IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 9 Ser. 3 (September. 2025), PP 72-88
www.iosrjournals.org

Comparative Evaluation Of Alignment Efficiency, Incidence Of Bracket Debonding And Pain Perception Between Passive Self Ligating And Conventional Pre-Adjusted Edgewise Bracket Systems– A Clinical Comparative Study

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Abstract
Aim: *To evaluate & compare Alignment efficiency, Incidence of Bracket Debonding & Pain Perception between Passive Self ligating & Conventional Pre-adjusted Edgewise Bracket systems.*
Methodology: *A comparative clinical study was carried out in which total 26 participants Patients with Average growth pattern & non-extraction treatment modality between 18-30 years of age were considered. The severity of crowding in mandibular anterior region should be between 1-6mm based on Little's Irregularity Index. Maintaining the similarity in amount of crowding present the patients were divided into two groups. Group A Passive Self ligating Pre-adjusted Edgewise Bracket system & Group B Conventional Pre-adjusted Edgewise Bracket System. Study models & Lateral cephalogram were taken as Pre-treatment record (T0). As per the selected bracket system bonding was carried out in each group. In Passive Self-ligating Pre-adjusted Edgewise Bracket system CuNiTi arch wires were used whereas in Conventional Pre-adjusted Edgewise Bracket system NiTi arch wires were used. Method of ligation for Passive Self-ligating & Conventional Pre-adjusted Edgewise bracket system were Self- ligation & Elastic Module respectively. With each archwire change pain perception was recorded using Visual Analogue Scale. The Mandibulae arch alignment was considered when on visual inspection incisal edge, buccal cusp & contact point alignment was achieved. Once the alignment achieved was stably maintained at 0.019*0.025 SS wire; Study models & Lateral cephalograms were taken as Post Decrowding records (T1). The Study models taken at T0 & T1 were assessed for Arch Depth & Arch Width. Parameters like Arch depth at Canine, Arch Depth at Molar, Inter-canine width, Inter-first premolar width, Inter-second premolar width & Inter-molar width were assessed. Lateral cephalograms taken at T0 & T1 were assessed for Mandibular Incisor Proclination using parameters like IMPA, L1-B angular & linear measurement, L1- APog & FMIA. The time difference between bracket bonding & achieved alignment was considered as Duration of alleviation of crowding. Debonding rate was encountered throughout the treatment restricted to incidence of single debonding of each bracket as & when reported by patients. Paired t test was carried out for Intragroup comparison between T0 & T1 for Group 1 & Group 2 whereas Unpaired t test was carried out for Intergroup comparison between Group 1 & 2.*
Result: *The intragroup comparison of Passive Self-ligating Pre- adjusted Edgewise Bracket system showed no statistically significant difference for proclination of mandibular incisors with $p>0.01$ (IMPA, L1-NB angle & linear measurement, FMIA & L1- APog angle). Arch Depth at Canine & Molar showed no significant result. Transverse expansion was experienced by Passive Self- ligating Bracket system with $p<0.01$ for Inter-canine width, Inter- premolar width & Inter-molar width. The intragroup comparison for Conventional Pre-adjusted Edgewise Bracket system showed significant Mandibular*

Incisor proclination with p <0.01 (IMPA, L1-NB angle & linear measurement & FMIA). Arch Depth at Canine & Molar was statistically significant (p=0.01), suggesting proclination of mandibular incisors. Transverse expansion was not significantly experienced by Conventional Pre-adjusted Edgewise Bracket system (p=0.08). The Intergroup comparison between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system showed statistically significant result for the transverse expansion with p<0.01 (Inter-canine width, Inter- premolar width & Inter-molar width). There was no significant difference for Debonding rate between two groups with p=0.08. The treatment duration & pain perception were significantly reduced in Damon group with p <0.01.

Conclusion: *The alignment efficiency with Passive Self-ligating Pre-adjusted Edgewise Bracket system showed significant transverse expansion, reduced treatment duration & less patient discomfort when compared to the Conventional Pre-adjusted Edgewise Bracket system. No significant difference for debonding rate between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system.*

Keywords: *Passive Self ligating, Conventional, Pre-adjusted Edgewise bracket, Damon Bracket system.*

Date of Submission: 08-09-2025 Date of Acceptance: 18-09-2025

I. Introduction

The field of orthodontics has expanded significantly over the period of time. There has been an implausible advancement in diagnostic aids & technology as well as orthodontic materials & diverse treatment modalities. The need for efficient orthodontic treatment by advanced & improved technology becomes epicenter for innovation in the orthodontic industry in order to provide most comprehensive patient care.[1]

Like the other Medical Remedies, Fixed Orthodontic Mechanotherapy has also evolved over time. The evolution initiated with brackets having vertical bracket slot like pin & tube appliance & Begg's appliance. Further derived the Edgewise brackets having horizontal slot providing two-point contact between archwire & bracket slot ensuring better control over tooth movement. Combination Dual slot bracket having Horizontal slot for engagement of main archwire & vertical slot for insertion of auxiliaries are also available. [2] Even then multiple efforts were made by many Orthodontists to incorporate Torque & Tip in Bracket system to deliver efficient, predictable & controlled tooth movement. This desire was accomplished with the development of Pre-adjusted Edgewise Bracket system having in-built Tip & Torque in Bracket itself. Torque in base brackets have torque built in bracket base wherein FA point, Base point & slot point are in same horizontal plane. Torque in base provides acceptable results without wire bending. Whereas, Torque in face brackets have torque built into face or slot of bracket in which slot axis no longer coincides with FA point.[3] Pre-adjusted Edgewise bracket system incorporates Torque in base.[4] The Recommended Bracket Placement Chart developed by MBT having different Torque & Tip measures for various tooth is most commonly used chart for bracket placement.[5]

The Conventional Pre-Adjusted Edgewise Bracket System requires additional ligation commonly in the form of elastic module or ligature wire [6] to secure orthodontic archwire within Bracket Slot to express inbuilt tip & torque. This ligation method increases the friction between bracket slot & wire along with prolonged chair-side ligation time.[7]Change of ligation in every visit also becomes an additional task for the Orthodontist. In Conventional Pre-Adjusted Edgewise bracket system the incidence of white spot lesion & plaque accumulation increases due to presence of elastic module or ligature wire tie.[8]

One of the recent advances related to Orthodontic Bracket System is Self-ligation. In Self-ligating Pre-adjusted Edgewise Bracket System the bracket slot is sealed off mechanically by a slide which is incorporated in the bracket securing the archwire within the bracket slot. This ligature-less method of securing the archwire in bracket slot is beneficial in reducing the friction between bracket slot & archwire along with reduced chair-side ligation time.[7,8]

The absence of ligation further reduces plaque accumulation & white spot lesions thus improves oral hygiene of patient.[8,9] However, Self-ligating bracket system has certain drawbacks including increased incidence of clip or slide breakage & more discomfort to lips due to larger & more labial positioned slides in the bracket.[10] These Self-ligating brackets are available as active & passive brackets. Active Self-ligating brackets include a spring clip; with stored energy; pressing archwire

providing continuous force on archwire. Active Self-ligating bracket system has higher friction & better control of Torque & rotation. Passive Self-ligating brackets have a slide that closes without applying any active force to the archwire. [11] Commonly used active self-ligating brackets include In-Ovation, Speed, & Time. Whereas Damon & Smart clip are two well-known passive self-ligating brackets.[7,10]

In Damon Self-ligating Bracket design, the slide placed within the shelter of tie wing reduces the labial prominence thus preventing the lip discomfort. It's easy mechanism for opening & closing reduces the incidence of slide breakage.[5] The Damon System is a combination of passive Self-ligation with super elastic Copper Nickel Titanium (CuNiTi) archwire. Cu incorporated in Niti archwire provides light continuous force by enhancing transition temperature range & reducing hysteresis in archwire. CuNiTi exhibit properties like shape memory, high spring back, low stiffness & super elasticity.[12] Thus, CuNiTi archwire provide faster & more efficient tooth movement.[13] The Damon System works based on Damon philosophy developed by Dwight Damon in 1990s.

