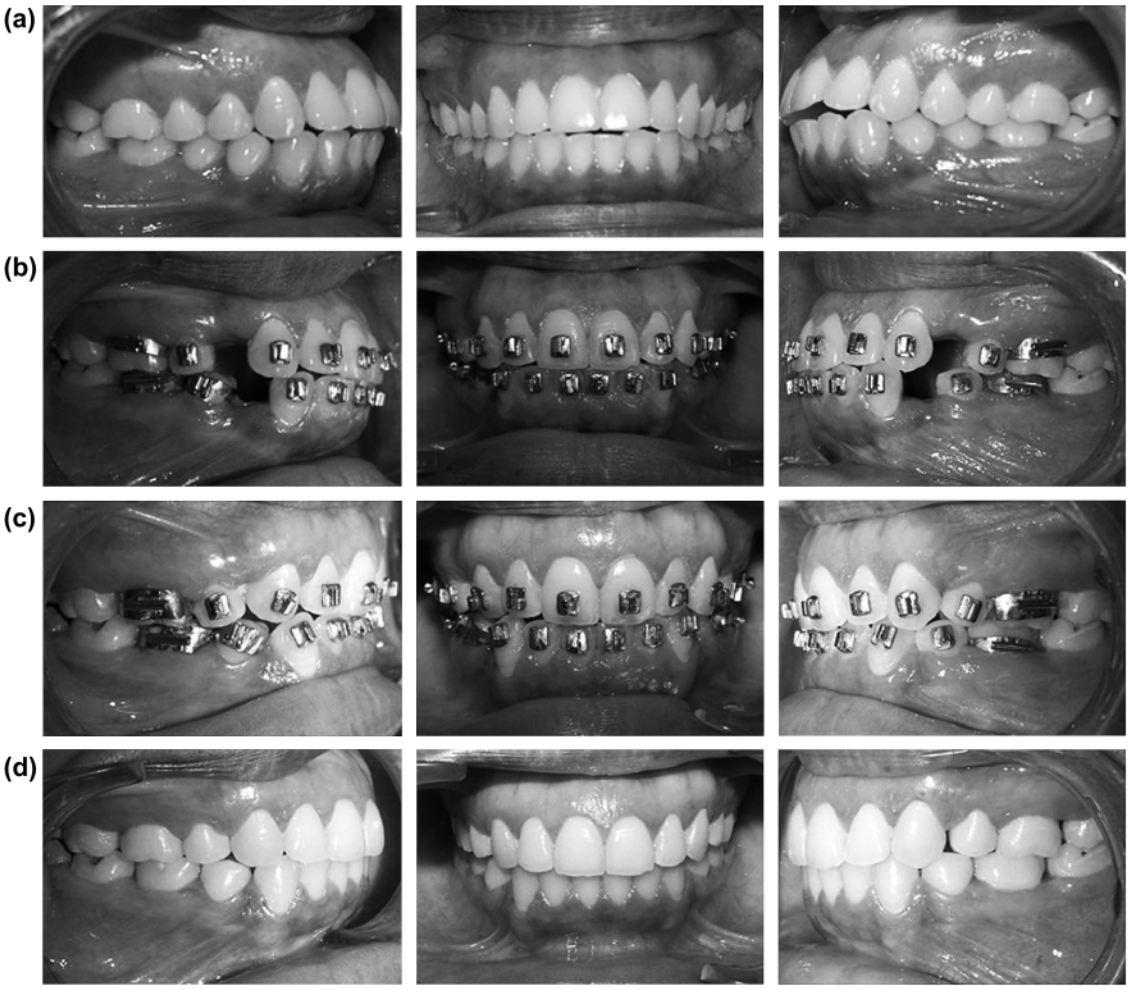

Figure 1 Intraoral photographs of treatment progress with the Begg appliance: (a) pre-treatment, (b) end of stage I, (c) end of stage II, and (d) post-treatment.

angular measurements. All cephalometric measurements are described in Table 1. The skeletal linear measurements were total face height (N–Me), lower anterior face height (LAFH), posterior face height (PFH), face height ratio (N–ANS/ANS–Me), and Jarabak's ratio (PFH:AFH). The skeletal angular measurements were FMA, SN–GoGn, and the Y axis. The dental parameters were lower molar to mandibular plane (LM–MP), lower molar to PTM perpendicular (LM–PTM⊥), upper molar to palatal plane (UM–PP), and upper molar to PTM perpendicular (UM–PTM⊥). The cephalometric super imposition method of Ricketts (1979) was used to compare the T1 and T2 changes.

