A PROSPECTIVE RANDOMIZED CLINICAL TRIAL TO ASSESS THE EFFICIENCY OF PASSIVE SELF-LIGATING BRACKET Vs CONVENTIONAL BRACKET SYSTEM

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"A PROSPECTIVE RANDOMIZED CLINICAL TRIAL TO ASSESS THE EFFICIENCY OF PASSIVE SELF-LIGATING BRACKET Vs CONVENTIONAL BRACKET SYSTEM"** is a bonafide and genuine research work carried out by me under the guidance of **Prof. (Dr.) N.R. KRISHNASWAMY, M.D.S.,** Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Ragas Dental College and Hospital, Chennai.

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This is to certify that this dissertation titled **"A PROSPECTIVE RANDOMIZED CLINICAL TRIAL TO ASSESS THE EFFICIENCY OF PASSIVE SELF-LIGATING BRACKET Vs CONVENTIONAL BRACKET SYSTEM"** is a bonafide record of work done by **Dr. DIWAKAR .B** under my guidance during his postgraduate study period **2013–2016.**

This dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**, in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY** in **BRANCH V** – Orthodontics and Dentofacial Orthopaedics. It has not been submitted (partially or fully) for the award of any other degree or diploma.

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CONTENTS

Introduction

INTRODUCTION

Self-ligation Brackets were introduced to orthodontics in a first form, about 7 decades ago as Russel lock edgewise bracket by Stolzenberg in 1935[52]. From past two decades there has been a boost in manufacturing and releasing of self-ligating appliances with active or passive self-ligation modes.[44]

The term self-ligation in orthodontics infers that the orthodontic bracket has the ability to engage itself to the arch wire. Self-ligating (SL) brackets have a mechanical device built into the bracket to close off the slot.

There are two categories of SL brackets:

- Active SL brackets: in which a spring clip actively presses against the arch wire.
- Passive SL brackets: in which the SL clip closes the slot creating a tube. In this type, the clip does not actively press against the wire.

The use of self-ligating brackets has been increased over time. In 2002, 8.7% of American orthodontists used at least one self-ligating system; in 2008, the number had increased to 42%[8].

Reduced friction with self-ligating brackets is claimed to be a great advantage over conventional brackets.

It is asserted that low friction allows for sliding mechanics to be accomplished in the truest sense, thereby facilitating alignment, increasing the appointment intervals, and possibly reducing the overall treatment time [18].

Also, with less friction, the idea that less force is needed to cause tooth movement has led to the presumption that self-ligating brackets produce more physiologically harmonious tooth movement by not interrupting the periodontal blood supply [7].

Therefore, more alveolar bone generation, greater amounts of lateral expansion, less proclination of anterior teeth, and less need for extractions are claimed to be possible with self-ligating brackets.

Other advantages of the self-ligating bracket system that have been highlighted for more certain full arch wire engagement, less chairside assistance, and faster arch wire removal and ligation, leading to reduced chair time [18].

Retrospective studies by Ebertinget al.[11] and Harradine[21] found significantly decreased total treatment time and fewer visits with self-ligating brackets.

However, a large retrospective study[5] and all prospective studies[5, 10, 15] have found no measurable advantages in orthodontic treatment time, the number of treatment visits, and time spent in initial alignment with self-ligating brackets over conventional brackets.

Studies investigating arch dimensions and mandibular incisor inclination haves shown no significant difference between the two groups for inter-canine and inter-molar widths[53, 27].

One of the other claims regarding SL brackets and arch wires is their ability to produce posterior dental transverse changes. Damon (1998) claims that in non-extraction cases, light-forced mechanics [Damon system] produce posterior expansion with teeth and arch form taking path of least resistance. Few studies have assessed the above-mentioned expansion. Two[25, 27] out of three[25-27] studies which compared expansion with SL brackets and with conventional brackets reported a significantly greater increase in inter-molar width with SL brackets, whereas one study[50] reported no significant differences. All three studies reported no significant difference between changes of inter-canine widths. The inter-premolar width, was only investigated by Chimenti et al in 2009[29] and reported that there was no difference among the two treatment groups. It is noteworthy that all these studies were done using dental casts and had different inclusion criteria for the subjects

For torque expression, a meta-analysis indicated that self-ligating brackets resulted in slightly less mandibular incisor proclination (1.5 degrees) [28]

Thus, evidence on the advantages of self-ligation appears to be mixed, and other well-conducted studies are needed to evaluate the various claims made by proponents of self-ligation.

Studies[30, 24] comparing the failure rate in treatment efficiency between self-ligating and conventional brackets have shown conflicting results. Pandis et al. [27] found no significant difference between the two systems.

Damon claims that unlike active SL brackets, which rely on their clip to create the force that moves the teeth, passive SL brackets are contingent upon the flexibility of the Copper Nickel Titanium (Cu-NiTi) arch wire. According to Damon (1998)[7], unlike the conventional orthodontic brackets, the Damon bracket-wire interface (reduced friction in all stages of treatment) and variable torque configurations built into the bracket take advantage of cheeks, tongue and periodontal forces in order to move teeth into the desired position. This dentoalveolar transverse adaptation occurs early in treatment with small round arch wires. Therefore, a balance of all these tissues and forces will establish the position of the teeth and the arch form.

According to Nigel harrdaine[20] there are two potential reasons why passive self-ligation might reduce the percentage of extraction cases. The first arises from the combination of secure arch wire control and lower resistance to sliding. It is a tenable hypothesis that this combination would facilitate tooth alignment with less need for the adjacent space which is provided by extractions. It is attributed to the appliances biomechanically facilitating a change of extraction planning i.e. an appliance may make non-extraction mechanically easier.

The second proposed reason for a potential reduction in extractions is the suggestion that this reduced resistance to sliding alters the distribution of forces around an arch to an extent which produces a qualitatively different pattern of tooth alignment. Specifically, it has been proposed that a reduced resistance to sliding may reduce undesirable incisor proclination in some situations and hence lower the extraction rate. Keeping these points as evidence, our study was done to find the efficiency of a new passive self-ligation system.

In our study we used Gemini SL* Self-Ligating Brackets which offer the simplicity of a passive door self-ligating appliance. An advanced Nitinol ligating mechanism provides low resistance to door opening and closing, without using special techniques or instruments. Nitinol also offers the advantage of high resistance to unwanted mechanism fatigue, which can affect door operation and bracket performance during treatment.

Passive self-ligating Unitek Gemini SL brackets feature reduced friction for treatment efficiency, but you can also utilize the benefits of tie-wings, which permit active control with ligatures when you need it. The bracket’s smooth finish and rounded profile offer improved patient comfort

* 3M Unitek. USA.

Review of Literature

REVIEW OF LITERATURE

In 1935 **Jacob Stolzenburg** [52], introduced self ligating bracket system for the first time and the features of Russell Lock attachment are explained, which were easier for the patients as there are no need for steel ligatures present for arch wire engagement, the fourth sliding wall completely secures the arch wire within the dimensions of the slot providing secured ligation mechanism and controlled tooth movement..

In 1994 **Shivapuja**[55] stated in his comparative study on the effect of self ligation bracket and conventional bracket ligation system that the self ligation system displayed a significantly lower level of frictional resistance, less chair side time and improved infection control compared to ceramic or metal bracket system

Luca Pizzoni[56] in 1998 studied the frictional resistance in two self ligating bracket systems (Speed, Damon SL) and two conventional brackets (Dentauram). These brackets were tested with four wires (Stainless steel, Beta titanium-round and rectangular). In results it showed that round wires had a lower friction when compared to rectangular wires. Beta titanium had higher friction than stainless steel. The self ligating brackets had markedly lower friction than conventional brackets at all angulations. It was proved that the selection of bracket design, wire material and wire cross section significantly influences the forces acting in a continuous arch system.

In 1998 **Dwight H Damon**[7] compared the friction produced among conventional twin brackets with three self ligating brackets.in the results it was found that the Conventional twins with metal ligatures had friction values more than 300 times compared to the passive self-ligating brackets, on the other hand the active brackets produced 216 times the friction of a passive self-ligating bracket system

In 2003 **Harradine Nigel**[19] got the results that the newly available self ligating brackets had the combination of low friction and also secured full bracket engagement. So it was evident that these developments gives a significant reduction in average treatment times and also in anchorage requirement.

Kusy[23] **in** 2004 explained the frictional behavior of four conventional and four self-ligating brackets were simulated using a mechanical testing machine. Analyses of the two-bracket types were completed by drawing samples of three standardized arch wires through quadrants of typodont models in the dry/wet states. Pretreatment typodonts of an oral cavity featured progressively malocclused quadrants. As nominal dimensions of the arch wires were increased, the drawing forces of all brackets increased at different rates. When coupled with a small wire, the self-ligating brackets performed better than the conventional brackets. For the 0.014- inch wires in the upper right quadrant, the maximum drawing forces averaged 125 and 810 cN for self-ligating and conventional brackets, respectively. When coupled with larger wires, various designs interchangeably displayed superior performance. For the 0.019 x 0.025-inch wires in the upper left quadrant, the maximum drawing forces averaged 1635 and 2080 cN for self-ligating and conventional brackets, respectively. As the malocclusion increased, the drawing forces increased. For example, in the least malocclused quadrant and with the smallest wire, maximum drawing forces for self-ligating and conventional brackets averaged 80 and 810 cN, respectively, whereas in the most malocclused quadrant tested with the same wire size, maximum drawing forces for self-ligating and conventional brackets averaged 870 and 1345 cN, respectively. For maximum values between the dry and wet states, significant differences between ambient states existed only for the In-Ovation brackets in the lower left quadrant. These test outcomes illustrated how bracket design, wire size, malocclusion, and ambient state influenced drawing forces.

Harradine in 2008[20] found that self-ligating brackets do not require an elastic or wire ligature systems, but have an in built mechanism that can be opened and closed to secure the arch wire. Various advantages were found which includes full arch wire engagement, reduced friction between bracket and the arch wire, optimal oral hygiene, less chair side assistance and faster arch wire removal and no special ligation method. Most of the brackets have a metal face to the bracket slot that is opened and closed with an instrument or using finger tip. The difference between active and passive clips in terms of alloy of which it's made of, the friction and torque which alters the treatment efficiency.

Goonawardane[5] in 2008 determine if self-ligating brackets are more efficient than conventional pre-adjusted brackets when used in a specialist practice setting seven hundred and sixty two patients, consecutively treated with fixed appliances, were evaluated retrospectively. All patients were treated by one orthodontist in a private orthodontic practice. Three hundred and eighty three patients were treated using a conventional pre-adjusted bracket system and 379 patients were treated with active self-ligating brackets. The total treatment time, number of appointments, appointment intervals, number of bracket breakages and number of unscheduled emergency appointments were recorded. Pretreatment characteristics identified by the ICON were related to these variables .The average treatment duration was 15.7 months (Range: 4.1-40.5 months; SD: 5.6 months). Comparable amounts of time were spent in rectangular and round arch wires by both appliances. Overall, there was no statistically significant difference between the durations of treatment with active self-ligating brackets and conventional pre-adjusted brackets. The number of de-bonded brackets and other emergency visits was significantly higher in patients treated with active self-ligating brackets. The treatment characteristics associated with prolonged treatment were; extraction of teeth, a Class II molar relationship and the degree of maxillary crowding or spacing, It was found that active self-ligating brackets appear to offer no measurable advantages in orthodontic treatment time, number of treatment visits and time spent in initial alignment over conventional pre-adjusted orthodontic brackets

Sayeh Ehsania[16] in 2009 compared the amount of expressed frictional resistance between orthodontic self-ligating brackets and conventionally ligated brackets in vitro as reported in the literature. Several electronic databases (Medline, PubMed, Embase, Cochrane Library, and Web of Science) were searched without limits. In vitro studies that addressed friction of self-ligating brackets compared with conventionally ligated brackets were selected and reviewed. In addition, a search was performed by going through the reference lists of the selected articles to identify any paper that could have been missed by the electronic searches A total of 70 papers from the electronic database searches and 3 papers from the secondary search were initially obtained. After applying the selection criteria, only 19 papers were included in this review. A wide range of methods were applied. Compared with conventional brackets, self-ligating brackets produce lower friction when coupled with small round arch wires in the absence of tipping and/or torque in an ideally aligned arch. Sufficient evidence was not found to claim that with large rectangular wires, in the presence of tipping and/or torque and in arches with considerable malocclusion, self-ligating brackets produce lower friction compared with conventional brackets.

Chen et al[4] in 2010 from his systematic review were to identify and review the orthodontic literature with regard to the efficiency, effectiveness, and stability of treatment with self-ligating brackets compared with conventional brackets. An electronic search in 4 data bases was performed from 1966 to 2009, with supplemental hand searching of the references of retrieved articles. Quality assessment of the included articles was performed. Data were extracted by using custom forms, and weighted mean differences were calculated. Sixteen studies met the inclusion criteria, including 2 randomized controlled trials with low risk of bias, 10 cohort studies with moderate risk of bias, and 4 cross-sectional studies with moderate to high risk of bias. Self-ligation appears to have a significant advantage with regard to chair time, based on several cross-sectional studies. Analyses also showed a small, but statistically significant, difference in mandibular incisor proclination (1.5° less in self-ligating systems). No other differences in treatment time and occlusal characteristics after treatment were found between the 2 systems. No studies on long-term stability of treatment were identified. Despite claims about the advantages of self-ligating brackets, evidence is generally lacking. Shortened chair time and slightly less incisor proclination appear to be the only significant advantages of self-ligating systems over conventional systems that are supported by the current evidences.

Johansson[35] in 2012 conducted a prospective and randomized study of the efficiency of orthodontic treatment with self-ligating edgewise brackets

(SL; Time2 brand, American Orthodontics) and conventional edgewise twin brackets (CE; Gemini brand, 3M). One hundred consecutive patients were randomized to treatment with either SL or CE brackets. The participants were treated by one of three specialists in orthodontics and with continuous instructions alternately by five orthodontic assistants according to our normal treatment routine (i.e., modified 0.0220 MBT preadjusted edgewise technique). The treatments were evaluated in terms of overall treatment time, number of visits, and treatment outcome using the Index of Complexity Outcome and Need (ICON). The number of emergency appointments, number of arch wires, overjet, relative space, and extractions at treatment start were noted. After dropouts, the analyzed material consisted of 44 patients treated with SL (mean age 15.3 years, mean ICON 60.7, 70.4% female) and 46 patients treated with CE (mean age 15.0 years, mean ICON 56.5, 71.7% female). There were no statistically significant differences between the SL and CE groups in terms of mean treatment time in months (20.4 vs 18.2), mean number of visits (15.5 vs 14.1), mean ICON scores after treatment (13.2 vs 11.9), or mean ICON improvement grade (7.9 vs 9.1). It was found that Orthodontic treatment with SL brackets does not reduce treatment time or number of appointments and does not affect posttreatment ICON scores or ICON improvement grade compared with CE brackets.

Smita B Patil in 2014[57] compared the aligning efficiency, rate of retraction and torque expression of Self Ligating bracket (SLB) system with Conventional Pre adjusted Edgewise bracket (CLB) system. Twelve patients were selected and divided into two groups treated with self ligating brackets (SLB, n=6) and conventional ligating brackets (CLB, n=6). The brackets used were 0.22 slot McLaughlin Bennet Trevesi (MBT) prescription. Aligning was evaluated with 0.14 NiTi followed by 19x25 Heat Activated NiTi and then 19x25 stainless steel wires for retraction within 4 months. The rate of retraction was evaluated per month and torque loss after space closure was also estimated. Results showed significant changes with SLB compared to CLB and also save more than 30% of chair side time during wire adjustments while rate of en masse retraction in SLB shows statistically non significance as compared to CLB system. In case of upper incisor changes when compared between two groups showed less torque loss in SLB than CLB although which was statistically no significant but % difference show SLB have better improvement result than CLB.