The philosophy believes in applying the minimum amount of pressure or threshold force necessary for tooth movement. Thus, the periodontium & orofacial muscles like the orbicularis-oris & mentalis are not overwhelmed by the light force, creating a steady biological environment. This muscle will act as "lip bumper" providing the alignment decrowding by expansion of arch along with restricted labial movement of dentition by lower lip & choosing the route of least resistance, which is by transverse dimensional changes.[14,15,16]

The efficiency of Alignment in orthodontic treatment using fixed appliances is determined by how precisely & quickly decrowding of teeth will happen with minimum patient discomfort. The duration of treatment is one of the important concerns in today's clinical scenario. The type of bracket, ligation method, composition of archwire & slot- wire interplay will determine the amount of friction generation that ultimately affects the duration of decrowding.[17] Precision of Alignment involves the levelling of anterior teeth's incisal edges, posterior teeth's buccal cusps & also achieving ideal contact point relationship.[18]In non-extraction treatment modality, the space required for decrowding is generally achieved either by Proclination, Arch Expansion, Molar Distalization, Proximal Stripping or combination of any.[18]

Breakages or Bracket Bond Failure are one of the important aspects of Orthodontic Treatment Modalities. A greater bracket bond failure rate results in additional visits for the patient & additional clinical time needed for the repair that eventually depreciates overall treatment outcome.[19]Temporary pulpitis, periodontal ligament compression, & mechanical trauma to the soft tissues are prime reasons of pain during orthodontic treatment, particularly after initial archwire placement & subsequent activations.[20]

So, the present research was carried out to conclude best bracket system amongst Passive Self-ligating & Conventional Pre- adjusted Edgewise bracket systems that align teeth efficiently with lesser chances of bracket debonding & reduced pain incidence.

Need of the study

According to literature reviewed till 01-04-2023; on various literature databases such as PubMed, Google Scholar, Science Direct; there were limited articles[9,14,17,19,20,21,22] that evaluated Alignment efficiency (Duration of Decrowding, Incisor Inclination and Arch Depth &Width), Incidence of Bracket Debonding and Pain Perception between Passive Self-ligating and Conventional Pre-adjusted Edgewise Bracket Systems.

As the conclusions of articles available in literature were contradictory in either Alignment efficiency[9,14,17,21] or Incidence of Bracket Debonding[19,21]or Pain Perception[20,22]; the present research was carried out for further clarification on selected topic.

Null Hypothesis:

There is No Significant Difference between Passive Self-ligating and Conventional Pre-adjusted Edgewise Bracket systems for Alignment efficiency, Incidence of Bracket Debonding and Pain Perception.

II. Aims And Objectives

Aim:

To evaluate & compare Alignment efficiency, Incidence of Bracket Debonding and Pain Perception between Passive Self- ligating & Conventional Pre-adjusted Edgewise Bracket Systems.

Objectives:

Primary Objectives:

1. To estimate Alignment efficiency (Duration of Decrowding, Incisor Inclination and Arch Depth & Width) for Passive Self-ligating Pre- adjusted Edgewise Bracket System.
2. To estimate Alignment efficiency (Duration of Decrowding, Incisor Inclination and Arch Depth & Width) for Conventional Pre- adjusted Edgewise Bracket System.
3. To compare Alignment efficiency (Duration of Decrowding, Incisor Inclination and Arch Depth & Width) between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket Systems.

Secondary Objectives

4. To estimate Incidence of Bracket Debonding & Pain Perception for Passive Self-ligating Pre-adjusted Edgewise Bracket System.
5. To estimate Incidence of Bracket Debonding & Pain Perception for Conventional Pre-adjusted Edgewise Bracket System.
6. To compare Incidence of Bracket Debonding & Pain Perception between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket Systems.

III. Material And Methodology

Study Design:

1. **Place of the study**: Department of Orthodontics and Dentofacial Orthopaedics, K.M. Shah Dental College & Hospital, Sumandeep Vidyapeeth Deemed to be University, Piparia, Waghodia, Vadodara, Gujarat 391760.
2. **Source of Sample**: Orthodontic Patients from Department of Orthodontics & Dentofacial Orthopedics who were willing to undergo Pre-adjusted Edgewise Fixed Mechanotherapy for correction of Malocclusion.
3. **Study Approval**: Study Approval was taken from Sumandeep Vidyapeeth Institutional Ethical Committee. (SVIEC/ON/Dent/BNPG/22/May/23/62 on 9th May 2023)
4. **Time Scale of the Study**: Study was started after obtaining SVIEC approval and was completed within 24 Months from the date of Study Approval.
5. **Selection Criteria**:

Inclusion Criteria:

i. Age group: 18 to 30 Years
ii. Patients indicated for Fixed Mechanotherapy with Non-Extraction Treatment Modality
iii. Patients having all Mandibular teeth erupted excluding Third Molars.
iv. Patients having Lower Anterior Crowding within 1mm to 6 m according to Little's Irregularity Index[29].
v. Average Growth pattern patients.

Exclusion Criteria:

i. Patient having history of Previous Orthodontic Treatment
ii. Patient with compromised Periodontium.
iii. Patient having any of Systemic illness like congenital heart disease, diabetes, bleeding disorder, etc.
iv. Patient having any types of dental anomalies like hypodontia, supernumerary teeth, microdontia, macrodontia, etc.
v. Patients having any syndrome like Apert syndrome, Crouzon syndrome, Treacher Collin syndrome, etc.
vi. Patient consuming any Analgesics.
vii. Patients having Fractured teeth due to Trauma from occlusion specifically in lower anterior teeth region
viii. Patients having any Missing teeth or Restored teeth. ix
ix. Patients having Fluorosis.

6. **Study Design**: A Clinical Comparative Study
7. **Sample Size Estimation**: Sample size was estimated based on the article titled "Evaluation of incisor position and dental transverse dimensional changes using the Damon system" by Rohini Vajaria[14], Table-1, Considering Incisor Mandibular Plane Angle (IMPA)difference as parameter for Sample size estimation, the expected standard deviation was 6.94, Alpha error of 5%, Power of Study was 80% and keeping effective clinically significant difference (d) of 6.09, we estimated sample size of 11 per group.

$N = (Z_{1-\alpha/2} + Z_{1-\beta})^2 s^2 / d^2$

$= [(1.95996398454005 + 0.841621233572915)^2 * 6.94^2] / 6.09^2$

$= [(2.80158521811297)^2 * 48.1636] / 37.0881$

$= [378.030303973296] / 37.0881$

$= 10.19276544$

= 11 per Group Where,

α is Type I error = 5%

β is Type II error = 20%, meaning 1−β is power=80% Z(1-α/2) is Z score for the alpha error chosen = 1.95

Z(1-β) is Z score for the power chosen = 0.84

s is average standard deviation=6.94

d is clinically significant difference = 6.09

Considering the Dropout Ratio of 20%, estimated sample size per group was 13. Total Sample Size for both the groups was 26.