Statistical analysis

All analyses were performed using the Statistical Package for Social Sciences, version 13.0 (SPSS Inc., Chicago, Illinois, USA). The mean and standard deviation for each cephalometric variable were determined. The following parametric statistical tests were used: two tailed paired *t*-tests (to determine the significance of changes in the groups after treatment) and unpaired *t*-tests (to determine the differences between the two groups either pre- or post-treatment). Correlation among various variables was calculated using Pearson's correlation coefficient (*r*). A confidence level greater than 5 per cent ($P > 0.05$) was not considered significant.

Method of error

Four weeks after the initial tracings, the radiographs of 10 patients were randomly selected and retraced by the same investigator. The tracings were analysed, and the differences in measurements between the two tracings of the same radiograph were calculated. Paired *t*-tests were used to determine significant differences between the two tracings. All cephalometric measurements were also repeated by the same examiner. Correlation among various variables was calculated by using Pearson's correlation coefficient (*r*). No significant differences ($P > 0.05$) were found between any of the measured variables.

Figure 2 Intraoral photographs of treatment progress with the preadjusted edgewise appliance: (a) pre-treatment, (b) initial alignment, (c) canine retraction, (d) incisor retraction, and (e) post-treatment.

Results

Cephalometric measurements of the two groups at T1 and T2 were calculated. To check for any bias in sample selection, the studied parameters of the Begg and PEA groups were compared at T1. None of the parameters showed any statistical significance (Table 2).

Changes in the Begg group

The Begg group showed a significant increase for the skeletal linear measurements of N–Me (0.92 ± 1.79 mm; $P < 0.05$), LAFH (0.88 ± 1.86 mm; $P < 0.05$), and S–Go (0.81 ± 1.14 mm; $P < 0.01$), while no significant changes were observed for N–ANS/ANS–Me ratio (−0.68 ± 3.22 mm; $P > 0.05$), and Jarabak's ratio (0.16 ± 1.34; $P > 0.05$; Table 3). In addition, no significant differences were recorded in the skeletal angular measurements for Y axis (−0.37 ± 2.02), FMA (−0.03 ± 2.19), and Sn–GoGn (0.14 ± 2.03). However, for the dental parameters, significant ($P < 0.001$) changes were observed for UM–PTM$^{\perp}$ (2.74 ± 1.64 mm), LM–MP (1.37 ± 1.52 mm), and LM–PTM$^{\perp}$ (2.74 ± 1.43 mm). UM–PP (0.22 ± 1.55 mm) did not show any significant differences between T2 and T1 values.

Changes in the PEA group

The PEA group had a highly significant increase in skeletal linear measurements of N–Me (1.39 ± 0.99 mm)

and LAFH (1.17 ± 1.09 mm; both $P < 0.001$; Table 3). A significant increase was also found for S–Go (0.89 ± 1.31 mm; $P < 0.05$) and in the reduction of the N–ANS/ANS–Me ratio (−1.18 ± 2.27 mm; $P < 0.05$). No significant differences were observed for Jarabak's ratio (−0.01 ± 1.11) or other skeletal angular measurements: Y axis (0.21 ± 1.52), FMA (0.21 ± 1.70), and Sn–GoGn (0.42 ± 1.28). Dental measurements showed highly significant changes ($P < 0.001$) for UM–PP (0.82 ± 1.09 mm), UM–PTM⊥ (3.00 ± 1.35 mm), LM–MP (1.67 ± 1.30 mm), and LM–PTM⊥ (2.94 ± 1.46 mm).