Wang Yi[4] in 2014 assessed the long-term stability of treatment with self-ligating brackets compared with conventional brackets. The long-term follow-up retrospective study sample consisted of two groups of patients; group SL (including passive and interactive self-ligating braces) comprised 30 subjects treated with self-ligating brackets at a mean pre-treatment (T0) age of 13.56 years, with a mean follow up period for 7.24 years; group CL comprised

30 subjects treated with conventional brackets at a mean pretreatment age of 13.48 years, with a mean follow up period for 7.68 years. Relapse were evaluated by dental casts examination using the Peer Assessment Rating (PAR) index and the Little's Irregularity Index. The two groups were evaluated for differences in the changing of PAR and Little irregularity index using paired-t tests. Inter-observer and intra-observer reliability was assessed by means of the Pearson's correlation coefficients method. There were no significant differences changed in PAR and the Little's Irregularity Index between groups for the long-term follow-up period. The study revealed that brackets type did not affect the long-term stability. Considering self-ligating brackets were expensive, given comprehensive consideration for the patients to choose suitable orthodontic bracket type was of critical importance.

Michael H Bert[58] in 2015 did a Meta-analysis of differences between conventional and self-ligating brackets concerning pain during tooth movement, number of patient visits, total treatment duration, and ligation times.Online search in Medline, Embase, and Central focused on randomized clinical trials and controlled clinical studies published between 1996 and 2012. Four studies on pain met our inclusion criteria, two on the number of appointments, two on overall treatment time but none on ligation times. Pain levels did not differ significantly between patients treated with conventional or self-ligating brackets after 4 hours, 24 hours, 3 and 7 days. The number of appointments and total treatment time revealed no significant differences between self-ligating and conventional brackets The lack of significant overall effects apparent in this meta-analysis contradicts evidence-based statements on the advantages of self-ligating brackets over conventional ones regarding discomfort during initial orthodontic therapy, number of appointments, and total treatment time. Due to the limited number of studies included, further randomized controlled clinical trials are required to deliver more data and to substantiate evidence-based conclusions on differences between the two bracket types considering orthodontic pain, number of visits, treatment, and ligation times.

ALIGNMENT EFFICIENCY

Srinivas[59] in 2003 has found that passive self-ligating appliances use less anchorage than conventional appliances. This supports the reduction in the use of anchorage devices experienced by users of passive self-ligation. Need for extractions to facilitate orthodontic mechanics because alignment is not hindered by frictional resistance from ligatures and can therefore be largely achieved with small diameter copper nickel titanium arch wires. Tooth alignment therefore places minimal stress on the periodontium as it occurs and so the possibility of iatrogenic damage to the periodontium is reduced

Miles P. G[28] et al in 2006 compared the effectiveness and comfort of Damon2 brackets and conventional twin brackets during initial alignment. Comfort on the lips, more esthetic look, and bracket failure rates were also recorded. The twin bracket was more uncomfortable with the initial arch wire. However, at 10 weeks, substantially more patients reported discomfort with the Damon2 bracket when engaging the arch wire. Patients preferred the look of twin bracket over the Damon2 and more SLB debonded during the study. He concluded that Damon2 brackets was no better during initial alignment than conventional brackets.

Coubourne et al[46] in 2008 compared the degree of discomfort experienced during the period of initial orthodontic tooth movement using Damon3 self-ligating and Synthesis conventional ligating pre-adjusted bracket systems. Sixty-two subjects were recruited from two centers (32 males and 30 females; mean age 16 years, 3 months) with lower incisor irregularity between 5 and 12 mm and a prescribed extraction pattern, including lower first premolar teeth. These subjects were randomly allocated for treatment with either bracket system. Fully ligated Damon3 0.014-inch Cu NiTi arch wires were used for initial alignment in both groups. Following arch wire insertion, the subjects were given a prepared discomfort diary to complete over the first week, recording discomfort by means of a 100 mm visual analogue scale at 4 hours, 24 hours, 3 days, and 1 week. The subjects also noted any self-prescribed analgesics that were taken during the period of observation. Data were analyzed using repeated measures analysis of variance. There were no statistically significant differences in perceived discomfort levels between the two appliances; discomfort did not differ at the first time point and did not develop differently across subsequent measurement times. Overall, this investigation found no evidence to suggest that Damon3 self-ligating brackets are associated with less discomfort than conventional pre-adjusted brackets during initial tooth alignment, regardless of age or gender.

Paul Scott [8] compared the efficiency of mandibular tooth alignment and the clinical effectiveness of a self ligating and a conventional pre adjusted edgewise orthodontic bracket system. . Sixty two subjects with mandibular incisor irregularities of 5 to 12mm and a prescribed extraction pattern including the mandibular first premolars were randomly allocated to treatment with Damon3 self-ligating v/s Synthesis conventionally ligated brackets. Fully ligated 0.014" Nickle Titanium arch wires were used first in both groups, followed by a sequence of 0.014 x 0.025" and 0.018 x 0.025" NiTi, and 0.019 x 0.025" stainless steel. Study casts were taken at the start of treatment (T1), the first arch wire change (T2), and the placement of the final 0.019 x 0.025" stainless steel arch wire (T3). Cephalometric lateral skull and long cone periapical radiographs of the mandibular incisors were taken at T1 and T3. Study concluded that there is no significant difference was noted in the initial rate of alignment for either bracket systems. Alignment was associated with an increase in inter-canine width, a reduction in arch length, and proclination of the mandibular incisors for both appliances, but the differences were not significant

Robert J Waynaut[30] in 2008 compared the effectiveness and comfort of Damon2 brackets and conventional twin brackets during initial alignment. Sixty consecutive patients participated in a split mouth design. One side of the lower arch was bonded with the Damon2 bracket and the other with a conventional twin bracket. The sides were alternated with each consecutive patient. The irregularity index (II) was measured for each half of the arch at baseline, at 10 weeks at the first arch wire change, and at another 10 weeks at the second arch wire change. Any difference in discomfort was assessed within the first few days of arch wire placement and again at the first arch wire change. Comfort on the lips, preferred look, and bracket failure rates were also recorded. The twin bracket was more uncomfortable with the initial arch wire.

However, at 10 weeks, substantially more patients reported discomfort with the Damon2 bracket when engaging the arch wire. At both arch wire changes at 10 and 20 weeks, the conventional bracket had achieved a lower II than the Damon2 bracket by 0.2 mm, which is not clinically significant. Patients preferred the look of the twin bracket over the Damon2 and more Damon2 brackets debonded during the study. The Damon2 bracket was no better during initial alignment than a conventional bracket. Initially, the Damon2 bracket was less painful, but it was substantially more painful when placing the second arch wire and had a higher bracket failure rate.

Harradine[20] in 2008 described about the combination of low friction and secure full engagement is particularly useful in the alignment of very irregular teeth and the resolution of severe rotations, where the capacity of the wire to release from binding and slide through the brackets of the rotated and adjacent teeth would be expected to significantly facilitate alignment with Low friction therefore permits rapid alignment and more certain space closure, whereas the secure bracket engagement permits full engagement with severely displaced teeth and full control while sliding teeth along an arch wire. It is this feature that greatly facilitates the alignment of crowded teeth, which have to push each other along the arch wire to gain alignment

In 2009 **Padhraig S, Fleming[14]**, found the difference in the efficiency of mandibular arch alignment in dimensions with self ligating bracket system (SmartClip) and a conventional pre-adjusted edgewise twin bracket (Victory) in non-extraction patients. 0.016-in round martensitic active nickel-titanium aligning arch wire was placed in all the subjects. Mandibular arch irregularity was re-measured after interval of 8 weeks and found that the bracket type had little influence on arch efficiency. It was concluded that efficiency of alignment in the mandibular arch in non-extraction patients is independent of bracket type. Alignment efficiency is largely influenced by initial irregularity

Pandis[27] in 2009 compared the time taken for alignment efficiency in maxillary anterior teeth between active and passive, non-extraction patients on basis of little irregularity index, models obtained in each intervals were measured with digital caliper, in results it was found that no change in duration of treatment, and no difference in crowding correction

Pandis. N et al[60] in 2010 compared the time required to complete the alignment of crowded maxillary anterior teeth from canine to canine between Damon MX and In-Ovation R self ligating brackets, the amount of crowding of the maxillary anterior dentition was assessed by using the little irregularity index. The number of days required to completely alleviate the maxillary anterior crowding in the two groups were investigated. An analysis of each protocol was performed. Study was concluded that there is no difference in crowding alleviation found between In-Ovation R and Damon MX.

TORQUE EXPRESSION

Pandis[27] 2007 investigated the duration of mandibular crowding alleviation with self-ligating brackets (Damon2) compared with the conventional appliances (Microarch) and the accompanying dental effects. Fifty four subjects were selected from a pool of patients. Lateral cephalometric radiographs were used to assess the alteration of mandibular incisor position before and after alignment. He concluded that overall, no difference in the time required to correct mandibular crowding with Damon 2 and conventional brackets were observed because in conventional cases the stress exerted by the elastomeric modules and wire ligature adjacent to the bracket sides, precluding free sliding of the wire into the slot walls and adversely affecting movement rate. When the crowding and space in the arch increases there is no difference found between the systems.

Hisham M. Badawi[61] and Roger W. Too Good in 2008 measured the difference in third-order moments that can be delivered by engaging 0.019 x 0.025-in stainless steel arch wires to active self-ligating brackets (In-Ovation, GAC) and 2 passive self-ligating brackets (Damon2, Ormco and Smart Clip, 3M Unitek. Conclusions drawn were that the active self-ligating brackets seemed to have better torque control, due to a direct result of their active clip forcing the wire into the bracket slot. The amount of arch wire bracket slot was considerably less for active self-ligating brackets than passive self-ligating brackets. The active self-ligating brackets expressed higher torque values than the passive self-ligating brackets at clinically usable torsion angles (0°-35°). The passive self-ligating brackets produced lower moments at low torsion angles and started producing higher moments at high torsion angle that cannot be used clinically. The clinically applicable range of torque activation was greater for the active self-ligating brackets than for the passive self-ligating brackets. All the brackets showed significant variations in the torque expressed, this seemed to be attributed to the variation in bracket slot dimensions. Damon2 and Speed brackets were relatively more consistent than Smart Clip and In-Ovation bracket.

Turnbull. N.R, David J Birne[53], in 2007 from their prospective clinical study, authors assessed the relative speed of arch wire changes in a patient, comparing self ligating brackets with conventional elastomeric ligation methods, and further assessed this in relation to the stage of orthodontic treatment represented by different wire sizes and types. The time taken to remove and ligate arch wires for 131 consecutive patients treated with either self ligating or conventional brackets was prospectively assessed. The main outcome measure was the time to remove or place elastomeric ligatures or open/close self ligating for two matched groups of fixed appliance patients: Damon2 SLB and a conventional mini twin bracket. The relative effects of various wire sizes and materials on ligation times were investigated. The study was carried out by one operator. Authors found that ligation of an arch wire was approximately twice as quick with self ligating brackets. Opening a

Damon slide was on average 1 second quicker per bracket than removing elastic modules from the mini twin brackets, and closing a slide was 2 seconds faster per bracket. This difference in ligation time became more marked for larger wire sizes used in later treatment stages.

Tae – kyung Kim[3] & Ki-Dal Kim 2008 compared the frictional force generated by various combinations of SLB types, arch wire sizes, and alloy types and the amount of displacement during the initial leveling phase of orthodontic treatment, by using a custom-designed typhodont system. Two passive (Damon2 and Damon3), and 3 active SLBs (Speed, In-Ovation R, Time2), and Smart Clip were tested with 0.014" and 0.016" austenitic nickel-titanium and copper-nickel-titanium arch wires. To simulate malocclusion status, the maxillary canines were displaced vertically, and mandibular lateral incisors horizontally from their ideal positions up to 3 mm with 1 mm intervals. Two conventional brackets 1-Mini Diamond MD and 2- Clarity CL were used as controls. Frictional forces were least in Damon and IN-Ovation R brackets in the typodont, regardless of arch wire size and alloy type. The Austenitic NiTi wire showed significantly lower frictional forces than Cu-NiTi wire of the same size. As the amounts of vertical displacement of the maxillary canine and horizontal displacement of the mandibular incisors were increased, frictional forces also increased.

David Birnie[25] in 2008 stated that The Damon philosophy is based on the principle of using just enough force to initiate tooth movement the threshold force. The underlying principle behind the threshold force is that it must be low enough to prevent occluding the blood vessels in the periodontal membrane to allow the cells and the necessary biochemical messengers to be transported to the site where bone resorption and apposition will occur and thus permit tooth movement. A passive self-ligation mechanism has the lowest frictional resistance of any ligation system. Thus the forces generated by the arch wire are transmitted directly to the teeth and supporting structures without absorption or transformation by the ligature system.

Stephanie Shih-Hsuan Chen[4] & a Geoffrey Michael Greenlee in 2010 found from their systematic review to identify and review the orthodontic literature with regard to the efficiency, effectiveness, and stability of treatment with self ligating brackets compared with conventional brackets. Self ligating appears to have a significant advantage with regard to chair side time, based on several cross- sectional studies. Analysis also showed a small, but statistically significant difference in mandibular incisor proclination, it was found that retraction efficiency is not significantly efficient compared to conventional.

Kusnoto & Begalio[28] in 2011 tested the hypotheses that the Damon system will maintain inter-canine, inter-premolar, and inter-molar widths. To test subsequent hypotheses that the Damon system will not produce a significant difference in maxillary and mandibular incisor position/angulation when compared with control groups treated with conventional fixed orthodontic appliances for similar malocclusion. Subjects treated with the Damon system (N = 27) were compared with subjects treated with a conventionally ligated edgewise bracket system (N = 16). Subject's pretreatment and posttreatment lateral cephalometric radiographs and dental models were scanned, measured, and compared to see whether significant differences exist between time points and between the two groups. Results did not support the claimed lip bumper effect of the Damon system and showed similar patterns of crowding alleviation, including transverse expansion and incisor advancement, in both groups, regardless of the bracket system used. Maxillary and mandibular inter-canine, inter-premolar, and inter-molar widths increased significantly after treatment with the Damon system. The mandibular incisors were significantly advanced and proclined after treatment with the Damon system, contradicting the lip bumper theory of Damon. Posttreatment incisor inclinations did not differ significantly between the Damon group and the control group. Patients treated with the Damon system completed treatment on average 2 months faster than patients treated with a conventionally ligated standard edgewise bracket system.

