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Original Research Article

Comparative evaluation of self-ligating and conventional pre-adjusted edgewise appliance in management of Class II Div 2 malocclusion: A prospective clinical study

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Abstract

Aim: To evaluate skeletal and dental changes in Class II div 2 malocclusion cases treated with passive self-ligating (SLB) and conventional Preadjusted Edgewise Appliance (PEA) after levelling and alignment stage.

Materials and Methods: A total of 20 cases of Angle Class II div 2 malocclusion selected for study (9 male, 11 female) were divided into two groups, treated with passive SLB (mean age 16.05+ 0.91 years) and conventional Preadjusted Edgewise Appliance (PEA) (mean age 16.51+ 1.61 years). Pre-treatment and post levelling alignment study models, lateral cephalograms were taken. Pre and post intervention records were analysed for selected skeletal, dental, soft tissue and study model parameters. Intergroup and Intragroup variations were assessed for statistically significant differences. Non parametric tests (Wilcoxon-Mann-Whitney U test) were used to make group comparison.

Results: Amongst the selected skeletal parameters, statistically significant increase in maxillomandibular differential (McNamara) was found in SLB group (0.60+ 0.7) compared to PEA group. Rest all other parameters had no statistically significant changes. Significant increase in UI – NA (Steiner's), UI-SN, UI-palatal plane, and increased change in interincisal angle was found in PEA group compared to SLB group. There were significant changes in inter premolar width over time and premolar inclination in SLB group. Change in molar inclination, intermolar width, intercanine width was non-significant.

Conclusion: The increased change in interpremolar dimension was associated with more buccal tipping of premolars in SLB group. Increased incisor proclination and buccal tipping of premolars resulted in resolution of crowding in both groups rather than physiologic arch expansion of arch form.

Keywords: Class II div 2 malocclusion, Self-ligating brackets, Preadjusted edgewise appliance

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1. Introduction

Malocclusion in various forms has been an aesthetic and functional concern for humans, since ancient times, with several attempts to resolve it also.[1] Amongst these, Angle's Class II div 2 malocclusion presents with retroclined upper / lower incisors, increased inter incisal angle, prominent canines, deep curve of spee / overbite and pronounced collum angle. Skeletal features include orthognathic maxilla, retrognathic mandible with horizontal growth pattern / anti-clockwise rotation leading to a skeletal deep bite.[2-6] These malocclusions are now effectively managed by contemporary Preadjusted Edgewise Appliances (PEA). Herein, stainless steel ligatures and elastomeric modules are used to secure arch wires in the bracket slots, with both methods having advantages and disadvantages.[7-12]

Self-ligating brackets (SLB), however present an alternate means to engage arch wires to the brackets. Since their introduction in 1935, SLB system have emerged as a *ligature less* system, witnessing numerous modifications.[13] These systems can be active or passive.[14] They not only eliminated the need for independent ligation requirements, but also ensured better expression of the properties of the shape memory arch wires, due to reduced friction between

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arch wire and bracket.[15-17] Further, passive SLBs generate low forces for a biologically favourable tooth movement.[18]

Though PEA systems level and align arches well, they cause increase in overjet during Class II mechanics. Appliances, which can increase transverse dimensions and limit incisor overjet are therefore, desirable in Class II div 2 malocclusions. Although, many commercial passive self-ligation systems are available in the market, Damon philosophy claims to increase the transverse arch length while maintaining teeth centred in the alveolar process, in a physiologic manner, for resolving Class II malocclusions. This has been supported by few evidences also.[19-22] However, many studies reported no major difference between PEA and self-ligation systems.[23,24] They claimed physiologic arch expansion is merely due to the buccal tipping of molars and premolars.[25] It follows; there is lack of consensus among different studies and with manufacturer claims, on transverse dimensions and restraining effects on the sagittal movement of anterior dentition.

In this context, this prospective study aimed at assessing the selected skeletal, dental and soft tissue changes achieved in Class II div 2 malocclusion cases treated with conventional Preadjusted Edgewise Appliance (PEA) and Damon self-ligating appliance, till the leveling and alignment stage, to ascertain the efficacy of two systems.

2. Materials and Methods

The prospective study protocol was presented and prior clearance was taken from ethical committee, Army Dental Centre (Research & Referral), Delhi before taking up the study. Informed and written consent from all patients was taken prior to inclusion in the study. Based on inclusion, exclusion criteria the selected study sample was divided into two equal groups matched for malocclusion.