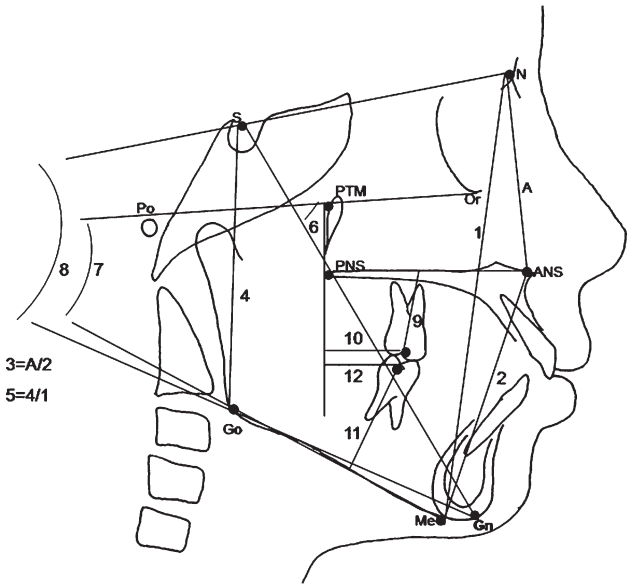

Figure 3 Skeletal linear measurements: 1, TFH (N–Me); 2, LAFH (ANS–Me); 3, UFH/LAFH (N–ANS/ANS–Me); 4, PFH (S–Go); 5, Jarabak's ratio (S–Go/N–Me). Skeletal angular measurements: 6, Y axis; 7, FMA; 8, Sn–GoGn. Dental measurements: 9, UM–PP–vertical position of maxillary first molar; 10, UM–PTM⊥–sagittal position of maxillary first molar; 11, LM–MP–vertical position of mandibular first molar; 12, LM–PTM⊥–sagittal position of mandibular first molar.

Comparison of Begg and PEA groups

No significant differences were found between the groups for any skeletal (linear and angular) or dental parameters (Table 4).

Correlations

A significant correlation ($P < 0.01$) was found between the change in LM–MP and LAFH for the Begg (0.50) and PEA group (0.66; Table 5) while only a weak non-significant inverse correlation was observed between the change in UM to PTM⊥ to FMA and in LM to PTM⊥ to FMA for both groups.

Discussion

This retrospective study is one of the first to cephalometrically compare the treatment effects of the conventional Begg technique with the PEA in terms of their effect on the vertical facial dimensions. Additionally, an attempt was made to find correlations between vertical and antero-posterior movement of the upper and lower molars and FMA and LAFH, respectively, for both groups.

Statistically significant intragroup differences ($P < 0.05$) were observed for both techniques for TFH, LAFH, PFH, and mesial movement and extrusion of both the upper and the lower molars, with the exception of UM–PTM⊥ for the Begg group ($P > 0.05$; Table 3). However, none of the parameters showed any statistically significant difference when the Begg group was compared with the PEA group. A significant correlation was found between the change in LM–MP and LAFH for both groups.

TFH increased by 0.92 mm in the Begg group and 1.39 mm in the PEA group which could be attributed to the extrusion of the molars with both techniques and is in accordance with the findings of Ahn and Schneider (2000),Yamaguchi and Nanda (1991), Staggers (1994),

Table 1 Definitions of linear and angular measurements.

Face height	Linear measurement from nasion (N) to menton (Me)
Lower anterior face height	Linear measurement from anterior nasal spine (ANS) to Me.
Posterior face height	Linear measurement from sella (S) to gonion (Go)
Face height ratio	The ratio between upper face height and lower anterior face height (N–ANS/ANS–Me)
Jarabak's ratio	The ratio between posterior and anterior face height. (S–Go/ N–Me)
FMA	The angle formed between the FH plane and mandibular plane (Go–Me)
SN–GoGn	The angle formed between the SN line and mandibular plane (Go–Gn)
Y axis	The angle between S–Gn line to the FH plane.
Lower molar to mandibular plane	Perpendicular distance from the mandibular plane (Go–Me) to the central fossa of the mandibular first permanent molar
Lower molar to PTM perpendicular	Linear measurement on a perpendicular line drawn from PTM point to the central fossa of the mandibular first permanent molar
Upper molar to palatal plane	Perpendicular distance from the palatal plane (ANS–PNS) to the central fossa of the maxillary first permanent molar
Upper molar to PTM perpendicular	Linear measurement on a perpendicular line drawn from PTM point to the central fossa of the maxillary first permanent molar

