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A Comparative Evaluation of Maxillary Anterior En-Mass Retraction Rate and Anchorage Loss in Self Ligating and Conventional Bracket System Using Sliding Mechanics- An In Vivo Study

Baha ul Haq Khan[1] and Heena Parveen Sartaj Ali[2]
[1] *(Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, India)*
[2] *(Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, India)*

Abstract
Objective: *to evaluate the maxillary anterior en-mass retraction rate and anchorage loss in self ligating brackets (SLBs) and conventional brackets.*
Material and method*: The study was conducted on 20 patients within the age group of 14-24 years. The patients had class I molar relationship with overjet not more than 5mm and class II molar relationship with proclined maxillary incisors who were planned for all four first premolar extraction, requiring maximum anchorage. The patients were randomly divided into 2 groups(n=10): group A consisted of 10 patients receiving 0.022×0.028-inch slot metal conventional brackets (MBT prescription) ; group B consisted of 10 patients receiving 0.022×0.028-inch slot metal self-ligating brackets (MBT prescription). A cone beam computed topography (CBCT) was taken for each patients maxilla before treatment initiation and after complete retraction. Using elstomeric ligatue (AO American Orthodontics), en-mass retraction on both sides and the rate of movement was measured.*
Result: T*he patients were recalled monthly after starting en-mass retraction to measure retraction rate and ensure that a force of 150g was being delivered. The pre and post retraction CBCT were superimposed to evaluate the rate of retraction and anchorage loss. The result showed no statistically significant difference between two groups, however, a perceivable difference in total retraction time with self ligating brackets being faster then conventional brakets was seen.*
Conclusion : *the type of brackets whether SLB or conventional does not affect the rate of retraction and the anchorage loss of upper molars is nearly the same.*
Keywords*: self ligating brackets, conventional brackets, en-mass retraction, anchorage loss*

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I. Introduction

The systematic evolution of dental materials has led to a constant pursuit of technological innovations in orthodontics. Appliance biocompatibility, treatment efficiency and patient convenience are the major confronting factors in success of orthodontic treatment.[1] One of the principal goals in orthodontics is to offer the most effective and efficient tooth movement and this quest for efficiency has stirred the development of innumerable materials in orthodontics intended at optimizing patient comfort and reducing treatment time. Friction being an imperative element in clinical orthodontics affects all stages of treatment and high frictional forces can affect the treatment results along with duration in a deleterious manner.[2]

Resistance to tooth movement is frequently encountered during orthodontic tooth movement, when an arch wire slides through the bracket slot (En-masse retraction of anterior teeth) or the bracket slides over the arch wire (Individual canine retraction), attributed to friction between the intermingling components of the orthodontic appliances such as brackets and arch wires.[3]

Self-ligating (SL) brackets were originally introduced in the early 20th century and, until recently, did not receive much attention in the orthodontic profession. Within the past decade, significant developments, new designs, and numerous proposed advantages of SL brackets have caused them to gain great popularity among practicing orthodontists.[8].Unlike conventional brackets, SL brackets have a mechanical device that secures the arch wire in the bracket slot, thereby eliminating the need for elastic or wire ligatures. Possibly the most advantageous feature proposed with this ligation method is a combination of reduced friction between the arch wire and the bracket along with more secure full arch wire engagement.[8] Together, these properties have been

suggested to allow more rapid alignment of teeth and faster space closure, while maintaining excellent control of tooth position.[8]

The emerging clinical popularity of SL systems has bypassed the research and evidence to definitely support all the proposed advantages.[13] Numerous conflicting studies comparing SL and conventional brackets have caused controversy regarding the treatment effectiveness of the different bracket systems.[5] As a result, the validity of the advantages offered by SL brackets is questioned.

The purpose of this study was to determine if there are significant clinical differences between SL and conventional brackets on orthodontic treatment as perceived by practicing orthodontists, and more specifically, if the proposed advantages of SL brackets are perceived to be evident in clinical practice.