The null hypothesis assumed that there was no difference in efficacy of conventional preadjusted edgewise appliance and self- ligating appliance in the initial levelling and alignment of class II div 2 malocclusion cases. The sample size as determined by G power analysis with 95% of confidence interval was calculated to be 20, divided equally into two groups. Group I included patients treated using SLB and ones treated using conventional PEA were included in group II.

Pretreatment records in the form of lateral cephalogram and study models were made before bonding at T0 (**Figure 1**). Mid-palatal line and dental midlines were marked on maxillary casts for cast orientation on orthodontic base unit (Dentaurum Inc). Plastic model bases were aligned and study models were prepared on orthodontic base unit. Study models were articulated on orthodontic base unit with occlusal plane parallel to base (**Figure 2**). Same protocol of bonding was followed for two groups with same etchant, primer and orthodontic adhesive resin used. Group 1 was bonded using conventional 0.022” MBT PEA brackets and 0.022” DAMON Q SLB in group 2. All patients were treated by single orthodontist, arch wires were sequentially ligated and changed after 6 weeks.

The patients were followed until a stainless-steel wire 0.019” × 0.025” was applied. After completion of initial levelling and alignment at T1 (**Figure 3**-**Figure 6**), lateral cephalograms and study models articulated on orthodontic base unit were evaluated for the defined parameters in both groups at T0 and T1.(**Table 2**) The linear measurement on study models was done using carbon fibre composites Digital Vernier calliper with an accuracy of 0$\pm$ 0.1mm/0.01” inch. Angular measurements for buccolingual inclination of teeth were done using stainless steel degree angle bevel protractor (D Head) (Kirti NDT and engineering services, Dombivli, Maharashtra; www.kirtindt.com). Horizontal slit was created on acrylic sheet (thickness 1.5mm) platform for mounting bevel protractor. Dental casts were moved through acrylic platform with occlusal surface upwards. Angular measurements were taken on protractor with readout arm of protractor touching buccal surface of premolars and molars (**Figure 7**). On study models FA point on the buccal surface of premolars and in case of posterior teeth buccal groove was taken as landmark for measuring inclination of teeth. For standardization, the same researcher performed all measurements.

3. Results

Data was recorded for the skeletal, dental, soft tissue, study model parameters of both groups at T0 and T1 stages and compiled in MS Excel spreadsheet program. Data was analysed using SPSS v23 (IBM Corp.) software. The descriptive statistics were elaborated in form of mean/ standard deviation. Intragroup and Intergroup variations were analysed for statistically significant differences in study parameters and results were considered statistically significant at p value < 0.05.

The study sample consisted of 11 female and 09 males diagnosed with skeletal Class II Angle Class II div 2 malocclusions treated with self-ligating and conventional PEA. The mean age of patients in the PEA group was 16.51 (+1.61) years and in self-ligating group 16.05 (±0.91) with no significant difference between the groups. In terms of gender distribution there were 40% male and 60% female in conventional PEA and 50% male 50% female in SLB group with no significant difference between the two groups. The results of both the treatment groups were analysed at pre and post levelling alignment stages. Intragroup and Intergroup variations were analysed for statistically significant differences in skeletal, dental, cephalometric and study model parameters. Non-parametric tests (Wilcoxon Mann-Whitney U Test) were used to make group comparisons.

3.1. Skeletal changes assessed on lateral cephalogram

The pre and post intervention assessment between two groups in terms of change in SNA, SNB, ANB and Wits Appraisal (mm) showed non-significant changes. The mean change in maxillomandibular differential (McNamara) (mm) (Post - Intervention) in the PEA group was 0.10 (0.32) and in SLB group was 0.60 (0.70). There was a significant difference between the 2 groups in terms of Change in maxillomandibular differential (McNamara) (mm) (post-intervention) with the median change in maxillomandibular differential (McNamara) (mm) (post-intervention) being highest in the SLB group. (**Table 3**, **Graph 1**.a) There was no significant difference of change occurred when compared over time (Pre and post intervention) in terms of change in Bjork sum of posterior angles, basal plane angle and lower anterior facial height.

