ALIGNMENT EFFICIENCY, GINGIVAL CREVICULAR FLUID VOLUME AND ALTERATIONS IN PERIODONTAL PARAMETERS BETWEEN TWO BRACKET SYSTEMS – AN INVIVO STUDY

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CERTIFICATE

This is to certify that this dissertation titled **"ALIGNMENT EFFICIENCY, GINGIVAL CREVICULAR FLUID VOLUME AND ALTERATIONS IN PERIODONTAL PARAMETERS BETWEEN TWO BRACKET SYSTEMS – AN INVIVO STUDY"** is a bonafide record work done by **Dr. HARISH.P** under my guidance during his post graduate study period 2015-2018.

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 Orthopedics. It has not been submitted (partially or fully) for the award of any other degree or diploma.

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CONTENTS

ABSTRACT

Aim:

The aim of the present study is to compare the alignment efficiency, arch dimensions and incisor inclination changes with passive self ligating (Damon Q) and conventional brackets and also to assess the changes in GCF volume, oral hygiene and periodontal status between the two brackets systems.

Materials and Methods:

10 patients having Angle's Class I malocclusion with moderate to severe crowding requiring all 1st premolar extractions were chosen according to inclusion and exclusion criteria and were randomly divided to 2 groups. Group 1 – Damon Q self ligating bracket system with 0.022 slot (ORMCO) and group 2 – Conventional bracket system (American Orthodontics – 0.022 slot with Roth system). Records such as Orthopantamogram (OPG), Lateral Cephalogram, plaster models, and intra oral photographs were taken at Pre-treatment (T0) and Post alignment (T2) stage.

Oral prophylaxis was done for all the patients prior to the start of treatment. GCF sample was collected at the start of treatment (T0) and after 60 days of treatment (T1). Likewise for all the patients, periodontal parameters such as PI (plaque index), GI (gingival index), and GBI (gingival bleeding index) were measured prior to the start of treatment (T0) and after 60 days of treatment (T1). Pre-treatment (T0) and post alignment (T2) study models were taken and models were scanned to provide digital digital models

measurements. The arch dimensional changes such as arch width, arch length and irregularity index was measured using both plaster models and digital models in both the groups at two different time points. T0 (prior to the start of the treatment) and T2 (at the end of alignment). The axial inclination of upper and lower incisors was also measured using Lateral Cephalogram at T0 and T2.

Results:

The periodontal parameters such as plaque index (PI), Gingival index (GI), Gingival bleeding index (GBI) and gingival crevicular fluid (GCF) increased in both the groups at T1 (after 60 days of orthodontic treatment). However when compared between two bracket types, there was no statistically significant difference in the periodontal parameters such as GI, PI, GBI taken at baseline (T0) and at 60 days (T1). The GCF volume of control group was higher compared to study group at 60 days but the difference is not statistically significant. The arch dimensions were measured in terms of arch width, arch length and irregularity index in both plaster and digital models. Results showed an increase in inter canine width, inter pre molar width and decrease in inter molar width and arch length in both the bracket systems. Significant decrease in irregularity index was seen, however when compared between both the groups the difference was not statistically significant.

Conclusions:

Damon Q passive self ligating brackets was not found to more clinically efficient or superior to conventional brackets in terms of alignment

and arch dimensional changes. The expanded arch form seem to play an important role in arch expansion rather than the bracket type. Thus the efficiency of both the systems are comparable and not superior to one another and also in terms of better oral hygiene compared to conventional brackets.

Keywords:

SELF LIGATING BRACKETS [SLB], DAMON Q, CONVENTIONAL BRACKETS [CLB], GINGIVAL CREVICULAR FLUID [GCF], GINGIVAL INDEX [GI], PLAQUE INDEX [PI], GINGIVAL BLEEDING INDEX [GBI]

Introduction

INTRODUCTION

In the recent years self-ligating brackets have been gaining popularity and there has been a significant increase in number of self-ligating bracket systems available to orthodontists. Some of the claimed advantages of self-ligating brackets include reduced frictional resistance, less chair side assistance, faster arch alignment, reduction in overall treatment time, improved periodontal health and better patient comfort[28].

Self ligating brackets can be dicotomized into those with a spring clip that can press against the archwire (active) and those with passive system in which the clip clearly does not press against the arch wire.

Damon passive self ligating system introduced in 1996 has broader arch wires with passive clip. Damon self ligating brackets have so called passive slide that opens and closes vertically only on the facial surface. It has been claimed that with Damon system, posterior expansion with bodily movement and minimal tipping of teeth is evident. Few literature reports greater inter molar arch width increase with Damon brackets compared to conventional brackets. However randomized clinical trials failed to show any significant difference in Damon passive self-ligating system when compared to conventional brackets with regard to transverse arch dimensions.[12]

In an attempt to improve the evidence based relative to Damon system, several prospective randomized clinical trial have been instigated. However

results reported weak evidence that Damon brackets can resolve crowding more rapidly than conventional brackets when treatment is carried out on a non-extraction cases. Perhaps these studies also demonstrate Damon appliance do not align teeth in a qualitatively different manner compared to conventional appliance in terms of incisor proclination, Nevertheless with moderate and severe crowding cases, Damon brackets alleviated crowding approximately 2.7 times faster than conventional appliances.[46]

Damon Q, introduced in 2009 is a low profile bracket with flexible sliding clip mechanism, whereas previous generations of Damon bracket had a rigid solid door. According to proponents of the Damon system, considerable expansion can be achieved in the buccal segments, producing a broader arch form that is more in balance with the tongue and cheek.

This system produces biologically induced tooth moving forces that results in the alteration of the arch form, thereby creating a new equilibrium that allows the arch to reshape itself to accommodate the full complement of teeth.

Furthermore, a recent study showed that broader form of copper-nickel-titanium and stainless steel archwires in the Damon group could expand the maxillary arch as much as the conventional straight wire system combined with the quad-helix appliance.[22]

Although Damon philosophy encourages a non-extraction approach, its proponents suggest that extraction decision is based on the treatment goals and therefore should be advocated, if warranted. Moreover in patients with

moderate to severe crowding, extraction treatment is the preferred method of choice to alleviate crowding. Irregularity index is a quantitative method of assessing the anterior irregularity and therefore used in the study. [60]

Since there is no sufficient literature evidence to assess the treatment efficiency of Damon Q brackets, the present study was done to assess the alignment efficiency and dimensional changes with Damon Q brackets compared to conventional brackets.

The arch width and arch dimensional changes were studied on dental casts and measured using digital calipers. They were also scanned to check the reliability of measurements on digital models. Digital models has been proved to be a reliable method for obtaining the tooth size, arch form and arch length tooth size discrepancies. There are few literature reports to show that digital models offer a high degree of validity when compared with direct measurement of plaster models. However there may be a small difference in measurements between on plaster models and digital models.

Fixed appliance therapy pose a threat to patient's oral hygiene by increasing bacterial colonization, enamel demineralization and plaque retention. Among various orthodontic appliances, brackets play a pivotal role in gingival inflammation by promoting plaque accumulation and adhesion of periodontal pathogens.

Conventional brackets with elastomeric modules or steel ligatures are more likely to reduce bacterial aggregation and hinder oral hygiene. In this regard self ligating brackets are designed with a concise configuration

claiming to reduce the microbial colonization and plaque retention due to the absence of elastomeric modules.[75] However previous studies have failed to show a difference in the streptococcus mutans count between patients with conventional and self ligating brackets and hence in conclusive till date.

GCF is an inflammatory exudate that is composed of serum and locally generated materials composed of tissue breakdown products, inflammatory mediators and antibodies. The amount of GCF at a given site increases significantly with the severity of gingival inflammation as assessed clinically. Therefore, qualitative assessment of GCF volume is an objective measurement of gingival inflammation that can supplement assessment made using subjective clinical indices of inflammation.

Till date, there has been no study done to assess GCF volume, the oral hygiene, and periodontal status using Damon Q self ligating brackets.

Therefore the aim of the present study is to assess the following:

- To compare the alignment efficiency of Damon Q passive self-ligating brackets with a conventional brackets.
- To assess the arch width and dimensional changes between conventional and self ligating brackets
- To study the change in GCF volume, oral hygiene and periodontal status between conventional and Damon Q self ligating brackets systems.

Review of Literature

REVIEW OF LITERATURE

The following topics were discussed

1. Conventional brackets Vs self ligating brackets
2. Digital models Vs plaster models
3. Bracket type Vs oral hygiene & periodontal status

Jacob Stolzenburg in 1935,[31] first introduced the self-ligating bracket system and the features of Russell Lock attachment were explained. This system was considered to be more patient friendly as there was no need for steel ligatures, and the fourth sliding wall completely secures the arch wire within the slot providing a secured ligation mechanism and controlled tooth movement.

Shivapuja in 1994,[61] in his comparative work between self-ligation bracket and conventional brackets showed that the self-ligating brackets showed a significantly lower degree of frictional resistance, less chair side time and improved infection control compared to conventional ceramic or metal brackets.

Dwight H Damon in 1998[10] compared the friction produced among the conventional twin brackets with three of the self ligating brackets, which are one active (Sigma) and two passive (Damon SL and Wildman Twin Lock). It was found that the conventional twin brackets with metal ligatures had

friction values approximately 300 times greater compared to that of the passive self-ligating brackets. Likewise the active brackets produced 216 times more friction compared to passive self-ligating brackets.

Harradine Nigel et al, in 2003[21] explained that currently available self-ligating brackets offer a valuable combination of low friction and secure full bracket engagement. These developments offer the possibility of a significant reduction in treatment time, and also anchorage requirements, particularly in cases where requiring greater tooth movement was required.

Pandis et al, in 2006[38] compared the engagement mode of wire to bracket affecting the buccolingual inclination of maxillary incisors in extraction and non-extraction treatment with self ligating (Damon 2) and conventional brackets. The study comprised of 105 patients, of which 54 patients were treated without extractions and 51 patients were treated with maxillary first premolar extractions. Each group received equal number of conventional and self ligating brackets. He concluded that self ligating brackets seems to be equally efficient in delivering torque to maxillary incisors in both extraction and non-extraction cases relative to conventional brackets.

Miles P. G, et al, in 2006[40] compared the effectiveness and comfort of Damon2 brackets and conventional twin brackets during initial alignment. The study also compared patients comfort, esthetic and bracket failure rates between the conventional and self ligating brackets. The conventional twin bracket was more uncomfortable for the patient during the phase of initial arch

wire. Nevertheless, at 10 weeks, substantially more patients reported discomfort with the Damon2 bracket while engaging the arch wire. Patients preferred twin bracket to be more esthetic and moreover there was an increased debonding of Damon bracket was seen. He concluded that Damon2 brackets had no better advantage during initial alignment when compared to conventional brackets.

Pandis et al, in 2007[46] investigated the duration of mandibular crowding alleviation with self-ligating brackets (Damon2) compared with the conventional appliances (Microarch) and the accompanying dental effects. The study included 54 subjects chosen 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 was seen in duration required to correct the mandibular crowding with Damon 2 and conventional brackets.

Turnbull. N.R, David J Birne, **in 2007**[70] from their prospective clinical study, assessed the relative speed of arch wire changes in a patient, comparing self ligating brackets with conventional elastomeric ligation methods, and also further assessed 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 were prospectively assessed. The main outcome measure was the time taken to remove or place elastomeric ligatures or

open/close self ligating brackets in both the groups and the efficiency of the ligation system was also assesed. The study was carried out by single operator. He 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.

According to **David Birnie et al, in 2008**[11] The Damon philosophy is based on the principle of using enough threshold force to initiate tooth movement with the threshold force. The underlying principle behind the threshold force is that it must be low enough to prevent occlusion of 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 of the ligature system.

Coubourne et al, in 2008[11] 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. The study comprised of 62 subjects and was 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. Subjects were randomly allocated for treatment in both bracket systems. 0.014-inch Cu NiTi was used for initial alignment. Following arch wire insertion, the subjects were given a prepared discomfort diary and self prescribed analgesics to be noted and completed over the first week, the recording discomfort by means of a 100 mm visual analogue scale at 4 hours, 24 hours, 3 days, and 1 week. No statistically significant differences between the two appliances was noted, discomfort did not differ at the first time point and did not develop differently across subsequent measurement times. Overall, in this study they 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.

Scott et al, in 2008[53] compared the efficiency of mandibular tooth alignment and clinical effectiveness of self ligating (Damon 3) and conventional brackets. The study comprised of 62 patients who required mandibular 1st premolar extraction with mandibular irregularities of 5 to 12 mm were randomly allocated between 2 groups. He reported that there was no difference in initial or overall rate of mandibular incisor alignment between the two bracket systems.

Harradine in 2008[29] found that self-ligating brackets do not require an elastic or wire ligature system, but have an inbuilt 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 the 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 fingertip. The difference between active and passive clips in terms of alloy of which it's made, alters the treatment efficiency by friction and torque.

Sayeh Ehsania et al, in 2009[62] 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 the review. A wide range of methods was applied. All the data concluded that when comparing 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. However, there was lack of evidence to show this claim with large rectangular archwire that self ligating bracket produce lower friction when compared with conventional bracket.

Pandis et al, in 2010[49] compared the time taken for alignment efficiency in maxillary anterior teeth between active and passive, non-extraction patients on basis of Little's irregularity index, Models were taken in each interval and measured with digital calliper, results were found that no change in duration of treatment, and no difference in crowding correction was found.

Emily Ong et al, in 2010[18] compared the efficiency of self ligating and conventional brackets in the extraction cases. They evaluated arch alignment, extraction spaces and arch dimensions at different stages of the first twenty weeks and concluded that self ligating brackets had no better efficiency compared to conventional bracket in alignment of anterior teeth and passive extraction space closure during orthodontic treatment of arch dimension changes were similar in both self ligating and conventional brackets.

Pandis. N et al, in 2010[48] compared the maxillary anterior alignment between Damon MX and In-Ovation R self ligating brackets for time required to complete the initial alignment and the amount of crowding of the maxillary anterior dentition and it was assessed by using the Little's 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. The study was concluded that there is no difference in crowding alleviation found between In-Ovation R and Damon MX bracket systems.

Fleming et al, in 2010[50] in his systemic review evaluated the clinical differences in the use of self ligating brackets**.** Electronic databases were searched. Six randomized control trials and eleven controlled clinical trial were identified. He concluded that self ligating brackets do not have any specific advantage with regard to subjective pain experience and there is insufficient evidence that self ligating brackets is either more or less efficient.

Stephanie Shih Hsuan Chen et al, in 2010[67] in a systemic review said that self ligation brackets do not appear to have a significant advantage with regard to chair side time. Moreover there is a slight proclination of mandibular incisor of 1.5° compared to conventional brackets. No differences in treatment duration was also observed.

Kusnoto & Begole et al in 2011[41] 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 make a substantial difference in maxillary and mandibular incisor position or angulation when compared with control groups treated with conventional fixed orthodontic appliances for similar malocclusion. The Subjects treated with the Damon system (N = 27) were compared with that of subjects treated

with a conventionally ligated edgewise bracket system (N = 16). Pretreatment and posttreatment lateral cephalometric radiographs and dental models were scanned, measured, and compared to see whether significant differences exist between time period of two groups. The results did not support the 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 advanced and proclined after the treatment with the Damon system, contradicting the lip bumper theory of Damon. Post treatment incisor inclinations did not differ significantly between the two groups. Patients treated with the Damon system completed treatment on an average of two months faster than the patients treated with a conventionally ligated standard edgewise bracket system.

Andrew T. Dibase et al, in 2011[15] in his randomized control trial compared the effect of bracket type on duration of orthodontic treatment and occlusal outcome measured by PAR index between Damon 3 self ligating brackets and conventional brackets. The study comprised of 62 patients with mandibular irregularity from 5mm to 12mm and requiring mandibular first premolar extractions were randomly allocated into 2 groups. Same arch wire sequence was used in both the groups. He concluded that use of Damon 3 self ligating brackets has no advantage over conventional brackets in terms of

overall treatment duration and occlusal outcome which was measured by PAR index.

Rohaya Megat Abdul Wahab et al, in 2011[61] investigated the difference in clinical efficiency between Damon 3 self ligating brackets compared with conventional brackets (Mini diamond - Ormco). The study comprised of 29 patients, and were randomily divided into 2 groups. In the alignment stage conventional brackets showed significantly faster alignment of teeth compared with self ligating brackets. Conventional group showed 98% crowding alleviation compared with 67% in self ligating group after levelling and aligning.

Kristina Johansson et al, in 2012[33] conducted a prospective randomized clinical trial on efficiency of orthodontic treatment with self ligating and conventional brackets. A total of 100 patients participated in the study and was randomly allocated into 2 groups of 50 each. They concluded that self ligating brackets do not improve the treatment time compared to that of conventional brackets.