Kocadereli (1999), Sarisoy and Darendeliler (1999), and Kim and Kim (2005). However, the increase observed in the present study was less compared with their observations. This difference might have occurred due to the mechanics employed or sample selection since most previous studies included growing children whereas the sample in the present study included patients who were at least in stage VI of skeletal maturity.

Table 2 Comparison of the pre-treatment morphological characteristics of the Begg and preadjusted edgewise appliance (PEA) groups.

	Begg ($n = 27$)		PEA ($n = 28$)			
	Mean	SD	Mean	SD	*P* value	Significance
Skeletal linear measurements						
TFH (N–ME; mm)	122.07	6.43	122.46	8.59	0.84	NS
LAFH (ANS–Me; mm)	70.78	5.99	70.68	6.77	0.95	NS
UFH/LAFH (%; mm)	76.7	6.53	76.86	8.25	0.94	NS
PFH (S–Go; mm)	77.11	6.35	78.39	6.85	0.48	NS
PFH/TFH (%)	63.23	4.77	64.05	4.23	0.5	NS
Skeletal angular measurements						
Y axis (°)	62.7	3.89	62.46	3.66	0.82	NS
FMA (°)	29.52	5.93	29.5	5.54	0.99	NS
Sn–GoGn (°)	35.07	6.03	34.39	5.15	0.65	NS
Dental measurements						
UM–PP (mm)	24.22	2.2	24.54	2.95	0.66	NS
UM–PTM ⊥ (mm)	22.89	3.09	23.21	3.53	0.72	NS
LM–MP (mm)	32.33	3.69	32.29	3.59	0.96	NS
LM–PTM ⊥ (mm)	24.14	3.07	24.83	3.86	0.47	NS

NS, not significant.

LAFH showed an increase of 0.92 mm for the Begg group as compared with 1.3 mm for the PEA group, which 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 face height was similar to the observations of James (1968), Yamaguchi and Nanda (1991), Kocadereli (1999), Sarisoy and Darendeliler (1999), Ahn and Schneider (2000), and Kim and Kim (2005). However, a smaller increase was found than reported by those authors. The findings in the PEA group were greater than those reported by Chua (1993), which could possibly be attributed to the bite opening mechanics employed or the Class II elastics used during finishing and detailing.

The increase in the PFH was similar for the two groups. In the Begg group, both PFH and LAFH increased by almost the same amount thereby indicating a possible forward translation of the mandible under the Class II elastic traction force similar to that reported by Payne (1971) and Begg and Kesling (1977) On the other hand, in the PEA group, LAFH increased marginally more than PFH indicating a very mild opening of the mandibular plane angle. This corresponds with the findings of Sarisoy and Darendeliler (1999) and Ahn and Schneider (2000), although the opening of the mandibular plane in the present study was significantly less and contrary to the reports of Kocadereli (1999) and Hayasaki and Henriques (2005) of a greater increase in PFH than LAFH.

Face height ratio decreased in both groups due to the increase in LAFH; it reduced more in the PEA group because of the greater increase in LAFH than in the Begg

Table 3 Cephalometric measurements in the Begg and preadjusted edgewise appliance (PEA) groups.