Thus, a clinical study was conducted to compare and evaluate the clinical efficiency of the self ligating brackets in the rate of space closure with that of the standard conventional brackets (design of McLaughlin Bennett and Trevisi) , Assessment of molar anchor loss when using interactive systems and CBs constituted the second part of the clinical study.

II. Material and method

Study participants selection

Amongst out patients attending the Department of orthodontics and dentofacial orthopaedics, Jaipur Dental College & Hospital (Rajasthan, India) twenty patients who were planned for fixed orthodontic treatment with extraction of all four first premolars, requiring maximum anchorage of posterior teeth were selected for the study.

Criteria for selection

Participants were selected to meet the following inclusion criteria: healthy individuals and not under any routine medication, age group: 14 – 24 years, class I molar relationship (± 1mm) and overjet not exceeding 5mm, class II malocclusion with proclined maxillary incisors, Well aligned maxillary and mandibular incisors with minimum crowding, Completely established permanent dentitions (except 3rd. molar), all teeth anatomically normal and vital, patient with good periodontal status, patient should not have any systemic disease or on medication that could interfere with orthodontic tooth movement, no history of trauma, bruxism, or para-functions, and no previous orthodontic treatment.

Twenty patients were divided randomly into two groups. The process of randomization and group allocation was undertaken.

GROUP A consisted of 10 patients receiving 0.022x0.028-inch slot metal conventional brackets (MBT prescription).

GROUP B consisted of 10 patients receiving 0.022x0.028-inch slot metal self ligating brackets (MBT prescription).

The research objectives were explained to the patients and an informed consent was signed by all of the patients and/ or their parents before starting the treatment.

Methodology

Brackets with 0.022' slots with the MBT prescription were bonded. Initial alignment and levelling of both arches were done by using 0.016-in nickel-titanium and 0.016×0.022-in nickel titanium archwires. The nickel-titanium wires were replaced by 0.019×0.025-in stainless steel arch wires, and arch levelling continued. Once alignment and levelling of the arches were achieved, maxillary study models were made and the distances between the mesiobuccal cusp tip of the first molar and the canine tip were measured with the digital vernier calliper and were considered as the baseline value to evaluate the amount of en mass retraction in subsequent intervals. Also pre-retraction CBCT images were taken.

En-mass retraction

All the anterior six teeth in group A and group B were ligated with conventional elastomeric ligatures. 150 grams of force was applied using the elastomeric chain (checked by the Dontrix tension gauge). The patients were recalled at 1 month interval after the start of en mass retraction. At each recall visit the arch wire were removed and checked for any damage and replaced if any damage was noted. Retraction force was rechecked to be maintained at 150 gms. The modules were replaced with another set in the respective quadrants. Clinical photographs and impressions for study models were taken at each appointment.

After both canines have been retracted completely into the extraction site (the distal surface of the canine reached the mesial surface of the second premolar), all post retraction records were taken, CBCT, analysed, and compared to pre-treatment records.

Figure: 1. Anteriors were retracted on both the sides using E-Chain

Cone beam computed tomography

Certain reference planes were assigned, according to which measurements would be taken. After completion of superimposition, the two scans (preoperative and postoperative) were one unit and moved in the same sequence. To assign the maxillary plane, three points were identified at the level of the hard palate: Anterior nasal spine (ANS) anteriorly and the right and left posterior maxillary points (PMPr and PMPl).[44] The coronal line was adjusted to pass through the PMPr and PMP1, and the sagittal line passed through the anterior nasal spine (ANS) and Posterior nasal spine (PNS).[44]

At this orientation, the following views were obtained:

a. Axial view representing the maxillary plane (ANS, PMPr, and PMPl)

b. Sagittal view representing the mid-sagittal plane and perpendicular to the maxillary plane

c. Coronal view representing a plane passing through the PMPr and PMPl and perpendicular to the maxillary plane and mid-sagittal plane.