Prettyman et al, in 2012[56] compared, any clinical difference between self ligating and conventional brackets during orthodontic treatment, as perceived by orthodontists. SLB were preferred during the initial stage of treatment based on the shorter adjustment appointments and faster initial treatment, On the other hand, conventional brackets were preferred during the finishing and detailing stages of treatment.

Fleming et al, in 2013[51] in his randomized controlled trial, compared the dimensional and inclinational changes in maxillary arch during alignment with conventional bracket, passive self ligating brackets (Damon Q) and active self ligating (In-ovation). No difference was found in arch dimensional or inclination changes during the initial alignment between conventional bracket, active or passive self ligating brackets.

Vijaya Bhaskara Reddy et al, in 2014[72] in his randomized clinical trial compared the efficiency of 5 different ligation systems (elastomeric ligature – Gemini 3M, stainless steel ligature – Gemini 3M, Leone slide ligature – Gemini 3M, passive self ligation – Smartclip 3M and active self ligation – In-Ovation GAC) for the alleviation of mandibular crowding. A total of 50 patients were selected according to the inclusion criteria and 10 patients were allocated to each group. Self ligating brackets was found to be more efficient than conventional brackets in anterior alignment, space closure, and mandibular incisal inclination change during the initial stage of treatment.

Smita B Patil et al, in 2014[66] 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 0.014 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 calculated. Results showed significant changes with SLB compared to CLB and also save more than 30% of chair side time during wire adjustments while the rate of en masse retraction in SLB shows statistically non significance as compared to CLB system. In case of upper incisor changes, less torque loss were seen compared to CLB although not statistically significant.

Ezgi Atik et al, in 2014[22] compared the incisor position, Transverse dimensional changes in maxillary arch, changes in maxillary molar inclinations, clinical periodontal parameters and pain intensity with class I malocclusion with constricted maxillary arch The study comprised of 33 patients, of which 17 patients were treated with Roth bracket system and 16 patients with Damon 3mx appliance system. In conventional group, Quad helix appliance was given before the start of fixed appliance treatment. The maxillary arches were expanded until the lingual cusp of first molars were in contact with the buccal cusp of lower 1st molars. Whereas in Damon group, quad helix was not used. They found that both conventional and Damon systems were found to be similar with regard to incisor position, transverse dimensional changes in maxillary arch and periodontal parameters. Damon system inclined the maxillary molars more buccally than the conventional brackets.

Marjan Askari et al in 2015[39] in their pilot study, compared the cases treated with Damon Q self ligating brackets and conventional brackets to evaluate the changes in dental and skeletal arch width and length using CBCT. Both extraction and non-extraction treatment resulted in inter occlusal expansion in both mandible and maxilla. Overall expansion of arches is greater in Damon Q self ligating group compared to conventional group. Arch length was increased in both maxilla and mandible, but not significantly in both groups. There was less tipping of teeth during arch expansion in conventional group.

Celar A et al[9]**,** in 2015 did a Meta-analysis of the 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 the 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 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.

Ezgi Atik et al[21], 2016 evaluated different bracket types combined with broad archwires in terms of maxillary dental arch widths and inclination of molars. The study comprised of 46 patients, who were aged between 13 to 17 years were selected according to inclusion criteria and were divided into 3 groups namely Nexus active self ligating bracket, conventional bracket and Damon 3 mx self ligating bracket. Non extraction treatment was carried out in both the arches. Maxillary inter-canine, inter-premolar and inter-molar widths were significantly greater in each bracket group at the end of treatment. No difference was found in incisor and molar inclination changes and maxillary arch dimensional changes with active self ligating bracket, passive self ligating brackets and conventional brackets.

Corey Shook et al[10], 2016 evaluated the effect of Damon 3 self ligating bracket and conventional bracket system on buccal corridor widths and areas. A total of 84 patients were included in this study and 45 patients were allocated in conventional group and 39 patients were allocated in Damon 3 group. Pre-treatment and post treatment frontal photograph were taken and transferred to photoshop CC, standardized using intercanthal width and linear and area measurements were performed. There were no significant differences

in post treatment inter canine and inter molar width in both self ligating and conventional groups. No significant difference in buccal corridor width was seen. Nevertheless there was an increase in the arch width in both conventional and self ligating brackets.

Yasmine M. Sayed[76] in 2016 evaluated the dental, skeletal and soft tissue change in moderate crowding cases treated with non-extraction approach using Damon Q self ligating brackets. Overall expansion was seen mostly in premolars followed by molars, with more expansion in maxilla compared to mandible. Expansion produced a small amount of uprighting in maxillary molars and significant degree in mandibular molars inclination.

Digital models vs Plaster models

Quimby et al[57]**,** 2004 tested the accuracy, reproducibility, efficacy, and effectiveness of measurements made on computer-based models and found that those measurements appeared to be generally as accurate and reliable as measurements from plaster models. Recently, electronic storage of models became available, permitting users to stash away and view 3D models on a computer. This concept could eliminate the problem of model memory in an orthodontic office and reduce the time necessary to perform space analyses.

Paredes et al[52]**, 2006** determined the Bolton indices in a large number of patients using a digital method and the traditional method. A new digital method for measuring tooth sizes and for calculating the Anterior (ABI) and

the Overall (OBI) Bolton Index was tested on 100 sets of study dental casts of the permanent dentition in a Spanish sample and compared with the traditional method. The reproducibility of this digital method versus the traditional one was analysed to determine intra- and inter-examiner measurement errors in calculating the coefficients of variation. The results demonstrated that the Bolton indices using the digital method are highly applicable to clinical practice and provides the advantages of measuring with ease and speed.

Mullen et al[42] **2007** compares the accuracy and time to perform the Bolton analysis with models and plaster models. The accuracy of a space analysis, such as the Bolton ratio was found to be similar with digital models and plaster models. The difference between the Bolton ratio calculations was statistically insignificant. The times taken to make the measurements and the calculations were statistically and clinically significant; the e-model software was an average of 65 seconds faster. E-model software for measuring a patient's dentition and calculating the Bolton ratio is just as accurate and faster than using digital callipers with plaster models.

Jennifer asquith et al[32]**, 2007** examined the accuracy and reproducibility of measurements made on digital models. Most parameters on digital models can be reliably measured. However, the upper arch length was not reliably reproduced and this is due to inability of software to produce a constructed point. 3D digital models can eliminate the requirement for production and storage of conventional dental cast.

Malik et al[38]**, 2009** evaluated whether the same information can be obtained from study models and photographs of study models for the purposes of medico-legal reporting. Thirty sets of study models were used in this study. Photographs of the study models were taken: anterior, right and left buccal views in occlusion and upper and lower occlusal views. Three examiners assessed the study models and photographs of the models in a random order. They concluded that the same orthodontic information can be obtained from study models and photographs of study models for the purposes of medico-legal reporting.

Gustavo et al27**, 2009** fifteen pairs of plaster models were obtained from orthodontic patients with permanent dentition before treatment. These were digitized to be evaluated by the program Cécile3 v2. 554.2 beta. The aim of this study was to determine the reproducibility, reliability and validity of measurements in digital models compared to plaster models. When the two types of measurements were compared, the values obtained from the digital models were lower than those obtained from the plaster models ($p < 0.05$), although the differences were considered clinically insignificant (differences< 0.1 mm).

Leifert et al[35]**, 2009** compared space analysis measurements made on digital models with those from plaster dental casts. Two sets of 25 alginate impressions, 25 in no. were taken for patients who had a permanent molar Class I crowded dentition. Each impression was made into a plaster cast and a

3-dimensional virtual orthodontic model. Measurements of tooth widths of their greatest mesio-distal dimension and arch length were recorded for both types of models. The accuracy of the software for space analysis, evaluation of digital models is clinically acceptable and reproducible when compared with traditional plaster study model analyses.

El-Zanaty et al[20], 2010 stated that dental measurements obtained from the 3D models are comparable with those from conventional models in the 3 planes of space. This technology has the added benefits of eliminating the need for taking impressions and the time needed for making models.

Horton et al[30], 2010 determined the technique for measuring the mesial – distal tooth width on digital models. 32 patient models with different malocclusion models were scanned. Although all digital models had a slight positive bias, it did not restrict the clinical use of digital techniques for measuring mesial and distal tooth width. Nevertheless, Occlusal technique's had more accuracy, repeatability compared to other methods.

According to **Akyalcin[2], 2011** digital models can only offer a valid alternative to plaster models if they are proven to be accurate. In the light of the current evidence, there is no doubt that digital models will take over conventional plaster casts in the near future. Nevertheless, we are still facing standardization issues related to the protocols in generating digital dental models. A 3D dental model should be able to be reproduced, viewed, measured and stored regardless of the technique-specific details in a highly consistent manner in the far corners of the world until a global acceptance is

achieved. Practitioners repeatedly used both the plaster and digital models until they were able to confirm the results based on their practice needs and treatment planning procedures.

Nalcaci, et al[43], 2013 compared the accuracy, reproducibility, efficacy and effectiveness of measurements obtained using digital models with those obtained using plaster models. A total of 20 digital models was produced by the Ortho Three‐ dimensional Models (O3DM) Laboratory using their software (O3DM version 2) was used. Identical plaster models were evaluated with a vernier calliper. He concluded that the accuracy, reproducibility and effectiveness of O3DM were clinically acceptable, making it an alternative to the traditional vernier calliper in orthodontic practice.

R. P. Reuschl et al[58], 2015 compared manual plaster cast and digitized model analysis for accuracy and efficiency. Nineteen plaster models of orthodontic patients in permanent dentition were analysed by two calibrated examiners. Analyses were performed with a diagnostic calliper and computer assisted analysis after digitization of the plaster models. In this he concluded that 3D laser-scanned plaster model analysis appeared to be an efficient, adequate and reliable alternative to the conventional method of model analysis using analogue calliper. In spite of hard and software bias in determining the correct landmark, digital model analysis should be accurate enough for treatment planning. Discrepancies in individual tooth diameters and linear measurements were not clinically significant for most values.

Liliana avia et al[36], 2013 with the use of dental casts, analysed the transverse changes of upper and lower dental arches, after non extraction treatment with self ligating brackets. 29 patients with class 1 malocclusion with upper and lower arch crowding with 4mm. results indicated that majority of transverse changes occurred at both premolar regions in both upper and lower arches.[28]

In a study by **Brandao et al[7], 2015** he assessed the reliability of Bolton analysis performed on three dimensional virtual models, and compare those findings with the traditional dental cast method. The study concluded that Bolton analysis performed on three-dimensional virtual models was reliable.

Rhee et al[59], (2015) evaluated the appropriate impression technique by analysing the superimposition of 3D digital model for evaluating accuracy of conventional impression technique and digital impression. Twenty-four patients who had no periodontitis or temporomandibular joint disease were selected for analysis. 3D laser scanner was used for scanning the cast. Each 3 pairs for 25 STL datasets were imported into the inspection software. The results showed that the three-dimensional deviations between intraoral scanner and dual-arch impression was bigger than full-arch and dual arch impression. The two-dimensional deviations between conventional impressions were smaller than intraoral scanner and conventional impressions.

Barreto et al[5], 2016 evaluated the reliability of digital orthodontic setup by comparing with model cast at the end of treatment. 20 patient models

of manual setup, digital setup, and final models was used in this study. Digital models were scanned using OrthoAnalyzer (3Shape R-700). He inferred that digital models were as effective and accurate as manual setups.therefore It can be considered as a reliable tool for diagnosis and treatment planning.

Tolga Sakar et al[69], 2017 evaluated the accuracy of measurements on 3D models obtained from CBCT and digital scanner, comparing with dental plaster casts. 120 maxillary cast was digitized using 2 different CBCT technique and digital scanner (Cerec Omnicam, Sirona). Digital models acquired from plaster models were as reliable as CBCT acquired and intra oral scanner. Digital models can be used as an alternative for plaster models.

Brackets type vs oral hygiene and periodontal status

Griffiths.G.S[26] in 1981 measured the plaque accumulation on mal-alignment of teeth compared to normally aligned teeth and distribution of plaque in anterior segment was measured. Crowded teeth have greater plaque accumulation compared with well aligned teeth.

Pandis et al[45], 2008 evaluated the use of self ligating brackets and conventional brackets associated with periodontal condition on mandibular anterior dentition. 50 patients were selected and were allocated between the 2 groups. Concluded that there is no advantage with the use of self ligating brackets over conventional brackets irrespective of periodontal status of mandibular anterior teeth.

Drummond.S et al[17], 2012 aimed at evaluating whether an orthodontic appliance or orthodontic tooth movement can induce any changes in GCF volume. 16 patients who required maxillary 2nd premolar extraction were selected. Maxillary canine subjected to distalizing force was considered as test tooth (TT),and the canine on the contralateral side was used as control tooth (CT). GCF sample was taken on both mesial and distal sites of control tooth and test tooth before applying orthodontic force, after 1 hour , 24 hour, 7, 14 and 21 days. There was significant increase in GCF volume over time was seen in both CT and TT groups with no differences between the experimental teeth. Subcinical tissue inflammation might be responsible for changes in GCF volume.

Pellegrini et al[55], 2009 reported that self ligating appliances promote less retention of oral bacteria and patients bonded with self ligating bracket had fewer bacteria in plaque.

Slavica Pejda et al[65], 2013 determined the effect of different bracket design on periodontal clinical parameters. Study sample consisted of 38 patients. Patients were randomly selected into two groups. Periodontal parameters were recorded before start of treatment (T0) and after 6 weeks of start of treatment (T1) and 12 weeks (T2) and 18 weeks (T3).the result showed Higher prevalence of A.actinomycetemcomitans in patients with conventional brackets than with self ligating brackets. Bracket types did not show statistically significant differences in periodontal clinical parameters. He

concluded that the bracket design does not have any strong influence on periodontal clinical parameters.

Mauricio de Almeida et al[8], 2015 evaluated the periodontal response during orthodontic treatment wih the use of conventional and self ligating brackets. 16 patients were divided into 2 groups of 8 each. Periodontal examination (plaque index, gingival bleeding index and clinical attachment levl) was recorded before the start of the treatment and was repeated at 30,60 and 180 days. Eight patients were treated with conventional brackets was used on lower arch and self ligating brackets on upper arch and other 8 patients received self ligating brackets on lower arch and conventional brackets on upper arch. Periodontal response to orthodontic treatment showed no significant difference between passive self ligating and conventional groups.

Bergamo et al[3], 2016 evaluated the alterations on plaque index (PI), gingival index (GI), gingival bleeding index (GBI), and gingival crevicular fluid (GCF) volume after use of three different bracket types for 60 days. Total of 20 patients of ages 11 to 15 years were selected. GCF sample was collected in all patients and PI, GI, and GBI was also measured. Patients were bonded with 3 different brackets – conventional (Gemini™, 3M Unitek), active self-ligating (In-Ovation®R; Dentsply GAC) and passive self-ligating (SmartClip™; 3M Unitek). A total of 60 teeth with different brackets were analysed. After 30 days of bonding, one batch of three teeth — including a tooth with Gemini, one with In-OvationR, and another with SmartClip — were analysed. After 60 days of bonding, another batch of three teeth were

analysed in the same way. The result of the study showed was no statistically significant correlation between tooth crowding, overjet, and overbite and the PI, GI, GBI scores, and GCF volume before bonding, indicating no influence of malocclusion on the clinical parameters regardless of the bracket design, no statistically significant difference was found for GI, GBI scores. PI and GCF volume showed a significant difference among the brackets in different periods. There was an increase in PI score and GCF volume 60 days after bonding of SmartClip™ self-ligating brackets, indicating the influence of bracket design on these clinical parameters.

Arnold S et al[64], 2016 carried out a systematic evaluation of adolescent populations over the short 4– 6 weeks and slightly longer-term 3–6 months and showed only 'scarce' evidence of a greater plaque index in conventional brackets at 3–6 months of treatment. However, gingival index and pocket depth pooled estimates revealed no substantial differences between SLBs and conventional brackets at either time-stop.