	Begg						PEA					
	Pre-treatment		Post-treatment				Pre-treatment		Post-treatment			
	Mean	SD	Mean	SD	*P* value	Significance	Mean	SD	Mean	SD	*P* value	Significance
Skeletal linear measurements												
TFH (N–ME; mm)	122.07	6.43	123	6.74	0.01	*	122.46	8.59	123.86	8.49	0	***
LAFH (ANS–Me; mm)	70.78	5.99	71.67	6.06	0.02	*	70.68	6.77	71.86	6.71	0	***
UFH/LAFH (%; mm)	76.7	6.53	76.02	7.22	0.28	NS	76.86	8.25	75.67	7.64	0.01	*
PFH (S–Go; mm)	77.11	6.35	77.93	6.24	0	**	78.39	6.85	79.29	7.05	0	**
PFH/TFH (%)	63.23	4.77	63.4	4.53	0.52	NS	64.05	4.23	64.04	4.2	0.95	NS
Skeletal angular measurements												
Y axis (°)	62.7	3.89	62.33	3.9	0.35	NS	62.46	3.66	62.68	3.68	0.46	NS
FMA (°)	29.52	5.93	29.48	5.99	0.93	NS	29.5	5.54	29.71	5.39	0.51	NS
Sn–GoGn (°)	35.07	6.03	35.22	6.14	0.71	NS	34.39	5.15	34.82	5.22	0.09	NS
Dental measurements												
UM–PP (mm)	24.22	2.2	24.44	2.34	0.46	NS	24.54	2.95	25.36	2.65	0	***
UM–PTM ⊥ (mm)	22.89	3.09	25.63	3.15	0	***	23.21	3.53	26.21	3.7	0	***
LM–MP (mm)	32.33	3.69	33.7	3.66	0	***	32.29	3.59	33.96	3.42	0	***
LM–PTM ⊥ (mm)	24.14	3.08	26.89	3.1	0	***	24.83	3.86	27.79	4.05	0	***

NS, not significant. *$P < 0.05$; **$P < 0.01$, ***$P < 0.001$.

group. The value was similar to that observed by Staggers (1994). Their difference was however insignificant. A similar result ($P > 0.05$) was obtained for Jarabak's ratio for both groups indicating good maintenance of the vertical dimension with both techniques. Inspite of both upper and lower molar extrusion, the mandibular plane angle remained the same in the Begg group and had a minimal clockwise rotation in the PEA group probably indicating that mesial movement of the molars compensated for their extrusion thus maintaining the vertical facial dimensions.

The *Y* axis reduced in the Begg sample by only 0.3 degrees ($P > 0.05$) indicating a very mild closing of the mandibular plane angle. In contrast, in the PEA group, again though statistically insignificant, the *Y* axis increased by 0.2 degrees indicating a mild opening of the mandibular plane angle similar to the observations of Ahn and Schneider (2000) and Kim and Kim (2005) who reported increases of 1 and 0.5 degrees, respectively.

FMA and Sn–GoGn in the Begg group indicated excellent control of the vertical dimension with almost no opening of the mandibular plane angle, whereas in the PEA group, both parameters showed a marginal increase indicating a non-significant clockwise rotation of the mandible similar to the observations of Gianelly (1984), Kocadereli (1999), and Kim and Kim (2005) but contrary to the findings of Garlington and logan (1990) and Hayasaki and Henriques (2005) who reported a 0.8 degree reduction in the mandibular plane angle. An increase in the mandibular plane angle was also reported by Kottraba (1971), Dougherty (1968), Swain and Ackerman (1969), Williams (1977), and James (1968). This possibly was because all the subjects in both groups were treated as high anchorage cases with maximum retraction of the incisors therefore avoiding any use of mechanics or geometries for molar protraction which could possibly cause closure of the vertical facial dimension by dewedging.

The upper molar to palatal plane angle showed a non-significant extrusion of the upper molar with the Begg technique of 0.2 mm as compared with 0.8 mm with the PEA. The lower molar to palatal plane showed a significant extrusion of 1.3 mm with the Begg technique and 1.6 mm with the 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 (Campe *et al.*, 1967; James, 1968; Bijlstra, 1969; McDowell, 1969; Swain and Ackerman, 1969; Grano, 1971; Barton, 1973; Hurd and Nikolai, 1977; Levin, 1977; Thompson, 1979). This finding however refutes the claims of Begg (1956) and Begg and Kesling (1977). However, the value in the current study was less than that found previous investigations as they mostly used the mesial cusp tip for measuring extrusion whereas in the current study, the central fossa was used thereby giving the true extrusion of

Table 4 Comparison of the treatment changes: post-treatment–pre-treatment in the Begg and preadjusted edgewise appliance (PEA) groups.