Equipment and Materials used for the study:

8. Diagnostic instrument like Mouth mirror, Explorer & Tweezer
9. Self-ligating Damon Q2 Pre-adjusted Edgewise 0.022" Bracket kit with CuNiTiArch wires (Ormco)
10. Conventional Mini Diamond Preadjusted Edgewise 0.022" MBT Bracket kit (Ormco)
11. 0.014"NiTi; 0.016"NiTi; 0.016*0.022" NiTi; 0.017*0.025" NiTi and 0.019*0.025" Stainless Steel (d-tech).
12. Elastic Modules (Morelli)
13. Digital Calliper
14. Alginate impression material (DPI)
15. Orthokal (Orthodontic stone Class 3)
16. Standardized Lateral Cephalograms of Dimension 8*10 inches
17. Pair of Set Squares
18. Tracing Table with X-ray View box
19. 12-inch Scale, big Protractor, Sharpener, and Eraser
20. Acetate Matte Tracing Paper (8*10*0.003 inch)
21. A sharp 3H Drawing pencil
22. Bracket Positioner and MBT Gauge
23. Pumice Powder
24. Polishing Brush/ Cup
25. Etching Agent (Frost)
26. Bonding kit (3M Transbond XT)
27. Curing light

Methodology

The study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics, K. M. Shah Dental College & Hospital, Piparia, Vadodara, Gujarat after receiving ethical approval from Sumandeep Vidyapeeth Institutional Ethical Committee (SVIEC). The patients were selected as per inclusion and exclusion criteria. The selected participants were introduced to the aim, objectives and methodology of the study with the help of Participant Information Sheet (PIS). If the participants agreed to participate in the study, a signed written informed consent had been obtained.

Based on equality of Lower Anterior Crowding, the selected participants will be equally distributed either into Group A (Damon Q2 Self-ligating 0.022" Pre-adjusted Edgewise Bracket System) or Group B (Conventional Mini Diamond 0.022"Pre- adjusted Edgewise Bracket System). The Severity of irregularity was regularized between both the Groups by Principal Investigator. The severity of crowding amongst both the Groups were measured by Little's Irregularity Index[29] on Pre-treatment Study Model with fine tip Digital Calliper.

As Pre-treatment records at T0, Lateral Cephalogram were obtained to record Incisor

Inclination with Incisor Mandibular Plane Angle (IMPA), Lower Incisor to A-Pog Line, Lower Incisor to N-B (angular and linear), Frankfort Mandibular Incisor Angle (FMIA) and Study models obtained to record Arch Depth at Canine & First Molar, Inter-canine Width, Inter-First Pre-molar Width, Inter-Second Pre-molar Width and Inter-First Molar Width.

After obtaining pre-treatment records, Bracket kit was allotted for both the Groups. After polishing of teeth surfaces with Pumice based Polishing paste, by mixing Pumice Powder with water, Acid Etching with 37% phosphoric acid was performed for 15-20 seconds. After thorough washing and drying and achieving white frosty tooth surface appearance, the primer was applied on teeth surface and cured for 15-30 seconds. Finally, after applying composite on bracket bases, for both the groups, brackets were appropriately positioned with help of Bracket Positioner and MBT Gauge and finally cured with curing light having 420-515 nm wavelength & 1200-2500mW/cm^2 intensity. Same bonding procedure including same bonding material with varying bracket system was carried out for both the groups.

The archwire sequence followed for Conventional Mini Diamond 0.022" Pre-adjusted Edgewise Bracket System was 0.014"NiTi; 0.016"NiTi; 0.016*0.022" NiTi; 0.017*0.025" NiTi and

0.019*0.025" Stainless Steel whereas for Self-ligating Damon Q2 0.022" Pre-adjusted Edgewise Bracket System was 0.014"CuNiTi; 0.014*0.025" CuNiTi;0.018*0.025"CuNiTi and 0.019*0.025"

Stainless Steel. For Conventional Bracket System Elastic Modules were used to secure arch wire within bracket slot.

All the procedure would be done by same operator for both the Groups. Similar Oral Hygiene and Appliance Maintenance instructions were given to both the groups.

Patient's next appointment was scheduled on monthly interval basis or as and when Incidence of bracket debonding. Patient's Pain Perception were recorded using a Visual Analogue Scale (VAS) at first archwire application & after each archwire change. Patient is asked to mark on unmarked horizontal line from 0 to 10 determining 0 to be 'No pain' and 10 to be 'Unbearable pain'. For each bracket Incidence of debonding will be restricted to first time bracket debonding only.

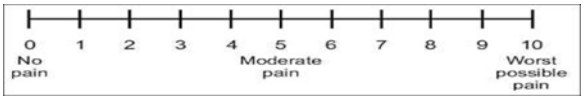


Figure 1*: Visual Analogue Scale to record Pain Perception*

Once Complete alleviation of crowding was achieved, judged by visual clinical inspection including incisal edge alignment, buccal cusp & contact point alignment. Post decrowding records at T1were taken that include Lateral Cephalogram to record Incisor Inclination with Incisor Mandibular Plane Angle (IMPA), Lower Incisor to A-Pog Line, Lower Incisor to N-B (angular and linear), Frankfort Mandibular Incisor Angle (FMIA) and Study models to record Arch Depth at Canine & First Molar, Inter- canine Width, Inter-First Pre-molar Width, Inter-Second Pre- molar Width and Inter-First Molar Width.

- ✓ T0 records: Pre-treatment records
- ✓ T1 records: Post decrowding records

All the collected data were entered & organized using Microsoft Excel (version 2017), Social Science (SPSS), version 26.0 (IBM Corp.) & were subjected to below mentioned statistical test.

1. Paired t test for intragroup comparison.
2. Unpaired t test for intergroup comparison.

Sr.No.	Name of the Parameter	Description	Normal Value
1	Incisor Mandibular Plane Angle (IMPA)	Angle formed by Mandibular plane and long axis of Mandibular central incisor	90°
2	Lower incisor to N-B (Angle)	Angle between Long axis of Mandibular incisor and N-point B	25°
3	Lower incisor to N-B (Linear)	Linear Distance between Long axis of Mandibular incisor and N-point B	4mm
4	Frankfort Mandibular Incisor Angle (FMIA)	Angle between Frankfort plane and long axis of Mandibular incisor	65°
5	Lower incisor to A-Pog Angle	Angle between long axis of Mandibular incisor and Point A-Pog line	22°

p value less than 0.05 was considered statistically significant result.

Table 1: *List of parameters for assessment of Mandibular incisor proclination using Lateral Cephalogram at T0 (Pre-treatment) & T1 (Post Decrowding).*

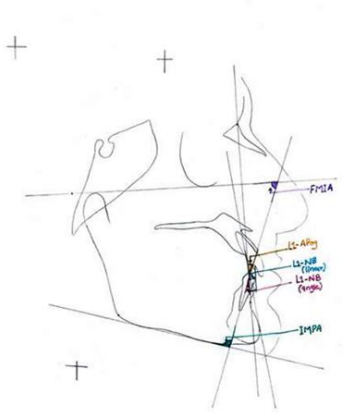


Figure 2*: Incisor Inclination assessment through Lateral Cephalogram*

The Arch Depth & Width were recorded by Digitally tracing using IC Measure Software.