Yang et al[75], 2016 compared plaque indices associated with passive Self Ligating Brackets and conventional brackets and found no significant differences.[63]

Woo-Sun Jung, Kyungsun Kim[74], 2016 studied the adhesion of periodontopathogens to self-ligating brackets (Clarity-SL [CSL], Clippy-C [CC] and Damon Q [DQ]) and keyed out the relationships between bacterial adhesion and oral hygiene indexes. Central incisor brackets from the maxilla and mandible were collected from 60 patients at debonding after the plaque

and gingival indexes were measured. Adhesions of Aggregatibacter actinomycetemcomitans (Aa), Porphyromonas gingivalis (Pg), Prevotella intermedia (Pi), Fusobacterium nucleatum (Fn), and Tannerella forsythia (Tf) were quantitatively determined using real-time polymerase chain reactions. Factorial analysis of variance was applied to analyse bacterial adhesion in relation to bracket type and jaw side. Correlation coefficients were calculated to determine the relationships between bacterial adhesion and the oral hygiene indexes. Total bacteria showed greater adhesion to CSL than to DQ brackets, whereas Aa, Pg, and Pi adhered more to DQ than to CSL brackets. CC brackets showed an intermediate adhesion pattern between CSL and DQ brackets, only it did not differ significantly from either bracket type. Adhesion of Fn and Tf did-not differ significantly among the 3 brackets. Greater quantities of bacteria were detected in the mandibular bracket than that of the maxillary bracket. The plaque and gingival indexes were not strongly correlated with bacterial adhesion to the brackets. Because Aa, Pg, and Pi adhered more to the DQ brackets in the mandibular area, orthodontic patients with periodontal problems should be carefully monitored in the mandibular incisor region where the distance between the bracket and the gingiva is small, especially when DQ brackets are used.[62]

Eleftherios G. Kaklamanosin 2017 compared the duration of orthodontic treatment and Gingival Index (GI) scores in Class I malocclusion patients treated with a conventional square-wire method (CG) or the Damon technique (DT). Twenty-two patients were randomly allocated to treatment in

a 1:1 ratio to either CG or DT group. Age at the beginning of treatment, initial PAR index and GI scores were similar between groups. All patients completed the survey, but the total duration of orthodontic treatment was almost half of the initial premise. No serious harms were observed other than gingival inflammation associated with oral biofilm accumulation. The study did not reveal any statistically significant differences between the compared conventional straight-wire method and Damon technique groups as regardless to total treatment duration and GI scores[15].

Materials and Methods

MATERIALS AND METHODS

Materials and Methods:

The study was conducted in Ragas Dental College & Hospitals Chennai. The study protocol was approved by the Institutional Review Board of the institutional research ethics committee. This clinical trial comprised of 10 patients having Angle's Class I malocclusion with moderate to severe crowding requiring all 1st premolar extractions.

The patients were chosen according to inclusion and exclusion criteria and were randomly divided to 2 groups

Group 1 – Damon Q self ligating bracket system with 0.022 slot (ORMCO)

Group 2 – Conventional bracket system (American Orthodontics – 0.022 slot with Roth system)

Inclusion criteria:

1. Young adults
2. No sex predilection
3. Angles Class I malocclusion with moderate to severe crowding of greater than 5mm
4. Patients who required all 1st premolar extractions

Exclusion criteria:

1. Previous history of orthodontic treatment,
2. Any missing tooth other than third molars,

3. Cleft lip and palate, any craniofacial deformities
4. TMJ dysfunction
5. Patients with poor periodontal conditions
6. Any systemic disorders

Methodology

Oral prophylaxis was done for all the patients prior to the start of treatment. GCF sample was collected at the start of treatment (T0) and after 60 days of treatment (T1).

The sample was collected using capillary tubes or micropipettes (sigma aldrich), of known diameter, and placed at the entrance of crevice and fluid ascended the tube by capillary action. The sample was taken at mesial and distal side in relation to 11, 12, 13, 21, 22, 23 for 5 minutes by holding the pipette.

Likewise for all the patients, periodontal parameters such as PI (plaque index), GI (gingival index) (Löe 1967)[37], and GBI (gingival bleeding index) (Ainamo & Bay 1975)[1] were measured (T0) at the start of treatment and (T1) after 60 days of treatment.

Plaque Index:

The criteria ranged from 0 - 3.

Scoring criteria:

0 - No plaque

1 - Plaque present on some but not on all interproximal, buccal, and lingual surfaces of the tooth.

2 - Plaque present on all interproximal, buccal, and lingual surfaces, but covering less than one half of these surfaces.

3 - Plaque extending over all interproximal, buccal and lingual surfaces, and covering more than one half of these surfaces.

-All areas (B , L , M , D) are scored as one unit.

-Only fully erupted teeth are scored.

-There is no substitution for excluded teeth.

$$\text{Calculation: } \frac{\text{Total scores}}{\text{No. of teeth examined}}$$

Gingival Index:

The Gingival Index (Löe and Silness, 1963) was done for all patients to assess the gingival condition and record qualitative changes in the gingiva. It scores the marginal and interproximal tissues separately using a score of 0 to 3. All patients were assessed after confirming that there was no use of antibiotics, antimicrobial mouthwashes, or any systemic medication within 3 months prior to study.

0= Normal gingiva;

1= Mild inflammation – slight change in color and slight edema but no bleeding on probing;

2= Moderate inflammation – redness, edema and glazing, bleeding on probing;

3= Severe inflammation – marked redness and edema, ulceration with tendency to spontaneous bleeding.

Gingival Bleeding Index:

Gingival Bleeding Index (GBI), introduced by Ainamo & Bay (1975)[1], was performed through gentle probing of the orifice of the gingival crevice. If bleeding occured within 10 seconds, a positive finding was recorded and the total number of positive sites were noted. The number of positive units is divided by the number of gingival margins examined and the result is multiplied by 100 to express the index as a percentage.

$$\text{Index \%} = \frac{\text{Number of positive units}}{\text{Number of gingival margins examined}} \times 100$$

The amount of crowding was assessed using Little's irregularity index (**Robert Little 1975)[60],** a quantitative method of assessing the irregularity of six anterior teeth. Measurement were done in both maxillary and mandibular cast with a calliper held parallel to the occlusal plane. Linear displacement of the adjacent anatomic contact points of the incisors are determined and the sum of the contact points were calculated.

Each cast was subjectively ranked on a scale ranging from 0 to 10, using the following criteria:

0 Perfect alignment

1 - 3 Minimal irregularity

4 - 6 Moderate irregularity

7 - 9 Severe irregularity

10 Very severe irregularity

An informed consent was obtained for all the patients prior to the start of the treatment. Pre-treatment records such as case history, Orthopantamogram (OPG), Lateral Cephalogram, intra oral and extra oral photographs, and plaster models were taken.

Patients were bonded with either Damon system or conventional bracket according to the groups.

Group 1: 5 patients were bonded with self ligating brackets (ORMCO – DAMON Q - 0.022 slot)

Group 2: 5 patients were bonded with conventional brackets (AO mini master – Roth 0.022 slot).

In both the groups, the following arch wire sequence was used for levelling and aligning.

0.014" round CUNiTi

0.014 x 0.025" CUNiTi

0.018 x 0.025" CUNiTi and

0.019 x 0.025" Stainless Steel

The arches were considered as levelled and aligned when 0.019 x 0.025" stainless steel wire was passively inserted into the bracket slot.

Post alignment (T2) records such as orthopantamogram (OPG), Lateral Cephalogram, plaster models, and intra oral photographs were taken.

Pretreatment (T0) and post alignment (T2) study models were scanned using ZIRKONZAHN.SCAN (version – 4.0.4623_3_5934). The arch length, arch width and arch dimensional changes were measured on both digital and plaster models. Scanned digital models were converted into STL file format and the measurements were done using DOLPHIN software (version – 11.9). Conventional plaster models were also measured for the same using digital vernier caliper (Aerospace) for reliability.

Measurements using 3D models[57]

1. Transverse arch width

   Maxilla:

   Inter canine width: Between the cusp tip of canines

   Inter pre molar width: between the palatal cusp tip of 2nd pre molars

   Inter molar width: Between the mesio palatal cusp tip of 1st molars

   Mandible:

   Inter canine width: Between the cusp tip of canine

   Inter pre molar width: Between the lingual cusp tip 2nd pre molar

   Inter molar width: Between the central fossa of 1st molars

2. Arch length

Segment A is the distance from the mesial contact point of the right first permanent molar to the mesial contact point of the right canine.

Segment B is the distance from the mesial contact point of the right canine to the mesial contact point of the right central incisor.

Segment C is the distance from the mesial contact point of the left central incisor to the mesial contact point of the left canine.

Segment D is the distance from the mesial contact point of the left canine to the mesial contact point of the left first molar.

The arch width and arch length measurements were also repeated in conventional plaster models. The measurements were repeated at 2 different times to check for intra-examiner reliability and reproducibility.

3. Pre-treatment and post alignment Lateral Cephalogram were taken, to assess the maxillary and mandibular incisor inclination using U1-PP, IMPA.

STATISTICAL ANALYSIS

The following statistical procedures were carried out:

1. Data compilation and presentation

2. Statistical analyses

I. Data compilation and presentation :

Data obtained were compiled systematically in Microsoft excel spread sheet. The dataset was subdivided and distributed meaningfully and presented as graphs and tables.

II. Statistical analyses:

Statistical analyses were performed using statistical package for Social Sciences Software (SPSS version 22, USA). Data comparison was done by applying specific statistical tests to find out statistical significance of the obtained results. Depending upon the nature of the data, the statistical tests were chosen p value of 0.05 was considered to be statistically significant.

Reliability test was done using Cohen's Kappa statistics.

The Gingival Crevicular Fluid volume and adhesion of periodontal parameters such as Gingival Index, Plaque Index and Gingival Bleeding Index was compared between the study and control group using Independent T test.

Mann Whitney U test was done to compare the GCF volume between the groups at baseline and 60 days.

The change in arch length, arch dimensions, maxillary and mandibular crowding and change in upper and lower incisor inclination was also compared between the study and control group.

Figures

Figure 1: ARMAMENTARIUM

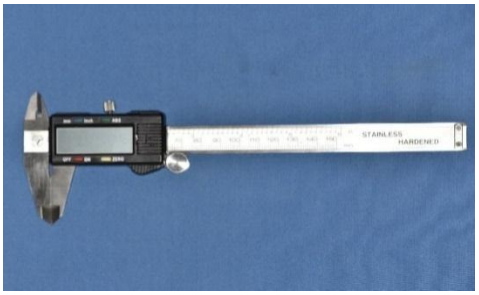


Fig 1a :- Digital Vernier Caliper

Fig 1b:- Micropipette

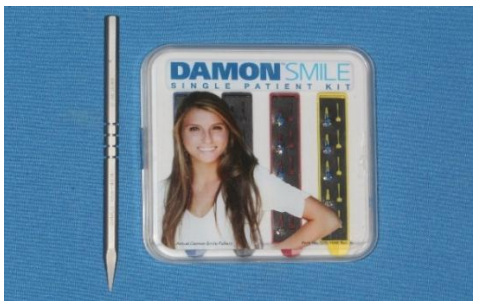


Fig 1c :- Damon Q brackets

Fig 1d :- Mini master brackets

Figure 2: COLLECTION OF GCF

Figure 3: PRE-TREATMENT LATERAL CEPHALOGRAM – T0

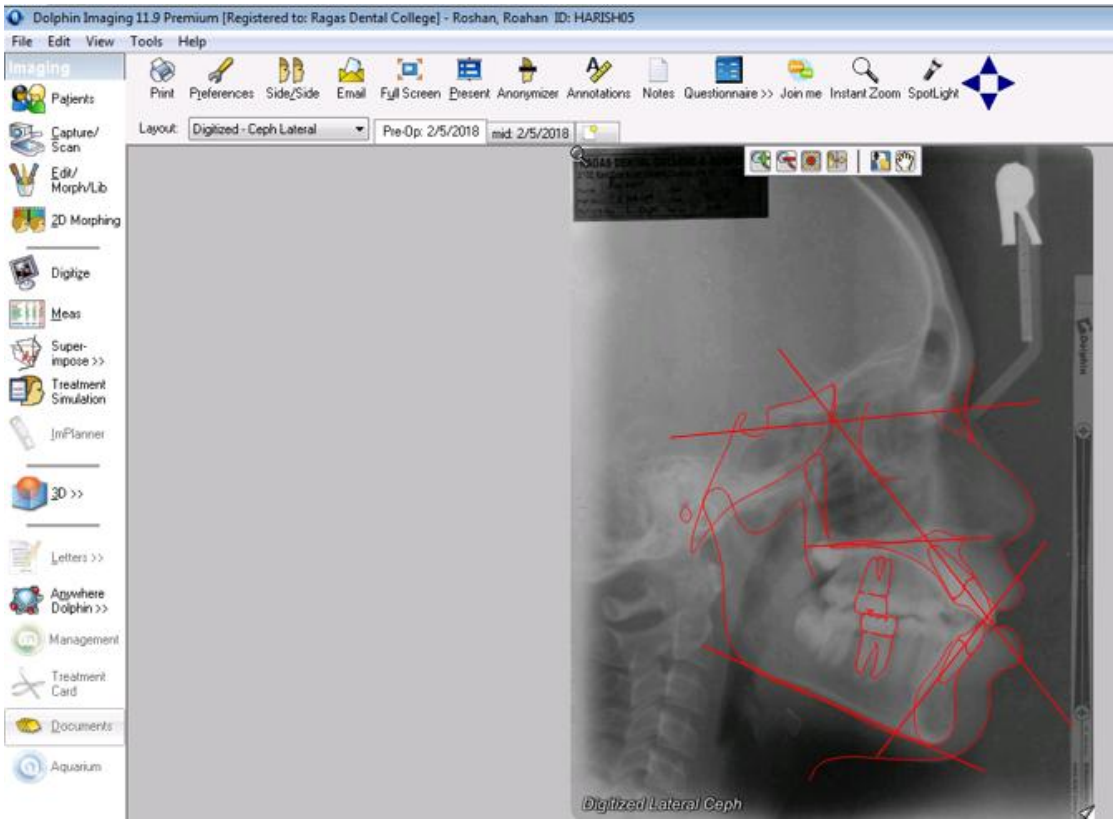


Figure 4: PRE-TREATMENT INTRA ORAL PHOTOGRAPHS (T0)

Frontal view

Right Lateral view

Left Lateral view

Upper Occlusal view

Lower Occlusal view

Figure 5:-MEASUREMENT OF LITTLE'S IRREGULARITY INDEX IN MAXILLARY AND MANDIBULAR PRE-TREATMENT (T0) MODELS USING DIGITAL VERNIER CALLIPER

Figure 5a: Maxillary arch irregularity index at T0

Figure 5b: Mandibular arch irregularity index at T0

Figure 6:-MEASUREMENT OF ARCH LENGTH IN MAXILLARY PRE-TREATMENT (T0) MODELS USING DIGITAL VERNIER CALIPER.

Fig 6a:- Segment A
Segment A – is the distance from the mesial contact point of the right first permanent molar to the mesial contact point of the right canine.

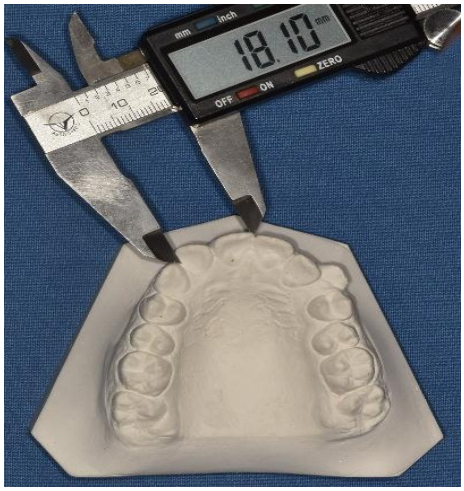


Fig 6b:-Segment B
Segment B – is the Distance from The mesial contact point of the right canine to the mesial contact point of the right central incisors

Fig 6c:- Segment C
Segment C – is the distance from the mesial contact point of the left central incisor to the mesial contact point of the left canine.

Fig 6d:-segment D
Segment D – is the distance from the mesial contact point of the left canine to the mesial contact point of the left first permanent molar

Figure 7:-MEASUREMENT OF ARCH LENGTH IN MANDIBULAR PRE-TREATMENT (T0) MODELS USING DIGITAL VERNIER CALIPER

Fig 7a:- Segment A
Segment A – is the distance from the mesial contact point of the right first permanent molar to the mesial contact point of the right canine.