ARCH EXPANSION

Dostalova[9] in 2004 stated that Computer image monitoring was used for evaluation of dental arch changes. A new special device captured geometrically calibrated images permitting comparison of several different dental casts. In the first part of this study 792 sets of study casts were screened. Measurements of dental arch width between reference points of canines, first premolars and first molars were made, for men: canines - 35.1 ± 0.13 mm, first premolar - 37.5 ± 0.13 mm, first molars - 48.1 ± 0.19 mm; women: canines - 33.4 ± 0.13 mm; first premolars - 35.6 ± 0.15 mm; first molars - 46.7 ± 0.19 mm. In the second part of the study, changes between initial, post-treatment and post-retention alignment (5-years after orthodontic therapy) of upper and lower dental arch of 36 subjects were analyzed. Upper and lower arch compression in first premolars and molars area was visible before treatment. We conclude that computer image monitoring can be used for evaluation of dental arch changes during the different steps of treatment

Scott[46] et al in 2008 did a Randomized controlled trial between Damon3 and conventional system, it was found that the Damon3 was no more efficient than conventional ligated pre adjusted brackets in initial or overall rate of mandibular incisor alignment. Alignment was associated with increased inter-canine width, maintenance of inter-molar width, some reduction of arch length, and proclination of mandibular incisors for both appliances, but the differences were not significant.

Padhraig S, Fleming, **Andrew. T.DiBase**[14] in 2009 compared the effects of two pre adjusted appliances on angular and linear changes of the mandibular incisors, and transverse mandibular arch dimensional changes over a minimum of 30 weeks. Sixty six consecutive patients allocated to treatment with a SLB – Smartclip, and conventional pre adjusted edgewise brackets Victory. Initial study models and cephalograms were obtained within a month of starting the study. All subjects received treatment with the following arch wire sequence: 0.016” round, 0.017 x 0.025” rectangular, 0.019 x 0.025” rectangular martensitic active nickel-titanium arch wires and 0.019 x 0.025” stainless steel arch wires. Final records, including study models and a lateral cephalograms, were collected after a minimum of 30 weeks after initial appliance placement. Lateral cephalograms were assessed for treatment related changes in mandibular incisor inclination and position. Transverse dimensional changes in inter-canine, and inter-molar distances, and the amount of crowding alleviated during the study period were assessed by comparison of pre treatment and post treatment model, it was found there was a statistically greater increase in inter-molar width in the group treated with SLB, although the difference was only 0.91 mm.

Chimenti[29] evaluated the transverse dimensions of the maxillary arch induced by fixed self-ligating and traditional straight-wire appliances during orthodontic therapy. Forty consecutive patients (age range 14 to 30 years) with normal or low mandibular plane angle, normal overbite, and mild crowding were included. The traditional appliance was composed of Victory Series MBT brackets (3M Unitek), and the self-ligating appliance of Damon-3MX brackets (Ormco). The leveling and aligning phase with round arch wires lasted 6 months and was followed by another 6 months of rectangular arch wires. The arch wire sequence with the MBT appliance was 0.016-inch and 0.019 x 0.025” Ni-Ti form II (3M Unitek), while in the Damon-3 MX, it was 0.014” and 0.016” followed by 0.016 x 0.025” copper nickel-titanium (Ormco). Inter-canine, first and second inter-premolar, and inter-molar widths in the maxilla were recorded before treatment (T0) and 12 months later (T1). In both groups, a significant increase from T0 to T1 was recorded for all transverse measurements, but no significant difference was observed between groups. Within 12 months of treatment, both appliances increased maxillary dentoalveolar widths.

Padhraig S. Fleming[15] in 2010 evaluated the clinical differences in relation to the use of self ligating brackets in orthodontics. Six RCTs and eleven CCT were identified from the electronic databases which investigated the influence of bracket type on alignment efficiency, subjective pain experience, bond failure rate, arch dimensional changes, rate of orthodontic space closure, periodontal outcomes, and root resorption were selected. Both authors were involved in validity assessment, and data extraction. Meta analysis of the influence of bracket type on subjective pain experience failed to demonstrate a significant advantage for either type of appliance. Authors concluded that it was difficult to assess the efficiency at this stage because there is insufficient high quality evidence to support the use of self ligating brackets over conventional bracket system.

Emily Ong and Hugh McCallum[62] 2010 compared the efficiency of self ligating and conventionally ligated bracket system during the first 20 weeks of extraction treatment. Fifty consecutive patients who had premolar extractions in the maxillary and/or mandibular arch, 0.022 x 0.028" slot brackets, and similar arch wire sequences were studied. Forty four arches received Damon3 MX brackets, and 40 arches received Victory Series or Mini Diamond brackets. The models were evaluated for anterior arch alignment, extraction spaces, and arch dimensions at pretreatment (T0), 10 weeks (T1), and 20weeks (T2). They concluded that there were no significant differences between the self ligating and conventionally ligated groups at 20 weeks in irregularity scores. There were no significant differences in passive extraction space closures between the groups.

PM Cattaneo, M Treccani, LHS Cevidanes, B Melsen[63] 2011 evaluated the transversal tooth movements and buccal bone modeling of maxillary lateral segments achieved with active or passive self-ligating bracket systems in a randomized clinical trial. Sixty-four patients, with Class I, II, and mild Class III malocclusions, were randomly assigned to treatment with passive (Damon 3 MX) or active (In-Ovation R) SLBs. Impressions and cone-beam CT-scans were taken before (T0) and after treatment (T1). Displacement of maxillary canines, premolars and molars, and buccal alveolar bone modeling were blindly assessed. Twenty-one patients in the Damon and 20 in the In-Ovation group completed treatment according to the prescribed protocol. Transversal expansion of the upper arch was achieved by buccal tipping in all but one patient in each group. It was found that there were no statistical significant difference in inter-premolar bucco-lingual inclination between the two groups from T0 to T1. The bone area buccal to the 2nd premolar decreased on average of 20% in the Damon and 14% in the In-Ovation group. They concluded saying that the anticipated translation and buccal bone modeling using active or passive SLBs could not be confirmed in the majority of the cases. Individual pre-treatment factors, like initial teeth inclination and occlusion, seemed to be important in determining the final outcome of the individual treatment, and CBCT-technology combined with digital casts was important to analyze 3D treatment outcomes both at dental and bone level in large study groups

Lilianaavila[64] in 2013 compared the arch width changes in non extraction patients with digital caliper in Damon2 series in maxilla and mandible. Results found that in maxilla inter-canine width has no much change compared to mandible, whereas in mandible inter-canine width is increased more, inter-premolar and inter-molar has increased in both maxilla and mandible which was found to be significant

Ezgi Atik[65] in 2014 compared the incisor position and transverse dimensional changes in nonextraction patients between Damon vs conventional bracket systems, in results it was found that no significant changes in all parameters, Damon system inclined maxillary molars more than the conventional.

Materials and Methods

MATERIALS AND METHODS

In our study, 16 consecutive patients (9 females and 7 males) were selected from which 8 patients were randomly divided again as Group A and Group B, in which 2 patients from each group were eliminated due to multiple breakage of brackets and irregular visits, so the final group comprised of 6 patients in each group. Group A was the study group with 3 females and 3 males, Group B was the control group with 4 females and 2 males, who were selected according to the inclusion criteria.

Inclusion criteria:

Age criteria: 13 to 25 years old of either gender who had all their permanent teeth.

Angles Class I, Class II Division 1,-and Bi-dentoalveolar malocclusion requiring orthodontic therapy.

Patients with moderate Irregularity Index for dental crowding.

Exclusion criteria

Patients with previous history of orthodontic treatment,

Patients with any missing tooth other than third molars,

Patients with cleft lip and palate, any craniofacial deformity or patients with temporomandibular dysfunction were excluded from the study.

The study Group were bonded with Self-Ligating brackets pre-adjusted edgewise, MBT 0.022 slot brackets (3M Gemini SL, Figure -1) and control group were bonded with conventional pre-adjusted edgewise, MBT 0.022 slot brackets (Mini Master series; American Orthodontics, Figure-2) which were positioned using Boon’s gauge in the upper and lower arches.

Arch form to be used was the OVOID arch form.

Leveling and aligning was to be done using a specific arch wire sequence:

0.014” round thermal NiTi

0.016” round thermal NiTi

0.018” round thermal NiTi

0.018” round Stainless Steel

0.019 x 0.025” NiTi

All the NiTi wires were to be changed after an interval of 4 weeks.

Once the alignment was achieved with 0.019 x 0.025” NiTi wire, the 0.019 x 0.025” stainless steel wire was inserted and which fitted passively into the bracket slot.

Stainless steel ligatures or elastomeric modules were used to secure arch wire into the conventional brackets. Arch wires were disengaged by cutting the ligatures or removing the modules. Whereas for self-ligating brackets, arch wires were removed by opening the passive slides with probe.

After alignment, 0.019 x 0.025” stainless steel with soldered hooks and retraction was to be done with sliding mechanics.

Impressions were made for each wire insertion that is TO T1 and T2, for 0.016”, 0.018” and 0.019 x 0.025 NiTi and models were made and lateral cephalograms were taken at initial and completion stage of alignment. All the lateral cephalograms, were evaluated by the same investigator.

All study models were evaluated by using Little’s Irregularity Index to quantify the alignment of the Six anterior teeth. Crowding was calculated as the difference between the sum of tooth widths and arch circumference taken from the line of best fit, through the contact points mesial to the first molars.

Inter-canine widths were measured from the cusp tips of the canines on the study models. Inter-molar widths were measured from the central and mesial occlusal pits of the mandibular and maxillary first molars.

The study models were measured with digital Vernier calipers (INSIZE Digital Electronic Caliper Series 1112, Measuring range: 0-150mm/0-6” (1112-150), Resolution: 0.01mm/0.0005”) with sharpened tips that were accurate to 0.01 mm. All model measurements were made by the principal researcher.

The total time taken in number of days for completion of alignment was calculated from T0 to T2.

STATISTICAL ANALYSIS

A Descriptive summary of values was measured and calculated using IBM SPSS VERSION 22.0 U.S for alignment efficiency, Irregularity Index, Torque expression and Arch expansion for each group and were put in descriptive statistics. [Table Ia, Table IIa]

Wilcoxon Signed Rank Test (Nonparametric) was done to compare the Irregularity Index between the Groups at various time points, that is at T0 (With the 0.016 NiTi), T1 (0.018 NiTi) and T2 (0.019 x 0.025 NiTi), in both maxillary and mandibular arches [Table Ib, Table Ic]

Mann-Whitney Test was used to find out alignment efficiency between Study group and Control group at various time points, that is T0 (With the 0.016 NiTi), T1(0.018 NiTi) and T2 (0.019 x 0.025 NiTi),in both maxillary and mandibular arches, which was also a nonparametric test [Table Id, Table IIb]

Paired T-Test to compare mean values between time points in each Group for torque expression which is also a parametric test

The test was done to determine the mean and standard deviation of all measures such as IMPA, Upper and lower incisor inclination changes among study group and control group separately before and after alignment [Table IIIa, Table IIIb].

Independent T-Test, Parametric test was used to compare the mean values between Study group and Control group for the torque expression. This test was done to determine the mean and standard deviation of the measures such as IMPA, Upper and lower incisor inclination changes in angle and linear measurements between both the study group and control group before and after alignment. [Table IIIc].

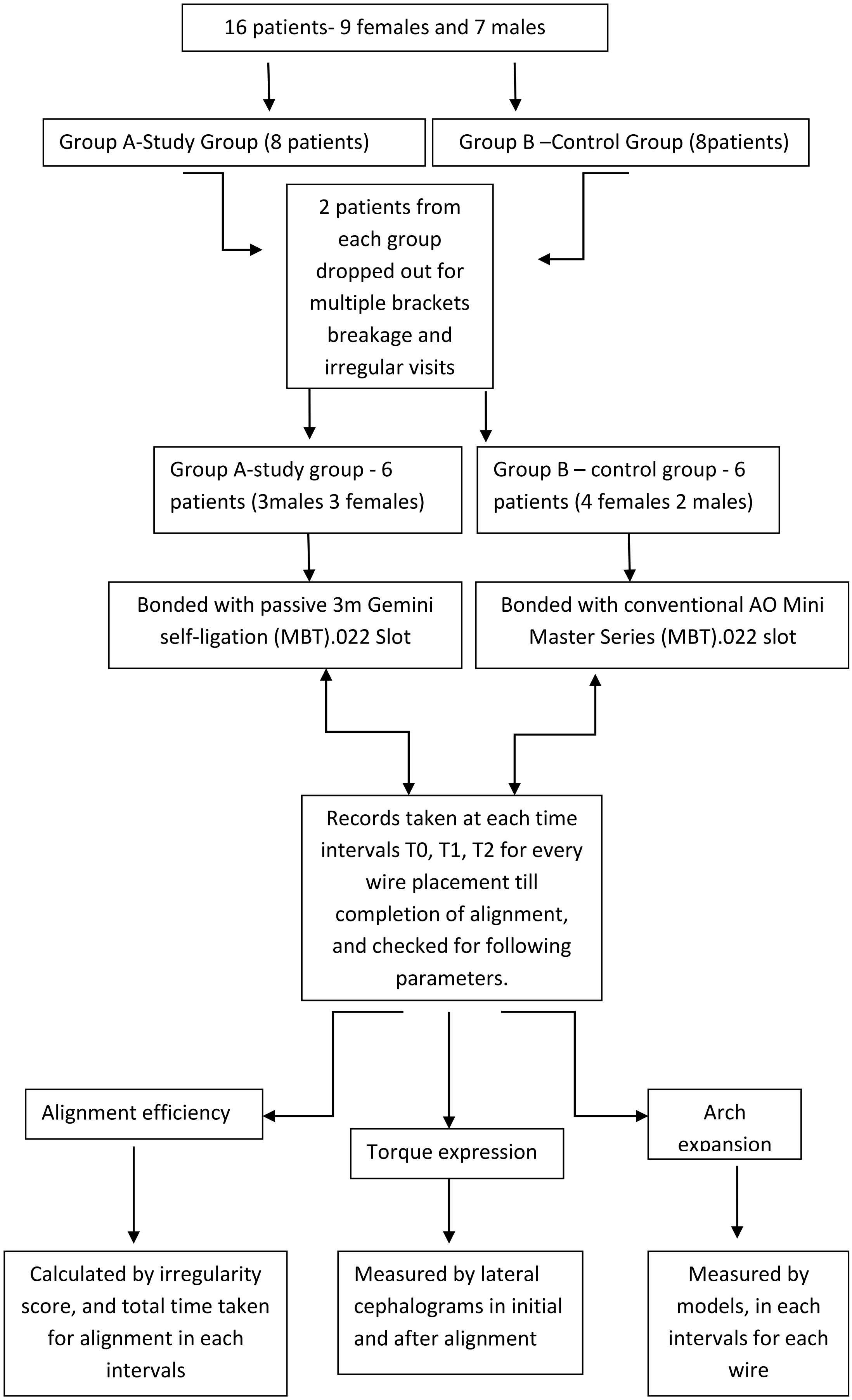
Paired T-Test (Parametric test) to compare mean values between time points in each Group for arch width changes

This test was done to determine the mean and standard deviation of arch width changes in maxilla and mandible at T0 T1 and T2 intervals for every arch wire change in each study group and control group separately. The measurements were done on changes at the canine, premolar and molar levels. [Table IVa, IVb, IVc].

Independent T-Test (Parametric test) to compare mean values between Study group and Control group for arch width changes

This test was done to determine the mean and standard deviation of arch width changes in maxilla and mandible at T0 T1 and T2 intervals for every arch wire change, between study group and control group at canine, premolar and molar levels [Table IVd, IVe, IVf].