The following points, lines and planes were identified on each CBCT image:

A- The points

1. Right and left posterior maxillary points (PMPr-PMPl): the point of maximum concavity of posterior border of the palatine bone in the horizontal plane at both sides
2. Anterior nasal spine (ANS): the most anterior midpoint of the ANS of the maxilla
3. PNS: the most posterior midpoint of the PNS of the palatine bone
4. UCCTr –UCCTl : the cusp tip of the maxillary canine, right and left
5. UCRAr –UCRAl : the midpoint on the maxillary canine root apex, right and left
6. U6MBCTr –U6MBCTl : the cusp tip of the mesio-buccal cusp of maxillary first molar, right and left 7. U6MBRAr –U6MBRAl : the midpoint on the apex of the mesio-buccal root apex of maxillary first molar, right and left.

B- The lines

1. Canine long axis: the line connecting UCCT and UCRA
2. Molar long axis: the line connecting U6MBCT and U6MBRA.

C- The planes

1. Maxillary plane (MxP): a plane that passes ANS and both PMPr-PMPl
2. Coronal plane (CP): a plane that passes both PMPr-PMPl.

Linear measurements

1. The distance between the cusp tip of the maxillary canine (UCCTr -UCCTl) and CP in the sagittal section
2. The distance between the midpoint on the maxillary canine root apex (UCRAr-UCRAl) and CP in the sagittal section
3. The distance between the cusp tip of the mesio-buccal cusp of the maxillary first molar(U6MBCTr -U6MBCTl) and CP in the sagittal section.
4. The distance between the midpoint on the apex of the mesio-buccal root of the maxillary first molar (U6MBRAr -U6MBRAl) and CP in the sagittal section.

Angular measurements

1. Maxillary canine mesio-distal angulation: the angle between the long axis of the right or left maxillary canine and maxillary plane in the sagittal section
2. Maxillary canine bucco-lingual inclination: the angle between the long axis of the right or left maxillary canine and maxillary plane in the coronal section

3. Maxillary first molar mesio-distal angulation: the angle between the long axis of the right or left maxillary first molar and maxillary plane in the sagittal section
4. Maxillary first molar bucco-lingual inclination: the angle between the long axis of the right or left maxillary first molar and maxillary plane in the coronal section.

Pre-and post- treatment maxilla cone beam computed tomographs (CBCTs) were taken for each patients. All CBCT images are taken by the same machine and analyzed by the same operator in order to avoid any error.

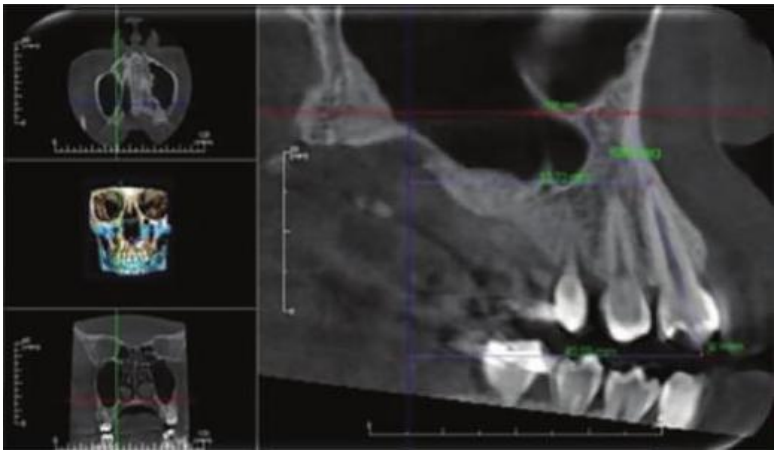


Figure: 2. CBCT showing the angle between the long axis of the maxillary canine and maxillary plane in the sagittal section (Mesio-distal angulation)

III. Results

This study comprised of 20 patients divided into two groups, Group A and Group B, of 10 patients each. The mean age of the patient were16 years ±3.2 years in both the groups.