Fig 7b:-segment B
segment B – is the distance from the mesial contact point of the right canine to the mesial contact point of the right central

Fig 7c:- Segment C
Segment C – is the distance from the mesial contact point of the left central incisor to the mesial contact point of the left canine

Fig 7d:-segment D
Segment D – is the distance from the mesial contact point of the left canine to the mesial contact point of the left first permanent molar

FIGURE 8:-MEASUREMENTS OF INTER CANINE, INTER PRE MOLAR AND INTER MOLAR WIDTH IN MAXILLARY AND MANDIBLE PRE TREATMENT(T0) MODELS USING DIGITAL CALIPER

Maxilla

Inter canine width – between the

Mandible

Inter canine width – between the cusp tip of canines

Inter pre molar width – between the palatal cusp tip of 2nd pre molar

Inter pre molar width – between the palatal cusp tip of 2nd pre molar

Inter molar width – between the mesio palatal cusp tip of 1st molar

Inter molar width – between the mesio buccal groove of 1st molar

Figure 9: POST ALIGNMENT-TREATMENT LATERAL CEPHALOGRAM – T2

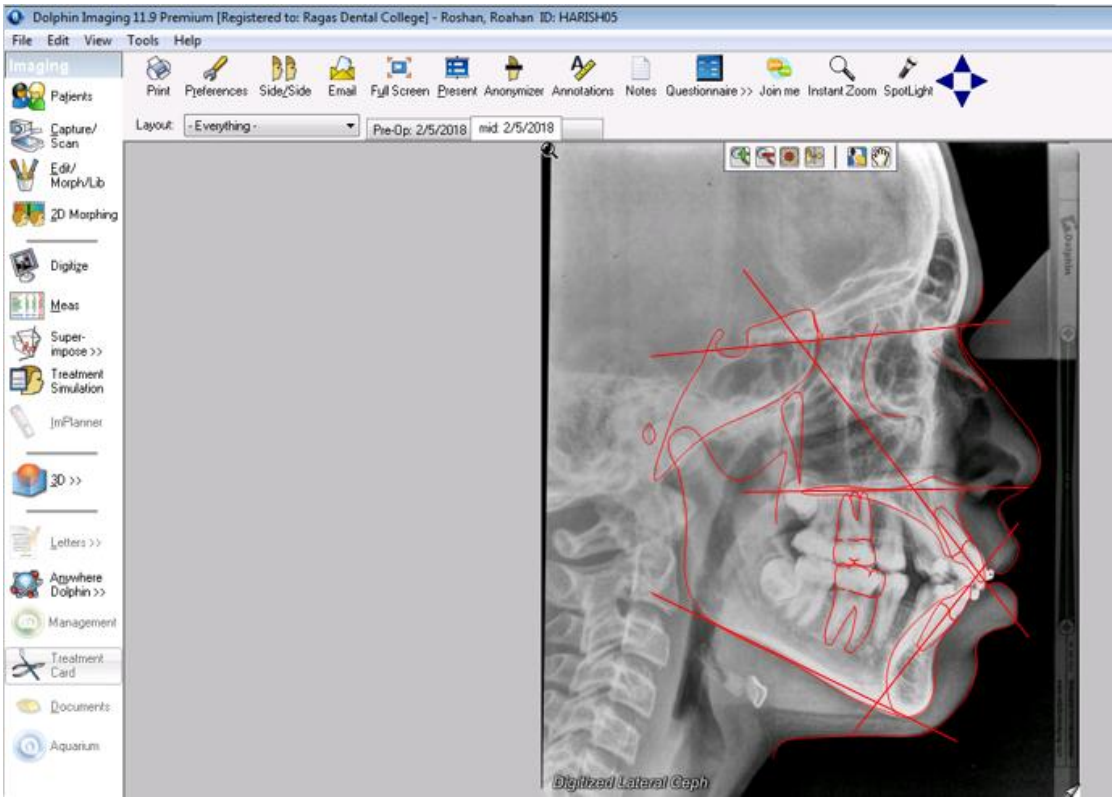


Figure 10: POST ALIGNMENT-TREATMENT PHOTOS – T2

Frontal view

Right lateral view

Left Lateral view

Upper Occlusal View

Lower Occlusal View

Figure 11:-MEASUREMENT OF LITTLE'S IRREGULARITY INDEX IN MAXILLARY AND MANDIBULAR POST ALIGNMENT (T2) MODELS USING DIGITAL VERNIER CALLIPER

Fig 11a:- Maxilla post alignment irregularity index

Fig 11b:- Mandible post alignment irregularity index

Figure 12:-MEASUREMENT OF ARCH LENGTH IN MAXILLARY POST ALIGNMENT (T2) MODELS USING DIGITAL VERNIER CALIPER.

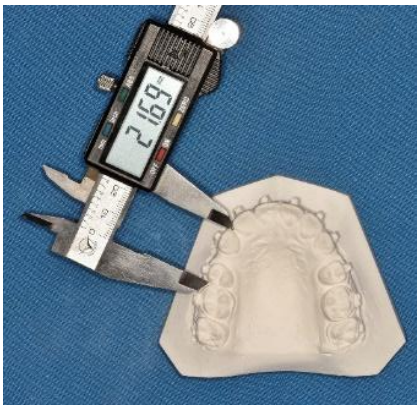


Fig 12a:- Segment A
Segment A – is the distance from the mesial contact point of the right first permanent molar to the mesial contact point of the right canine.

Fig 12b:-Segment B
Segment B – Is The Distance from The mesial contact point of the left canine to the mesial contact point of the left central incisors

Fig 12c:- Segment C
Segment C – is the distance from the mesial contact point of the right central incisor to the mesial contact point of the right canine.

Fig 12d:-segment D
Segment D – is the distance from the mesial contact point of the left canine to the mesial contact point of the left first permanent molar

Figure 13:-MEASUREMENT OF ARCH LENGTH IN MANDIBULAR POST ALIGNMENT (T2) MODELS USING DIGITAL VERNIER CALIPER.

Fig 13a:- Segment A
Segment A – is the distance from the mesial contact point of the right first permanent molar to the mesial contact point of the right canine.

Fig 13b:-segment B
Segment B – is the distance from the mesial contact point of the right canine to the mesial contact point of the right central

Fig 13c:- Segment C
Segment C – is the distance from the mesial contact point of the left central incisor to the mesial contact point of the left canine

Fig 13d:-segment D
Segment D – is the distance from the mesial contact point of the left canine to the mesial contact point of the left first permanent molar

Figure 14:-MEASUREMENTS OF INTER CANINE, INTER PRE MOLAR AND INTER MOLAR WIDTH IN MAXILLARY AND MANDIBLE POST ALIGHNMENT MODELS USING DIGITAL CALIPER

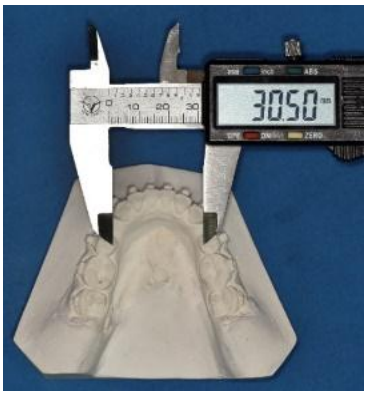
Maxilla

Mandible

Inter canine width – between the cusp tip of canines

Inter canine width – between the cusp tip of canines

Inter pre molar width – between the palatal cusp tip of 2nd pre molar



Inter pre molar width – between the lingual cusp tip of 2nd pre molar

Inter molar width between the mesio palatal cusp tip of 1st molar

Inter molar width between the mesio buccal groove of 1st molar

Figure 15: ARCH LENGTH, INTER CANINE, INTER PRE MOLAR AND INTER MOLAR WIDTH IN DIGITAL MODELS MEASURED USING DOLPHIN SOFTWARE

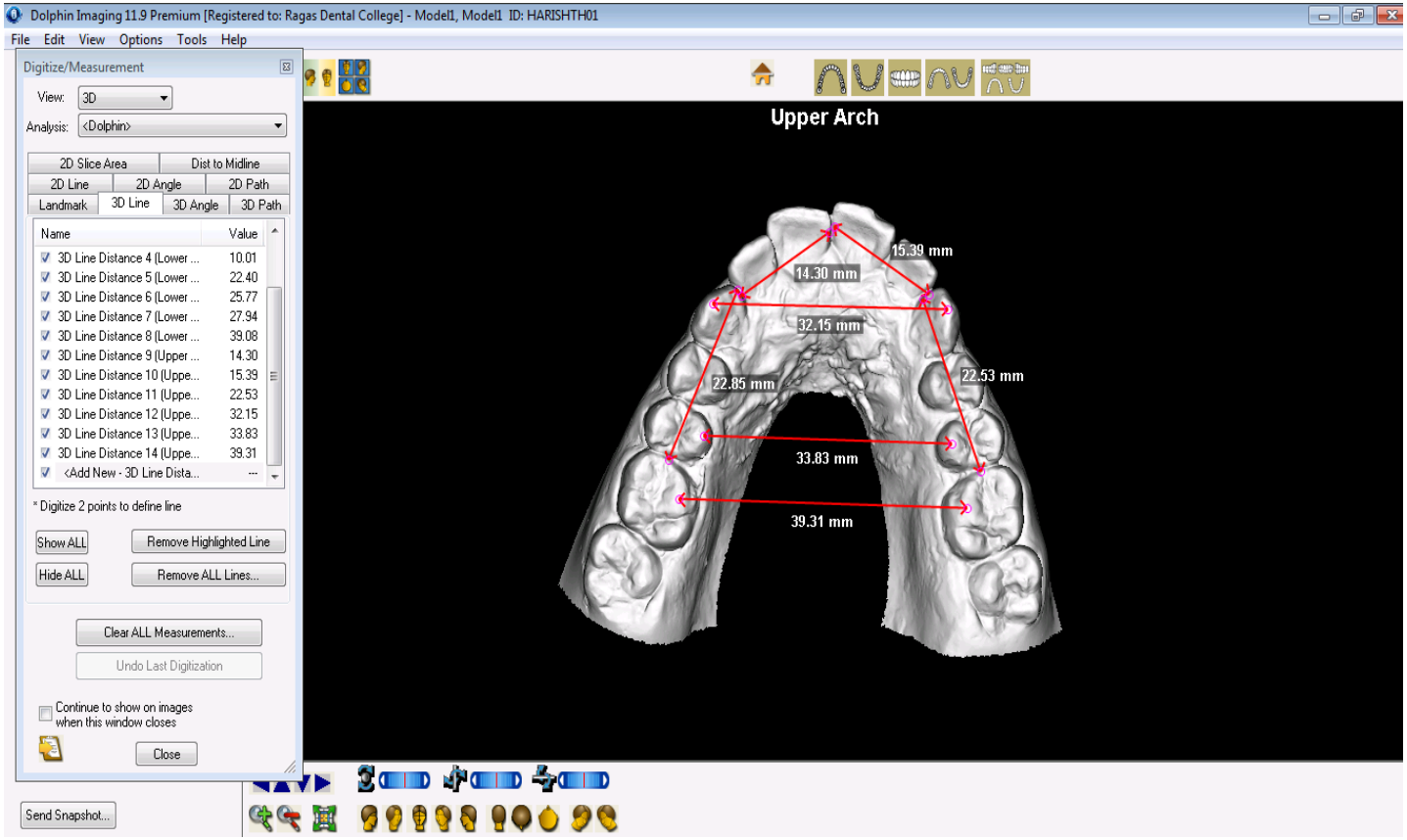
1. 

Figure 16: PRE TREATMENT (T0) ARCH LENGTH, INTER CANINE, INTER PRE MOLAR AND INTER MOLAR WIDTH IN DIGITAL MODELS ARE MEASURED USING DOLPHIN SOFTWARE

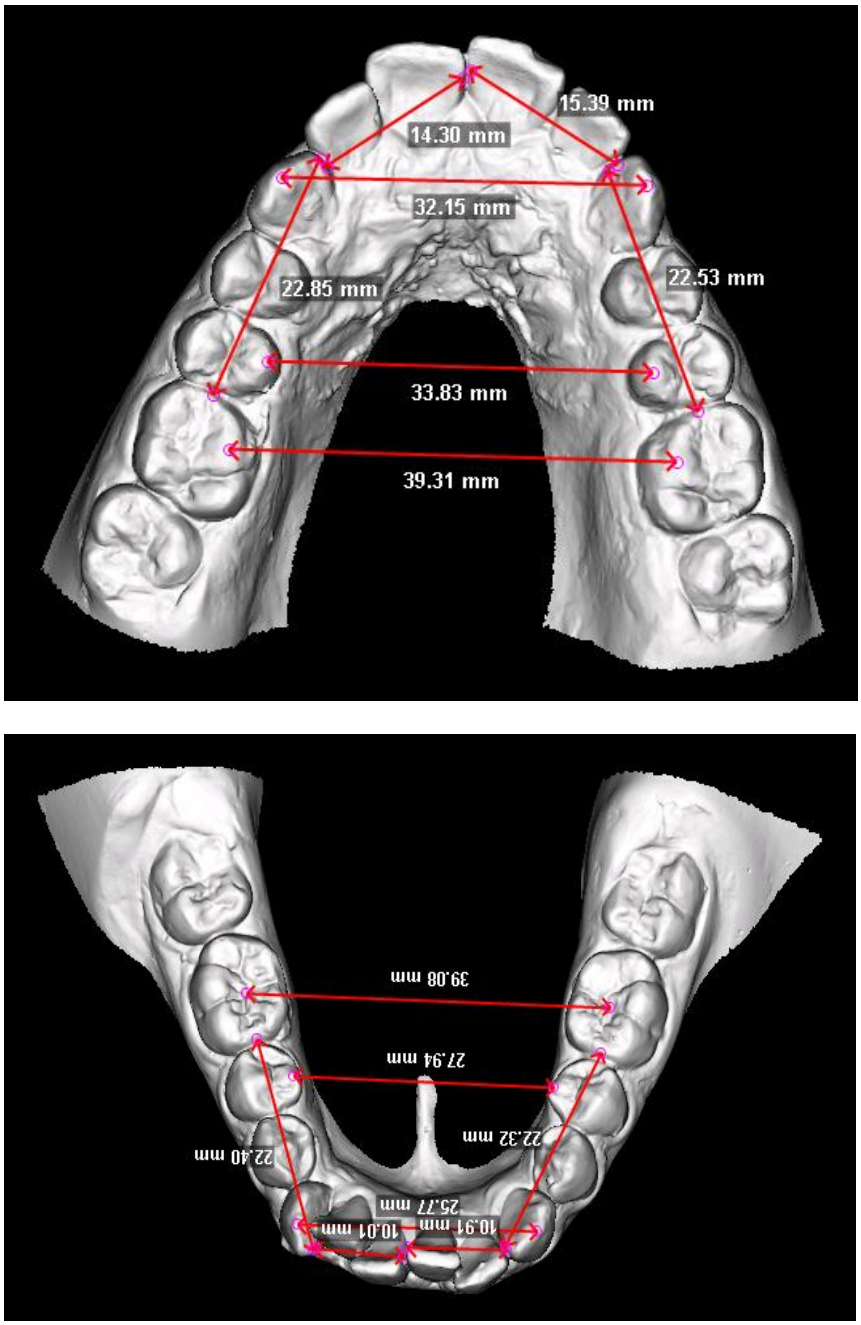
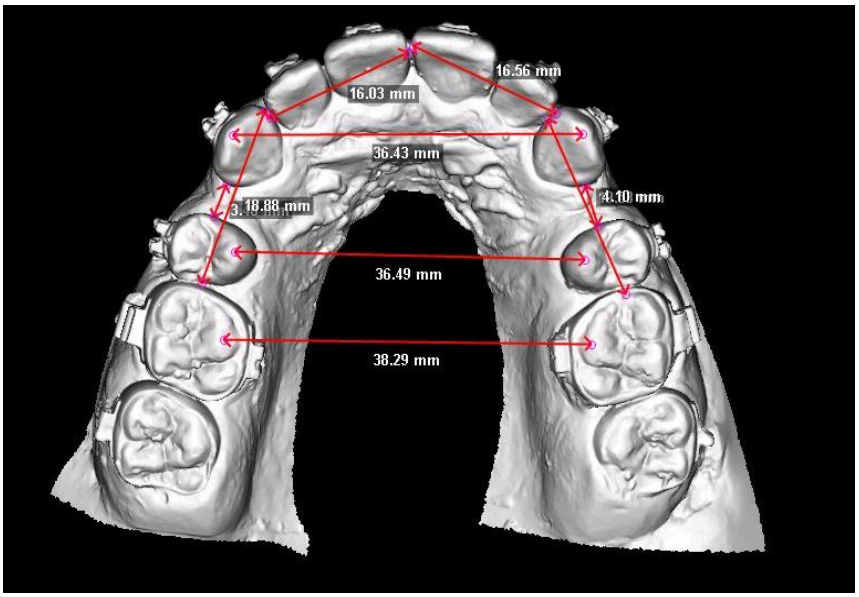
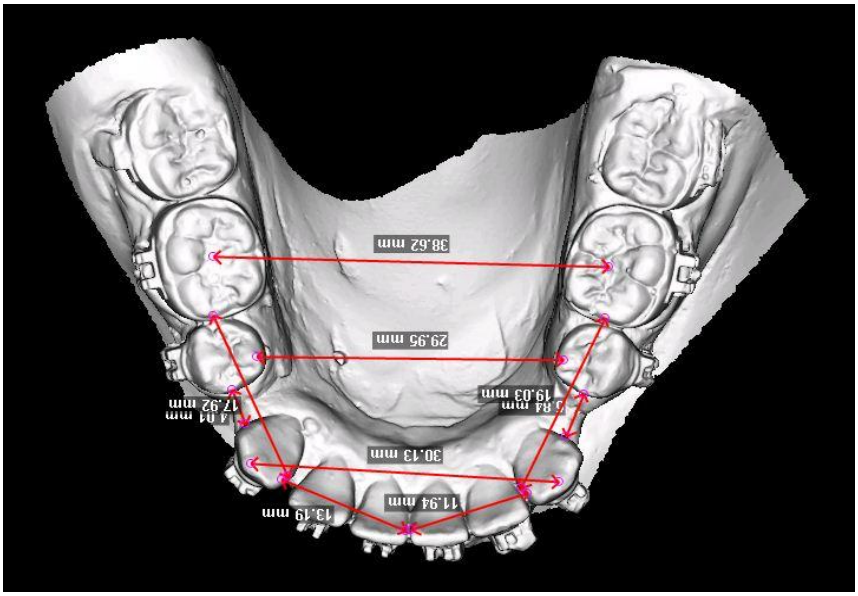


Figure 17: POST TREATMENT (T2) ARCH LENGTH, INTER CANINE, INTER PRE MOLAR AND INTER MOLAR WIDTH IN DIGITAL MODELS ARE MEASURED USING DOLPHIN SOFTWARE





Results

Table 1 shows demographic variables of the groups including age, sex and irregularity index. This study comprised of 10 patients (mean age 17.5±5years) who were randomly divided into two groups, the average mean age in the study group patients was 18.6 (14±23) and the average mean age in the control group patients was 16.4 (12±22). The mean irregularity index in maxillary arch was 9.71mm in the study group and 8.55mm in the control group and in the mandibular arch it was 11.36 mm and 9.02mm respectively in study and control group. All the patients with dental Class 1 malocclusion who required first bicuspid extraction were selected for this study.