Consort diagram



Figures

Figure1. Passive self ligation system

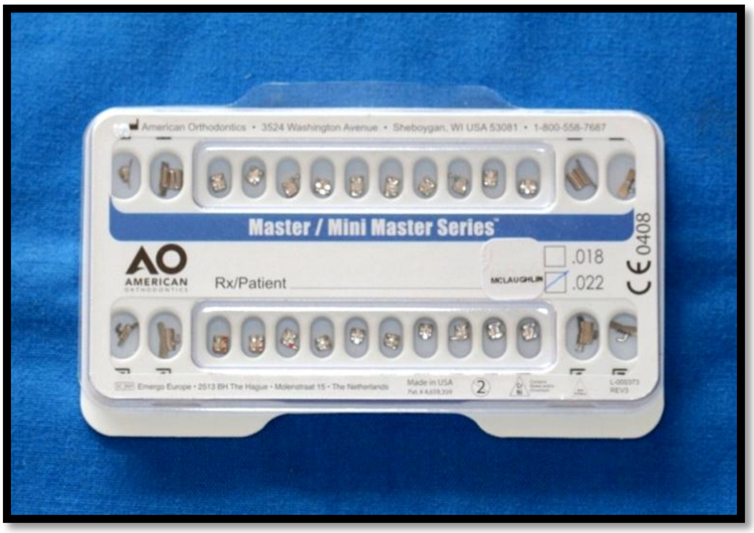


Figure 2. Conventional Bracket System

CALCULATION FOR IRREGULARITY INDEX MEASURED AT T0and T2

SAMPLE | **CONTROL**

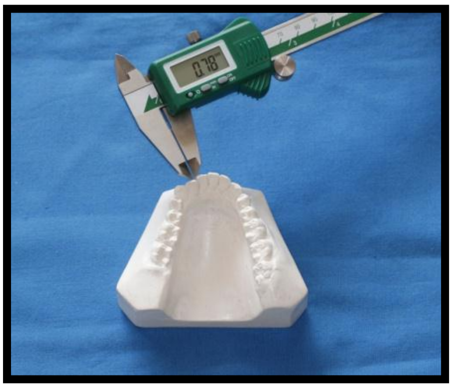


Figure 3a. Study Group Mandibular T0 Irregularity Index

Figure 3b.Control Group Mandibular Irregularity Index T0

Figure 4a. Study Group Mandibular Irregularity Index T2

Figure 4b. Control Group Mandibular Irregularity Index T2

MEASUREMENTS FOR TRANSVERSE DIMENSIONAL CHANGES

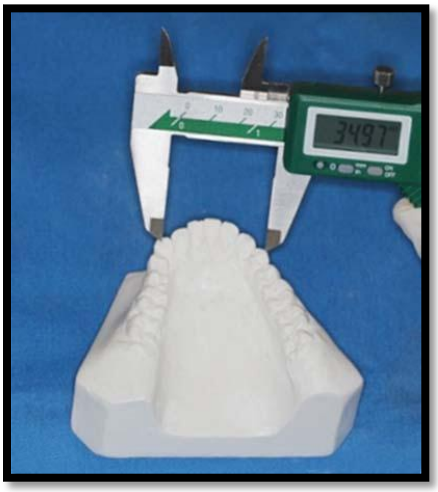


Figure 5. Study Group Mandibular Inter Canine Width T0

Figure 6. Study Group Mandibular Inter premolar Width T1

Figure 7. Study Group Mandibular Inter molar Width T2

Figure 8a.

CEPHALOMETRIC RADIOGRAPH TO MEASURE TORQUE EXPRESSION AT T0

Figure 8b.

CEPHALOMETRIC RADIOGRAPH TO MEASURE TORQUE EXPRESSION AT T2

Results

RESULTS

The study comprised of 16 patients (9 females and 7 males) in which 8 patients were randomly divided into Group A and Group B. Group A was considered as study group and Group B as control group. In the study group passive self-ligating bracket 0.022 Slot 3M Gemini SL (MBT) and in control group pre adjusted edgewise bracket 0.022 Slot Mini Master Series AO (MBT) were bonded. During the treatment one patient from each group eliminated due to irregular visits and one patient from each, control and study group were eliminated due to multiple breakage of brackets. After the alignment the results obtained for all measures among study and control groups were discussed below.

The Little's Irregularity Index showed statistically significant difference in all the time intervals, that is T0–T1 (P < 0.026), T1-T2 (P < 0.039), T0-T2 (P < 0.026) in maxillary arch and T0-T1 (P < 0.026), T1-T2 (P < 0.024), T0-T2 (P < 0.026) in mandibular arch in study group. [Table Ib]

The control group showed no statistically significant difference in the Irregularity Index for the time interval of T1-T2, both in maxilla and mandible, with the P values of 0.102 and 0.059 respectively. Whereas T0-T1 and T0-T2 showed statistically significant difference both in maxilla and mandible with the P value of 0.026, for both time intervals except T0-T2 in mandible which is 0.027 [Table Ic].

Comparison of Irregularity Index from T0-T2 (P > 0.100) showed no statistically significant difference in maxilla and mandible between study group and control group [Table Id].

The alignment efficiency analyzed by Mann Whitney test showed that the study group took lesser time, when compared to controls during all time intervals. Time interval of T0-T1 took more time when compared to other time intervals both in study group and control group with the mean value of 10 weeks and 13.33 weeks respectively in maxilla [Table IIb]

When torque expression was compared to pre and post alignment in study group, the mandibular incisor showed statistically significant difference with the P value of 0.006. This was due to the loss of torque in mandibular incisors [Table IIIa].

When torque expression was compared for pre and post alignment in control group, it was found that there was no statistically significant differences in both maxilla and mandible, with the P values of 0.317 and 0.310 [Table III b].

On Comparison of torque expression between control and study group, it was found that although a significant mean difference of 0.9° found among study group for IMPA, there was no statistically significant difference found between study group and control group, for any other measures [Table III c]

The arch expansion at the level of canine showed a statistically significant increase in study group, whereas control group showed no statistical significance in time interval of T0-T2 [Table IVa]. The arch expansion at the premolar level showed statistically significant increase in both control as well as study group in time interval of T0-T2 [Table IV b]. However there was no statistically significant difference in arch expansion at the level of molar for both study group and control group at the time interval of T0-T2 [Table IV c].

The comparison of arch expansion between study group and control group at the level of canine, premolar and molar were statistically insignificant [Table IV d, e, f].

Tables and Graphs

Table 1a-Descriptive statistics for irregularity index

Measure	Statistic	Group		
		Study	Control	Total
Maxilla (mm) - T0	N	6	6	12
	Mean	2.67	3.17	2.92
	Std. Dev	.88	.98	.93
	1st Quartile	2.0	2.0	2.0
	Median	2.3	3.5	2.8
	3rd Quartile	3.5	4.0	4.0
Maxilla (mm) - T1	N	6	6	12
	Mean	.58	1.08	.83
	Std. Dev	.66	.66	.69
	1st Quartile	1.0	.0	.0
	Median	1.0	.5	1.0
	3rd Quartile	1.5	1.0	1.3
Maxilla (mm) - T2	N	6	6	12
	Mean	.00	.00	.00
	Std. Dev	.00	.00	.00
	1st Quartile	.0	.0	.0
	Median	.0	.0	.0
	3rd Quartile	.0	.0	.0
Mandible (mm) - T0	N	6	6	12
	Mean	3.58	4.75	4.17
	Std. Dev	1.80	1.60	1.74
	1st Quartile	2.5	4.0	2.8

	Median	3.0	5.0	4.0
	3rd Quartile	4.0	6.0	5.5
Mandible (mm) - T1	N	6	6	12
	Mean	1.17	1.75	1.46
	Std. Dev	1.17	.98	1.08
	1st Quartile	1.0	.0	1.0
	Median	1.3	1.5	1.3
	3rd Quartile	2.0	2.0	2.0
Mandible (mm) - T2	N	6	6	12
	Mean	.00	.00	.00
	Std. Dev	.00	.00	.00
	1st Quartile	.0	.0	.0
	Median	.0	.0	.0
	3rd Quartile	.0	.0	.0

Table 1b-wilcoxan signed rank tests to compare between time points in each group for irregularity score Group: Study group

Measures	Z-Value	P-Value
Maxilla (mm) - T1 - Maxilla (mm) - T0	2.232	0.026
Maxilla (mm) - T2 - Maxilla (mm) - T0	2.226	0.026
Maxilla (mm) - T2 - Maxilla (mm) - T1	2.060	0.039
Mandible (mm) - T1 - Mandible (mm) - T0	2.214	0.027
Mandible (mm) - T2 - Mandible (mm) - T0	2.207	0.024
Mandible (mm) - T2 - Mandible (mm) - T1	2.226	0.026

Table 1 c Wilcoxon Signed Ranks Test to compare between time points in each Group for irregularity score Group: Control group

Measures	Z-Value	P-Value
Maxilla (mm) - T1 - Maxilla (mm) - T0	2.232	0.026
Maxilla (mm) - T2 - Maxilla (mm) - T0	2.232	0.026
Maxilla (mm) - T2 - Maxilla (mm) - T1	1.633	0.102
Mandible (mm) - T1 - Mandible (mm) - T0	2.226	0.026
Mandible (mm) - T2 - Mandible (mm) - T0	2.207	0.027
Mandible (mm) - T2 - Mandible (mm) - T1	1.890	0.059

Table I d- Comparision of Alignment efficiency irregularity score between Study and Control group using Mann-Whitney Test at T0,T1 & T2

Measures	Z-Value	P-Value
Maxilla (mm) - T0	0.931	0.352
Maxilla (mm) - T1	1.187	0.061
Maxilla (mm) - T2	0	1
Mandible (mm) - T0	1.129	0.259
Mandible (mm) - T1	0.499	0.618
Mandible (mm) - T2	0	1

Table II a Descriptive Statistics for time taken for Alignment

stasitic		Study	control	Total
Time taken T0-T1 Max	N	6	6	12
	Mean	10.00	13.33	11.67
	Std. Dev	1.41	3.27	2.96
	1st Quartile	9.0	12.0	9.5
	Median	10.0	14.0	11.5
	3rd Quartile	11.0	16.0	14.0
Time taken T1-T2 Max	N	6	6	12
	Mean	7.17	11.33	9.25
	Std. Dev	1.47	1.63	2.63
	1st Quartile	6.0	12.0	7.5
	Median	7.5	12.0	8.5
	3rd Quartile	8.0	12.0	12.0
Time taken T0-T1 Mand	N	6	6	12
	Mean	10.00	13.33	11.67
	Std. Dev	1.41	3.27	2.96
	1st Quartile	9.0	12.0	9.5
	Median	10.0	14.0	11.5
	3rd Quartile	11.0	16.0	14.0
Time Taken T1-T2 Mand	N	6	6	12
	Mean	7.17	11.33	9.25

	Std. Dev	1.47	1.63	2.63
	1st Quartile	6.0	12.0	7.5
	Median	7.5	12.0	8.5
	3rd Quartile	8.0	12.0	12.0
Total time taken (weeks)	N	6	6	12
	Mean	17.17	24.67	20.92
	Std. Dev	2.32	3.01	4.68
	1st Quartile	15.0	24.0	17.5
	Median	17.5	24.0	20.0
	3rd Quartile	19.0	28.0	24.0

Table II b- Mann-Whitney Test to compare the time taken for alignment between Study Group and Control group at T0,T1,T2

Measures	**Z-Value**	**P-Value**
Time taken T0-T1 Max	1.875	0.061
Time taken T1-T2 Max	2.677	0.007
Time taken T0-T1 Mand	1.875	0.061
Time Taken T1-T2 Mand	2.677	0.007
Total time taken (weeks)	2.832	0.005

Paired samples T-Test to compare mean values between time points in each Group

Table III a -Group: study group

Pair	Measure	N	Mean	Std. Dev	t-Value	P-Value
Pair 1	IMPA-PRE	6	106.33	6.218	4.540	0.006
	IMPA-POST	6	104.17	5.419		
Pair 2	Lower Incisor to NB-PRE	6	39.00	4.561	4.719	0.005
	Lower Incisor to NB-POST	6	36.67	3.882		
Pair 3	Lower Incisor to NB (mm)-PRE	6	12.17	1.602	2.666	0.045
	Lower Incisor to NB (mm)-POST	6	10.67	1.033		
Pair 4	Upper Incisor to NA-PRE	6	32.33	6.593	0.620	0.562
	Upper Incisor to NA-POST	6	31.33	5.203		
Pair 5	Upper Incisor to NA (mm)-PRE	6	7.33	3.933	0.338	0.749
	Upper Incisor to NA (mm)-POST	6	7.83	1.472		

Table III b Group: Control group

Pair	Measure	N	Mean	Std. Dev	t-Value	P-Value
Pair 1	IMPA-PRE	6	111.67	3.830	1.536	0.185
	IMPA-POST	6	108.33	8.641		
Pair 2	Lower Incisor to NB-PRE	6	41.83	4.708	1.130	0.310
	Lower Incisor to NB-POST	6	39.83	8.353		
Pair 3	Lower Incisor to NB (mm)-PRE	6	12.33	3.011	1.052	0.341
	Lower Incisor to NB (mm)-POST	6	11.50	4.550		
Pair 4	Upper Incisor to NA-PRE	6	30.50	3.391	1.112	0.317
	Upper Incisor to NA-POST	6	28.83	2.714		
Pair 5	Upper Incisor to NA (mm)-PRE	6	10.50	1.378	0.756	0.484
	Upper Incisor to NA (mm)-POST	6	9.83	1.472		

Comparison of amount of torque loss between Group A and Group B

Table III C -Independent samples T-Test to compare mean values between study group and Control group

Measure	Group	N	Mean	Std. Dev	t-Value	P-Value
IMPA-PRE	Study	6	106.33	6.218	1.789	0.104
	Control	6	111.67	3.830		
IMPA-POST	Study	6	104.17	5.419	1.001	0.341
	Control	6	108.33	8.641		
Lower Incisor to NB-PRE	Study	6	39.00	4.561	1.059	0.315
	Control	6	41.83	4.708		
Lower Incisor to NB-POST	Study	6	36.67	3.882	0.842	0.419
	Control	6	39.83	8.353		
Lower Incisor to NB (mm)-PRE	Study	6	12.17	1.602	0.120	0.908
	Control	6	12.33	3.011		
Lower Incisor to NB (mm)-POST	Study	6	10.67	1.033	0.438	0.678
	Control	6	11.50	4.550		
Upper Incisor to NA-PRE	Study	6	32.33	6.593	0.606	0.558
	Control	6	30.50	3.391		
Upper Incisor to NA-POST	Study	6	31.33	5.203	1.044	0.321
	Control	6	28.83	2.714		
Upper Incisor to NA (mm)-PRE	Study	6	7.33	3.933	1.861	0.092
	Control	6	10.50	1.378		
Upper Incisor to NA (mm)-POST	Study	6	7.83	1.472	2.353	0.140
	Control	6	9.83	1.472		

Table IV a -Paired samples T-Test to compare mean values between time points in each Group :INTERCANINE WIDTH