	Begg (n= 27)		PEA (n=28)			
	Mean	SD	Mean	SD	*P* value	Significance
Skeletal linear measurements						
TFH (N–ME; mm)	0.92	1.79	1.39	0.99	0.24	NS
LAFH (ANS–Me; mm)	0.88	1.86	1.17	1.09	0.49	NS
UFH/LAFH (%; mm)	−0.68	3.22	−1.18	2.27	0.5	NS
PFH (S–Go; mm)	0.81	1.14	0.89	1.31	0.82	NS
PFH/TFH (%)	0.16	1.34	−0.01	1.11	0.58	NS
Skeletal angular measurements						
Y axis (°)	−0.37	2.02	0.21	1.52	0.23	NS
FMA (°)	−0.03	2.19	0.21	1.7	0.64	NS
Sn–GoGn (°)	0.14	2.03	0.42	1.28	0.54	NS
Dental measurements						
UM–PP (mm)	0.22	1.55	0.82	1.09	0.1	NS
UM–PTM ⊥ (mm)	2.74	1.64	3	1.35	0.53	NS
LM–MP (mm)	1.37	1.52	1.67	1.3	0.42	NS
LM–PTM ⊥ (mm)	2.74	1.43	2.94	1.46	0.6	NS

NS, not significant.

Table 5 Correlations in the Begg and preadjusted edgewise appliance (PEA) groups.

	LAFH						FMA					
	Begg			PEA			Begg			PEA		
	Pearson's correlation	*P* value	Significance	Pearson's correlation	*P* value	Significance	Pearson's correlation	*P* value	Significance	Pearson's correlation	*P* value	Significance
UM–PP	−0.17	0.38	NS	0.12	0.54	NS	0.19	0.33	NS	0.26	0.18	NS
UM–PTM ⊥	0.19	0.33	NS	0.22	0.25	NS	−0.47	0.01	*	−0.34	0.07	NS
LM–MP	0.5	0.01	**	0.66	0	***	−0.29	0.14	NS	0.13	0.5	NS
LM–PTM ⊥	0.24	0.21	NS	0.21	0.27	NS	−0.4	0.04	NS	−0.29	0.13	NS

NS, not significant. $^{**}P < 0.01$, $^{***}P < 0.001$.

the molars (the molar can be distally tipped under the effect of the anchor bend giving an exaggerated value of its extrusion). In the PEA group, this extrusion could probably be attributed to the bite opening mechanics employed (Yamaguchi and Nanda, 1991; Ahn and Schneider, 2000; Hayasaki and Henriques, 2005).

The upper and lower molars to PTM perpendicular showed that the upper molar migrated 2.7 mm mesially in the Begg group and 3 mm in the PEA group. The lower molar also migrated 2.7 mm in the Begg group and 2.9 mm in the PEA group showing that the Begg technique was marginally better at conserving anchorage than the PEA. This could be attributed to the fact that with the PEA higher forces are employed to produce bodily tooth movement resulting in more reactionary force acting on the molars causing anchorage loss. This was similar to the findings of Hayasaki and Henriques (2005) in their Class I extraction sample but contrary to the report of Ahn and Schneider (2000). In the Begg group, the anchorage loss could be attributed to the high reactionary forces exerted during torquing of the anterior teeth.

In an attempt to identify, a correlation between extrusion, mesial movement of the upper and lower molars and the mandibular plane angle, or increase in LFH increase, Pearson's correlation coefficient was used. A significant correlation was found between the change in LM–MP and LAFH probably indicating that the lower molar was more responsible than the upper molar in increasing the vertical facial dimensions, which could be attributed to the use of anchor bends/Class II elastics with the Begg appliance and the bite opening mechanics in PEA thereby causing an extrusive effect on the lower molar. Weak statistically insignificant negative correlations were also found between mesial movement of the upper and lower molars and the FMA for both groups.