Table 2: *List of parameters for assessment of Arch Depth & Width on Study model at T0 (Pre-treatment) & T1 (Post Decrowding)*

Sr. No.	Name of the Parameter	Description
1	Arch Depth at Canine	Distance of incisal edge of most proclined incisor to transverse line connecting the cusps tips of canine
2	Arch Depth at Molar	Distance of incisal edge of most proclined incisor to transverse line connecting mesial contact point of first molar.
3	Inter-canine width	Transverse distance between cusp tips of canine.
4	Inter-first premolar width	Transverse distance between central occlusal pits of first premolar.
5	Inter-second premolar width	Transverse distance between central occlusal pit of second premolar.
6	Inter-molar width	Transverse distance between central groove of first molars.

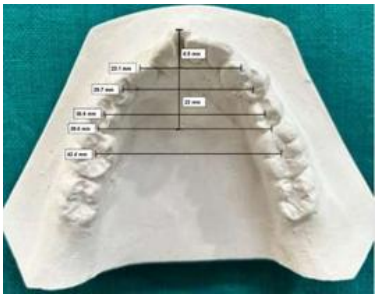
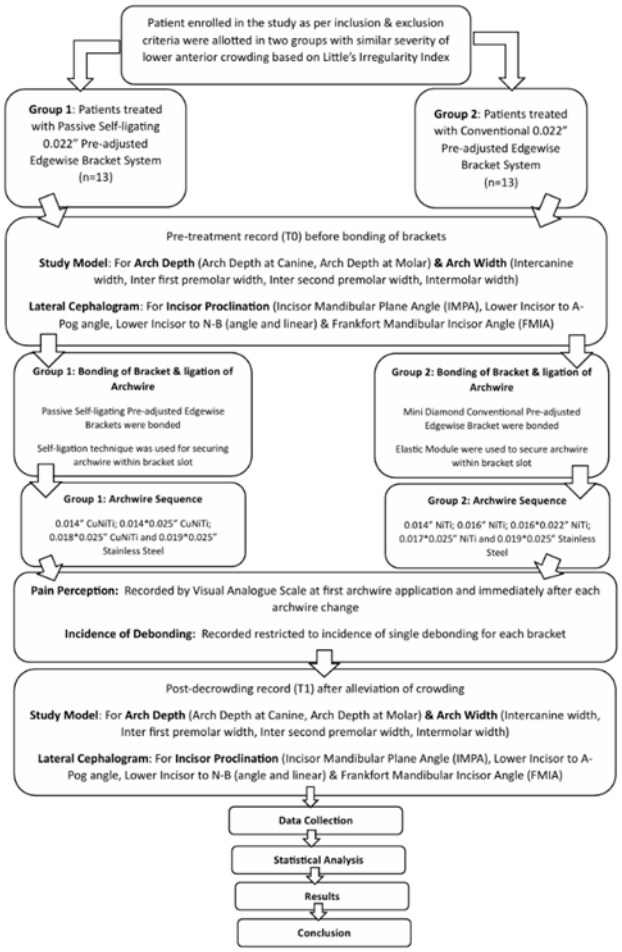


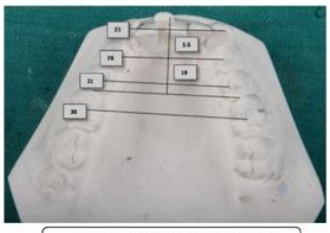
Figure 3*: Arch Depth & Arch Width assessment on Study Model*

- **The Duration of the Decrowding** was recorded in days from First Archwire placement to Complete alleviation of crowding.
- **Incidence of Debonding** was recorded restricted to incidence of single debonding for each bracket.

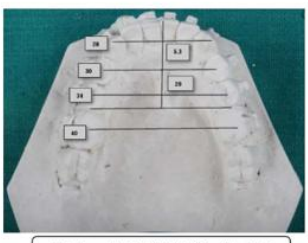
FLOWCHART



Group 1: Passive Self-ligating Pre-adjusted Edgewise Bracket System

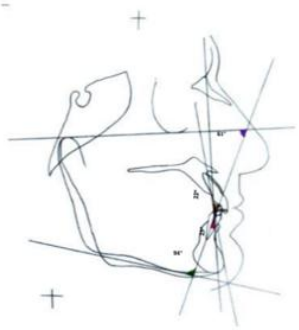


Pre Treatment Study Model of Mandibular Arch

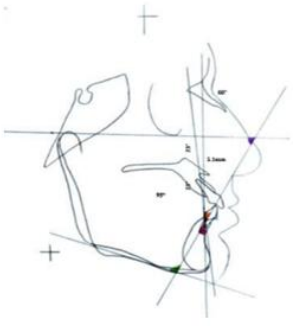


Post Decrowding Study Model of Mandibular Arch

Group 1: Passive Self-ligating Pre-adjusted Edgewise Bracket System

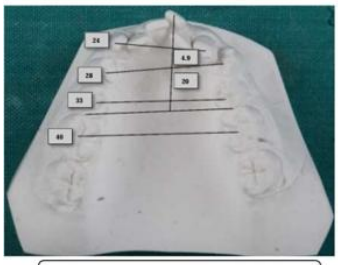


Pre Treatment Lateral Cephalogram

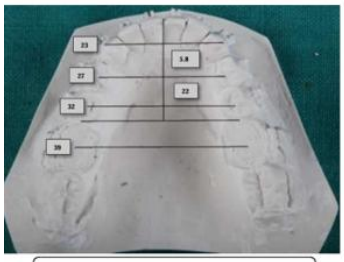


Post Decrowding Lateral Cephalogram

Group 2: Conventional Pre-adjusted Edgewise Bracket System

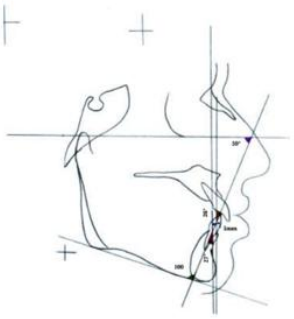


Pre Treatment Study Model of Mandibular Arch

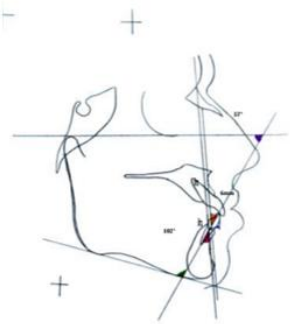


Post Decrowding Study Model of Mandibular Arch

Group 2: Conventional Pre-adjusted Edgewise Bracket System



Pre Treatment Lateral Cephalogram



Post Decrowding Lateral Cephalogram

IV. Results

The study was conducted on total 26 patients (13 in each group) appropriate to the inclusion and exclusion criteria. Data obtained from the study was analyzed for intragroup and intergroup comparison.

Table 3: Intra group comparison of Mandibular Incisor Proclination for Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
IMPA	95.15	9.38	96.00	9.48	0.85	2.34	0.22
L1-NB (angle)	24.31	6.82	24.92	6.49	0.62	1.12	0.07
L1-NB (linear)	5.08	2.22	5.15	1.72	0.08	0.95	0.78
FMIA	62.15	7.37	61.92	8.23	-0.23	1.59	0.61
L1- Apog	23.62	4.77	23.92	4.03	0.31	4.59	0.81

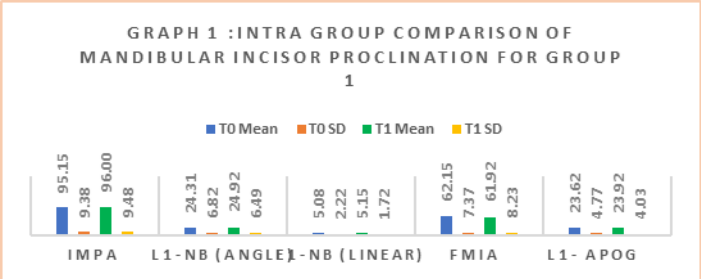


Table 3 represents Intra group comparison for Passive Self-ligating Pre-adjusted Edgewise bracket system. The mean value of IMPA was 0.85 ± 2.34 with p value 0.22 which was not statistically significant. Mean value for L1-NB angular measurement was 0.62 ± 1.12 with p value of 0.07 representing no statistically significant difference. For L1-NB linear measurement the mean value was 0.08 ± 0.95 with p value 0.78 which was not statistically significant result. Similarly, FMIA and L1-APog resulted mean value-0.23 ± 1.59 and 0.31 ± 4.59 respectively with p value

0.61 and 0.81 respectively which was also not statistically significant difference. **Graph 1** represents Intragroup data at T0 & T1 (Mean & SD) for Passive Self-ligating Pre-adjusted Edgewise bracket system.