In [**Table2, 3 and 4**] The Gingival Crevicular Fluid (GCF) volume was measured prior to the treatment (i.e) Baseline – (T0) and at 60 days of orthodontic treatment in both the groups. There was no change in the GCF volume at T0 in both the groups. However, there was significant increase in the GCF volume at T1 in both study and control group.

However there was a statistically significant difference increase in GCF volume at T1 in the control group particularly in the canine region. In maxillary right canine (13) the mean Gingival Crevicular Fluid (GCF) volume in the control group was (7.80) and study group measured (3.20). In maxillary left canine (23) the mean Gingival Crevicular Fluid volume in the control group was (7.30) and study group was (3.30). It could be noted that GCF volume greatly increased in the control group in both the canines.

However Gingival index (GI), Plaque index (PI), Gingival Bleeding index (GBI) also measured in both the groups at baseline and at 60 days. Although all the parameters increased at 60 days of orthodontic treatment in both the groups. Intergroup comparison failed to demonstrate any significant difference between them.

The arch dimension changes in both the study and control groups were measured and tabulated [**Table 5 and Table 6].** There was no statistically significant difference in the arch dimension changes between study and control group at the end of alignment (T2). The maxillary and mandibular inter canine and inter premolar width increased in both study and control groups. However the inter molar width reduced in both study and control group in both maxilla and mandible. Likewise the maxillary and mandibular arch length reduced considerably in both the groups. The measurements were made using Digital vernier caliper for plaster models and using Dolphin imaging program for digital models. The research faialed to demonstrate any significant difference in the measurements made using either plaster models and digital models. The measurements were repeated twice at two different time points and Cohen's Kappa statistics was done to check for intra examiner reliability and was found to be moderately to highly reliable.

The axial inclination of upper incisor (UI) to palatal plane (PP)and lower incisor to mandibular plane (IMPA) were measured using lateral cephalogram at pre treatment (T0) and post alignment (T2) **[Table 7]** in both

the groups. There was no statistically significant difference in the incisor inclination with convention brackets and Damon Q brackets.

The overjet and overbite reduced at the end of alignment (T2) in both study and control group. There was no statistically significant difference in the values between both the groups.

Table 8 shows passive extraction space closure, residual extraction spaces were measured on left and right sides of maxilla and mandible in both study and control group. The extraction spaces reduced greatly in both study and control groups at the end of alignment stage (T2).

Tables and Graphs

TABLE 1: DEMOGRAPHIC DATA FOR ASSESSMENT OF AGE, MAXILLARY AND MANDIBULAR ARCH CROWDING (T0)

Variable	Total	Study group		Control group		p-value
		mean	SD	mean	SD	
Age(years)	17.5(12±23)	18.6(14±23)	3.64	16.4(12±22)	4.72	0.434
Maxillary irregularity index	5	9.71	0.58	8.55	3.76	0.51
Mandibular irregularity index	5	11.36	6.15	9.02	2.02	0.44

*** SIGNIFICANT (p<0.05)**

**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

TABLE 2: ASSESSMENT OF GINGIVAL INDEX, PLAQUE INDEX , GINGIVAL BLEEDING INDEX AND GINGIVAL CREVICULAR FLUID AT BASELINE (T0) AND 60DAYS (T1) WITHIN STUDY AND CONTROL GROUP

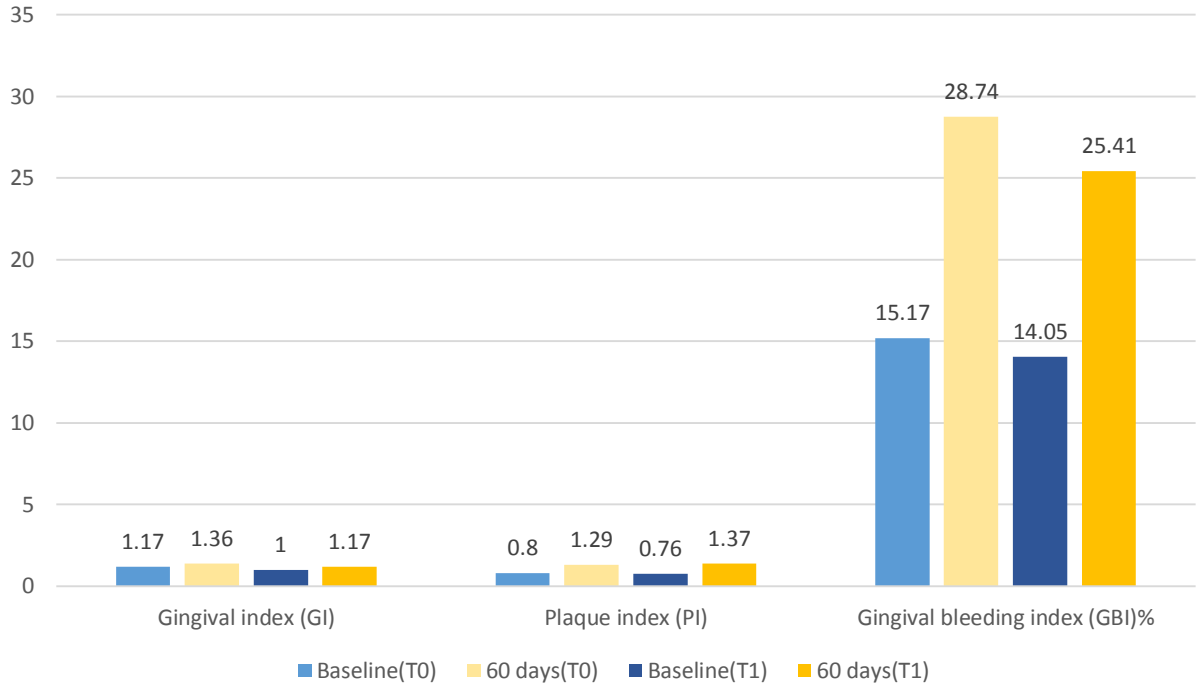
Variables	Study Group			Control Group		
	Baseline Mean(SD)	60 Days Mean (SD)	P value	Baseline Mean(SD)	60 Days Mean(SD)	P value
Gingival index (GI)	1.17(0.09)	1.36(0.19)	**0.018***	1.00(0.14)	1.17(0.19)	**0.016***
Plaque index (PI)	0.80(0.07)	1.29(0.21)	**0.003****	0.76(0.10)	1.37(0.39)	**0.009****
Gingival bleeding index (GBI)%	15.17(2.75)	28.74(12.69)	**0.001*****	14.05(1.24)	25.41(5.91)	0.100
Gingival crevicular fluid(GCF)	0.70(0.14)	0.81(0.03)	0.155	0.80(0.11)	0.94(0.10)	0.226

*** SIGNIFICANT (p<0.05)**

**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

GRAPH 2a: ASSESSMENT OF GINGIVAL INDEX, PLAQUE INDEX AND GINGIVAL BLEEDING INDEX AT BASELINE (T0) AND 60 DAYS (T1) WITHIN STUDY AND CONTROL GROUP



GRAPH 2b: ASSESSMENT OF GINGIVAL CREVICULAR AT BASELINE (T0) AND 60DAYS (T1) WITHIN STUDY AND CONTROL GROUP

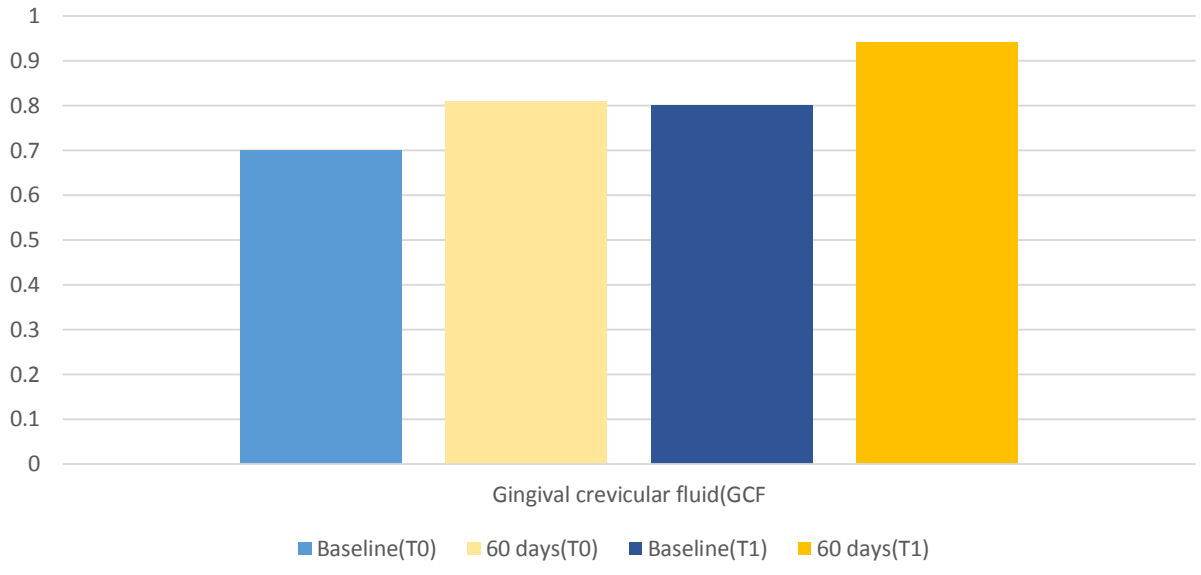


TABLE 3: ASSESSMENT OF GINGIVAL INDEX, PLAQUE INDEX, GINGIVAL BLEEDING INDEX AND GINGIVAL CREVICULAR FLUID AT BASELINE (T0) AND 60 DAYS (T1) BETWEEN STUDY AND CONTROL GROUP

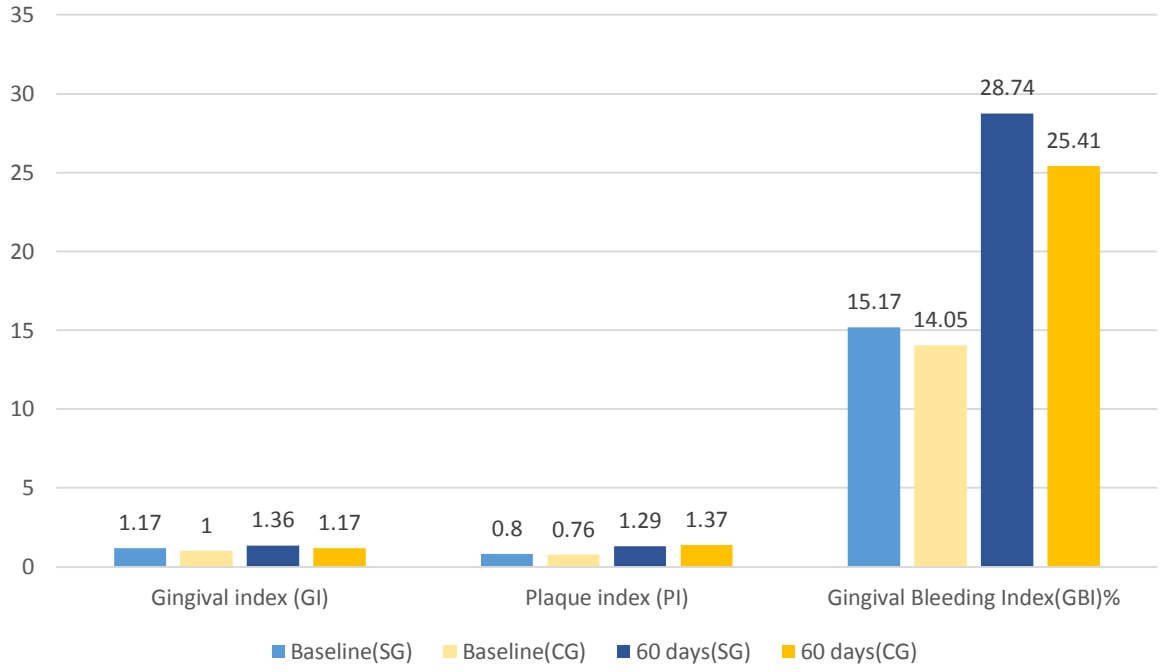
Variables	Baseline			60 Days		
	Study Group Mean(SD)	Control Group Mean(SD)	P value	Study Group Mean(SD)	Control Group Mean(SD)	P value
Gingival index (GI)	1.17(0.09)	1.00(0.14)	0.056	1.36(0.19)	1.17(0.19)	0.160
Plaque index (PI)	0.80(0.07)	0.76(0.10)	0.502	1.29(0.21)	1.37(0.39)	0.714
Gingival bleeding index (GBI)	15.17(2.75)	14.05(1.24)	0.430	28.74(12.09)	25.41(5.91)	0.595
Gingival crevicular fluid(GCF)	0.70(0.14)	0.80(0.38)	0.242	0.81(0.03)	0.94(0.10)	**0.027***

*** SIGNIFICANT (p<0.05)**

**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

GRAPH 3a: ASSESSMENT OF GINGIVAL INDEX, PLAQUE INDEX AND GINGIVAL BLEEDING INDEX AT BASELINE (T0) AND 60 DAYS (T1) BETWEEN STUDY AND CONTROL GROUP



GRAPH 3b: ASSESSMENT OF GINGIVAL CREVICULAR FLUID AT BASELINE (T0) AND 60 DAYS (T1) BETWEEN STUDY AND CONTROL GROUP

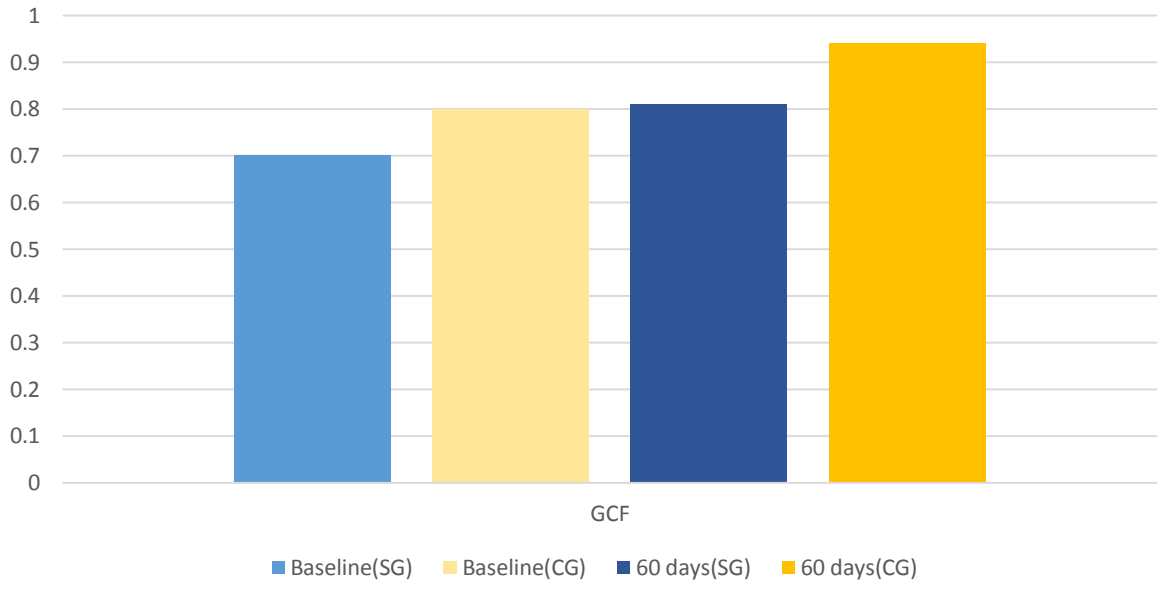


Table 4a: COMPARISON OF GCF VOLUME BETWEEN STUDY AND CONTROL GROUPS AT BASELINE (T0)