Independent T test was done to compare the molar anchorage loss, amount of anterior retraction, at T1 (before retraction) and T2 (end of retraction) between conventional (Group A) and Self-ligating (Group B) brackets.

P>0.05 was considered statistically significant

Comparison of Molar Anchorage Loss between Group A and Group B: Table 1

Comparison between Conventional and Self-ligating groups for molar anchorage loss is tabulated in Table 1. Results showed there was no statistically significant difference in molar anchor loss in maxillary arch.

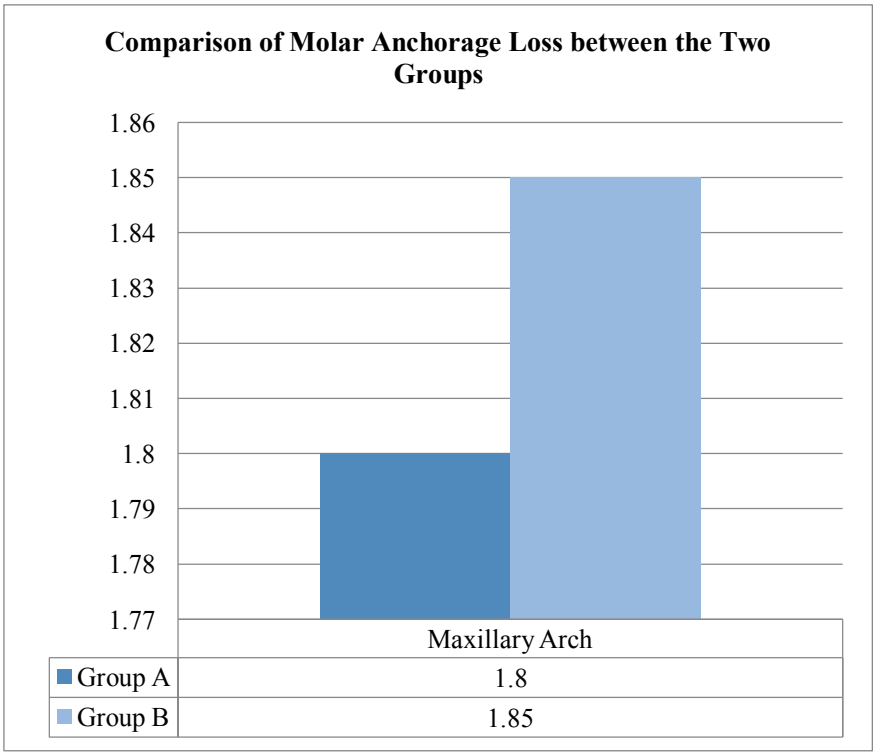
Table: 1. Molar Anchorage Loss between Two Groups

Group A Vs **Group B**	**N**	**Mean**	**Std. Deviation**	**Std. error mean**	**P value**	**Significance**
Group A maxillary arch	10	1.8000	0.25820	0.08165	0.660	NS
Group B maxillary arch	10	1.8500	0.24152	0.07638		

NS: Not significant;

*p < 0.05 (statistically significant);