Table 4: Intragroup Comparison of Arch Depth for Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
AD Canine	5.77	2.05	5.54	1.94	-0.23	1.54	0.30
AD Molar	20.92	2.99	21.00	3.29	0.08	2.02	0.89

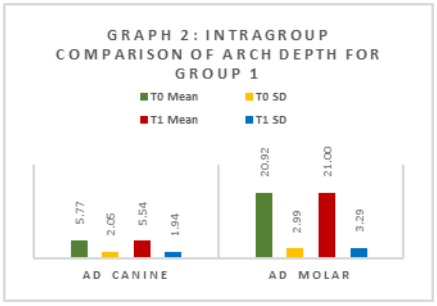
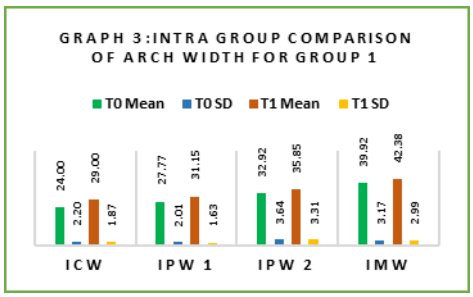


Table 4 signifies no statistically significant difference for Arch Depth at Canine & Arch depth at Molar with p value 0.30 & 0.89 respectively. **Graph 2** represents Mean and SD of Arch Depth at Canine & Molar at T0 and T1 for Passive Self-ligating Pre-adjusted Edgewise Bracket system.

Table 5: Intra group Comparison of Arch Width for Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
ICW	24.00	2.20	29.00	1.87	5.00	1.78	**<0.01**
IPW 1	27.77	2.01	31.15	1.63	3.38	2.02	**<0.01**
IPW 2	32.92	3.64	35.85	3.31	2.92	1.04	**<0.01**
IMW	39.92	3.17	42.38	2.99	2.46	0.66	**<0.01**



Arch Width for Group 1 was represented in **Table 5**. The mean value for Inter-canine width, Inter-first premolar width, Inter-second Premolar width & Inter-molar width were 5 ±1.78, 3.38 ± 2.02, 2.92 ± 1.04 and 2.46 ± 0.66 respectively with p value <0.01 representing statistically significant difference between T0 & T1. Thus, the decrowding in the participants treated with Passive self-ligating bracket system was carried out by transverse expansion. **Graph 3** represents comparison of Arch width for group 1 between T0 & T1.

Table 6: Intra group Comparison of Mandibular Incisor Proclination for Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
IMPA	100.31	9.91	102.38	10.36	2.08	0.64	**<0.01**
L1-NB (angle)	28.46	8.17	29.77	8.25	1.31	0.75	**<0.01**
L1-NB (linear)	5.54	2.50	6.31	2.43	0.77	1.01	**0.01**
FMIA	58.92	7.02	57.31	7.61	-1.62	2.18	**0.02**
L1-Apog	27.15	8.72	28.08	7.58	0.92	3.30	0.33

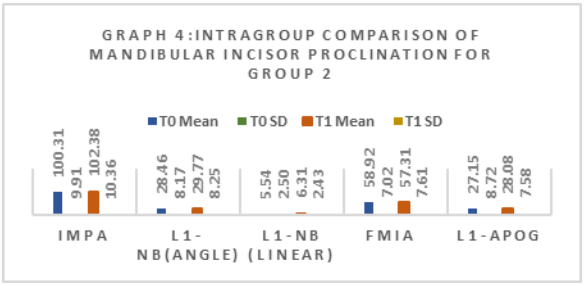


Table 6 represents intragroup comparison for Conventional Pre-adjusted Edgewise Bracket system. The mean value for IMPA was 2.08 ± 0.64 with p value <0.01 which is statistically significant difference between T0 & T1. Similarly, the mean value for L1-NB angular measurement was 1.31 ± 0.75 with p value <0.01 suggesting statistically significant different result. Also, L1-NB linear measurement resulted with mean difference of 0.77 ± 1.01 and p value of 0.01 which was statistically significant difference. The mean value for FMIA was -1.62 ± 2.18 with p value 0.02 suggesting statistically significant result. But on contrary L1-APog showed mean value 0.92 ± 3.30 and p value 0.33 which is not statistically significant difference between T0 & T1. Thus, Conventional group underwent decrowding with proclination of mandibular incisors. **Graph 4** represents the Mean & SD of mandibular Incisor proclination for Conventional group at T0 & T1.

Table 7: Intra group comparison of Arch depth for Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
AD Canine	5.08	1.32	5.85	1.63	0.77	1.17	**0.03**
AD Molar	20.92	2.02	22.00	2.55	1.08	1.44	**0.01**

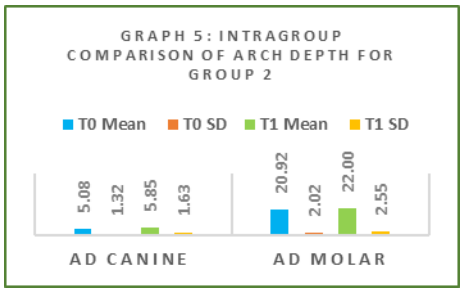


Table 7 represented Arch Depth at Canine & Molar with p value 0.03 and 0.01 respectively suggesting statistically significant difference between T0 & T1. **Graph 5** represents Mean & SD of Arch Depth for Conventional Pre-adjusted Edgewise Bracket system at T0 & T1.

Table 8: Intra group Comparison of Arch Width for Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	T0		T1		Difference		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P value**
ICW	24.23	2.17	23.77	2.49	-0.46	1.20	0.10
IPW 1	29.08	3.59	28.46	2.93	-0.62	1.50	0.08
IPW 2	34.31	3.59	33.69	3.64	-0.62	1.50	0.08
IMW	41.00	3.08	40.31	3.33	-0.69	1.49	0.06

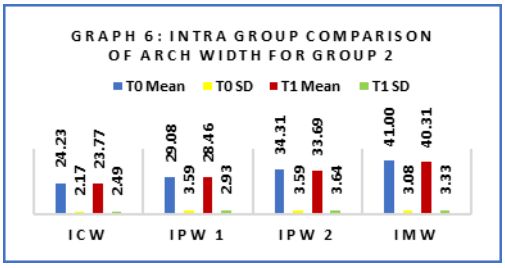
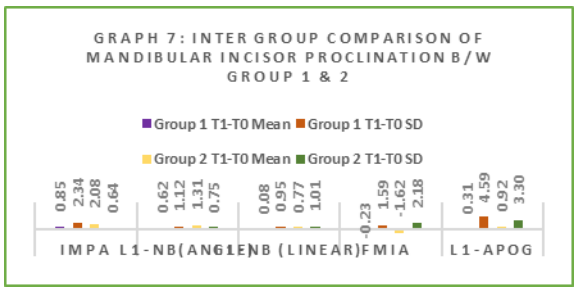