3.2. Dental changes assessed on lateral cephalogram

The change in incisor to NA (Steiner's) (degree) (post-intervention) ranged from 16 – 34 in the PEA group and from 5 – 23 in SLB group. There was significant difference between the 2 groups in terms of change in incisor to NA (Steiner's) (degree) (Post - Intervention) (P = 0.001), with the median change in incisor to NA (Steiner's) (degree) (post-intervention) being highest in the PEA group. There was no significant difference between the groups in terms of change in incisor to NA. (Steiner's) (mm) (Post - Intervention) (P = 0.250). The mean (SD) change in upper incisor to SN (degree) (Post – Intervention) was 23.90 (6.12) in the PEA group and 15.80 (6.88) in SLB group. The change in upper incisor to SN (degree) (Post - Intervention) in the PEA group ranged from 16 – 34 and from 5 – 30 in SLB group. There was significant difference between the 2 groups in terms of change in upper incisor to SN (degree) (Post - intervention) (P = 0.014), with the median change in upper incisor to SN (degree) (post-intervention) being highest in the PEA group. (**Table 3**, **Graph 1**.d)

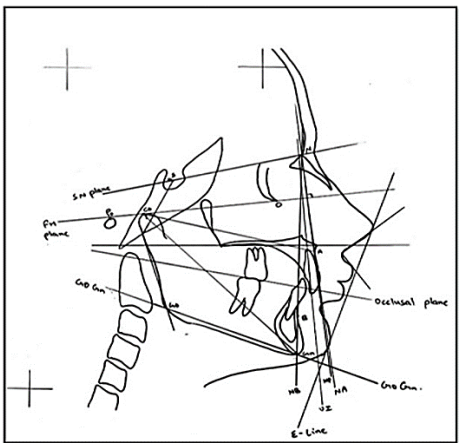


Figure 1: Cephalometric landmarks

Figure 2: Articulation of study models **(a)** Front view; **(b)** Lateral View; **(c)** Occlusal view

Figure 3: Pre-Treatment Intraoral Photographs T0 **(a)** Frontal; **(b)** Occlusal; **(c)** Right buccal; **(d)** Left buccal

Figure 4: After initial levelling and alignment (Conventional PEA) (T1) **(a)** Frontal; **(b)** Maxillary occlusal; **(c)** Right buccal; **(d)** Left buccal

Figure 5: Pre-treatment intra-oral photographs (T0) **(a)** Frontal; **(b)** Maxillary occlusal; **(c)** Right buccal; **(d)** Left buccal

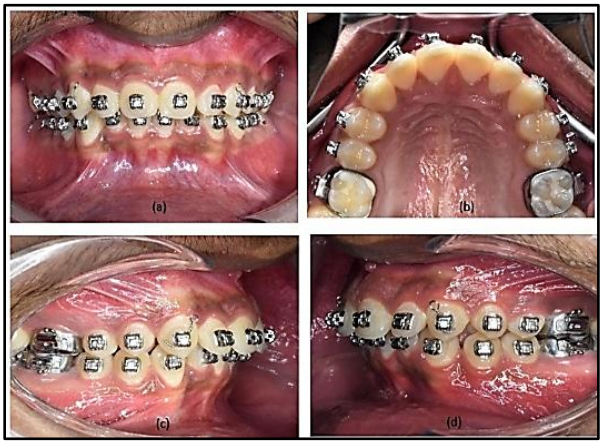


Figure 6: After initial levelling and alignment (Damon Group) (T1) **(a)** Frontal; **(b)** Maxillary occlusal; **(c)** Right buccal; **(d)** Left buccal

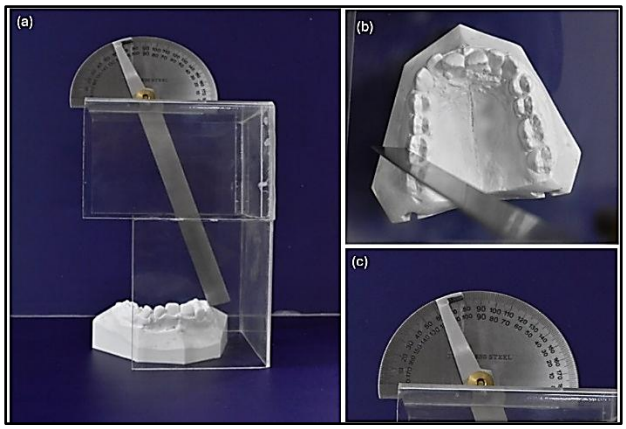


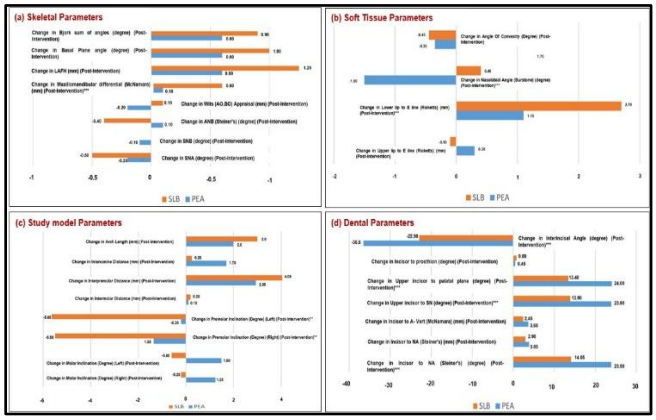
Figure 7: Inclination measurement **(a)** cast orientation on inclinostat; **(b)** measurement on bevel protractor; **(c)** buccal groove as landmark

