
# A COMPARATIVE STUDY OF BANDED MOLARS VERSUS BONDED MOLARS ON ANCHORAGE DURING ALIGNMENT AND RETRACTION PHASE - AN *IN VIVO* STUDY.

By

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**IN**

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I hereby declare that this dissertation entitled "***A comparative study of banded molars versus bonded molars on anchorage during alignment and retraction phase - an in vivo study*** is a bonafide and genuine research work carried out by me under the guidance of ***Prof. Dr Tony Michael*** , Professor of Orthodontics& Dentofacial Orthopaedics, St Gregorios Dental college ,Chelad, Kothamangalam

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# ABSTRACT

**Background and Objectives:**

Anchorage loss is a potential side effect of orthodontic mechanotherapy and one of the main cause for unsuccessful treatment results. The causes for anchorage loss is multifactorial. According to some case reports periodontal damage can be induced by banding the anchor molars. Gingival inflammation and hyperplasia may occur due to banding and separator placement. There are four possible reasons which may cause gingival inflammation associated with orthodontic banding. First, orthodontic bands may mechanically irritate gingival tissues. Second, chemical irritation may occur due to the cement used to retain the band, which is in close proximity to the gingival tissues. Third, a greater risk of food impaction which may trigger gingival and periodontal irritation. Finally, the patients have a tendency to clean their posterior teeth less effectively than their anterior teeth. Previous studies indicate increased levels of prostaglandins during inflammatory changes. Increased levels of prostaglandins is also known to accelerate orthodontic tooth movement. The presence of molar bands usually triggers inflammatory changes around the anchor molars. This study is to evaluate the effect of banded molars on anchorage when compared to bonded molars.

**Objectives of the study:**

To compare the anchorage loss of banded upper anchor molars with bonded upper anchormolars during orthodontic retraction.

**Methods:**

20 patients from the Department of orthodontics were selected after obtaining their written consent forms. Pre-treatment lateral cephalograms were taken, and study models were made as a part of the treatment. All patients were started with MBT brackets with 0.22 slot. Maxillary anchor molar was bonded on one side and banded with standardized preformed bands with buccal tubes welded onto it on the other side. Adequate space was created in either side of the molars using separators. After the

retraction phase of the treatment, cephalograms and study models were repeated and the data was analyzed for assessing the anchorage loss.

**Results and Discussion**

The amount of anchor loss was greater in the banded group than the bonded group, which was statistically significant with a p value<0.05. This could be due to the release of prostaglandins from the inflamed tissues surrounding the bands caused by the separator placement and prolonged impingement of band materials or cement on the gingiva.

**Conclusion**

Post retraction mesial movement of both the banded and bonded molars were observed ,indicating anchorage loss. The loss of anchorage was found to be more with banded group when compared to the bonded group which is found to be statistically significant.

**Key words**: Banded molars, Bonded molars, Anchorage loss

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# ***INTRODUCTION***

# INTRODUCTION

According to Newton's third law of motion, for every action there is an equal and opposite reaction. Teeth are exposed to forces and moments throughout treatment and these forces continually generate reciprocal forces of similar magnitude however opposite in direction.[1] These reciprocal forces must be controlled in order to minimize the unwanted tooth movement and to attain a better result. Anchorage is defined as the resistance to orthodontic tooth movement. It can be obtained from other teeth, palate, head, neck or implants.[2]Therefore, anchorage control and selecting appropriate treatment mechanics is crucial during treatment planning. Several intra oral and extra oral adjuncts are used in orthodontics to anchorage conservation. Some of them are trans palatal arch, Nance palatal button, and lingual arches, headgears and temporary anchorage devices (TADs)

Anchorage loss is an unfortunate consequence during the steps of leveling and aligning, overjet reduction or space closure etc. and is usually greater in the maxillary arch than the mandibular arch. Many factors have been reported to influence loss of anchorage. These include the type of tooth movement, malocclusion, root morphology /length of the root, number of the missing teeth. Biomechanics of space closure, patient compliance, extent of crowding, overjet, overbite, bone morphology of the extraction site, skeletal parameters, eruption status of the third molars, and localized pathologies (i.e., ankyloses, periodontitis), also can play a role in anchorage loss. In most of the fixed orthodontic treatment anchorage is derived from molars. The molars are usually bonded or banded with buccal tubes attached to them. Prior to banding, separators are placed to create enough space to accommodate the band.