	GROUP	N	Mean Rank	Sum of Ranks	p-VALUE
13(1)	STUDY GROUP	5	4.60	23.00	.329
	CONTROL GROUP	5	6.40	32.00	
	Total	10			
12(1)	STUDY GROUP	5	5.40	27.00	.915
	CONTROL GROUP	5	5.60	28.00	
	Total	10			
11(1)	STUDY GROUP	5	3.50	17.50	.061
	CONTROL GROUP	5	7.50	27.50	
	Total	10			
21(1)	STUDY GROUP	5	4.10	20.50	.140
	CONTROL GROUP	5	6.90	34.50	
	Total	10			
22(1)	STUDY GROUP	5	5.70	28.50	.830
	CONTROL GROUP	5	5.30	26.50	
	Total	10			
23(1)	STUDY GROUP	5	4.50	22.50	.292
	CONTROL GROUP	5	6.50	32.50	
	Total	10			

*** SIGNIFICANT (p<0.05)**

**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

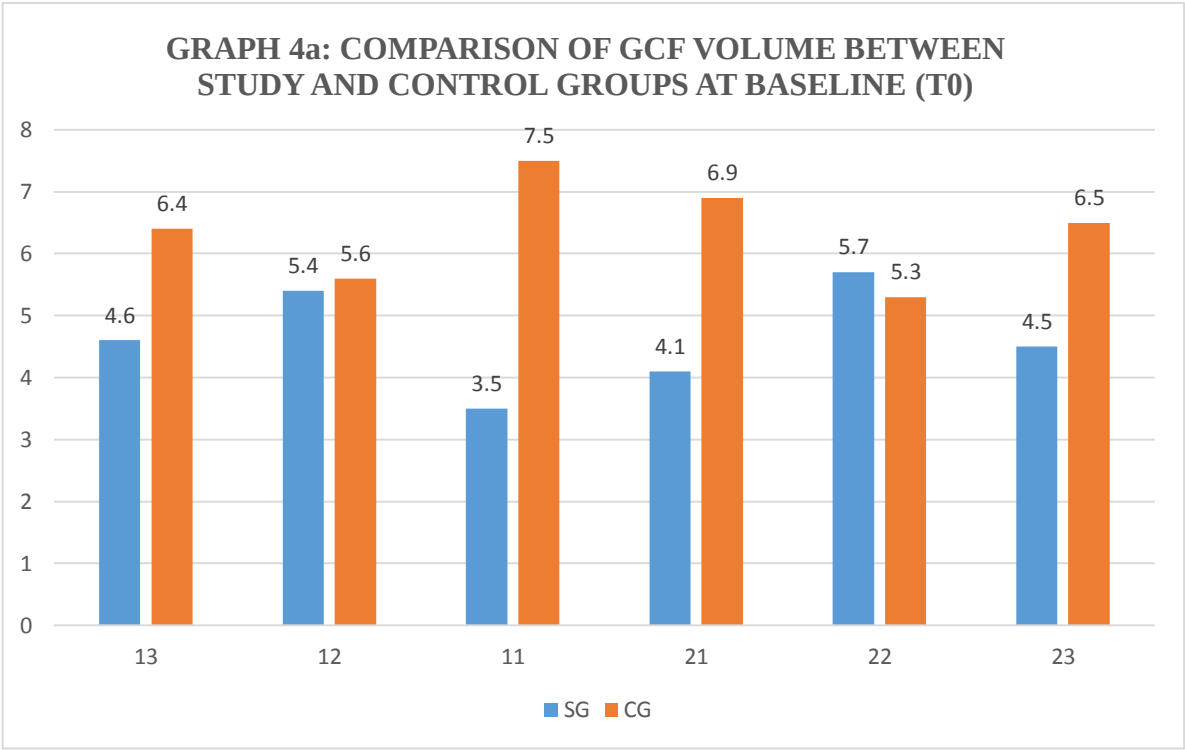

GRAPH 4a: COMPARISON OF GCF VOLUME BETWEEN STUDY AND CONTROL GROUPS AT BASELINE (T0)
8
7
6
5
4
3
2
1
0
4.6
6.4
5.4
5.6
3.5
7.5
4.1
6.9
5.7
5.3
4.5
6.5
13
12
11
21
22
23
SG
CG

Table 4b: COMPARISON OF GCF VOLUME BETWEEN STUDY AND CONTROL GROUPS AT 60 DAYS (T1)

	GROUP	N	Mean Rank	Sum of Ranks	p-VALUE
	STUDY GROUP	5	3.20	16.00	
13(2)	CONTROL GROUP	5	7.80	39.00	**.013***
	Total	10			
	STUDY GROUP	5	5.60	28.00	
12(2)	CONTROL GROUP	5	5.40	27.00	
	Total	10		21.00	.915
	STUDY GROUP	5	4.20		
11(2)	CONTROL GROUP	5	6.80	34.00	
	Total	10			.164
	STUDY GROUP	5	4.40	22.00	
21(2)	CONTROL GROUP	5	6.60	33.00	
	Total	10			.239
	STUDY GROUP	5	5.70	28.50	
22(2)	CONTROL GROUP	5	5.30	26.50	
	Total	10			.828
	STUDY GROUP	5	3.30	16.50	
23(2)	CONTROL GROUP	5	7.70	38.50	
	Total	10			**.016***

*** SIGNIFICANT (p<0.05)**

**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

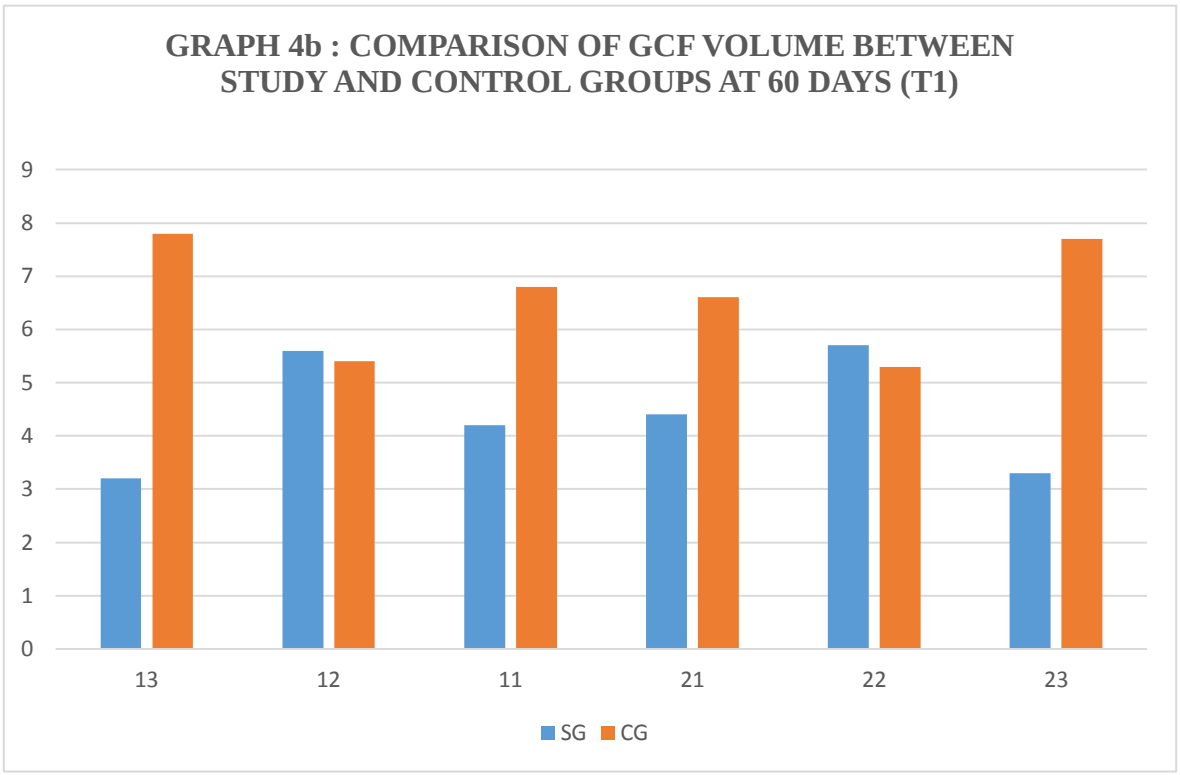

GRAPH 4b : COMPARISON OF GCF VOLUME BETWEEN STUDY AND CONTROL GROUPS AT 60 DAYS (T1)
9
8
7
6
5
4
3
2
1
0
13
12
11
21
22
23
SG
CG

TABLE 5: MEASUREMENTS OF MAXILLARY AND MANDIBULAR ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN DIGITAL MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)

Variables	PRE			POST		
	Study Group Mean(SD)	Control Group Mean(SD)	P value	Study Group Mean(SD)	Control Group Mean(SD)	P value
Arch length						
Maxilla	76.74(7.49)	76.79(2.64)	0.989	74.06(4.44)	71.99(1.99)	0.371
Mandibular	65.61(6.41)	67.93(4.31)	0.522	61.82(4.72)	61.72(2.34)	0.968
Arch width						
Maxilla :						
Inter canine width	35.17(3.12)	33.17(0.66)	0.199	37.76(1.88)	36.35(1.19)	0.196
Inter premolar width	34.66(3.04)	34.81(2.65)	0.934	36.61(2.25)	35.97(2.13)	0.655
Inter molar width	39.29(2.64)	39.96(1.29)	0.626	38.73(1.78)	38.34(1.22)	0.698
Mandible :						
Inter canine width	26.01(3.07)	25.07(1.38)	0.548	29.24(1.88)	28.13(1.30)	0.310
Inter premolar width	30.62(5.06)	29.57(2.68)	0.692	30.66(3.47)	30.66(1.79)	0.999
Inter molar width	38.98(2.27)	39.77(1.76)	0.560	37.93(1.57)	39.27(2.00)	0.274

*** SIGNIFICANT (p<0.05)**

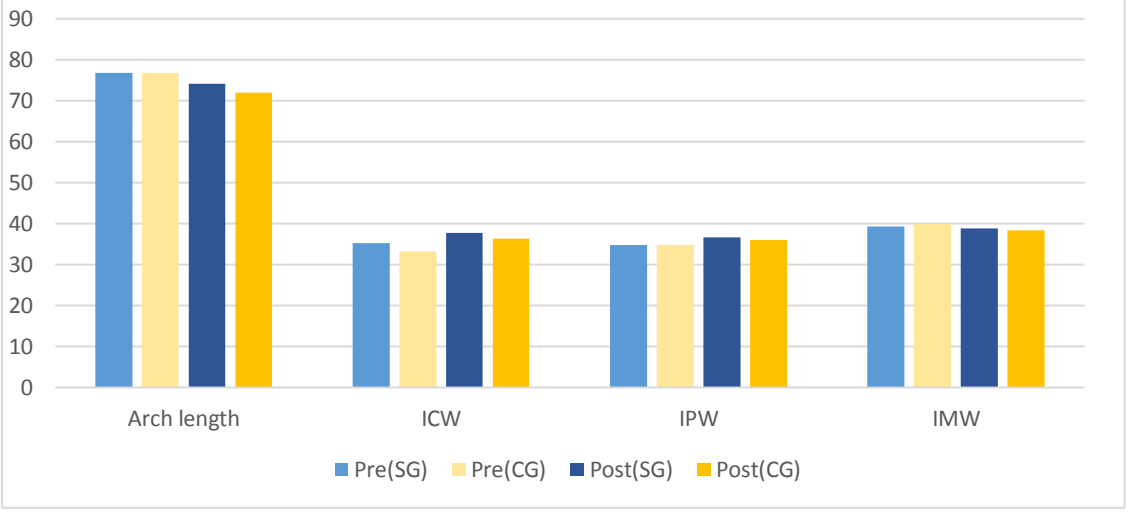
**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

T0- PRETREATMET

T2-POST ALIGNMENT

GRAPH 5a: MEASUREMENT OF MAXILLARY ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN DIGITAL MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)



GRAPH 5b: MEASUREMENTS OF MANDIBULAR ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN DIGITAL MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)

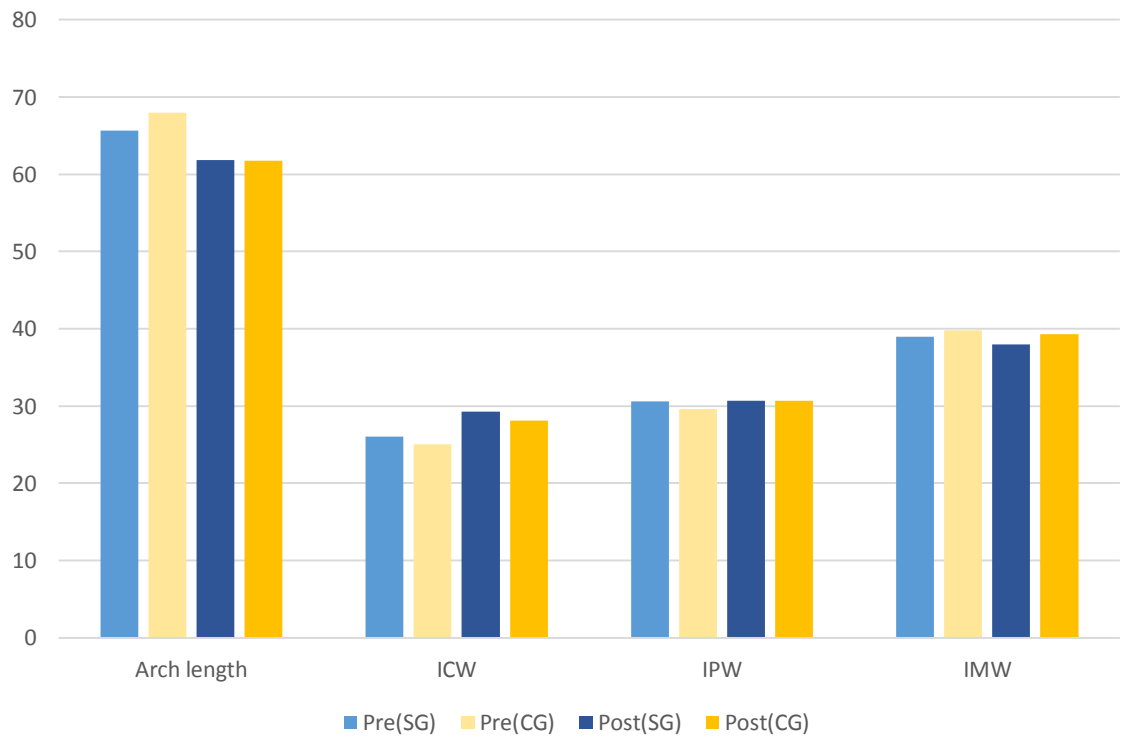


TABLE 6: MEASUREMENTS OF MAXILLARY AND MANDIBULAR ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN PLASTER MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)

Variables	PRE			POST		
	Study Group Mean(SD)	Control Group Mean(SD)	P value	Study Group Mean(SD)	Control Group Mean(SD)	P value
Arch length						
Maxilla	76.89(6.35)	77.83(2.15)	0.764	74.65(5.01)	72.80(1.60)	0.454
Mandible	66.36(5.82)	67.75(2.79)	0.643	62.05(4.98)	62.32(2.09)	0.914
Arch width						
Maxilla :						
Inter canine width	35.11(3.12)	33.62(0.67)	0.327	37.34(2.07)	36.51(1.20)	0.464
Inter premolar width	34.76(2.71)	34.99(2.51)	0.894	36.50(2.10)	36.41(1.74)	0.943
Inter molar width	39.65(2.34)	39.93(1.81)	0.838	39.05(1.86)	38.97(0.81)	0.930
Mandible :						
Inter canine width	25.63(3.19)	25.20(0.96)	0.785	29.71(1.69)	29.17(1.25)	0.141
Inter premolar width	31.22(4.79)	29.87(2.43)	0.589	30.89(3.52)	30.92(1.74)	0.987
Inter molar width	39.04(2.29)	39.49(2.14)	0.757	37.97(1.60)	39.04(2.31)	0.420