**p < 0.001 (statistically highly significant)



Graph: 1. Comparison of Molar Anchorage Loss between the Two Groups

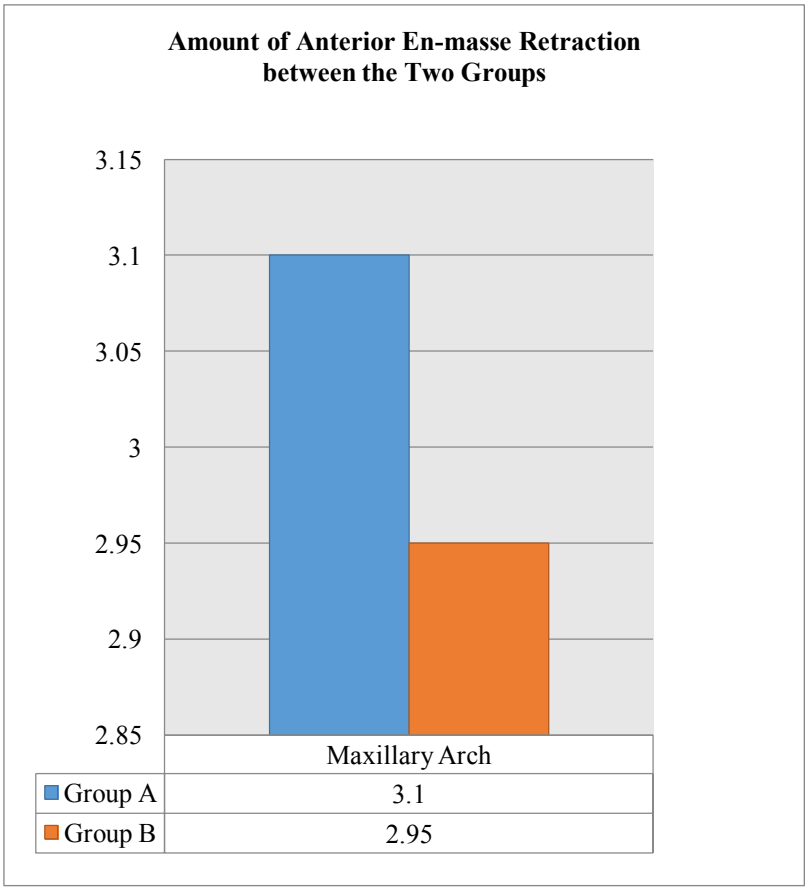
Comparison of Amount of Anterior Retraction between Group A and Group B: Table 2.

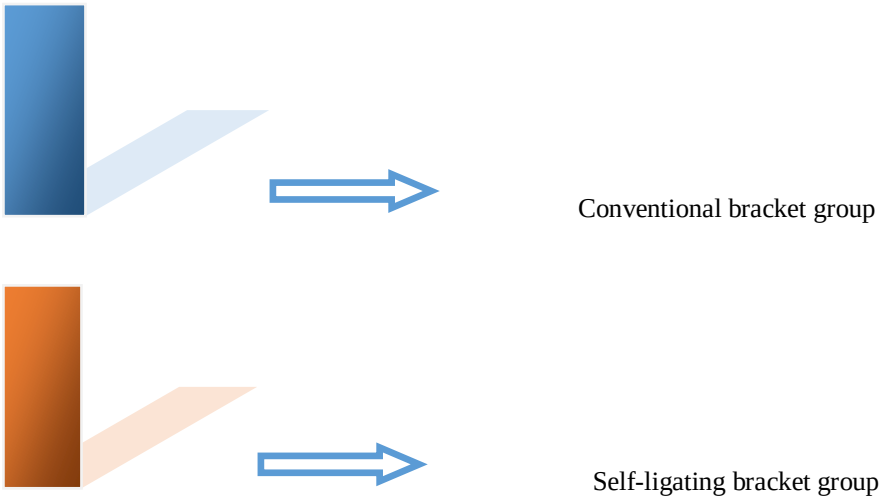
Comparison between Conventional and Self-ligating brackets groups for amount of anterior retraction is tabulated in Table 2. Results showed there was no statistically significant difference in amount of anterior retraction in maxillary arch.