Orthodontic separators (also referred to as spacers) are elastomeric bands or metal appliances and are placed in the interdental region mesial and distal to the molars, in order to house molar bands during fixed orthodontic treatment.[3] The spacers remain in between the teeth for one week and move the teeth apart slowly until they have created enough space so that the orthodontist can fit the molar bands. Orthodontic separators exert forces on the adjacent teeth to push them apart. Brass wires, latex elastics, elastomeric and spring-type separators are the most commonly used separators in orthodon-

tics .[4]The separators are left in between the teeth for around 24 hours to 1 week and the process is very pain painful. This may induce pain for the patients due to inflammation. Pain could be a subjective response, has massive individual variations and depends on various factors like age, gender, emotions, stress variations former pain experiences etc. Prostaglandins are hormones that exert heaps of influence over key physiological processes in our body including pain pathways and inflammation.

As part of natural healing, body synthesizes prostaglandins at the sites of inflammation or tissue damage. The prostaglandin called thromboxane induces blood clot formation. It conjointly causes the muscle within the vessel wall to contract. Another autacoid known as prostacyclin has the opposite effect to thromboxane, reducing blood clotting and removing any clots that are no longer needed. It also causes the muscle within the blood vessel wall to relax. The counter balancing effects of thromboxane and prostacyclin control the amount of blood flow and regulate inflammatory changes.

Prostaglandins have the ability to induce orthodontic tooth movement. NSAIDS are the drugs usually given for pain management, these drugs have also shown to reduce bone resorption and hence impede the orthodontic tooth movement. Great attention has been targeted on the consequences of prostaglandins and leukotrienes in orthodontic tooth movement.[5]

Orthodontic bands usually cause periodontal inflammation, hence the usage of a buccal tube (bond) instead of a band should prevent or minimize periodontal changes because bonded buccal tubes are positioned away from the gingival margins.[6] More over bonding eliminates the need for separators and thereby reduces tissue damage.

Gingival inflammation and hyperplasia may occur during separator placement and banding the tooth.[7]There are four possible reasons which may cause inflammation during orthodontic banding. First, orthodontic bands may mechanically irritate gingival tissues. Second, chemical irritation may occur due to the cement used to retain the band on the anchor molars, which is in close proximity to the gingival tissues. Third, a greater risk of food impaction which may trigger gingival and periodontal irritation. Finally, the patients have tendency to clean their posterior teeth less effectively than their anterior teeth[8]

Previous studies have indicated increased levels of prostaglandins during inflammatory changes.[9] Increased levels of prostaglandins is known to accelerate orthodontic tooth movement. The presence of molar bands usually triggers inflammatory changes around the anchor molars.

Anchorage loss has been investigated with various orthodontic fixed appliance systems. In their retrospective study, Gerone et al [10]found that anchorage loss was significantly greater with labial edgewise appliances compared with lingual edgewise appliance systems. Various literatures have concluded that no significant differences exist between conventional bracket systems and self-ligating bracket systems for anchorage loss [11-16.] Rajesh et al [17]found that anchorage loss was greater with Roth prescription than MBT appliances due to the added tip values of the prescription.

There are a number of studies regarding the clinical efficacy of banded and bonded molars, but none regarding their effect on anchorage loss. This study is attempted to compare the effect of banded and bonded molars on the anchorage conservation.

# ***OBJECTIVES***

## AIM

To evaluate the anchorage loss in banded upper anchor molars when compared to bonded upper anchor molars.

## OBJECTIVES

- To find out the anchorage loss in Banded upper anchor molars
- To find out anchorage loss in Bonded upper anchor molars
- To compare the anchorage loss in Banded and Bonded anchor molars.

# ***BACKGROUND & REVIEW OF LITERATURE***

## BACKGROUND OF THE STUDY

Anchorage preparations play a vital role in the effective management of orthodontic patients for obtaining both structural balance as well as treatment results. Anchorage is a treatment perspective may be defined as the resistance to unwanted tooth movement or as the desired reaction of posterior anchor teeth to space closure mechanotherapy.[18] Depending on the treatment strategy, it can be classified as minimum, medium, or maximum anchorage. Obtaining maximum or absolute anchorage has always been a relentless goal for the orthodontist often resulting in a condition termed as anchorage loss. It is a reciprocal reaction that can obstruct the success of orthodontic treatment. Anchorage control is usually critical in patients if maximum anterior tooth retraction is desired. Extra oral appliances such as headgears have been effective in molar anchorage control but their effectiveness depends on patient compliance.[19,20] The use of multiple teeth as an anchorage segment to form a large counterbalancing unit and the application of differential moments have also been described as methods to stabilize the anchor molar position.[21,22]

Banding and bonding are the usual methods of fixing attachments in orthodontics. But an often neglected outcome of the banded treatment is increased gingival and periodontal inflammation caused either by the band itself, the use of separators or the cement used to fix the band and often the lack of providing proper oral hygiene to the posterior area by the patient. The mesial movement of the anchor molars which are observed could be due to the Prostaglandins synthesized at the inflammation site. This study is an attempt to compare the effect of banded as well as bonded molars on anchorage.