Group		Measurements	N	Mean	Std. Dev	t-Value	P-Value
Study	Pair 1	Maxilla (mm) - T0	6	35.1583	1.94858	2.530	0.053
		Maxilla (mm) - T1	6	36.2433	1.25775		
	Pair 2	Maxilla (mm) - T0	6	35.1583	1.94858	3.002	0.030
		Maxilla (mm) - T2	6	36.9683	1.21289		
	Pair 3	Maxilla (mm) - T1	6	36.2433	1.25775	3.691	0.014
		Maxilla (mm) - T2	6	36.9683	1.21289		
	Pair 4	Mandible (mm) - T0	6	27.3850	2.63540	2.955	0.032
		Mandible (mm) - T1	6	27.9167	2.48255		
	Pair 5	Mandible (mm) - T0	6	27.3850	2.63540	5.147	0.004
		Mandible (mm) - T2	6	28.9500	2.34833		
	Pair 6	Mandible (mm) - T1	6	27.9167	2.48255	3.009	0.030
		Mandible (mm) - T2	6	28.9500	2.34833		
Control	Pair 1	Maxilla (mm) - T0	6	35.4333	2.48659	1.267	0.261
		Maxilla (mm) - T1	6	36.0083	1.76436		
	Pair 2	Maxilla (mm) - T0	6	35.4333	2.48659	1.612	0.168
		Maxilla (mm) - T2	6	36.2767	1.51191		

	Pair 3	Maxilla (mm) - T1	6	36.0083	1.76436	1.376	0.227
		Maxilla (mm) - T2	6	36.2767	1.51191		
	Pair 4	Mandible (mm) - T0	6	26.2167	2.12553	3.179	0.025
		Mandible (mm) - T1	6	27.7283	1.74809		
	Pair 5	Mandible (mm) - T0	6	26.2167	2.12553	3.894	0.011
		Mandible (mm) - T2	6	28.2667	1.29915		
	Pair 6	Mandible (mm) - T1	6	27.7283	1.74809	2.476	0.056
		Mandible (mm) - T2	6	28.2667	1.29915		

Table IV b-Paired samples T-Test to compare mean values between time points in each Group :INTERPREMOLAR WIDTH

Group		Measurements	N	Mean	Std. Dev	t-Value	P-Value
Sample	Pair 1	Maxilla (mm) - T0	6	46.8033	2.24292	3.185	0.024
		Maxilla (mm) - T1	6	47.0883	2.17008		
	Pair 2	Maxilla (mm) - T0	6	46.8033	2.24292	2.719	0.042
		Maxilla (mm) - T2	6	47.5550	2.19445		
	Pair 3	Maxilla (mm) - T1	6	47.0883	2.17008	1.964	0.107
		Maxilla (mm) - T2	6	47.5550	2.19445		
	Pair 4	Mandible (mm) - T0	6	39.4867	1.36907	2.255	0.074
		Mandible (mm) - T1	6	40.4883	1.72444		
	Pair 5	Mandible (mm) - T0	6	39.4867	1.36907	2.606	0.048
		Mandible (mm) - T2	6	41.1683	1.86961		
	Pair 6	Mandible (mm) - T1	6	40.4883	1.72444	1.663	0.157
		Mandible (mm) - T2	6	41.1683	1.86961		
Control	Pair 1	Maxilla (mm) - T0	6	45.4717	2.28963	6.534	0.001
		Maxilla (mm) - T1	6	47.4617	1.98365		
	Pair 2	Maxilla (mm) - T0	6	45.4717	2.28963	5.838	0.002
		Maxilla (mm) - T2	6	47.9550	2.02477		

	Pair 3	Maxilla (mm) - T1	6	47.4617	1.98365	2.419	0.060
		Maxilla (mm) - T2	6	47.9550	2.02477		
	Pair 4	Mandible (mm) - T0	6	38.0517	1.96486	4.553	0.006
		Mandible (mm) - T1	6	40.3650	1.43581		
	Pair 5	Mandible (mm) - T0	6	38.0517	1.96486	4.264	0.008
		Mandible (mm) - T2	6	40.6567	1.51373		
	Pair 6	Mandible (mm) - T1	6	40.3650	1.43581	2.139	0.085
		Mandible (mm) - T2	6	40.6567	1.51373		

Table IV c-Paired samples T-Test to compare mean values between time points in each Group :INTERMOLAR WIDTH.

Group		Measurements	N	Mean	Std. Dev	t-Value	P-Value
Study	Pair 1	Maxilla (mm) - T0	6	46.9600	1.38527	0.879	0.420
		Maxilla (mm) - T1	6	46.7333	1.11148		
	Pair 2	Maxilla (mm) - T0	6	46.9600	1.38527	0.438	0.680
		Maxilla (mm) - T2	6	46.7467	1.11475		
	Pair 3	Maxilla (mm) - T1	6	46.7333	1.11148	0.049	0.963
		Maxilla (mm) - T2	6	46.7467	1.11475		
	Pair 4	Mandible (mm) - T0	6	41.2400	2.29486	0.200	0.849
		Mandible (mm) - T1	6	41.2917	2.37384		
	Pair 5	Mandible (mm) - T0	6	41.2400	2.29486	0.181	0.864
		Mandible (mm) - T2	6	41.1317	2.70053		
	Pair 6	Mandible (mm) - T1	6	41.2917	2.37384	0.468	0.660
		Mandible (mm) - T2	6	41.1317	2.70053		
Control	Pair 1	Maxilla (mm) - T0	6	45.3900	2.25904	0.859	0.430

		Maxilla (mm) - T1	6	44.7900	3.06267		
	Pair 2	Maxilla (mm) - T0	6	45.3900	2.25904	0.083	0.937
		Maxilla (mm) - T2	6	45.3533	2.58197		
	Pair 3	Maxilla (mm) - T1	6	44.7900	3.06267	2.103	0.089
		Maxilla (mm) - T2	6	45.3533	2.58197		
	Pair 4	Mandible (mm) - T0	6	38.5417	2.00847	0.168	0.873
		Mandible (mm) - T1	6	38.6117	2.11353		
	Pair 5	Mandible (mm) - T0	6	38.5417	2.00847	0.231	0.826
		Mandible (mm) - T2	6	38.6517	2.20760		
	Pair 6	Mandible (mm) - T1	6	38.6117	2.11353	0.371	0.726
		Mandible (mm) - T2	6	38.6517	2.20760		

Table IV d-Independent samples T-Test to compare mean values between Study group and control group

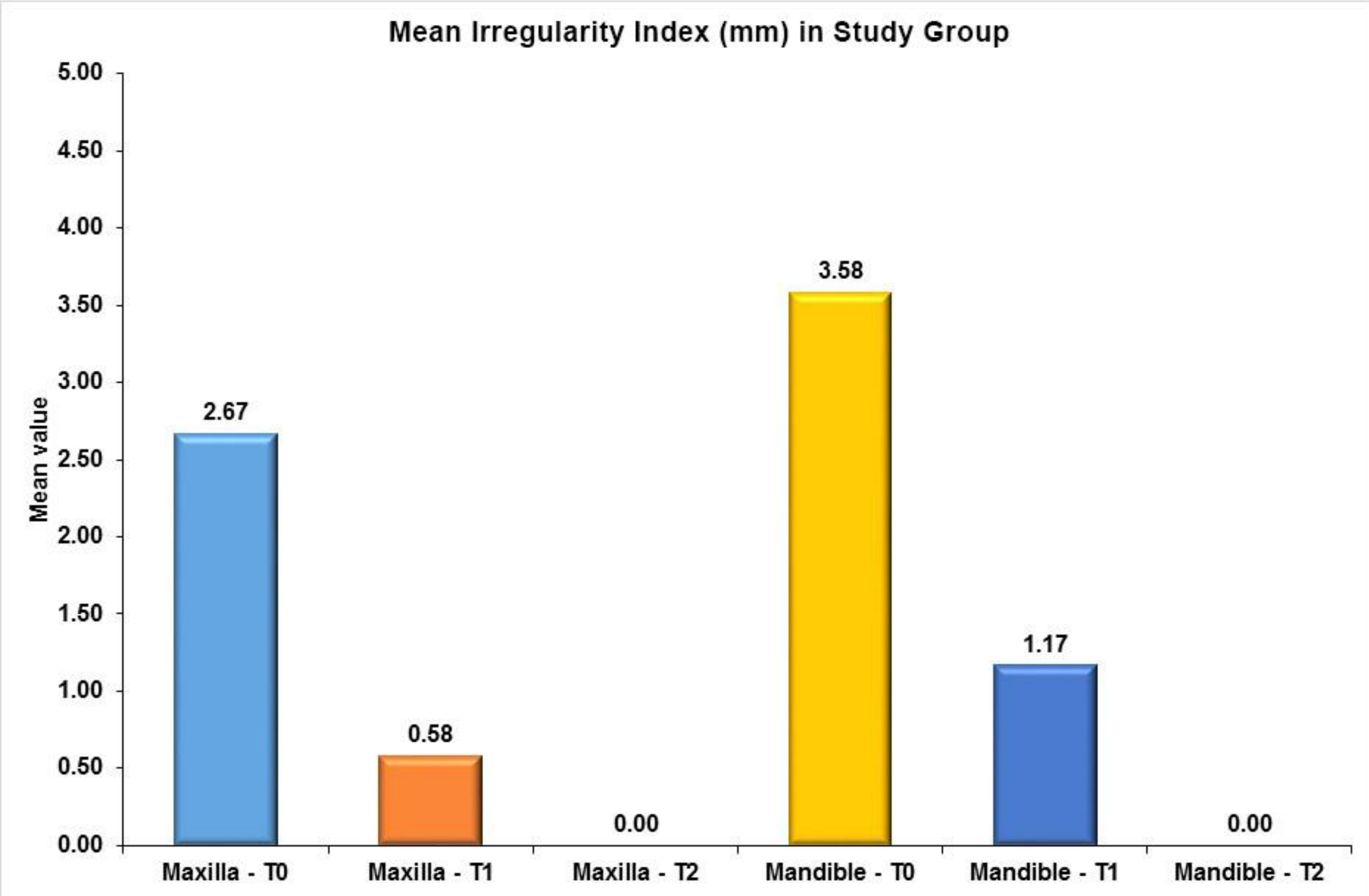
Width	Measure	Group	N	Mean	Std. Dev	t-Value	P-Value
INTERCANINE WIDTH	Maxilla (mm) - T0	Study	6	35.1583	1.94858	0.213	0.835
		Control	6	35.4333	2.48659		
	Maxilla (mm) - T1	Study	6	36.2433	1.25775	0.266	0.796
		Control	6	36.0083	1.76436		
	Maxilla (mm) - T2	Study	6	36.9683	1.21289	0.874	0.403
		Control	6	36.2767	1.51191		
	Mandible (mm) - T0	Study	6	27.3850	2.63540	0.845	0.418
		Control	6	26.2167	2.12553		
	Mandible (mm) - T1	Study	6	27.9167	2.48255	0.152	0.882
		Control	6	27.7283	1.74809		
	Mandible (mm) - T2	Study	6	28.9500	2.34833	0.624	0.547
		Control	6	28.2667	1.29915		

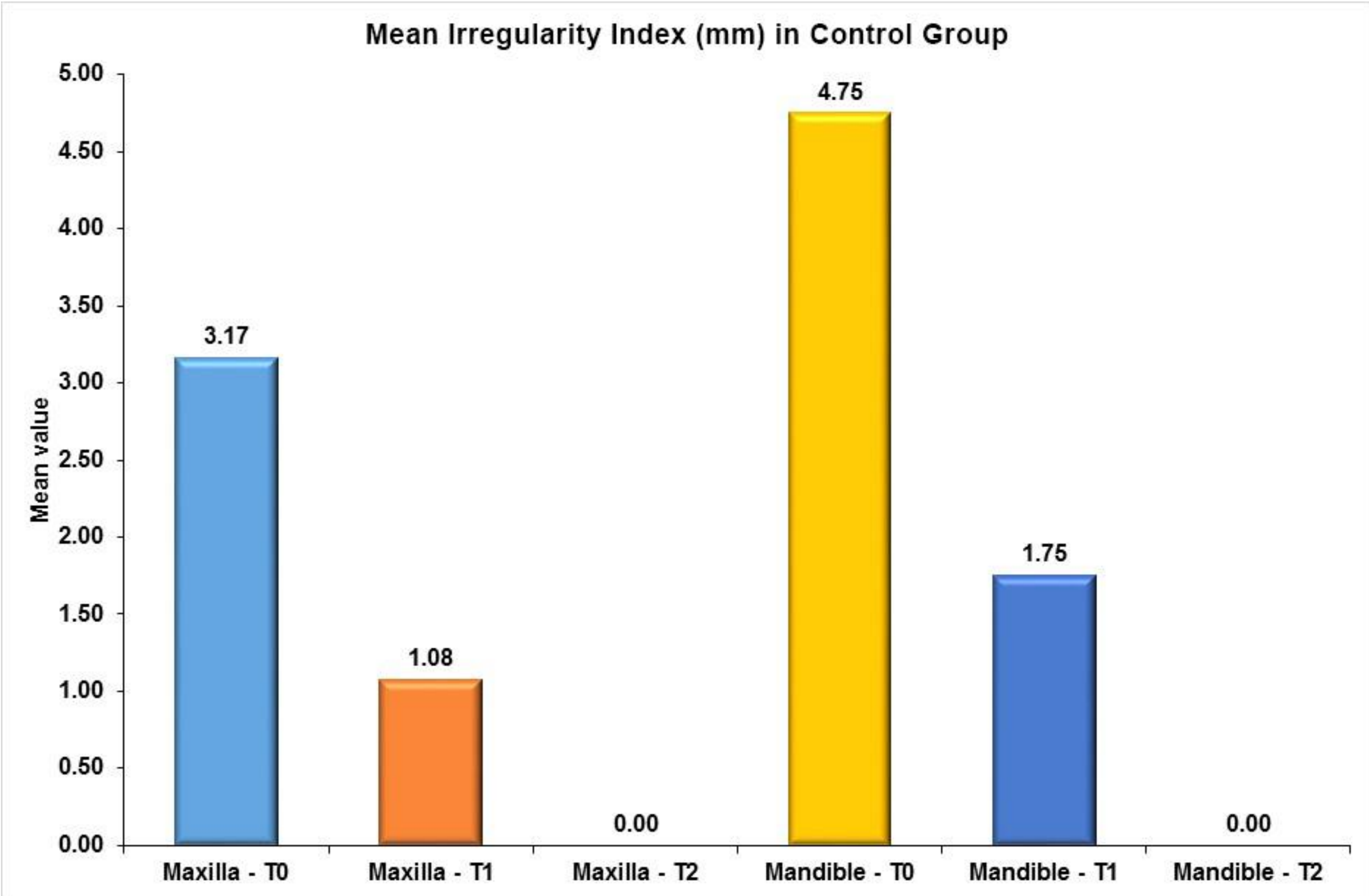
Table IV e Independent studys T-Test to compare mean values of Inter premolar width between Study group and Control group