Table 8 represents Intragroup comparison of Arch width for conventional group. The mean value for Inter-canine width, Inter- premolar width & Inter-molar width were -0.46 ± 1.20, -0.62 ± 1.50, -0.69 ± 1.49 respectively with p value of 0.10, 0.08 & 0.06 respectively. There was no statistically significant difference present for arch width for the Conventional Pre-adjusted Edgewise Bracket system. **Graph 6** represents Mean & SD of Arch Width at T0 & T1 for Conventional pre-adjusted Edgewise Bracket system. Thus, the decrowding in patients treated with conventional bracket system is carried out majorly by proclination of mandibular anterior rather than transverse expansion

Table 9: Intergroup Comparison of Mandibular Incisor Proclination between Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system) & Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	Group 1		Group 2		
	T1-T0		T1-T0		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
IMPA	0.85	2.34	2.08	0.64	0.09
L1-NB (angle)	0.62	1.12	1.31	0.75	0.08
L1-NB (linear)	0.08	0.95	0.77	1.01	0.09
FMIA	-0.23	1.59	-1.62	2.18	0.08
L1-Apog	0.31	4.59	0.92	3.30	0.70



Intergroup comparison between Passive Self-ligating Pre-adjusted Edgewise Bracket system & Conventional Pre-adjusted Edgewise Bracket system was represented in **Table 9**. The mean value for IMPA, L1-NB angular and linear measurement, FMIA & L1-APog were higher in group 2 but no statistically significant difference was analyzed with p value 0.09, 0.08, 0.09, 0.08 & 0.70 respectively. **Graph 7** represents Mean & SD of mean difference & SD difference (T1-T0) for Group 1 & Group 2.

Table 10: Intergroup Comparison of Arch Depth between Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system) & Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	Group 1		Group 2		
	T1-T0		T1-T0		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
AD Canine	-0.23	1.54	0.77	1.17	0.07
AD Molar	0.08	2.02	1.08	1.44	0.08

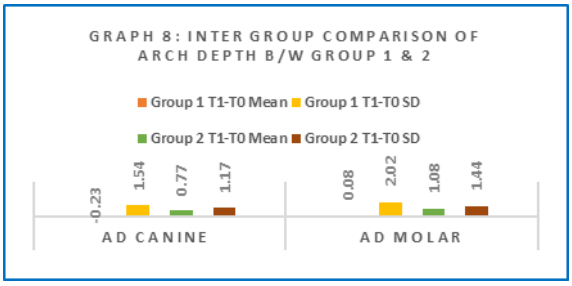


Table 10 represents the Inter group comparison for Arch Depth at Canine & Molar. There was no statistically significant difference found for arch depth at Canine & Molar with p value 0.07 and 0.08 respectively. **Graph 8** shows graphical representation of Mean & SD difference (T1-T0) for Group 1 & Group 2.

Table 11: Inter group Comparison of Arch Width between Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system) & Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	Group 1		Group 2		
	T1-T0		T1-T0		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
ICW	5.00	1.78	-0.46	1.20	**<0.01**
IPW 1	3.38	2.02	-0.62	1.50	**<0.01**
IPW 2	2.92	1.04	-0.62	1.50	**<0.01**
IMW	2.46	0.66	-0.69	1.49	**<0.01**

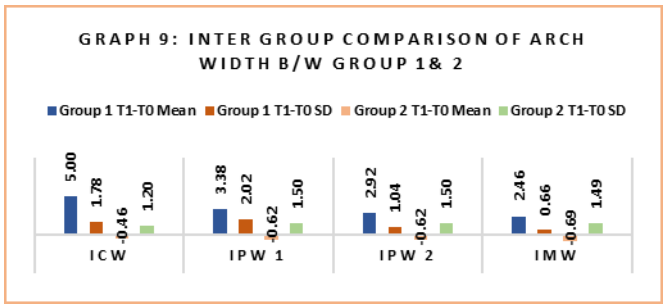


Table 11 represents Inter group comparison of Arch Width. The Mean of Mean difference for Inter-canine width, Inter-first premolar width, Inter-second premolar width & Inter-molar width were 5, 3.38, 2.92 & 2.46 respectively which was significantly greater in Passive Self-ligating group. On contrary the Inter-canine width, Inter-first premolar width, Inter-second premolar width and Inter-molar width significantly reduced with mean value of -0.46, -0.62, -0.62 & -0.69 respectively. The p value for Inter-canine width, Inter-premolar and Inter-molar width was <0.01 resulting statistically significant difference for arch width between Passive Self-ligating and Conventional Pre-adjusted Edgewise Bracket system. **Graph 9** graphically represents the table 11 data for Mean & SD of T1-T0 for Group 1 & 2.

Table 12: Inter Comparison of Debonding rate, Treatment duration and Pain perception between Group 1 (Passive Self-ligating Pre-adjusted Edgewise Bracket system) & Group 2 (Conventional Pre-adjusted Edgewise Bracket system)

	Group 1		Group 2		
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
No of Debonding	0.92	0.76	1.38	0.87	0.08
Treatment Duration	11.92	3.28	17.46	2.40	**<0.01**
Pain Perception	1.62	0.51	3.54	0.97	**<0.01**

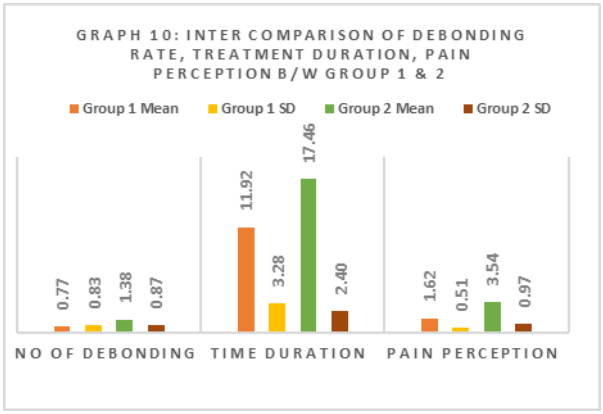


Table 12 & **Graph 10** represented Inter group comparison of Debonding rate, Pain perception and Duration of Decrowding. Debonding rate was not statistically significant with p value of 0.08. Duration of decrowding was statistically significant with p value <0.01. Faster alignment was present in Passive Self-ligating Bracket system with mean value of 11.92 ± 3.28 months. Whereas mean value for Conventional Bracket system was 17.46 ± 2.40. Pain perception had statistically significant difference with p value <0.01. The mean value for Passive Bracket system and Conventional Bracket system were 1.62 ± 0.51 and 3.54 ± 0.97 respectively. Thus, alleviation of crowding for Passive Self-ligating Pre-adjusted Edgewise bracket system was by transverse expansion whereas for Conventional Pre-adjusted Edgewise Bracket system was by Proclination of Mandibular Incisors.

The Debonding rate was not statistically different between Passive Self-ligating and Conventional Pre-adjusted Edgewise Bracket system. Pain perception was significantly less in Passive Self-ligating Bracket system. Also, faster alignment was achieved in Passive Self-ligating Pre-adjusted Edgewise Bracket system when compared to conventional Pre-adjusted Edgewise Bracket system.