3.3. Soft tissue parameters assessed on lateral cephalogram

Significant difference was seen between the 2 groups in terms of change in nasolabial angle (post-intervention) with the median change being highest in the SLB group. No significant difference was seen between the groups in terms of change in Angle of Convexity (Degree), upper lip - E line and lower lip - E line (mm) post - intervention and when compared between groups over a period before and after intervention. (**Table 3**, **Graph 1**.b)

3.4. Study model parameters

The two groups differed significantly in terms of premolar inclination (Degree) and interpremolar distance(mm) post-intervention with the increased mean (SD) change in SLB group compared to PEA group. Significant change in premolar inclination was seen between two groups when compared over time. The post levelling alignment results showed no significant difference between the groups in terms of change in molar inclination, intermolar, interpremolar, intercanine distance and archlength. (mm) (Post - intervention) (**Table 3**, **Graph 1** c) The overall changes in above parameters over time between the two groups were non-significant.



Graph 1: Comparative Change in **(a)** skeletal; **(b)** soft tissue; **(c)** study model; **(d)** dental parameters between two groups

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion criteria
Skeletal Class II maxillo-mandibular relation with ANB>4	History of previous orthodontic treatment
Angle's Class II div 2 malocclusion	Medically compromised individuals
Permanent dentition with no missing or supernumerary teeth	Presence of periodontal disease
Patients giving written consent to participate in the study	Cases with cleft lip palate and other craniofacial anomalies

Table 2: Study parameters

Skeletal Parameter	Dental Parameter	Soft Tissue Parameter	Study Model Parameters
SNA	Incisor to NA (Steiner's)	Upper Lip to E- line (Ricketts)	Arch length
SNB	A-Vert (McNamara)	Lower Lip to E-line (Ricketts)	Intercanine width
ANB (Steiner's)	Upper incisor to SN	Nasolabial angle (Burstone)	Interpremolar width
Wits (AO, BO) Appraisal	Upper incisor to palatal plane	Angle of convexity (Holdaway's)	Intermolar width
Maxillomandibular Differential (McNamara)	Incisor to prosthion		Inclination of maxillary 1st premolar and 1st molar
Lower anterior facial height	Interincisal angle		
Basal plane angle			
Bjork's sum of angles			

Table 3: Summary of association between group and parameters

Parameters	Group		p value
	PEA (n = 10)	SLB (n = 10)	
Change in Molar Inclination (Degree) (Right) (Post-Intervention)	1.25 ± 1.84	-0.20 ± 3.71	0.515[1]
Change in Molar Inclination (Degree) (Left) (Post-Intervention)***	1.50 ± 1.51	-0.60 ± 3.06	0.416[1]
Change in Premolar Inclination (Degree) (Right) (Post-Intervention)***	-1.35 ± 3.92	-5.50 ± 2.27	0.019[1]
Change in Premolar Inclination (Degree) (Left) (Post-Intervention)***	-0.20 ± 4.15	-5.65 ± 2.38	0.005[1]
Change in Intermolar Distance (mm) (Post-Intervention)	0.10 ± 1.47	0.20 ± 1.99	0.699[1]
Change in Interpremolar Distance (mm) (Post-Intervention)	2.95 ± 1.67	4.05 ± 0.83	0.143[1]
Change in Intercanine Distance (mm) (Post-Intervention)	1.70 ± 2.56	0.25 ± 2.74	0.271[1]
Change in Arch Length (mm) (Post-Intervention)	2.00 ± 1.43	3.00 ± 1.13	0.206[1]
Change in SNA (degree) (Post-Intervention)	-0.20 ± 0.42	-0.50 ± 0.71	0.182[1]
Change in SNB (degree) (Post-Intervention)	-0.10 ± 0.32	0.00 ± 0.67	0.727[1]
Change in ANB (Steiner's) (degree) (Post-Intervention)	0.10 ± 0.32	-0.40 ± 0.97	0.144[1]
Change in Wits (AO,BO) Apraisal (mm) (Post-Intervention)	-0.20 ± 0.63	0.10 ± 1.07	0.259[1]
Change in Maxillomandibular differential (McNamara) (mm) (Post-Intervention)***	0.10 ± 0.32	0.60 ± 0.70	0.031[1]
Change in LAFH (mm) (Post-Intervention)	0.60 ± 0.84	1.25 ± 1.96	0.589[1]
Change in Basal Plane angle (degree) (Post-Intervention)	0.60 ± 0.84	1.00 ± 1.41	0.700[1]
Change in Bjork sum of angles (degree) (Post-Intervention)	0.60 ± 0.84	0.90 ± 1.52	0.901[1]
Change in Incisor to NA (Steiner's) (degree) (Post-Intervention)***	23.90 ± 6.19	14.05 ± 4.81	0.001[1]
Change in Incisor to NA (Steiner's) (mm) (Post-Intervention)	3.85 ± 1.73	2.90 ± 1.60	0.250[1]
Change in Incisor to A- Vert (McNamara) (mm) (Post-Intervention)	3.65 ± 1.56	2.45 ± 1.52	0.107[1]
Change in Upper incisor to SN (degree) (Post-Intervention)***	23.90 ± 6.12	13.90 ± 4.70	0.001[1]