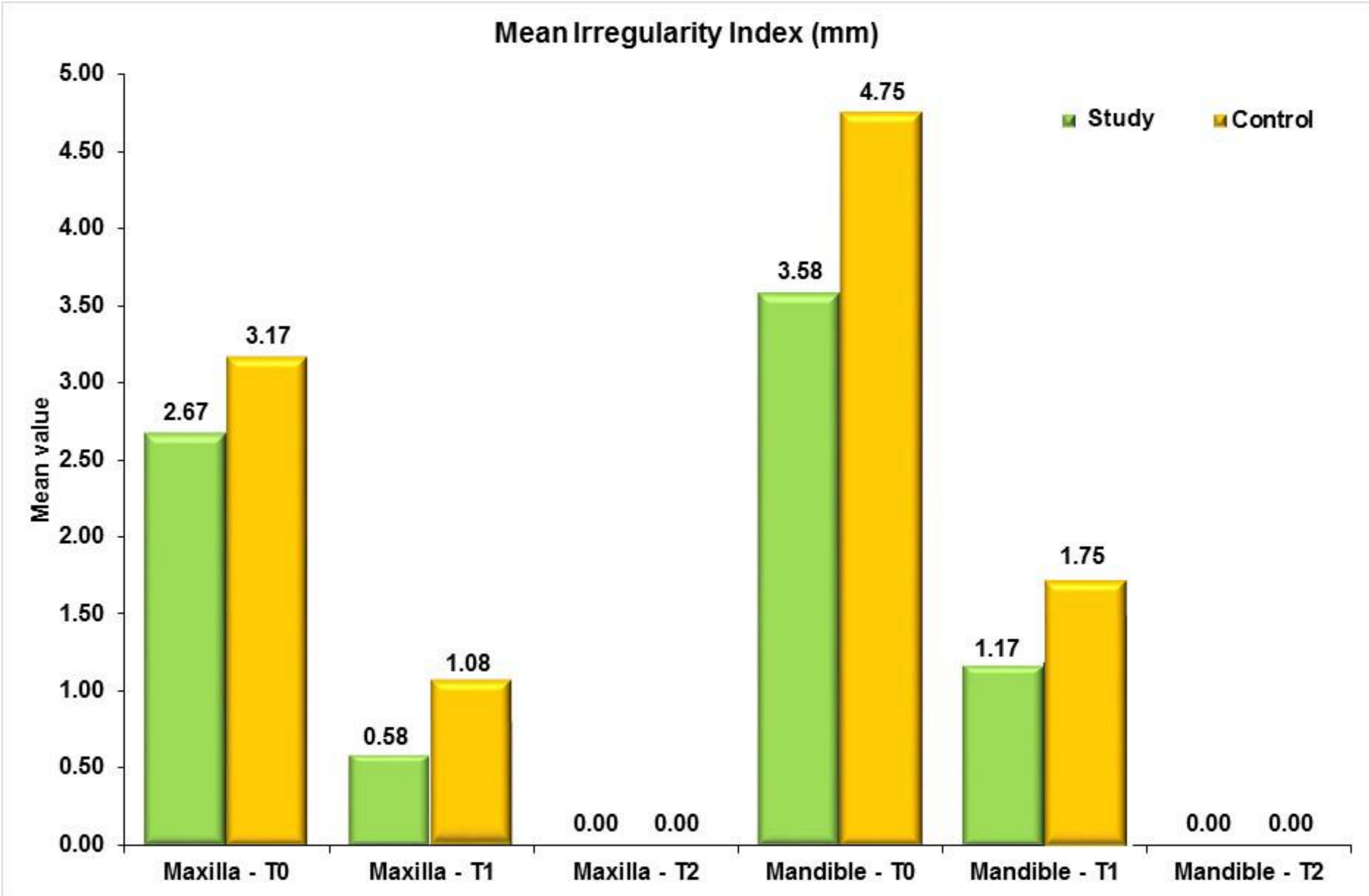
Width	Measure	Group	N	Mean	Std. Dev	t-Value	P-Value
INTERPREMOLAR WIDTH	Maxilla (mm) - T0	Study	6	46.8033	2.24292	1.018	0.333
		Control	6	45.4717	2.28963		
	Maxilla (mm) - T1	Study	6	47.0883	2.17008	0.311	0.762
		Control	6	47.4617	1.98365		
	Maxilla (mm) - T2	Study	6	47.5550	2.19445	0.328	0.750
		Control	6	47.9550	2.02477		
	Mandible (mm) - T0	Study	6	39.4867	1.36907	1.468	0.173
		Control	6	38.0517	1.96486		
	Mandible (mm) - T1	Study	6	40.4883	1.72444	0.135	0.896
		Control	6	40.3650	1.43581		
	Mandible (mm) - T2	Study	6	41.1683	1.86961	0.521	0.614
		Control	6	40.6567	1.51373		

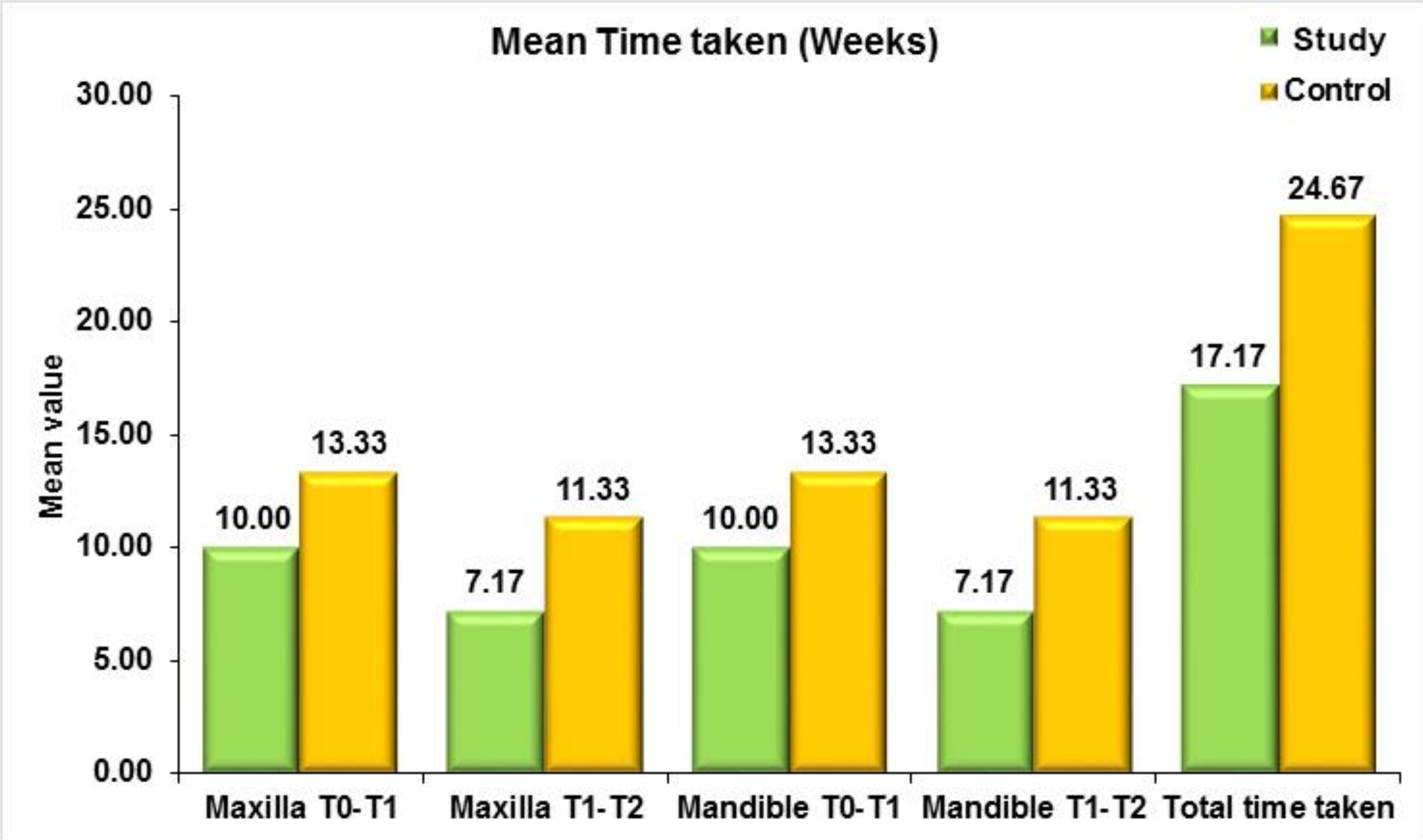
Table IV f Independent studys T-Test to compare mean values of Inter Molar width between Study group and Control group

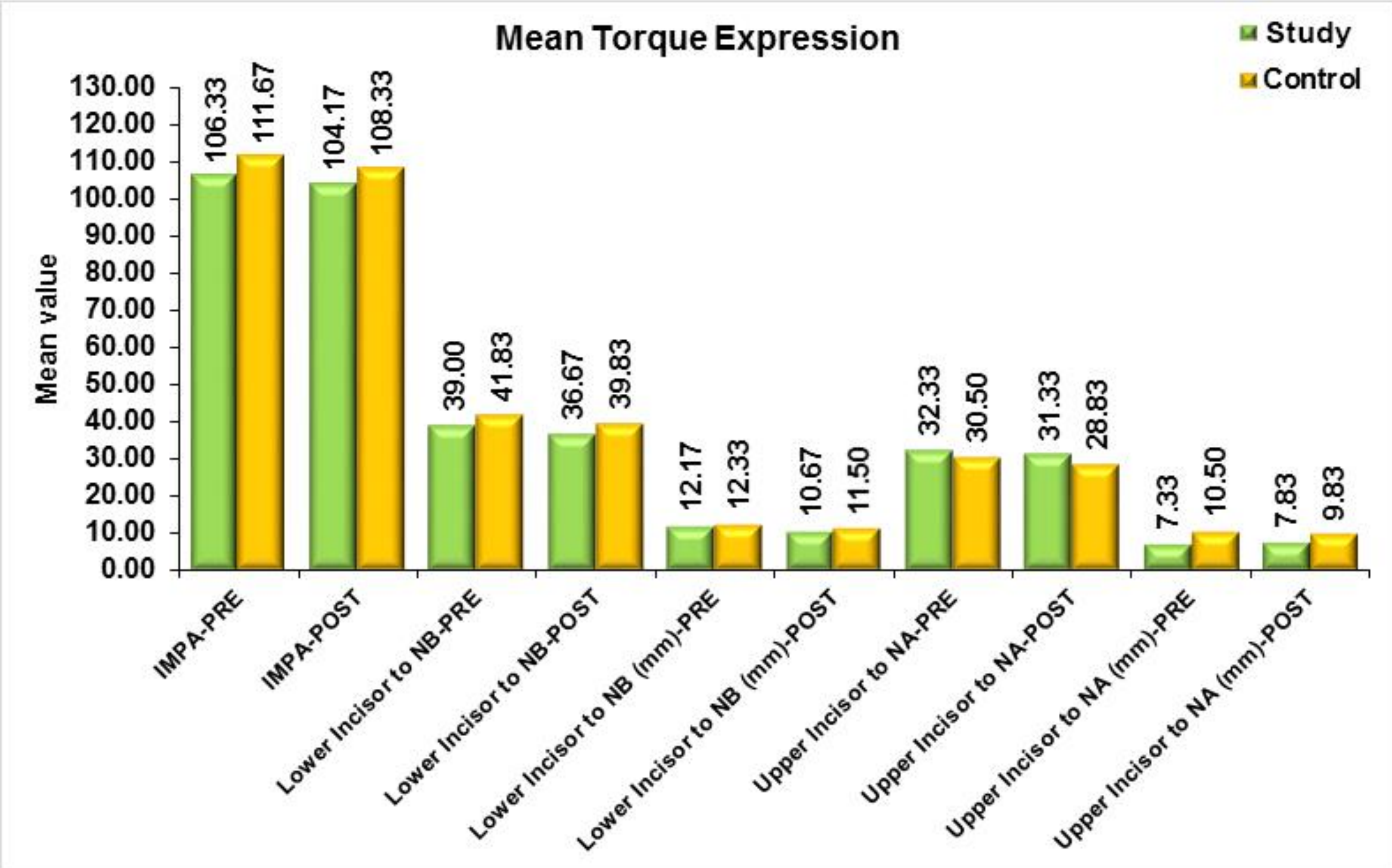
Width	Measure	Group	N	Mean	Std. Dev	t-Value	P-Value
INTERMOLAR WIDTH	Maxilla (mm) - T0	Study	6	46.9600	1.38527	1.451	0.177
		Control	6	45.3900	2.25904		
	Maxilla (mm) - T1	Study	6	46.7333	1.11148	1.461	0.192
		Control	6	44.7900	3.06267		
	Maxilla (mm) - T2	Study	6	46.7467	1.11475	1.214	0.265
		Control	6	45.3533	2.58197		
	Mandible (mm) - T0	Study	6	41.2400	2.29486	2.167	0.055
		Control	6	38.5417	2.00847		
	Mandible (mm) - T1	Study	6	41.2917	2.37384	2.065	0.066
		Control	6	38.6117	2.11353		
	Mandible (mm) - T2	Study	6	41.1317	2.70053	1.742	0.112
		Control	6	38.6517	2.20760		


Mean Irregularity Index (mm) in Study Group
Mean value
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.67
0.58
0.00
3.58
1.17
0.00
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2

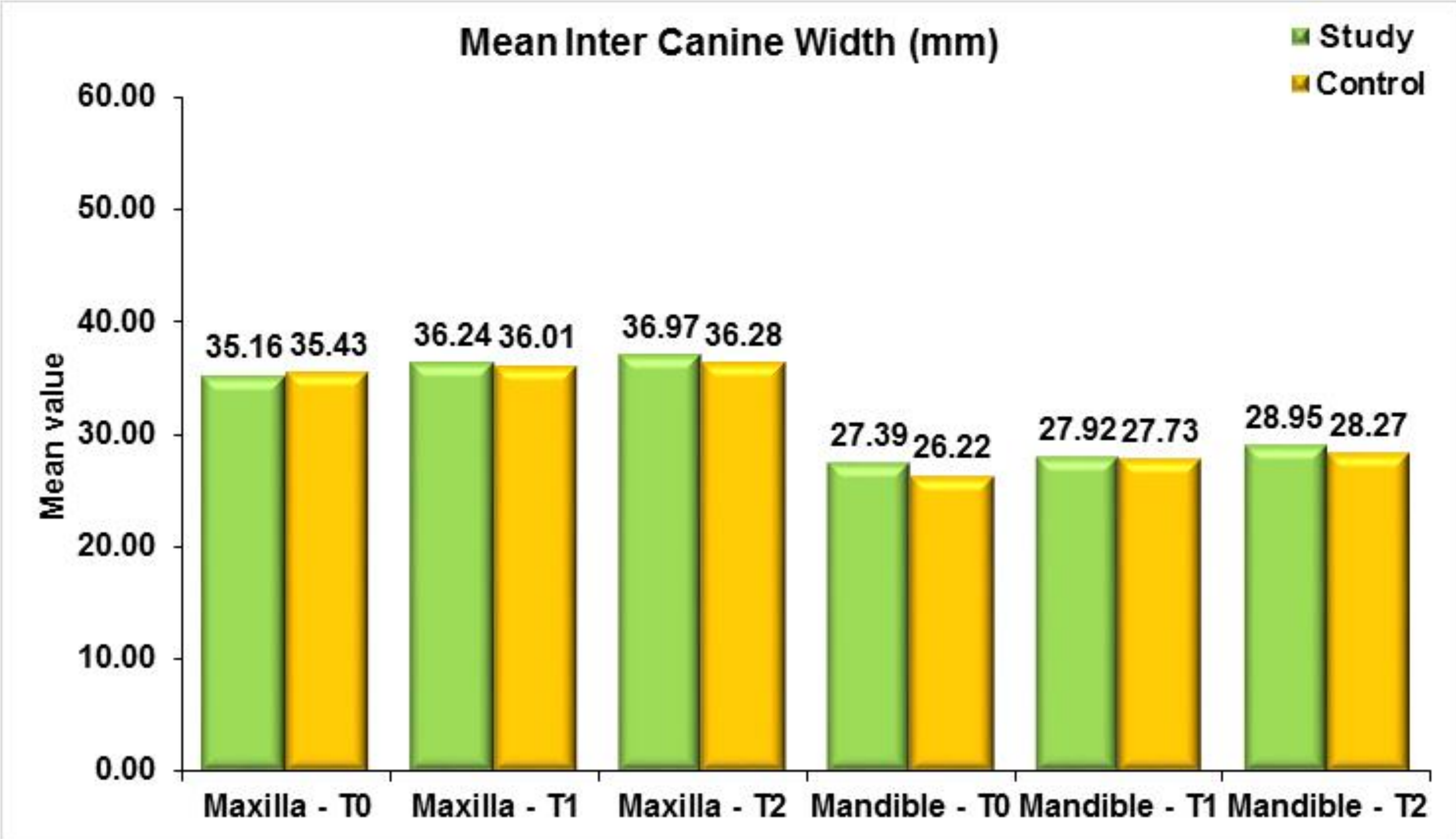

Mean Irregularity Index (mm) in Control Group
Mean value
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.17
1.08
0.00
4.75
1.75
0.00
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2