Table 2: Amount of Anterior En-Masse Retraction between Two Groups

GROUP A VS **GROUP B**	**N**	**MEAN**	**Std. Deviation**	**Std. error mean**	**P value**	**Significance**
Group A maxillary arch	10	3.1000	0.31623	0.10000	0.342	NS
Group B maxillary arch	10	2.9500	0.36893	0.11667		

NS: Not significant;
*p < 0.05 (statistically significant);
**p < 0.001 (statistically highly significant)





IV. Discussion

The ability to close extraction spaces preferentially is an essential skill required during orthodontic treatment. Space closure is usually done in one step (en masse) or two step (individual canine retraction), either with friction mechanics or frictionless mechanics. One of the major factors which affect the treatment efficiency is the ligation system and friction that is increased by elastomeric module, elastomeric chain and stainless steel ligature because of the stress they exert on the wire adjacent to the bracket sides. Thereby, precluding free sliding of the wire into the slot walls and adversely affecting rate of tooth movement.[12]

Interest in self-ligating brackets has grown in recent years. Several in-vitro studies have demonstrated a substantial decrease in the coefficient of friction of self-ligating brackets, a possible clinical advantage over conventional brackets, especially for sliding mechanics.[13]

Literature is scant with reference to treatment efficiency of interactive self-ligating brackets during en-masse space closure. Prospective clinical trials by Peter G Miles[10] have found no significant difference in the rate of space closure between passive self-ligating brackets and conventional twin brackets.

Mauricio Mezomo[1] evaluated the distal movement of canine and molar anchor loss between passive self-ligating bracket and conventional bracket and found no significant difference between the two bracket systems.

Jack Burrow[21] compared the canine retraction rate of self-ligating brackets with conventional bracket system and found a faster retraction with conventional bracket, probably due to the narrower bracket width of self-ligating brackets. However, one of the drawbacks of passive self-ligating bracket is lack of 3- dimensional control of teeth during retraction.[18]

Resistance to sliding leads to increased efficiency of treatment. The mode of ligation influences friction at the bracket, wire and ligature interfaces and may extend the overall treatment time. Frictional resistance at the binding unit caused by ligation have received limited attention in the literature. It has been proved in previous studies that elastic ligatures significantly contribute to friction compared to stainless steel ligatures and exert 50 gms to 150 gms of force at the time of seating.[15, 16]

Thus, the present study was done to compare the en-masse retraction efficiency of self-ligating bracket (3M Unitek Gemini SL self-Ligating brackets) and conventional bracket (3M Unitek Gemini Metal brackets) with elastomeric chain (AO American Orthodontics).

The current study was conducted using 20 randomly allocated patients, ages 14–20 years, with the mean age of 15.5 years. The age range was selected to decrease the gap in the age between patients to ensure more or less the same biological response in all evaluated patients.[49,50]

Previous studies have reported that the space resulting from premolar extraction could be closed with different devices. The choice of elastomeric chain was based on their clinical effectiveness, which, although similar to that of nickel-titanium springs, affords more convenient installation and less patient discomfort.[1].

The force employed in the present study (150 g) followed recommendations of many investigators who applied forces between 100 g and 200 g for enmass retraction. Boster and Johnston concluded that the 150 g force level gave the highest canine retraction rate (1.3 mm/months) when compared to 60, 240, and 350 g that gave 0.8, 0.8, and 1 mm/month, respectively. The 150 g force used was considered optimal as it could result in rapid tooth movement with minor discomfort, avoiding or minimizing rare resorption.[7]

In this study, CBCT, which is a three-dimensional tool, was utilized in an attempt to overcome the limitation of the traditional two-dimensional projections. Many researchers have concluded that the 2-D cephalometric and panoramic projections were not reliable tools for assessing mesio-distal and bucco-lingual tooth angulation, particularly in premolar and canine regions, while CBCT images are considered an accurate alternative.[19, 20]

In the present study, Group A anchorage was used. Comparison between conventional and self-ligating group also showed no statistically significant difference in molar anchorage loss. It would therefore appear that although the molar anchor loss was slightly lesser in self-ligating group it did not make a significant difference clinically. This could be probably because of the same retraction mechanics used in both the groups.