Change in Upper incisor to palatal plane (degree) (Post-Intervention)***	24.00 ± 6.24	13.40 ± 4.53	0.001[1]
Change in Incisor to prosthion (degree) (Post-Intervention)	0.45 ± 1.34	0.80 ± 0.79	0.154[1]
Change in Interincisal Angle (degree) (Post-Intervention)***	-36.50 ± 8.57	-22.90 ± 9.35	0.004[1]
Change in Upper lip to E line (Ricketts) (mm) (Post-Intervention)	0.30 ± 1.16	-0.10 ± 0.88	0.343[1]
Change in Lower lip to E line (Ricketts) (mm) (Post-Intervention)***	1.10 ± 1.37	2.70 ± 2.58	0.0431
Change in Nasolabial Angle (Burstone) (degree) (Post-Intervention)***	-1.50 ± 1.51	0.40 ± 1.71	0.0091
Change in Angle Of Convexity (Degree) (Post-Intervention)	-0.35 ± 0.88	-0.45 ± 0.60	0.6821

4. Discussion

SLB do not require an elastic or wire ligature but have an inbuilt mechanism that can be opened and closed to secure the arch wire. In the majority of designs, this mechanism is some form of metal labial face to the bracket slot, which is opened and closed with an instrument or fingertip.[18] This system overcomes the high friction, increased treatment time, trauma risk and an added oral hygiene challenge associated with stainless steel ligatures, elastomeric modules.[9-11] Consequent to these, the emergence of SLB system offered substantial improvements in relation to all these drawbacks.[19] Manufacturers and advocates of SLB have proposed many advantages of SLB over conventional PEA brackets. It is believed that with the mechanics of self-ligation, greater arch expansion with less incisor proclination is achieved and therefore fewer extractions are required to provide space for tooth movement.[19]

Last century witnessed several modifications, pertaining to SLB system since the introduction of Russel lock edgewise attachment by Stolzelenberg.[13] Amongst these designs, Damon system was introduced by "A" Company in the mid-1990s. The present study aimed at assessing the effectiveness of DAMON Q passive self-ligating system and conventional PEA in Class II div 2 cases. Records were taken at pretreatment and post leveling alignment stages which were compared for change in skeletal, dental, soft tissue and study model parameters.

Literature cites numerous methods for the evaluation of tooth inclination, which includes measurement on study model, radiographic methods (CT and CBCT) and software-based methods.[26-28] In the present study skeletal and dental changes following the treatment of Class II div 2 malocclusion using Damon SLB system and conventional Pre-adjusted Edgewise Appliance (PEA) were evaluated using lateral cephalogram while dental parameters such as changes in arch width, arch length and inclination of maxillary 1st premolar and 1st molar were evaluated on study models.

4.1. Skeletal changes assessed on lateral cephalogram

In the present study changes in SNA, SNB and ANB between two groups were statistically non-significant though these differed significantly at T^0 and at T^1. Similar results were reported by the study carried out by Al Abdwani et al.[29] which revealed 0.4mm and 0.3mm movement of point A and point B respectively for every 10-degree change in anterior tooth inclination. The change in SNA angle occurred due to the bone remodeling and shifting of point A posteriorly on horizontal plane due to the change in incisor inclination.