V. Discussion

Field of Orthodontics have evolved in terms of bracket design. The innovation was accomplished from Begg's appliance system to Self-ligating bracket system. Self-ligating bracket system eliminates the ligature tie or elastic module usage to snugly secure archwire within the bracket slot. Active & Passive bracket are form of Self-ligating Pre-adjusted Edgewise Bracket system. This study aimed to compare the alignment efficiency, incidence of bracket debonding & pain perception of Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system. The comprised of 26 patients (13 in each group) maintaining the severity of mandibular anterior crowding based on Little's Irregularity Index amongst both the groups.

In present research proclination of mandibular incisors was evident in Conventional Pre-adjusted Edgewise Bracket system (p=<0.01), whereas Passive Self-ligating group showed slight proclination (mean value IMPA was 0.85) with no statistically significant difference (p value for IMPA = 0.22). Also, there was no statistically significant difference found between Passive Self-ligating & Conventional Bracket system for Mandibular Incisor Proclination (p=0.09). Even **Darwin et al** [28] presented a case report utilizing Damon Sel-ligating Bracket system wherein the maxillary incisors were proclined but mandibular incisors were upright maintaining IMPA from 99.84° pre-treatment to 98.61° post treatment. Harmoniously **Niara et al** [27] found increased arch length in conventional group compared to Damon Self-ligating group (p=0.02) depicting the mandibular incisor proclination. The difference observed in both the groups is due to difference in the archwire along with the bracket system. Contradicting to this result the **Vajaria et al**[14] & **Sayed et al**[24]studies resulted that the Damon system did not support the claimed lip bumper effect showing incisor advancement & proclination (p value <0.01). Increased density of mandibular bone prevents the expansion of the posterior arch (p value 0.5) leading to proclination for alleviation of crowding. Certainly, **Tarulata et al**[25] also found presence of Lower

incisor proclination with IMPA increased from pre-treatment (99°) to post treatment (101°). But **Adriana et al**[26] found the result of proclination of both maxillary & mandibular incisors without any statistically significant difference (p value for IMPA was 0.3). Similarly, **Pandis et al** [9] no significant difference with some amount of proclination amongst both groups (p>0.01). According to author the free play in self-ligating bracket system facilitates labial movement of crown. The amount of crowding present & the utilization of similar archwire with similar arch form were the two major factors influencing the proclination of mandibular incisors. If severity of crowding in more in both groups Passive self-ligating group also experiences proclination of mandibular incisors.

Transverse expansion was significantly observed in Passive Self-ligating Pre-adjusted Edgewise Bracket system with p value <0.01. **Pandis et al** [9] found increased intermolar width in Damon group (p value <0.05). **Darwin et al** [28] stated that the alignment of both the arches was enabled by expansion of posterior segments wherein he experienced 5mm increase in WALA ridge at mandibular canine.

The expansion by alveolar bone remodelling & not just by lateral tipping of the teeth. Harmoniously **Niara et al** [27] found greater increase in inter-canine & inter-premolar width for Damon group (p value 0.02). The difference observed in both the groups is due to difference in the archwire along with the bracket system. Utilization of CuNiTi archwire in Passive Self-ligating Bracket system provides transverse expansion maintaining the severity of irregularity in both groups. Contrary to this **Vajaria et al**[14] found no statistically significant difference for arch width in 2nd premolar region (p value 0.07). Thus, correction of mandibular anterior crowding by transverse expansion or proclination of incisors majorly depends on amount of irregularity present & the archwire used.

The alignment was significantly faster in Passive Self-ligating Pre-adjusted Edgewise Bracket system compared to Conventional Pre-adjusted Edgewise Bracket system with p value <0.01. The mean duration for Passive Self-ligating group was 11.92 months & for Conventional group was 17.46 months. Supporting this result **Eberting et al**[17] found reduction in treatment time for Damon bracket systems for extraction as well as non-extraction cases. Even **Vajaria et al**[14] found that Damon group completed treatment 2 months prior to conventional group. But contradicting to this **Pandis et al** [23] in his second study found no difference for time of alignment between two bracket systems (p= 0.21). Similarly, **Dywer at al**[21] found no significant difference with treatment duration for self-ligating bracket system being 25.12 months whereas that for conventional bracket system was 25.8 months & p value was 0.68. There was a very important point high lightened by **Pandis et al**[9] that the amount of treatment duration was proportional to present irregularity index i.e. more irregularity leads to reduction in ultimate treatment duration. He also stated that till moderate irregularity index the treatment duration was improved in Damon self-ligating bracket system which is similar to present study; beyond that no statistically significant difference was found for the treatment duration amongst the two groups.

Debonding rate was not statistically different between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system with p value 0.08. Supporting present research results **Dywer et al**[21] found the overall bracket bond failure for self-ligating bracket system was less (6.6%) than the conventional bracket system (7.2%) but no statistically significant difference was found. Contradicting to this **Milles et al**[19] when measured debonding rate including only 2 archwire changes found the Debonding rate was more in Damon bracket system compared to conventional bracket (p<0.0005). The debonding in self-ligating group is usually due to operator inexperience when engaging & removal of archwire which may apply a debonding force to the bracket. The other reason could be the risk of moisture contamination, masticatory forces or any habit. Also, in majorly of researches irregularity which is confounding factor for the debonding rate is not taken into consideration.

Discomfort to patient in terms of pain was significantly lesser in Passive Self-ligating Pre-adjusted Edgewise Bracket system compared to Conventional Pre-adjusted Edgewise Bracket system. The mean value on VAS scale for Passive Self-ligating group was 1.62 & Conventional group was 3.54 providing statistically significant difference with p value <0.01. **Milles et al**[19] compared the irregularity index, discomfort level to lips, preferred looks & the debonding rate including only 2 archwire changes. For both Damon & Conventional group, the 2 archwire used were 0.014 CuNiTi & 0.016*0.022 CuNiTi wire. Pain experienced was varying with less pain on 1st archwire placement (p=0.04) & more pain on 2nd archwire placement (p=0.004). The reason for this varying result is difference in the irregularity index, the Damon group had more irregularity compared to conventional group. Contradicting to the present research **Rahman et al**[20] & **Fleming et al**[22] found Self-ligating bracket system provided more pain during insertion & removal compared to the conventional bracket system (coefficient +0.174 & p = 0.03) but during follow up of 4,24,72 hrs & 7 days of wire placement there was no clinical & statistically significant difference found in the pain perception with p = 0.958, 0.289, 0.569, 0.756 respectively. Reason being wire engagement; specifically rectangular wire; is difficult & mandates heavy force during engagement but once initial alignment is achieved pain perception decreases with following days. Also, utilization of CuNiTi archwire in Passive Self-ligating Pre-adjusted Edgewise bracket system compared to NiTi wire in Conventional Pre-adjusted Edgewise Bracket system provides significantly lesser pain in Passive Self-ligating group.

Thus, the severity of irregularity present & the archwire used are two major confounding factors while assessment of alignment efficiency, incidence of bracket debonding & pain perception between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system.

VI. Conclusion

The present research compared the alignment efficiency, incidence of bracket debonding and pain perception between Passive Self-ligating and Conventional Pre-adjusted Edgewise Bracket system.

- Compared to Conventional Pre-adjusted Edgewise Bracket system; Passive Self-ligating Bracket system experienced statistically significant transverse expansion.
- Conventional group when compared to Passive Self-ligating group showed proclination of mandibular incisors during alleviation of crowding but was not statistically significant.
- The mandibular arch alignment was significantly faster in Passive Self-ligating Pre-adjusted Edgewise Bracket system group compared to conventional group.
- No statistically significant difference found for the debonding rate between Passive Self-ligating & Conventional Pre-adjusted Edgewise Bracket system.
- The pain perception experienced by patients was significantly lesser in Passive Self-ligating group compared to Conventional Pre-adjusted Edgewise Bracket system.