# REVIEW OF LITERATURE

**Begg et al in 1956,** concluded that the begg appliance offers an economy in the use of intra oral anchorage. This is brought about in the first place, through bodily control given to anchor units with the help of anchor bend (tip-back bend) and, the freedom to tilt offered to the units that are to be moved and the light differential forces employed. The light forces are inadequate to cause rapid movement of the anchorage unit, and forces applied to correct the axial inclinations of the tilted units, in the later stage of the treatment partially counterbalance one another when inter maxillary elastics are added, the two dental arches virtually become one unit, the whole being resistant to any displacing force created by the balancing action of the spring auxiliaries. Anchorage for retraction after arch wire is attached, Class II elastics are placed between the inter maxillary hook of upper arch wire and the hook on mesial end of lower molar tube. It will tend to pull the molar forward, retract the anteriors and anchorage bend counteracts the mesial pull. [23]

**Stoner et al in 1958,** explained in his literature about the contributions of Calvin case and E.H Angle. Calvin Case advocated the use of reciprocal elastics to effect movement between individual teeth in opposite arches. However, Baker moved forward with the use of Angles E arch, in correction of Class II irregularities. In his seventh edition, Angle stated that inter maxillary anchorage is the ideal force and the reciprocal activity at each end of rubber band, provided the best anchorage for correction of class II condition and the creation of normal occlusion. Inter maxillary elastics pit the upper teeth to the lower teeth and are common means of gaining differential tooth movement. The direction of the elastic defines its force vector and the terminology used to describe it. Class II elastics are attached to the anterior maxillary teeth and the posterior mandibular teeth. Thus a class II elastic corrects class II relationship by retracting the upper anterior teeth and a simultaneous protraction force to the lower molars. [24]

**Vanderlinder et al in 1971,** stated that the removable appliances mainly obtained their anchorage from base plates. Tooth borne appliances such as activator, bionator and twin block obtain their anchorage from capping of incisal margins of lower incisors and proper fit of cups of teeth into acrylic. If deciduous molars are present, it is used as anchor teeth and labial bow prevents anterior flaring and posterior displacement of the appliance.[25]

**Baker et al in 1972,** concluded that Anchorage can be reinforced by including as many teeth as possible in the anchorage unit. The ratio of the PDL area of the anchorage unit to the PDL area of the tooth movement unit is calculated. For skeletal anchorage systems, it should be 2:1 without friction and 4:1 with friction.[26]

**Ricketts et al in 1976,** stated that the movement of the tooth is diminished when the root contacts the cortical bone. It restricts the mesial movement when extraction spaces are to be closed, by torqueing the roots of posterior teeth outward against the cortical plate.[27]

**Roth et al in 1976,** stated that tooth has to be over corrected prior to the deboning. The banding of second molars at the onset of treatment can minimize the anchorage loss. During leveling and alignment, flexible wires helps to conserve the anchorage. Small wires exert light continuous forces on teeth and the overbite and occlusion hold the arches in the rest position.[28]

**J. R. Sandy and M. Harris et al in 1984,** stated that non-steroidal anti-inflammatory drugs can inhibit orthodontic tooth movement. The most likely mechanism is the inhibition of prostaglandins formation with a resultant inhibition of osteoclastic activity and bone resorption.[29]

**Peter Ngan et al in 1989**, concluded that One of the key factors that may defer a patient from pursuing orthodontic consultation is fear of pain. Orthodontic patients usually are informed that there may be some discomfort and pain associated with the insertion of orthodontic separators, initial arch wires and during periodic adjustment of orthodontic appliances. Studies have shown that the response of patients to the initial

movement of teeth varies' and it is difficult for the orthodontist to respond accurately to prospective patient inquiries regarding the extent and duration of discomfort that might be experienced. The results of this study showed that there is discomfort associated with either the insertion of separators or initial arch wires. Orthodontic patients may be expected to experience some discomfort within at least 4 hours after insertion of either separators or arch wires. The level of difficulties tends to increase in the next few hours but decreases to pre-placement level in one week. Separator placement tends to increase the level of discomfort on the posterior teeth, whereas the placement of arch wires tends to increase the level of discomfort on the front teeth for initial alignment of the anterior teeth.[30]