*** SIGNIFICANT (p<0.05)**

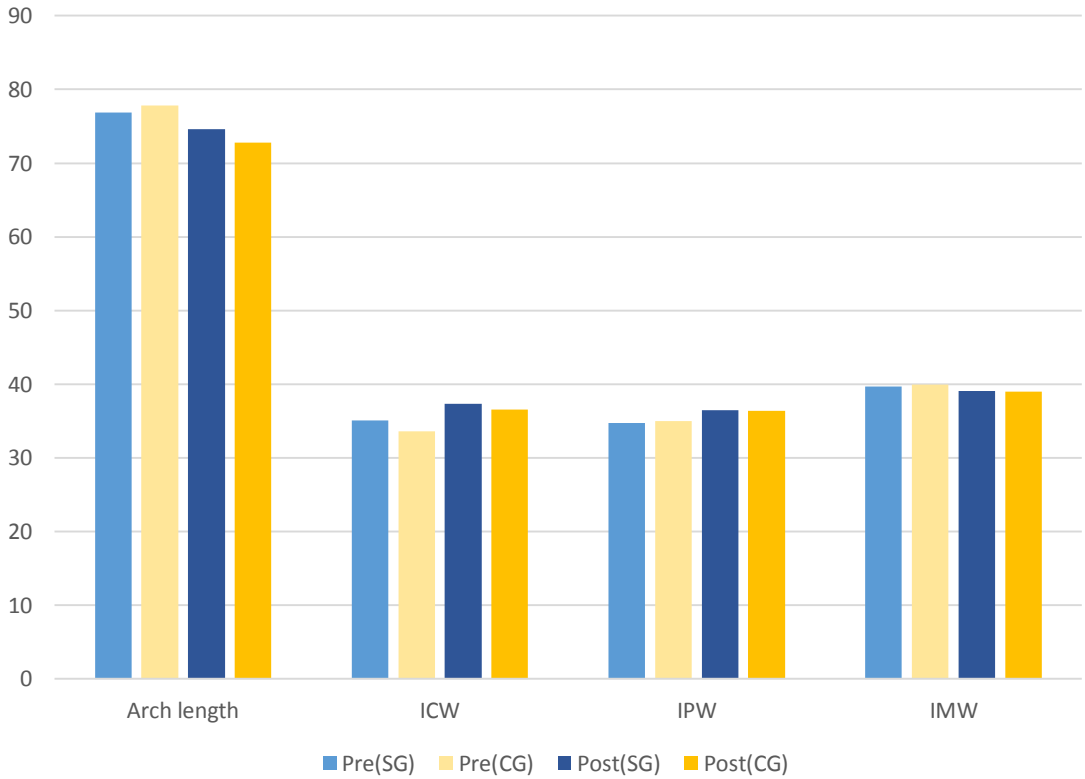
**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

T0- PRETREATMET

T2-POST ALIGNMENT

GRAPH 6a: MEASUREMENTS OF MAXILLARY ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN PLASTER MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)



GRAPH 6b: MEASUREMENTS OF MANDIBULAR ARCH LENGTH, INTERCANINE WIDTH, INTER PREMOLAR WIDTH AND INTER MOLAR WIDTH IN PLASTER MODELS BETWEEN STUDY AND CONTROL GROUP (T0-T2)

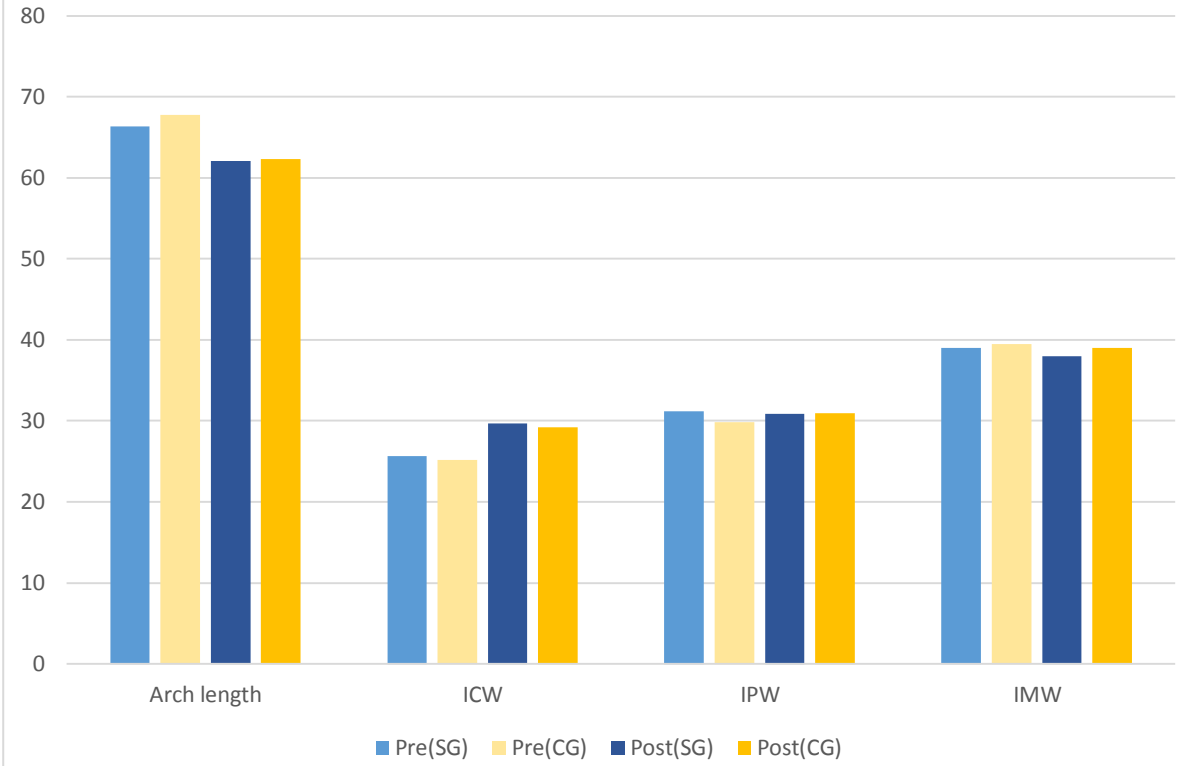


TABLE 7: MEASUREMENTS OF INCISOR INCLINATION, OVERJET, OVERBITE AND IRREGULARITY INDEX BETWEEN STUDY AND CONTROL GROUP (T0-T1)

Variables	PRE			POST		
	Study group mean(SD)	Control group mean(SD)	P value	Study group mean(SD)	Control group mean(SD)	P value
Upper incisor to palatal plane	58.40(7.66)	61.40(6.76)	0.53	61.20(5.26)	63.20(4.02)	0.51
Lower incisor to mandibular plane	101.60(4.21)	102.20(7.25)	0.87	98.40(6.80)	97.60(7.53)	0.86
irregularity index in maxilla	9.71(0.58)	8.55(3.76)	0.51	0.37(0.53)	0.14(0.33)	0.44
irregularity index in mandible	11.36(6.15)	9.02(2.02)	0.44	1.15(1.66)	0.49(1.11)	0.48
Overjet	5.40(2.88)	4.7(1.98)	0.66	3(0.93)	2.7(0.27)	0.51
Overbite	3(0.61)	2.5(0.86)	0.32	2.5(0.50)	2.3(0.27)	0.45

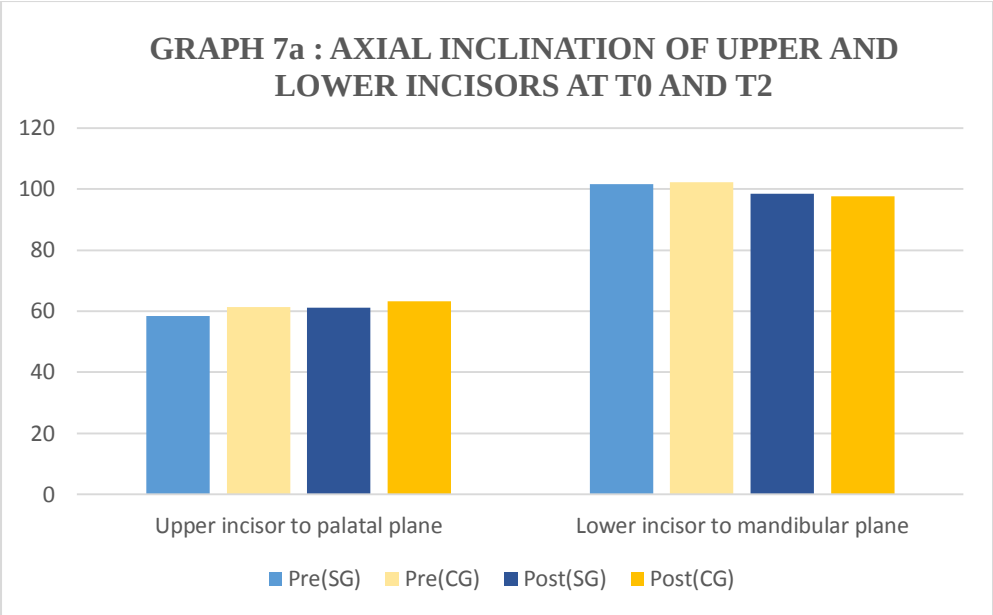
*** SIGNIFICANT (p<0.05)**

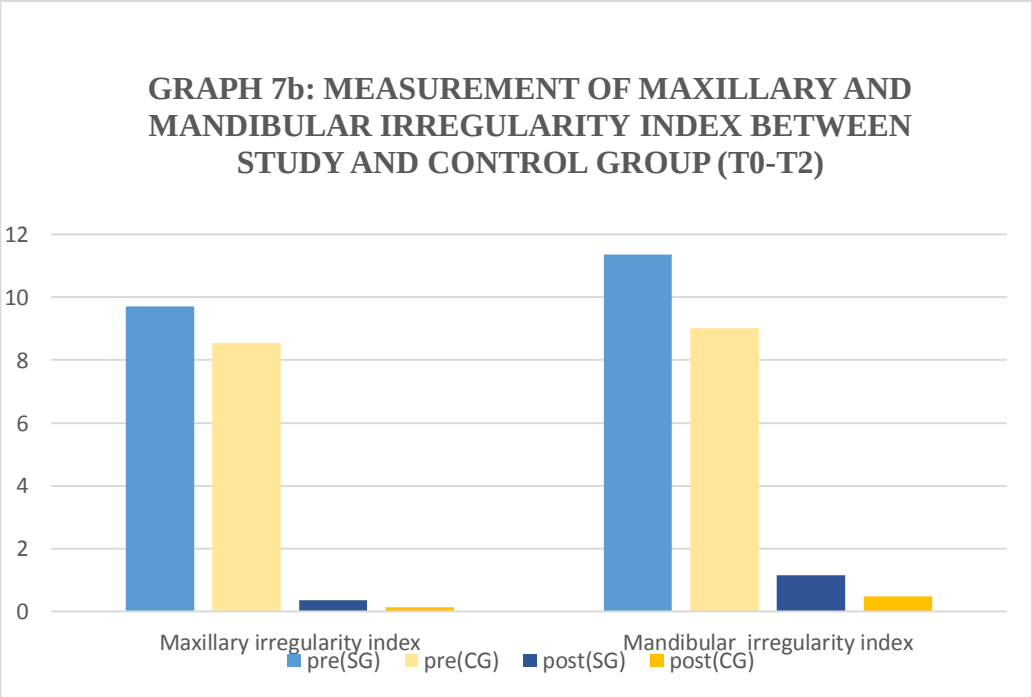
**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

T0- PRETREATMET

T2-POST ALIGNMENT


GRAPH 7a : AXIAL INCLINATION OF UPPER AND LOWER INCISORS AT T0 AND T2
120
100
80
60
40
20
0
Upper incisor to palatal plane
Lower incisor to mandibular plane
Pre(SG)
Pre(CG)
Post(SG)
Post(CG)


GRAPH 7b: MEASUREMENT OF MAXILLARY AND MANDIBULAR IRREGULARITY INDEX BETWEEN STUDY AND CONTROL GROUP (T0-T2)
12
10
8
6
4
2
0
Maxillary irregularity index
Mandibular irregularity index
pre(SG)
pre(CG)
post(SG)
post(CG)

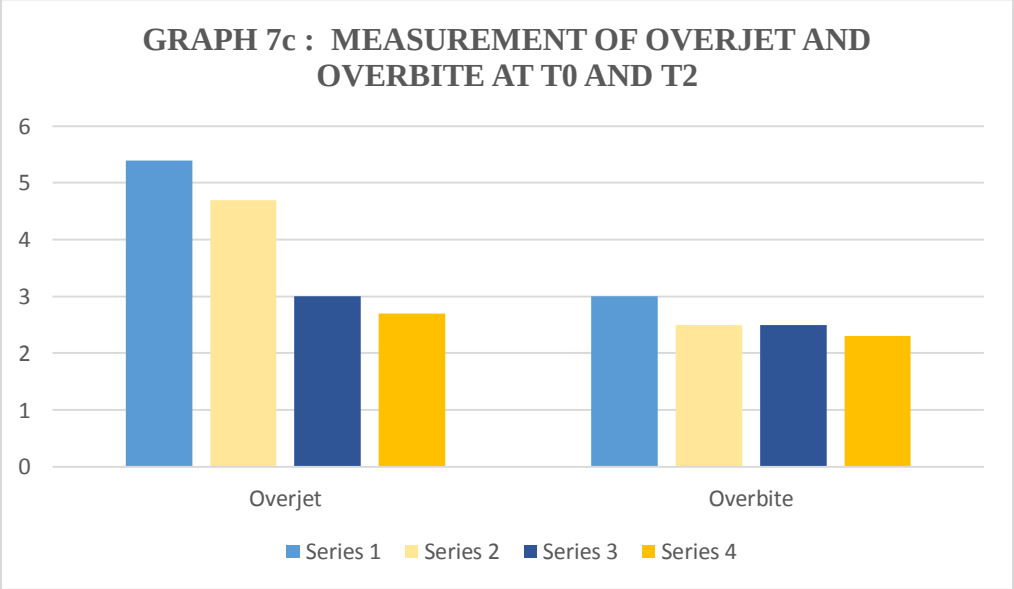

GRAPH 7c : MEASUREMENT OF OVERJET AND OVERBITE AT T0 AND T2
6
5
4
3
2
1
0
Overjet
Overbite
Series 1
Series 2
Series 3
Series 4

TABLE 8: EXTRACTION SPACE BETWEEN STUDY AND CONTROL GROUP (T0-T2)

Arch	PRE			POST		
	Study Group Mean(SD)	Control Group Mean(SD)	p-value	Study Group Mean(SD)	Control Group Mean(SD)	p-value
14	7.37(0.42)	7.51(0.35)	0.572	4.7(0.99)	3.67(1.23)	0.183
24	7.47(0.52)	7.56(0.54)	0.798	4.17(1.43)	4.86(0.88)	0.390
34	7.37(0.80)	7.20(0.56)	0.708	3.21(2.12)	4.92(0.99)	0.140
44	7.42(0.74)	7.19(0.44)	0.562	3.91(1.13)	4.88(0.99)	0.190

*** SIGNIFICANT (p<0.05)**

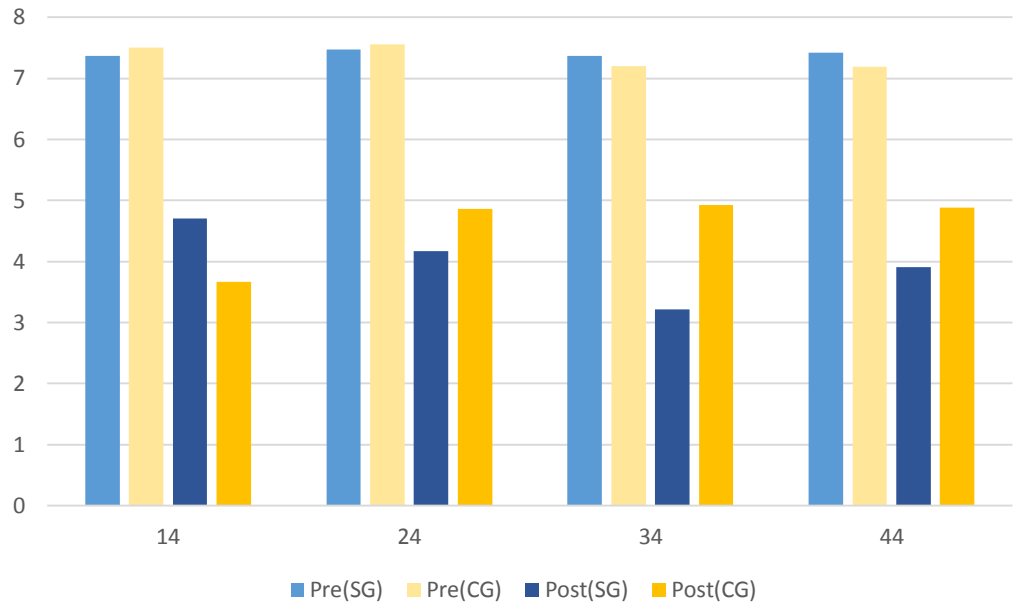
**** HIGHLY SIGNIFICANT (p<0.01)**

***** VERY HIGHLY SIGNIFICANT (p<0.001)**

T0- PRETREATMET

T2-POST ALIGNMENT

GRAPH 8: EXTRACTION SPACES BETWEEN STUDY AND CONTROL GROUP (T0-T2)



Discussion

DISCUSSION

Although self-ligating bracket system has gained immense popularity in the last few years, clinical trials have failed to demonstrate any scientific evidence with regard to self-ligating and conventional brackets.