Mesial movement of the posterior teeth tended to keep pace with their extrusion such that it increased the anterior and posterior face heights minimally and maintained or very minimally increased the mandibular plane angle thus nullifying any bite-closing effect due to the protraction of the posterior segment. This is similar to the findings of Cusimano and McLaughlin (1993) and Upadhyay *et al.* (2008).

While the current study was performed pre- and post-treatment, long-term evaluation is advocated to obtain a clearer picture of retention of the vertical dimensional changes. In addition, although the sample selected was in stage VI of skeletal maturity, residual growth might still be a factor and should probably be considered in future similar studies.

Conclusions

1. None of the observed parameters showed any statistically significant difference when the Begg and the PEA group were compared.
2. In the intragroup comparisons, a statistically significant difference was observed with both techniques for TFH, LAFH, PFH, and mesial movement and extrusion of both the upper and lower molars.
3. Mesial movement of the molars tended to keep pace with their extrusion and nullified any bite opening effect.
4. A significant correlation was found between the change in LM–MP and LAFH.
5. There was no significant difference when the Begg mechanotherapy was compared with the PEA technique at T2 for evaluation of vertical dimensional changes, contrary to the general consensus that Begg mechanotherapy is associated with a greater increase in vertical facial dimensions.

References

Ahn J G, Schneider B J 2000 Cephalometric appraisal of postreatment vertical changes in adult orthodontic patients. American Journal of Orthodontics and Dentofacial Orthopedics 118: 378–384

Barton J J 1973 A cephalometric comparison of cases treated with edgewise and Begg techniques. Angle Orthodontist 43: 119–146

Begg P R 1956 Differential force in orthodontic treatment. American Journal of Orthodontics 42: 481–510

Begg P R, Kesling P C 1977 The differential force method of orthodontic treatment. American Journal of Orthodontics 71: 1–39

Bijlstra R 1969 Vertical changes during Begg technique. Transactions of the European Orthodontic Society pp. 385–396

Campe G, Marcus M I, Margolis H I 1967 Comparative analysis on reduction of overbite using removable appliance, Begg treatment and Tweed treatment. American Journal of Orthodontics 53: 150–151

Chua A L 1993 The effects of extraction versus nonextraction orthodontic treatment on the growth of the lower anterior face height. American Journal of Orthodontics and Dentofacial Orthopedics 104: 361–368

Cusimano C, McLaughlin R P 1993 Effects of first bicuspid extractions on facial height in high-angle cases. Journal of Clinical Orthodontics 27: 594–598

Dougherty H L 1968 The effect of mechanical forces upon the mandibular buccal segments during orthodontic treatment. American Journal of Orthodontics 54: 83–103

Fischer J C 1974 A cephalometric comparison of vertical dimension changes in Begg v/s Edgewise cases during treatment. Thesis, St. Louis University

Garlington M, Logan L R 1990 Vertical changes in high mandibular plane cases following enucleation of second premolars. Angle Orthodontist 60: 263–268

Gianelly A A 1984 A comparison of Class II treatment changes noted with the light wire, edgewise, and Fränkel appliances. American Journal of Orthodontics 86: 269–276

Grano D J 1971 A radiographic cephalometric study of certain tooth movements observed in the post retention period of deep overbite cases treated with the Begg technique. American Journal of Orthodontics 60: 202–203

Hans M G, Groisser G 2006 Cephalometric changes in overbite and vertical facial height after removal of 4 first molars or first premolars. American Journal of Orthodontics and Dentofacial Orthopedics 130: 183–188

Hassel B, Farman A G 1995 Skeletal maturation evaluation using cervical vertebrae. American Journal of Orthodontics and Dentofacial Orthopedics 107: 58–66