According to Muguruma et al [22] SLBs produced less static friction when compared with CBs, which might lead to better anchorage control in SLB system, and Chen et al[23] stated that there was better anchorage control in interactive SLB system when compared with CB system, which concurred with the study, i.e., anchor loss was less in interactive SLB system when compared with CB system. The null hypothesis had been proved as stated.

Amount of Anterior Retraction: One of the popular methods of space closure to conserve treatment time is enmasse retraction. In the present study CBCT were taken at T1 (before retraction) and at T2 (end of retraction). All CBCT were superimposed by the same operator. For maxillary arch, The reported movement of the enmass retraction was mainly uncontrolled tipping as indicated by the reduction in the upper canine angulation after retraction and the reduction in the distance between the upper canine cusp tip and the posterior maxillary point (PNS) (the point of maximum concavity of posterior border of the palatine bone in the horizontal plane at both right and left). There was also a reduction in the distance between the upper canine root apex and the posterior maxillary point, but with a lesser value, indicating retraction with uncontrolled tipping. These findings were observed in both groups without significant differences between them. These findings may be related to the distance between the point of force application and the center of resistance with moment creation. This dynamic is mainly because of the presence of even a minor space between the arch wire and the bracket slot walls because the retraction arch wire was a rectangular 0.019 × 0.025inch s.s. arch wire, in a 0.022 bracket slot. This was in accordance with the findings of other studies.[26]

There was no statistically significant difference between the right and left sides within the same group. The present study also showed similar changes with both conventional and self-ligating brackets.

Few clinical studies have also compared space closure with self ligating and conventional brackets. Miles et al[11] found similar rates of tooth movement whether self-ligating or conventional brackets were used for en mass retraction of the six anterior teeth.

Sirinivas[9] found higher rates of distal movement of canines with self ligating brackets compared with conventional brackets. Nevertheless, measurements were taken only at canine cusps so that tooth inclination

might have overestimated the performance of self-ligating brackets. He also found greater loss of anchorage than was found in this study using SS 0.019 x 0.025 -inch wires and nickel-titanium springs loaded with 150 g force.

One of the claims of self-ligating bracket system is reduced treatment time.[4] However, previous studies have not found any significant difference in overall treatment duration between conventional and self- ligation bracket systems.[24] Therefore, the type of movement and ligation mechanism does not seem to affect the duration of treatment.

In the present study the retraction rate was faster with interactive self-ligating brackets compared to conventional brackets. There are very few literature studies evaluating the efficacy of self-ligating brackets during en-masse space closure. The result of the present study is in contrast to other studies. Thorstenson and Kusy[6] demonstrated that in-vitro; the resistance to sliding of self-ligating brackets was lower than those of conventional brackets in the absence of ligation force.

However, Peter G Miles[11] in his prospective clinical trial demonstrated no significant difference between conventional and passive self-ligating group with sliding mechanics.

The present study evaluated the efficiency of self-ligation and conventional brackets only in sagittal plane. Arch width changes and vertical changes have not been addressed. Other possible confounding variables could include the bone density, bone turnover rate and age of the patient. Moreover, it is postulated that light continuous forces produces 1.8 times greater tooth movement compared to light dissipating or heavy forces.[25]

Therefore, further studies with more sample size are needed to investigate the force delivery of interactive self-ligating brackets compared to conventional brackets and their effect on overall treatment efficiency.

V. Conclusion

The following conclusions can be made from the present study.

1. There was no difference in the quantum of molar anchorage loss between conventional brackets and self-ligating brackets in both the arches.
2. No difference in the quantum of anterior retraction between conventional brackets and self-ligating brackets in both the arches was observed.
3. However there was perceivable difference in total retraction time with self-ligating brackets being faster compared to the conventional brackets.

Therefore, both the bracket systems are equally efficient during en-masse retraction with Sliding mechanics.

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