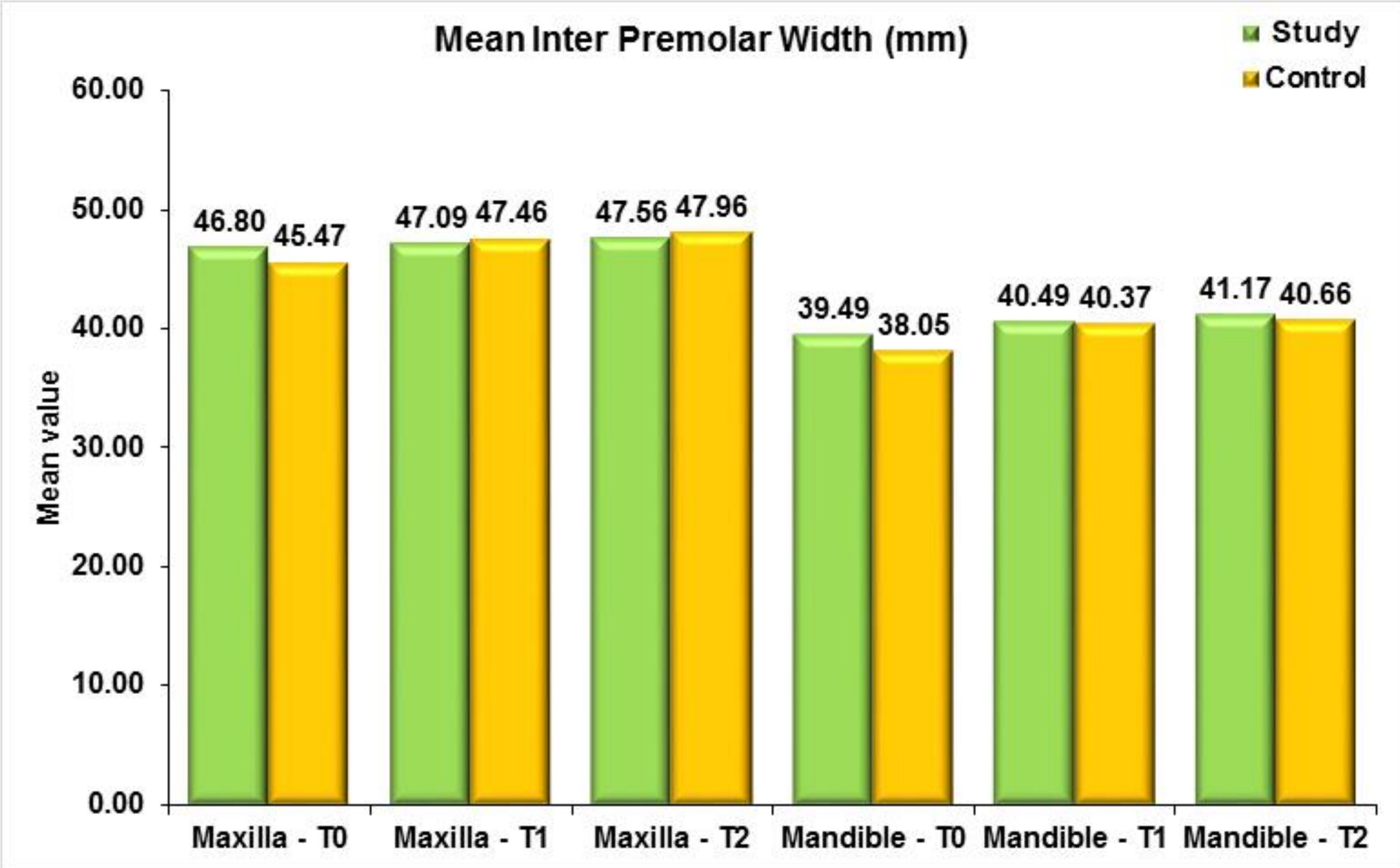

Mean Irregularity Index (mm)
Mean value
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Study
Control
2.67
3.17
0.58
1.08
0.00
0.00
3.58
4.75
1.17
1.75
0.00
0.00
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2

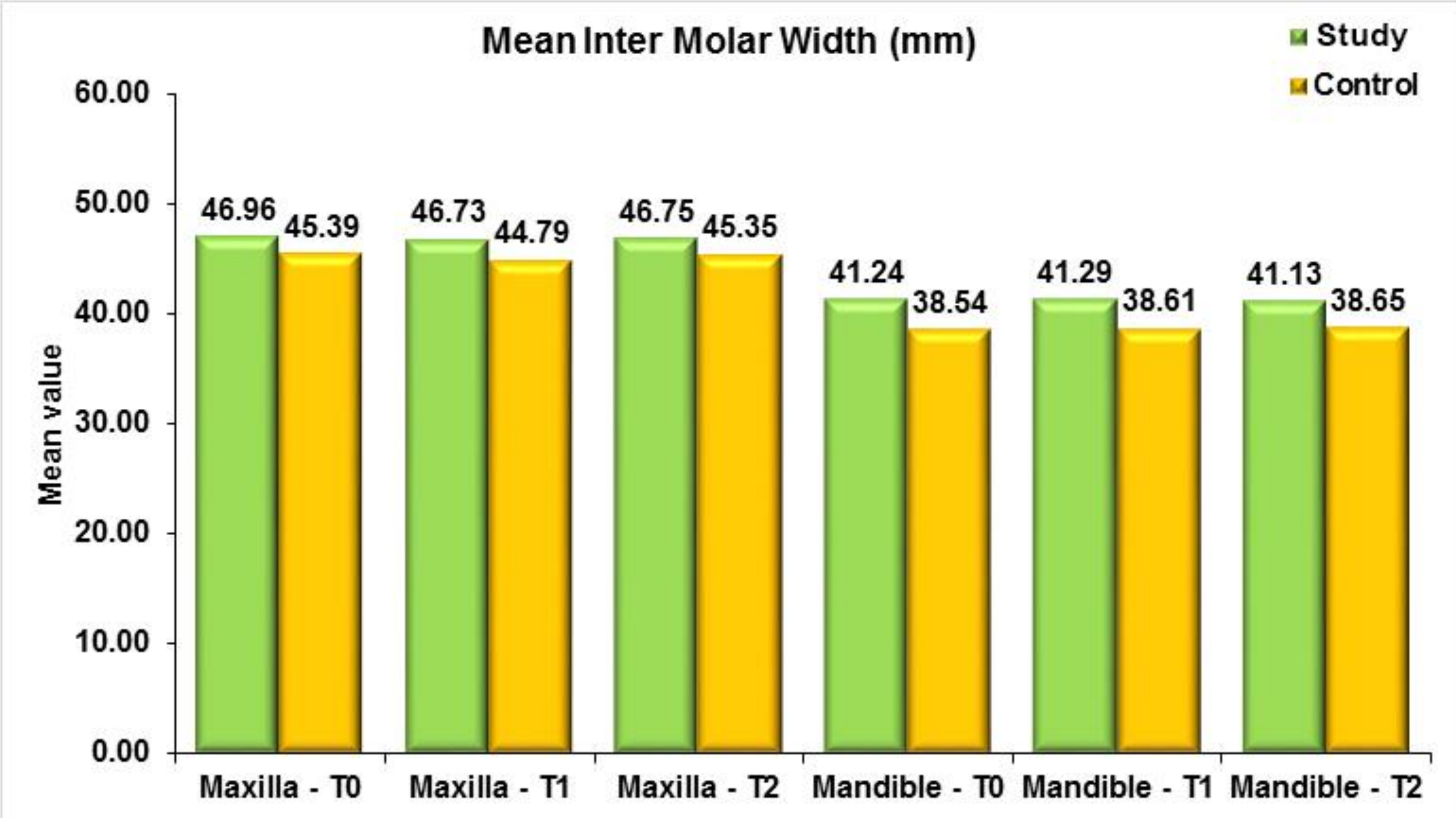

Mean Time taken (Weeks)
Study
Control
Mean value
30.00
25.00
20.00
15.00
10.00
5.00
0.00
10.00
13.33
7.17
11.33
10.00
13.33
7.17
11.33
17.17
24.67
Maxilla T0-T1
Maxilla T1-T2
Mandible T0-T1
Mandible T1-T2
Total time taken



Mean Torque Expression
Study
Control
Mean value
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
106.33
111.67
104.17
108.33
39.00
41.83
36.67
39.83
12.17
12.33
10.67
11.50
32.33
30.50
31.33
28.83
7.33
10.50
7.83
9.83
IMPA-PRE
IMPA-POST
Lower Incisor to NB-PRE
Lower Incisor to NB-POST
Lower Incisor to NB (mm)-PRE
Lower Incisor to NB (mm)-POST
Upper Incisor to NA-PRE
Upper Incisor to NA-POST
Upper Incisor to NA (mm)-PRE
Upper Incisor to NA (mm)-POST


Mean Inter Canine Width (mm)
Study
Control
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Mean value
35.16
35.43
36.24
36.01
36.97
36.28
27.39
26.22
27.92
27.73
28.95
28.27
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2


Mean Inter Premolar Width (mm)
Study
Control
Mean value
60.00
50.00
40.00
30.00
20.00
10.00
0.00
46.80
45.47
47.09
47.46
47.56
47.96
39.49
38.05
40.49
40.37
41.17
40.66
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2


Mean Inter Molar Width (mm)
Study
Control
Mean value
60.00
50.00
40.00
30.00
20.00
10.00
0.00
46.96
45.39
46.73
44.79
46.75
45.35
41.24
38.54
41.29
38.61
41.13
38.65
Maxilla - T0
Maxilla - T1
Maxilla - T2
Mandible - T0
Mandible - T1
Mandible - T2

Discussion

DISCUSSION

Self-ligating brackets are ligature less bracket systems that have a mechanical device built into the bracket to close off the edgewise slot. The cap holds the arch wire in the bracket slot and replaces the steel/elastomeric ligature. With the self-ligating brackets, the moveable fourth wall of the bracket is used to convert the slot into a tube.[48]

Reduced friction with self-ligating bracket is claimed to be a great advantage over conventional brackets. It is asserted that low friction allows for sliding mechanics to be accomplished in the truest sense, thereby facilitating alignment, increasing the appointment intervals, and possibly reducing the overall treatment time.

Other advantages of the self-ligating bracket system that have been listed include

a) Full arch wire engagement,
b) Less chair side assistance, and
c) Faster arch wire removal and ligation, leading to reduced chair time

Due to the inbuilt mechanism in self-ligation system, secured arch wire engagement is achieved more than conventional system. In the overwhelming majority of designs in self-ligation, this mechanism is a metal face to the bracket slot which is opened and closed with an instrument or fingertip. Because self-ligation reduces the resistance to tooth movement and provides good security of wire engagement, it is natural to suggest that treatment might be more rapid compared to conventional system. Clinical studies evaluating total treatment time have shown results in favor of both bracket types. Retrospective studies[11, 21] found significantly decreased total treatment time and fewer visits with self-ligating brackets. However, a large retrospective study[5] and all prospective studies have found no measurable advantages in orthodontic treatment time, the number of treatment visits, and time spent in initial alignment with self-ligating brackets over conventional brackets.[15, 10, 34] Meta-analyses done by Fleming et al and Elberting et al[11, 15] included only some retrospective studies[18, 4] due to significant methodological differences and found no difference in terms of reduced overall treatment time, number of visits, and efficiency of initial orthodontic alignment between self-ligating brackets and conventional brackets. In spite of insufficient evidence for overall treatment time, some benefits, such as ease of ligation, and reduced chair time with the self-ligating brackets, were supported. Cross-sectional studies have shown decreased chair time with significantly shorter arch wire ligation and removal times when compared with conventional brackets[43, 53]. The meta-analysis by Chen et al[4], which included these two studies, reported a mean time savings of 20 seconds per arch for self-ligation versus ligature removal. Many other studies also have shown[15, 34] that self-ligation offers savings in chair side time compared to elastomeric ligation. Maijer and Smith[3] found that there is a 10 minute time saving in removal and replacement of ligation on just the anterior 12 teeth in a pair of arch wires, when compared to conventional brackets.

A study later by Ebertinget al[12] of intra-practitioner differences in three practices found an average reduction in treatment time of 7 months (from 30 to 25) and seven visits (from 28 to 21) for passive self-ligation compared to conventional ligation. During leveling and aligning friction at bracket wire interface will prevent the attainment of optimal force levels in the supporting tissues, therefore a decrease in frictional resistance tends to benefit in alignment efficiency. Mode of ligation is one of the important factor that affect frictional resistance along with arch wire dimension and material, presence of saliva, and angulation of wire to the bracket.

Self-ligating brackets have been developed, as active, passive and interactive. These terms refer to the mode in which they interact with the arch wire. The active type has a spring clip that encroaches on the slot from the labial/buccal aspect and presses against the arch wire providing an active seating force on the arch wire and ensuring engagement such as, SPEED*

The newly introduced so called interactive self-ligating brackets combine the advantages of Passive and Active self -ligating brackets. They can lock (Passive) and seat (Active) the arch wires into the base of the slot with low functional friction so as to fully express the prescription such as In-Ovation-R**, EMPOWER***.

*Strite Industries, Cambridge, Ontario, Canada, **GAC International, Bohemia, USA, ***American Orthodontics.

Time brackets* during space closure the anteriors can be made active for proper torque control and posteriors are passive to allow for reduced friction.

In the passive type, the clip does not press against the arch wire. Instead, these brackets use a rigid door or latch to entrap the arch wire providing more room for the arch wire such as Damon**, Smart Clip™ ***, and Oyster ESL****.

Studies[31, 33, 34] have showed that Passive Self-ligation bracket system generate lesser frictional resistance during alignment compared to conventional bracket system.

Ligated brackets have more frictional resistance than Self-ligating brackets due to the addition of ligatures. So the ligated systems, demand higher forces to overcome the frictional resistance generated by the ligature. Self-Ligating appliances move teeth within the bone more efficiently when lighter forces are employed. Heavier forces can cause the periodontal ligament (cells) to react in such a way that it restricts tooth movement.

*Adenta, Gilching/Munich, Germany, **Ormco/"A"Company, ***3M Unitek USA, ****Gestenco International, Gothenburg, Sweden.