Thus, the alignment efficiency with Passive Self-ligating Pre-adjusted Edgewise Bracket system showed significant transverse expansion, reduced treatment duration and less patient discomfort compared to the Conventional Pre-adjusted Edgewise Bracket system.

References

[1]. Hardik Suvagiya. A Review On Recent Advances In Orthodontics. International Journal Of Dental Sciences. 2021;3(1):87-90.
[2]. Sharma, S., & Kundra, K. (2020). Evolution Of Orthodontic Brackets. LAP Lambert Academic Publishing.
[3]. Deepshikha, Chaukse A, Gupta K. Torque In Orthodontics.J Orofac Res. 2020;9(3):32-38.
[4]. Tariq M, Asif S. An Overview Of The Andrews Preadjusted Edgewise Appliance. Indian J Orthod Dentofacial Res. 2016;2(1):32-33.
[5]. Ishita Agrawal, Falguni Mehta, Renuka Patel, Rahul Trivedi, Skanda Keerthana J. Orthodontic Brackets From Past To Present. International Journal Of Creative Research Thoughts. 2020;8(9):537-547.
[6]. Rai S, Tikku T, Khanna R, Maurya RP, Verma S, Shrivastava K. Various Methods Of Ligation Ties. Indian J Orthod Dentofacial Res 2019;5(1):5-10
[7]. Cacciafesta V, Sfondrini MF, Ricciardi A, Scribante A, Klersy C, Auricchio F. Evaluation Of Friction Of Stainless Steel And Esthetic Self-Ligating Brackets In Various Bracket-Archwire Combinations. Am J Orthod Dentofacial Orthop. 2003;124(4):395–402.
[8]. Baka ZM, Basciftci FA, Arslan U. Effects Of 2 Bracket And Ligation Types On Plaque Retention: A Quantitative Microbiologic Analysis With Real-Time Polymerase Chain Reaction. Am J Orthod Dentofacial Orthop. 2013;144(2):260–7.
[9]. Pandis N, Polychronopoulou A, Eliades T. Self-Ligating Vs Conventional Brackets In The Treatment Of Mandibular Crowding: A Prospective Clinical Trial Of Treatment Duration And Dental Effects. Am J Orthod Dentofacial Orthop. 2007;132(2):208–15.
[10]. Chen SS-H, Greenlee GM, Kim J-E, Smith CL, Huang GJ. Systematic Review Of Self-Ligating Brackets. Am J Orthod Dentofacial Orthop. 2010;137(6): 726.E1-726.E18; Discussion 726-7.
[11]. Baxi, S., Tripathi, A. A., Bhatia, V., Prasad Dubey, M., Kumar, P., & Bagde, H. (2023). Self-Ligating Bracket Systems: A Comprehensive Review. Cureus, 15(9), E44834.
[12]. Pathak, P., Banerjee, R., Duseja, S., & Sharma, T. (2022). Newer Orthodontic Archwires: A Review. International Journal Of Oral Health Dentistry, 8(1), 27–30.
[13]. Ahmed T, Puri A, Singla A, Singh R, Sharma S, Vaidyan MK. Efficacy Of Cu-Niti Wires In Orthodontics: A Systematic Review. Int J Dent Sci Clin Res. 2024 Aug;6(5):8–17.
[14]. Vajaria R, Begole E, Kusnoto B, Galang MT, Obrez A. Evaluation Of Incisor Position And Dental Transverse Dimensional Changes Using The Damon System. Angle Orthod. 2011;81(4):647–52.
[15]. Birnie D. The Damon Passive Self-Ligating Appliance System. Semin Orthod. 2008;14(1):19–35.
[16]. Wright N, Modarai F, Cobourne MT, Dibiase AT. Do You Do Damon®? What Is The Current Evidence Base Underlying The Philosophy Of This Appliance System? J Orthod. 2011;38(3):222–30.
[17]. Eberting JJ, Straja SR, Tuncay OC. Treatment Time, Outcome, And Patient Satisfaction Comparisons Of Damon And Conventional Brackets. Clin Orthod Res. 2001;4(4):228–34
[18]. Gravina MA, Brunharo IHVP, Fraga MR, Artese F, Campos MJ Da S, Vitral RWF, Et Al. Clinical Evaluation Of Dental Alignment And Leveling With Three Different Types Of Orthodontic Wires. Dental Press J Orthod. 2013;18(6):31–7.
[19]. Miles PG, Weyant RJ, Rustveld L. A Clinical Trial Of Damon 2 Vs Conventional Twin Brackets During Initial Alignment. Angle Orthod. 2006;76(3):480–5.
[20]. Rahman S, Spencer RJ, Littlewood SJ, O'Dywer L, Barber SK, Russell JS. A Multicenter Randomized Controlled Trial To Compare A Self-Ligating Bracket With A Conventional Bracket In A UK Population: Part 2: Pain Perception. Angle Orthod. 2016;86(1):149–56.
[21]. O'Dywer L, Littlewood SJ, Rahman S, Spencer RJ, Barber SK, Russell JS. A Multi-Center Randomized Controlled Trial To Compare A Self-Ligating Bracket With A Conventional Bracket In A UK Population: Part 1: Treatment Efficiency. Angle Orthod. 2016;86(1):142–8.
[22]. Fleming PS, Dibiase AT, Sarri G, Lee RT. Pain Experience During Initial Alignment With A Self-Ligating And A Conventional Fixed Orthodontic Appliance System. A Randomized Controlled Clinical Trial: A Randomized Controlled Clinical Trial. Angle Orthod. 2009;79(1):46–50.
[23]. Pandis N, Polychronopoulou A, Katsaros C, Eliades T. Comparative Assessment Of Conventional And Self-Ligating Appliances On The Effect Of Mandibular Intermolar Distance In Adolescent Nonextraction Patients: A Single-Center Randomized Controlled Trial. Am J Orthod Dentofacial Orthop . 2011;140(3): E99–105.

[24]. Sayed YM, Selim HA, Hegazy SA. Effectiveness Of The Damon System In The Treatment Of Non-Extraction Orthodontic Cases. Tanta Dental Journal. 2016;13(1):18–27.
[25]. Shyagali TR, Doshi J. Correction Of Severely Crowded Lower Anterior Teeth Using Self-Ligating Bracket System: A Case Report. Iran J Orthod. 2017 Feb 28; In Press (In Press): E9472.
[26]. Nogueira ACA, Freitas KMS, De Lima DV, Valarelli FP, Cançado RH. Comparison Of Changes In Incisors Position In Cases Treated With Damon Self-Ligating And Conventional Fixed Appliances. Open Dent J. 2018 Mar 30; 12:275–282.
[27]. Lima NCJ, Freitas-Falcão Icdmc, De Freitas KMS, De Lima DV, Valarelli FP, Cançado RH, Et Al. Comparison Of Changes In Dental Arch Dimensions In Cases Treated With Conventional Appliances And Self-Ligating Damon System. Open Dent J. 2018; 12:1137–46.
[28]. De Lima DV, Freitas KMS, De Freitas MR. Nonextraction Treatment Of Severe Crowding With A Self-Ligating Appliance. J Clin Orthod. 2020;54(12):765–72.
[29]. Little RM. The Irregularity Index: A Quantitative Score Of Mandibular Anterior Alignment. Am J Orthod. 1975;68(5):554–63.