Hayasaki S M, Henriques J F C 2005 Influence of extraction and nonextraction orthodontic treatment in Japanese-Brazilians with Class I

and Class II division 1 malocclusions. American Journal of Orthodontics and Dentofacial Orthopedics 127: 30–36

Hurd J J, Nikolai R J 1977 Maxillary control in Class II division I Begg treatment. American Journal of Orthodontics 72: 641–652

Isaacson J R 1971 Extreme variation in vertical facial growth and associated variation in skeletal and dental relations. Angle Orthodontist 41: 219–229

James T A 1968 Changes in vertical relationships of teeth during and following use of the Begg light wire differential. American Journal of Orthodontics 54: 152

Kashani M A, Neishabori A 2003 The effect of quadrilateral first premolar extractions on vertical occlusal dimensions. European Journal of Orthodontics 25: 530–531

Kim T K, Kim J T 2005 First or second premolar extraction effects on facial vertical dimension. Angle Orthodontist 75: 177–182

Kocadereli I 1999 The effect of first premolar extraction on vertical dimension. American Journal of Orthodontics and Dentofacial Orthopedics 116: 41–45

Kottraba T M 1971 The Begg light-wire treatment: a comparative study. American Journal of Orthodontics 59: 386–401

Levin R I 1977 Treatment results with the Begg technique. American Journal of Orthodontics 72: 239–260

McDowell C S 1969 Static anchorage in the Begg technique. Angle Orthodontist 39: 162–170

Parker W S 1969 A consideration of the pure Begg technique. Angle Orthodontist 39: 1–10

Payne G S 1971 The effect of intermaxillary elastic force on the temporomandibular articulation in the growing macaque monkey. American Journal of Orthodontics 60: 491–504

Pearson L E 1973 Vertical control through use of mandibular posterior intrusive forces. Angle Orthodontist 43: 194–200

Pearson L E 1978 Vertical control in treatment of patients having backward rotational growth tendencies. Angle Orthodontist 48: 132–140

Reddy P, Kharbanda O P 2000 Skeletal and dental changes with nonextraction Begg mechanotherapy in patients with Class II division 1 malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics 118: 641–648

Ricketts R M 1979 Bioprogressive therapy. Rocky Mountain Orthodontics, Denver

Roth R H 1972 Gnathological concepts and orthodontic treatment goals. In: Jarabak J R, Fizzel J A (eds). Technique and treatment with light-wire edgewise appliances, 2nd edn. Mosby, St Louis, pp. 1160–1223

Sarisoy L T, Darendeliler N 1999 The influence of extraction orthodontic treatment on craniofacial structures: evaluation according to two different factors. American Journal of Orthodontics and Dentofacial Orthopedics 115: 508–514

Sims M R 1964 The Begg philosophy and fundamental principles. American Journal of Orthodontics 50: 15–24

Staggers J A 1990 A comparison of results of second molar and first premolar extraction treatment. American Journal of Orthodontics and Dentofacial Orthopedics 98: 430–436

Staggers J A 1994 Vertical changes following first premolar extractions. American Journal of Orthodontics and Dentofacial Orthopedics 105: 19–24

Swain B F, Ackerman J L 1969 An evaluation of the Begg technique. American Journal of Orthodontics 55: 668–687

Thompson W J 1972 Current application of Begg mechanics. American Journal of Orthodontics 62: 245–271

Thompson W J 1979 Occlusal plane and overbite. Angle Orthodontist 49: 47–55

Tulley W J 1959 Role of extraction in orthodontic treatment. British Dental Journal 107: 199–205

Upadhyay M, Yadav S, Nagaraj K, Patil S 2008 Treatment effects of mini-implants for *en-masse* retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics 134: 18–29

Williams R 1977 Cephalometric appraisal of the light wire technique-Begg orthodontic theory and technique. Chapter 17, 3rd edn. W.B Saunders Co, Philadelphia

Yamaguchi K, Nanda R S 1991 The effects of extraction and nonextraction treatment on the mandibular position. American Journal of Orthodontics and Dentofacial Orthopedics 100: 443–452

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