The study[10] done by Andrew et al showed a faster improvement in Irregularity Index with the passive SL brackets when compared to conventional brackets which is statistically significant. Pandis *et al*[8] found that mild crowding was eliminated more rapidly with passive SL brackets than with conventional brackets in the hands of the same operator.

Thorstenson and kussy[23] in their study stated that the active self ligation brackets showed significantly more frictional resistance compared to the passive self-ligating brackets.

The Objective of our study was to Quantify maxillary and mandibular arch dimensional changes in transverse plane, maxillary and mandibular incisor inclination and alignment efficiency by comparing a passive self-ligating brackets 0.022 Slot 3M Gemini SL (MBT) with 0.022 Slot conventional brackets system (MBT). The self-ligating door in this bracket system is an advanced Nitinol ligating mechanism which provides low resistance for opening and closing, without using special techniques or instruments. Nitinol also offers the advantage of high resistance to unwanted mechanism fatigue, which can affect door operation and bracket performance during treatment.

Age criteria for sample were from 13 to 25 years old and they were of either gender who had all their permanent teeth with the Angles Class I, Class II Division 1 and Bi-dentoalveolar Malocclusion requiring all first premolar extraction followed by fixed orthodontic therapy and Patients with moderate Little’s Irregularity Index score for dental crowding.

The study comprised of 16 patients (9 females and 7 males) who were randomly divided in two groups in Group A as study group and Group B as controls. In this 16 patients 2 patients were dropped out for lack of regular visits and 2 patients were unable to carry out treatment due to multiple breakage of brackets. So our final group comprised of 12 patients (7 females and 5 males) in which 6 patients were divided again as Group A and Group B for each group.

Group A patients were bonded with Self-Ligating brackets Pre-adjusted edgewise, MBT 0.022 Slot brackets (Gemini SL, 3M), Group B patients were bonded with conventional pre-adjusted edgewise, MBT 0.022 Slot brackets (Mini Master Series; American Orthodontics), which were positioned using Boon’s gauge in the upper and lower arches. . Leveling and aligning was done using following arch wire sequence: 0.014” round thermal NiTi, 0.016” round thermal NiTi, 0.018 round thermal NiTi, 0.018” round stainless steel and 0.019 x 0.025” NiTi.

All the NiTi wires were changed after an interval of 4weeks, and the arch forms used were OVOID (3M). Stainless steel ligatures or elastomeric modules were used to secure arch wire into the conventional brackets. Arch wires were disengaged by cutting the ligatures or removing the modules. For the Self-ligating brackets, arch wires were removed by opening the passive slides with probe or arch wire director. Impressions were taken for each wire insertion that is TO, T1 and T2, for 0.016”, 0.018” and 0.019 x 0.025 NiTi respectively and models were made. All the lateral cephalograms, obtained in starting stage of treatment and during completion of alignment stage, were evaluated by the same investigator for upper and lower incisor angulation changes by calculating the IMPA, and angular and linear measurements for upper incisor to NA and lower incisor to NB for both study and control groups. All study models were evaluated by using Little's irregularity index to quantify the alignment of the six anterior teeth. Crowding was calculated as the difference between the sum of tooth widths and arch circumference taken from the line of best fit, through the contact points mesial to the first molars. Inter-canine and Inter-premolar widths were measured from the buccal cusp tips of the canines and premolar on the study models. Inter-molar widths were measured from the central and mesial occlusal pits of the mandibular and maxillary first molars.The study models were measured with digital Vernier calipers (INSIZE Digital Electronic Caliper Series 1112 - Measuring range: 0-150mm/0-6" (1112-150), Resolution: 0.01mm/0.0005") with sharpened tips that were accurate to 0.01 mm. All model measurements were made by the principal researcher. The total time taken in number of days and weeks for completion of alignment is calculated from T0 to T2.

In our study we used plaster models to calculate the arch dimensional changes in study group and controls at each time interval that is TO, T1 and T2, till the completion of alignment. In our study the arch width changes were measured by obtaining the plaster models from each interval of wire placement till the alignment was completed which was about 18 weeks in study group and 28 weeks in control group. The models were selected instead of measurements like CBCT to overcome the disadvantage of repeated radiation dosage within short intervals. The radiation dose in CBCT is about 40% smaller than CT, but still 3 to 7 times greater than that of the panoramic radiographic examinations. This fact reinforces that the use of CBCT for shorter intervals is not advisable for the patients. Since our study had alignment phase from 18 to 28 weeks the use of CBCT was not a viable option. Hence lateral cephalograms were used in this study for measuring torque expression and plaster models for arch expansion.

Passive Self-ligating brackets are known for very low friction values, however an assumption has been made that with low friction comes more rapid alignment and reduction in treatment time. The study by Miles[28] has clearly demonstrated that Self ligating brackets did not perform any better than conventional twin bracket, and Self ligating brackets had 0.2mm irregularity at the end of alignment and levelling. Wahab et al[38] in his study concluded that over a period of 4 month aligning and levelling phase, the comparison of difference in the overall tooth alignment for Little's Irregularity Index Score showed faster changes for conventional brackets when compared with Self-ligating brackets, which was contradicting our results in this study. This can be explained by the fact that full arch wire engagement with maximum contact of the arch wire with the bracket slot was easily achieved with twin bracket. On rotated tooth surfaces, the metal slot of the Self ligating brackets could not be closed due to excessive bending of arch wire at the end of first month, this resulted in no engagement of the arch wire within the Self ligating brackets, hence it affected the rate of tooth movement in terms of relieving severely crowded cases. But our study group were having moderate rotation and crowding.

The results obtained in our study was similar to an in vivo study by Miles et al[41], in which comparison of alignment efficiency of Self ligating brackets with conventionally ligating brackets was studied in the mandibular arch. The author found at the end of 20 weeks period the Self-ligating brackets were no more effective in reducing irregularity than the conventionally ligated twin brackets. Arch dimensional changes with conventionally ligated and self-ligated brackets appeared to be similar. According to Fleming et al the ideal alignment procedure would involve slight incisor proclination and inter-canine and inter-molar expansion, which are important for long-term stability. Celikoglu and Chen[3] et al found similar result to our study that passive self-ligating and conventional brackets did not show significant differences in initial arch alignment in both maxillary and mandibular arch, without any expansion in molar or canine regions. Contrarily, Fleming et al[15] reported approximately 1-mm greater increase in inter-molar width with self-ligating brackets. This difference can be attributed to several factors including alignment and leveling over 30 weeks. Eberting et al[12] reported the quality of finished cases, between passive self-ligating brackets and conventional brackets which was found to be equivalent at reducing occlusal irregularity as measured by PAR and Irregularity scores, and cases treated with SL brackets were actually found to have better ABO scores, even when treated in less time than cases with conventional brackets, which was contrary to our findings. Ong et al reported that self-ligating brackets are no more efficient than conventional brackets for anterior arch alignment or closure in the maxillary and mandibular arch during the first 20 weeks, with no statistical significance, supporting the finding in our study. Overall, it is difficult for studies to compare SL and conventional brackets in their ability to detail and finish cases, and ultimately, it is the responsibility of each individual practitioner to determine with which bracket type they are capable of achieving the best results. However, other studies[11, 27] have found that both bracket types to be equally efficient in delivering torque, and there was no statistically significant difference between passive self-ligation and conventional groups, supporting our results. Most studies have depicted mandibular incisor proclination in both self-ligation and conventional groups with no statistical difference[8, 22], indicating that the mechanism for relieving crowding in non-extraction cases involves incisor proclination and transverse expansion through tipping of posterior teeth, which is similar for conventional and self-ligating brackets. Also, another study by Vajaria[28] using CBCT to compare the labiolingual inclination of mandibular incisors relative to the occlusal plane between active and passive self-ligating brackets confirmed a significant proclination of mandibular anterior teeth, thereby rejecting the claim of better torque control by self-ligating systems[26]. The meta-analysis including three of these studies showed that self-ligating brackets had 1.5° less proclination that was statistically significant, although it may not be a clinically significant change[3]. Vajaria et al. and Jiang and Fu[29] indicated that both the conventional and passive SL bracket systems cause labial inclination of the incisors. These results emphasize that both different treatment systems proclined maxillary and mandibular incisors in a similar manner, which was not seen in our study. Burke et al[31], in his meta-analysis, evaluated studies that investigated the longitudinal stability of the inter-canine distance, in cases treated with and without extraction and different treatment modalities. This data was checked to verify the relationship in the stability in the inter-canine dimension. The results showed that the inter-canine distance tends to increase in the order of 1 to 2 mm, irrespective of malocclusion, treatment modality and treatment with or without extraction, and that this alteration tends to be lost in the post-retention period. In our study when comparing study group and control group, highest increase was about 2.3 mm for inter-canine width in maxilla and 2.1 mm in mandible, and 1.2 mm in inter-premolar width in maxilla and 2.1mm in mandible, 0.8 mm in maxilla for inter-molar and 1 mm in mandible is found in self-ligation group. In case of control highest value was about 1.8 mm increase in inter-canine width in maxilla and 1.6 mm in mandible, for inter-premolar 1.5 mm in maxilla and 2 mm in mandible, and for inter-molar width 0.6mm in maxilla and 0.8mm in mandible was observed. An exception to this, there was a decrease in inter-molar width in one sample of our study group in which the maxillary and mandibular molars were more buccally placed before the treatment. Johnson et al[35] also evaluated the inter-canine and inter-molar distances in dental casts of cases treated with and without extractions. An average increase of 0.8 mm in the inter-molar distance was found, and 0.3 mm for the inter-canine distance, while the maximum increase was 1.5 mm in one case without extraction, the inter-canine distance did not change. In our study it showed that the self-ligation group brought about increased arch width, in inter-canine and inter-premolar levels. Jiang and Fu & Fleming[15] showed an increase of only 0.91 mm in inter-molar width, which is clinically insignificant, which was not supporting our study. On other hand there have been other studies[3, 14] that did not show any significant changes in arch width when comparing self-ligating brackets. The studies have shown that inter-molar expansion in the maxillary arch comprises primarily of buccal tipping with self-ligating brackets and similar low friction systems, which leads us to believe that physiologic buccal expansion and alveolar bone generation is questionable[18] .Unlike this, our study showed no clinically significant change in arch expansion at the level of molars.

In our study the torque in study group (3M Gemini SL) for maxillary central incisor showed a mean increase of 0.25 mm and in control group (Mini Master Series AO), mean decrease of 0.33 mm was found, in case of mandibular incisors it showed a mean decrease of 0.75 mm in study group and a mean decrease of 0.41 mm in control group. But there was no torque loss for maxillary and mandibular incisors in control group. However the comparison between control group and study group showed no statistically significant values with the P value of 0.678 and 0.140 for maxillary and mandibular incisors respectively.

From the obtained results in our study it was found that there was decrease in lower incisor torque in both study and control groups. The degree of decrease in lower incisor inclination is not significantly reduced in study groups, comparing to the control group. The difference of about 0.8° was found to be more in control than study group. The total time taken for complete alignment in study group is around 14 to 18 weeks whereas in control group it was about 15 to 28 weeks.

Summary and Conclusion

SUMMARY AND CONCLUSION

Our study aimed at comparing the arch alignment, torque expression, and arch expansion changes between passive self-ligation bracket (3M Gemini SL) and conventional bracket (AO Mini Master Series) system. The final study group consisted of 12 patients, who were randomly divided into two groups, Group A as study group and Group B as control group with six patients each. Impressions were made for each wire insertion that is TO, T1 and T2, for 0.016", 0.018" and 0.019 x 0.025 NiTi and models were made and measured to evaluate arch dimensional changes, lateral cephalograms were taken at initial and completion stage of alignment. All the lateral cephalograms, were evaluated by the same investigator. All study models were evaluated using Little's Irregularity Index to quantify the alignment of the six anterior teeth.

Results showed that for torque expression in study group 3M Gemini SL for maxillary central incisor showed a mean increase of 0.25 mm and in control group Mini Master Series AO, mean decrease of 0.33 mm was found, in case of mandibular incisors it showed a mean decrease of 0.75 mm in study group and a mean decrease of 0.41 mm in control group. But there was no torque loss for maxillary and mandibular incisors in control group. The degree of decrease in lower incisor inclination is not significantly reduced in study group, comparing to the control group .The difference of about 0.8° was found to be more in control than study group. The total time taken for complete alignment in study group is around 14 to 18 weeks in study group, in other hand in control groups is about 15 to 28 weeks. On irregularity score study group showed more corrections than the control groups in each time interval. For arch expansion, highest increase of about 2.3 mm for inter-canine width in maxilla and 2.1 mm in mandible, and 1.2 mm in inter-premolar width in maxilla and 2.1 mm in mandible, 0.8 mm in maxilla for inter-molar and 1 mm in mandible was found in self-ligation group. In case of control group highest value of about 1.8 mm increase in maxilla and 1.6 mm in mandible, for inter-premolar 1.5 mm in maxilla and 2 mm in mandible, and for inter-molar width 0.6 mm in maxilla and 0.8 mm in mandible is observed. Statistically the results observed on the Comparison of Irregularity Index between study group and control group showed that there was no statistically significant difference in maxilla and mandible between study group and control group. Comparison of torque expression between control and study group, was not statistically significant. The comparison of arch expansion between study group and control group at the level of canine, premolar and molar were also found statistically insignificant.

The power of the study would have improved greatly if the sample size was more. The other limitation was absence of 3 dimensional diagnostic aid like CBCT, which would have provided more information about root torque and cortical bone thickness.

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Annexure

ANNEXURE –I

RAGAS DENTAL COLLEGE & HOSPITAL

(Unit of Ragas Educational Society)
Recognized by the Dental Council of India, New Delhi
Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai

2/102, East Coast Road, Uthandi, Chennai - 600 119. INDIA.
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TO WHOM SO EVER IT MAY CONCERN

Date: 05-01-2016

Place: Chennai

From
The Institutional Review Board,
Ragas Dental College & Hospital,
Uthandi,
Chennai – 600119.

The thesis topic **'A PROSPECTIVE RANDOMIZED CLINICAL TRIAL TO ASSESS THE EFFICIENCY OF PASSIVE SELF-LIGATING BRACKET VS CONVENTIONAL BRACKET SYSTEM, submitted by Dr. DIWAKAR. B** has been approved by the institutional review board of Ragas Dental College & Hospital on 5th May, 2014.

(Dr. S. RAMACHANDRAN M.D.S.)
Secretary, Institutional Review Board,
Head of the Institution,
Ragas Dental College & Hospital,
Uthandi,
Chennai - 600119

PRINCIPAL
RAGAS DENTAL COLLEGE AND HOSPITAL
UTHANDI, CHENNAI - 600 119.

RAGAS DENTAL COLLEGE Chennai

ANNEXURE II

DECLRATION OF PLAGARISM CHECK

FROM

Dr. Diwakar.B

III-Postgraduate student

Department of Orthodontics and Dentofacial Orthopaedics,

Ragas Dental College and Hospital

Chennai.

TO

The Head of the Department

Department of Orthodontics and Dentofacial Orthopaedics,

Ragas Dental College and Hospital

Chennai.

SUB: Declaration of plagiarism check of my dissertation to be submitted to The Tamilnadu Dr.M.G.R Medical University – April 2016.

I hereby declare that I have checked my dissertation for plagiarism using "small seo tools" -plagiarism checker software on 06.01.2015 date for this dissertation .The unique content was 72.5% and the plagiarism content was 28.5%. The plagiarism content corresponds to definitions and terminologies that have to quoted.

Yours sincerely,

Diwakar.B