It was initially proposed that the elimination of elastomeric modules would reduce the site available for colonization of microbes thereby decreasing the plaque and calculus accumulation.[55] Elastomeric ligation gives unreliable arch wire control, resulting in force decay and thus control of tooth movement becomes difficult. Some of the other drawbacks of elastomeric modules include high friction, increased chair side time and an added oral hygiene challenge. On the contrary, wire ligation is very time consuming, has inconsistent force application and the wire ends can traumatize both the patient and operator if proper care is not taken.

In contrast to this, the self ligating brackets are supposed to offer a number of advantages namely robust ligation, full bracket engagement, low friction, increased efficiency, and maintenance of optimal oral hygiene.[29]

The design of the self ligating brackets is said to reduce colonization of microorganisms and promote better oral hygiene because of its concise configuration and absence of ligatures. As a result, self ligating brackets have been claimed to decrease the plaque retention and periodontal breakdown.

GCF is an inflammatory exudate that is composed of serum and locally generated materials with tissue breakdown products, inflammatory mediators and antibodies. The amount of GCF at a given site increases significantly with the severity of gingival inflammation as assessed clinically.[22]

Considering that tissue remodelling incident to orthodontic tooth movement is triggered by an inflammatory process in which one of the first events is an increase in vascular permeability (Krishnan and Davidovitch, 2006) it has been hypothesized that the amount of GCF production might reflect these tissue changes.[73]

There are two methods widely used for collecting GCF. One method uses paper strips and the volume measured using Periotron device and the other method is done using micropipettes.[25] However, there is no literature evidence to show that one method is superior to another. Therefore in the present study, we used micropipettes for collecting GCF.

In the present study, GCF was collected using micropipettes. The sample was collected at mesiobuccal, buccal and distobuccal site for 5 minutes in each tooth in relation to upper anterior tooth (13, 12, 11, 21, 22, 23). The plaque index, gingival index, gingival bleeding index was recorded prior to start of the treatment (T0). Brackets with two different systems were bonded, and oral hygiene instructions were provided to all patients in both the groups.

It is well documented in literature that GCF volume is influenced by both gingival inflammation and orthodontic tooth movement.[55] Literature

reports that under healthy conditions, the GCF volume can range from 3 to 8 μL for 20 to 30 min, while under conditions of inflammation, the gingival inflammatory exudate has a flux volume around 20 μL (Griffiths 2003).[25] In the present study GCF sample was collected for 5 minutes in each tooth for standardization purpose. The GCF volume was calculated only in relation to the anterior teeth. The posterior component of dentition was not included to negate the effect of saliva contamination that can occur, due to proximity of the salivary duct. Baldwin et al[4] reported that the increase in GCF flow induced by orthodontic tooth movement begins much earlier even before the pronounced changes in GCF components are seen. The findings in the study suggests that increase in GCF is an immediate effect of orthodontic force on the blood vessels, rather than an induction of biochemical changes in the extracellular matrix. In contrast, Uematsu et al[71] reported that the volume of GCF around the experimental tooth during orthodontic movement was similar to that of healthy teeth. Therefore an increase or alteration in GCF volume could be due to either plaque accumulation or orthodontic force systems that may trigger inflammatory changes in the periodontal ligament.

Many studies have reported a significant correlation between plaque accumulation, gingival inflammation and volume of gingival crevicular fluid (Demling et al, 2009)[14]. In addition, the effect of orthodontic brackets and force systems and GCF volume cannot be determined unless other factors are under control. However few studies have reported that a significant increase in

GCF flow rate during orthodontic treatment is not related to the presence or absence of gingival inflammation.

The sample used in the present study were predominantly young adults from similar socio-economic background. Patients in both the groups were matched for malocclusion with a fairly healthy periodontium and no mutilated dentition was seen.

In the present study, the GCF volume was not significantly different between the study and control group at the baseline, whereas at 60 days GCF volume increased significantly in the control group and specifically in the region of canines bilaterally. This could be possibly due to the high orthodontic force with conventional elastomeric ligation when compared to bracket without elastomeric ligation (self ligation). Force levels were found to vary between the bracket types[17]. With Damon system, the passive ligation would produce a lower force on the dentition which may be qualitatively different to that seen in the presence of elastomeric ligation—badavi 2009 . On the contrary, Pandis et al[45], demonstrated higher values for self ligating brackets compared to conventional brackets. However, the author concluded that active self ligating brackets exhibit higher forces and moments compared to passive self ligating brackets. Perphaps it was an in-vitro study and force systems varied in all three planes of space with different bracket types. It is reasonable to assume that the GCF volume change is due to orthodontic tooth movement and not by local factors. Therefore further clinical studies are

needed to validate the force levels and its effects on dentition with different bracket systems.

Plaque formation is usually seen around the cervical region of brackets due to difficulty in brushing around the cervical region[6]. Literature reports that conventional brackets with elastomeric ligation accumulate more plaque compared to self ligating brackets. Elastomeric ligatures were found to acquire 38% more micro oragnisms in the form of plaque compared to steel ligatures[26]. Self ligation brackets contain a special locking mechanism to secure the archwire in the bracket without the need for an additional ligation. However studies have shown that these clips might act as a retention site for plaque accumulation. Lee et al[34], reported that the design of the bracket play an important role for alteration in the oral microbiota thereby leading to gingivitis or periodontitis.

Accumulation of bacterial plaque in self-ligating and conventional brackets was assessed by Pellegrini et al[55] who concluded that active self-ligating brackets are less likely to accumulate dental plaque when compared to conventional brackets. The author claimed that active self-ligating brackets allowed better oral hygiene because they did not have a rigid door or lock completely closing the bracket slot thereby forming a fourth wall (buccal) similar to molar tubes. Passive brackets, on the other hand had a rigid buccal wall and this could be reason for greater plaque accumulation inside the bracket slot. Very few literature on passive self ligating brackets which tells

that there is no significant difference between them. We have used Damon Q passive self ligating brackets in our study.

Atik[21] et al reported higher plaque index with conventional brackets compared to other bracket types. Likewise Nalaci[43,44] et al, reported that plaque index and gingival index were lower in self ligating group compared to conventional group after 5 weeks of orthodontic treatment. This difference obtained could be due to change in the dietary habits and population type. However there is no sufficient literature evidence to support the use of one type of bracket over the other for improving the oral hygiene status. The present study also failed to demonstrate any significant difference in gingival index, plaque index and gingival bleeding index between the study and conventional group although all the parameters increased after 60 days of treatment in both the groups.

The ability of the plaque to adhere to various orthodontic brackets have been studied previously and the outcomes have been controversial. While there has been claims that the self ligating brackets tends to attract more plaque, it seems to be a mere opinion of the author and not by well conducted clinical trials. In the absence of conclusive evidence that self ligating self ligating brackets promote more plaque accumulation, it may be reasonable to assume that the inflammation produced is primarily due to tooth movement and not bracket design. Since there are few literature reports on passive self ligating system and no significant differences were seen between active and passive self ligation, we used a passive self ligating bracket in the study.

The role of crowding in oral hygiene status has been extensively studied. It is well established in literature that crowded teeth accumulate greater plaque compared to well aligned teeth. Therefore in the present study both the groups had moderate to severe crowding assessed using Little's irregularity index to begin with in order to negate the effect of malocclusion on treatment outcome.

The effect of age and gender on oral hygiene measures did not seem to have any significant results. In the present study the patients were predominantly young adults and both the genders were included for the study.

Digital vs Plaster models

With the advent of digitization and use of digital models obtained either by scanning the plaster models or by direct intra oral scanning, the software allows visualization of models in all three dimensions such that the orthodontist can evaluate various parameters of the patients dentition such as the occlusion, tooth size, arch length, arch width, over jet and overbite. Currently digital models have been used for 3D superimposition on CBCT scans for diagnosis and treatment planning (Tolga et al)[69]. The reliability of digital setups for treatment planning have also been found to be effective and accurate compared to manual setup (Baretto et al)[5]. In the present study, both the conventional plaster models and digital models were used to evaluate arch dimension changes and to check the accuracy and reproducibility of measurements made using both the models

Meredith et al[57], compared the measurements of arch dimensions using both plaster models and digital models. He concluded that the reproducibility and efficacy was high for measurements made on both computer based models and plaster models. This is well supported in literature.

In the present study, the digital models were obtained by scanning the plaster models. Results inferred that digital models were effective and accurate for arch dimension such as arch width, arch length and arch alignment and thus can be considered a substitute for plaster models.

Arch Dimension Changes

A total of 10 patients with Angle's class I malocclusion who required first premolar extractions were selected for the study to assess the arch width and dimensional changes and compare the alignment efficiency with two bracket systems.

Self ligating brackets have been claimed to be more efficient and also exhibit significant arch dimension changes. There is also a consensus that extractions could be avoided with self ligating brackets particularly with the Damon philosophy[12], which has broad arch wires and passive clip claiming that posterior expansion with the bodily movement and minimal tipping of teeth is made possible. However there appears to be little basis for the claims that self ligating brackets induce such distinctive arch dimension changes.

In the present study, the arch dimensional changes were recorded in terms of arch length and arch width at the canines, 2nd premolars and first

molars. Results confirmed that arch dimensional changes with both Damon and conventional brackets were similar and not significantly different. The arch length decreased in both the groups. This is in concurrence with previous literature which showed a decrease in arch length in extraction patients, probably due to the distal movement of the anterior teeth and forward movement of posterior teeth[53].

The inter canine and inter premolar width increased in both the groups, while the inter molar width was reduced in both study and control group. This is again well supported in literature[21]. Since the Damon broader archwires were used in both bracket systems, the expansion obtained at the canines and premolars were similar. Scott et al[53] reported that the increase in the inter canine width could also be due to the distal movement of canines into first premolar spaces during alignment stage. Likewise, the decrease in inter molar width can be attributed to the forward movement of the first molars that could have negated the expansion effect taken place at the first molars[53].

SL brackets encourage passive space closure during initial alignment of teeth. There is a relative lack of evidence comparing the efficiency of self Ligating and Conventional Ligating brackets in extraction patients because most studies have investigated mixed samples. Only 2 clinical trials have compared self Ligating and conventional ligating brackets solely in extraction patients. The increase in inter canine width in the maxilla was 2.5mm and 3.1mm in the study and control group respectively. Likewise the mean

increase in mandibular arch was 3.23mm and 3.06mm respectively in study and control group. In a study by Fleming et al[51,50], the arch width changes were assessed using the different bracket systems. Results showed no significant difference in transverse arch dimension between self ligating brackets. Similarly Ezik et al[21], also found that the maxillary arch dimensional changes with active, passive self ligating and conventional brackets were similar, when treated with the same Damon archwires. Therefore it is the archwire shape that decides the quantum of expansion and not the bracket design or bracket type.

All the study models were assessed for crowding using Little's irregularity index. The irregularity index was 9.71mm in maxilla and 11.36mm in mandible in the study group. In the control group, an irregularity index of 8.55mm and 9.02mm was seen in the maxillary and mandibular arch respectively. This shows that the quantum of discrepancy was greater than 5mm showing severe crowding in both the groups. The irregularity index scores was reduced to 9.34mm in maxilla and 10.21mm in mandible with Damon brackets. In the control group, the irregularity score reduced to 8.41mm and 8.53mm in maxilla and mandible respectively. This showed that although, the arch alignment and crowding correction was similar and was not significantly different between conventional and Damon brackets. It is documented in literature that, for patients with irregularity scores greater than

5mm, the alignment shown by Damon brackets as supposed to conventional brackets were similar and not significantly different[15,46,47,48,49].

In the present study, Damon Q brackets was used. It is a newer generation of Damon brackets having a low profile and torque values in upper and lower incisors have been increased. There is only one clinical trial by Fleming et al[51], who compared Damon Q brackets with In-Ovation C and conventional bracket system. His study did not result in any significant changes in arch dimensions or irregularity scores between all 3 bracket systems. Therefore, any specific advantage of Damon Q brackets over the other prescription of Damon brackets is yet to be validated.

The incisor inclination was assessed in relation to palatal plane for maxillary incisor and mandibular plane for lower incisors. Results showed that the upper and lower incisors retracted in both the groups at the end of alignment. [18,46.] This is due to the fact that in extraction cases, the upper and lower incisors align and move distally and upright themselves without causing undue proclination of anterior teeth. Previous literature studies have assessed the efficiency of self ligating brackets in non-extraction cases and results inferred proclination of maxillary and mandibular anterior teeth. Since, our study was done on extraction patients, the upper and lower incisors uprighted and is an anticipated and expected outcome.

The changes in the arch dimensions were similar in both the groups. Thus, the claims made by the Damon system has not been proved in the

present study. The expanded arch form seemed to play an important role in arch expansion rather than the bracket type. Therefore, the efficiency of both the systems are comparable and not superior to one another.

Limitations and future research

The present study had limited sample size. Moreover the GCF samples were collected at pre treatment and at the end of 60 days of orthodontic treatment. GCF collection at different time points may be needed to validate the periodontal response to the effect of orthodontic force system in different bracket systems.

Therefore further controlled clinical trial with greater sample size are needed to validate the clinical efficiency of Damon Q self ligating brackets.

Summary and Conclusion

SUMMARY AND CONCLUSION

The purpose of the study was to compare the alignment efficiency, arch dimensions and incisor inclination changes with (Damon Q) passive self ligating and conventional brackets and also to evaluate the periodontal status in terms of (PI)plaque index, (GI) gingival index, (GBI) Gingival bleeding index, Gingival Crevicular Fluid volume (GCF) in patients with both the groups.

10 patients having Angle's Class I malocclusion with moderate to severe crowding requiring all 1st premolar extractions were chosen according to inclusion and exclusion criteria and were randomly divided to 2 groups .Group 1 – Damon Q self ligating bracket system with 0.022 slot (ORMCO). Group 2 – Conventional bracket system (American Orthodontics – 0.022 slot with Roth system).Pre-treatment (T0) and Post alignment (T2) records such as orthopantamogram (OPG), Lateral Cephalogram, plaster models, and intra oral photographs were taken. Oral prophylaxis was done for all the patients prior to the start of treatment. GCF sample was collected at the start of treatment (T0) and after 60 days of treatment (T1). Likewise for all the patients, periodontal parameters such as PI (plaque index), GI (gingival index), and GBI (gingival bleeding index) were measured at the start of treatment (T0) and after 60 days of treatment (T1). Pre-treatment (T0) and post alignment (T2) study models were measured and also scanned to obtain measurements in digital models. The axial inclination of the upper and lower

incisor were measured at T0 and T2 using lateral cephalogram. The changes in the arch dimensions such as Inter canine width(ICW), inter premolar width(IPW),inter molar width(IMW), arch length changes and irregularity index scores were calculated using both plaster models and digital models in both the groups. Digital models were imported using Dolphin program to measure the Pre and Post alignment changes in maxillary and mandibular arch using Damon and conventional brackets A reliability test for digital and plaster models was done using Cohen's Kappa statistics. The GCF volume was assessed at baseline and after 60 days of orthodontic treatment in both the study and control group. Results demonstrated where the GCF volume increased from baseline to 60 days in both the groups. However inter group comparison showed that GCF volume increased significantly to a greater extend in the control group compared to study group and the increase was particularly evident in the canines bilaterally. Independent T test to assess the periodontal parameters such as gingival index, plaque index and gingival bleeding index between study and control group. Results showed, in all periodontal parameters increased significantly in both the groups at T1. However, there was no statistically significant difference when compared between study and control group. Similarly, the GCF volume increased at the end of 60 days of orthodontic treatment in both study and control group.

The arch dimensions were measured in terms of arch width, arch length and irregularity index using both plaster and digital models in both the groups. Results showed an increase in inter canine width, inter pre molar

width and decrease in inter molar width and arch length was observed with both bracket types. The irregularity index also scores decreased in both the groups.

Therefore Damon Q self ligating bracket were found to be no more efficient than conventional brackets in terms of arch alignment and arch expansion. The expanded arch form seem to play an important role in arch expansion rather than the bracket type. Thus the efficiency of both the systems are comparable and not superior to one another. Bracket design does not seem to have a significant impact on oral hygiene status and periodontal response to orthodontic treatment.

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Annexures

Annexure – I

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TO WHOMSOEVER IT MAY CONCERN

Date: 18.12.2017
Place: Chennai

From
The Institutional Review Board,
Ragas Dental College and Hospital,
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The dissertation topic titled **"ALIGNMENT EFFICIENCY, GINGIVAL CREVICULAR FLUID VOLUME, AND PERIODONTAL PARAMETERS ALTERATIONS BETWEEN TWO BRACKET SYSTEMS - AN INVIVO STUDY"** submitted by **Dr. HARISH. P,** has been approved by the Institutional Review Board of Ragas Dental College and Hospital.

Dr. N.S. Azhagarasan M.D.S,
Member secretary,
Institution Ethics Board,
Ragas Dental College & Hospital
Uthandi,
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Annexure – II

URKUND

Urkund Analysis Result

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