There is paucity of data available on comparison of maxillomandibular differential and Wits appraisal in passive SLB system and conventional PEA. In the current study, change in maxillomandibular differential was more pronounced in passive SLB group as compared to conventional PEA. Significant change in case of passive self-ligating group was seen when both the groups were compared for intragroup and intergroup variations. These results may be attributed to remodeling of point A and point B. The present study also revealed statistically non-significant changes in terms of basal plane angle, Bjork sum of posterior angles and lower anterior facial height. These findings are in accordance with the results of the study by Basficiti et al.[30]

4.2. Dental changes assessed on lateral cephalogram

The results of present study revealed increased proclination of incisors in conventional PEA group as compared to Damon SLB group resulting in significant increase in UI- SN, UI-Pal, UI to NA (Steiner's analysis) and non-significant changes in UI to NA (Steiner's analysis), change in UI to A-Vert (McNamara analysis), UI to prosthion. These findings are in accordance with DAMON philosophy stating less proclination of teeth with self-ligating appliance as compared to conventional PEA. It may also be contributed by the difference in the torque prescription of DAMON Q (standard torque) and 0.022 MBT appliance used in the present study. Similarly, Morina et al[31] reported maximum torque expression in conventional PEA appliance as compared to ceramic brackets and self-ligating appliance. However, contrary findings were reported by Pandis et al[32] and Atik et

al.[24] Pandis et al[32] reported no significant differences in UI-SN and UI-NA in both the groups though the bracket slot and finishing arch wires were same for both groups i.e 0.019" X 0.025" stainless steel in 0.022" slot. However, the study by Pandis et al. differed from the present study as instead of DAMON Cu NiTi arch wires, NiTi arch wires were used in both groups for alignment. Atik et al[24] also reported similar torque expression in conventional and passive self-ligating group on using DAMON arch wires in both groups.

4.3. Soft tissue parameters assessed on lateral cephalogram

The present study revealed statistically significant decrease in nasolabial angle in conventional PEA group as compared to SLB group over a period. This was due to the difference in bracket prescription torque between two groups leading to different inclination change in maxillary incisors. No significant changes were seen in upper lip - E line, lower lip - E line distance. Similar findings were reported by Basciftci et al.[30]

4.4. Dental parameters assessed on study model

The results of present study showed statistically no significant differences among passive self-ligating and conventional PEA in terms of changes in molar inclination, intermolar, inter premolar and inter canine width. Similar findings were reported by Alabdullah MM et al[33] and Atik et al.[24] On the contrary, Vajaria et al[34] reported comparatively increased intermolar distance in passive SLB group owing to differences in the finishing arch wires in conventional PEA group (0.16" X 0.022" SS) and passive SLB group (0.019" X 0.025" SS) due to different bracket slot sizes used in two groups. Mateu ME et al[21,22] and Yazicioglu et al.[35] reported increased buccal tipping of maxillary 1st premolars resulting in increased arch width in maxillary 1st premolar region.

The present study revealed significant increase in maxillary incisor proclination in conventional PEA group as compared to SLB group. Similar findings were reported by Lima et al.[20] It could have been due to the differences in the torque prescriptions of the two bracket systems The present study evaluated both treatment groups based on well-defined parameters. Nevertheless, a larger sample with better homogeneity among participants with respect to growth status and long term follow up would have been desirable. Also, the stage comparison in relation to mandibular arch alignment may substantiate the findings.

5. Conclusions

1. The assessment of study models revealed no significant changes in transverse arch dimensions pertaining to inter canine and intermolar arch width. The increased arch width in premolar region was associated with buccal tipping of maxillary premolars in both groups.
2. On cephalometric dentoalveolar assessment significant changes were seen in labial inclination of maxillary teeth but torque expression was more evident in conventional PEA group as compared to SLB group. Increased labial tipping of anterior teeth in both groups indicate resolution of crowding at expense of proclined maxillary anterior teeth rather than physiologic expansion of arch form.
3. Cephalometric skeletal parameters show pre and post treatment variability in parameters influenced by change in position of point A and point B only. Minimal non-significant change was seen between two groups in terms of basal plane angle, Bjork sum of posterior angles and lower anterior facial height.
4. Soft tissue assessment revealed significant change in conventional PEA as compared to passive self-ligating appliance used.

6. Source of Funding

None.

7. Conflict of Interest

None.

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