**Bishara et al in 1989** stated that**,** second-order tip-back bends can be utilized to prepare anchorage. The degree of tip-back on the anchor molars should be such that when the arch wire is placed in the buccal tubes, it will pass through the cuspid teeth at their cemento enamel junctions. After placing the arch wire in the molar tubes of the anchor molars when it is raised and ligated to the two brackets on the first molar teeth, the mesial cusps of the terminal molar teeth are elevated and the first molars are depressed. At this point, the arch wire will rest gingival to the brackets on the second premolar teeth. When the arch wire is placed in the slots of the second premolar brackets, the first molars are elevated and the second premolars are depressed. Thus, the force to tip the terminal molars are transferred to the second premolar teeth.[31]

**Sala et al in 1991,**stated that prostaglandins are not pre-stored in cells but are formed only when the activation of phospholipase or other lipases takes place in tissue. This activation result from various factors such as physiological stimulus, pharmacological stimulus [e.g. angiotensin, bradykinin, noradrenaline (norepinephrine)], or pathological stimulus (tissue injury or disease). Prostaglandins exhibit a number of effects, primarily upon those cells immediately surrounding the site of their formation, partly because they are rapidly inactivated. Prostanoids have been shown to have a wide range of effects on many systems and a role for prostaglandins in tissue inflammation and injury has been proposed.[32]

**Carriere. Pp et al in 1990,** concluded that, Anchorage preparation is chiefly done in maxillary arch. Treatment begins in the upper arch starting from distal segment and moves towards mesial side in sequence. Hence there is no strain on anchor part. Steps in the anchorage preparations are as following

a. Posterior leveling and retraction
b. Anterior leveling and retraction.[33]

**Bradley J. Leiker et al in 1995**, conducted a study to evaluate the long-term effects of varying concentrations of injectable, exogenous prostaglandin E2 on the velocity of tooth movement and the amount of root resorption. The results indicated that injections of exogenous PGE 2 over an extended period of time in rats did enhance the velocity of orthodontic tooth movement. However, there was no significant difference in tooth movement in between the amount of root resorption as seen from scanning electron micrographs increase with the use of prostaglandin injections, specifically with increased numbers of injections and with increased concentrations of prostaglandin.[34]

**Burstone CJ et al in 1995**, stated that controlled distribution of forces between the anterior and posterior parts of a fixed appliance can only be accomplished by dividing the arch into several segments. Every segment is consolidated into a fixed unit by a section of rigid rectangular wire, with negligible play between wire and bracket slot. The anterior segment, usually including the incisors and possibly the cuspids, forms the active unit, and the two posterior segments, including the bicuspids and molars, are the reactive segment. When necessary, the reactive units are connected by a TPA to form a single rigid, multirooted entity. The planned displacement of the anterior part and the corresponding reaction of the posterior segments are carried out by connecting the anterior and anchorage units with active elements, such as retraction spring. The point of force application is the bracket. If a pure force is directed distal to the bracket, the tooth will undergo a distal tipping movement. If a pure bodily movement of the tooth is desired, the counteracting moment must be neutralized. This can be done by calibrating the retraction spring to produce an equal and opposite force at the canine bracket **.**[35]

**Philipp A Scheurer et al in 1996,** conducted a study on Perception of pain as a result of orthodontic treatment with fixed appliances and found that there is difference in perception of pain after the insertion of fixed appliances based on sex, age and tooth position. Pain intensity is peak during initial days and subside after few days. Several patients reported back with moderate pain but only 16 percentages of them consumed analgesics during the first day. In this study pain is mostly seen during mastication.[36]

**Joseph O. McLaughlin et al in 1996** conducted a study on the incidence of bacteremia after banding procedure. An orthodontic band was placed on the anchor molar of each subject. Blood samples were taken before, and 1 to 2 minutes after banding. Microbiologic tests performed on the blood samples revealed a low incidence of bacteremia after orthodontic banding. In patients with gingival and periodontal health, orthodontic banding produces a low incidence of bacteremia compared with other dental procedures. The orthodontist is advised to seek guidance from the patient's physician before placing orthodontic bands. Alternatively, avoiding trauma to the gingival tissue by placing bonded attachments to the molars may help resolve this clinical problem.[37]

**Braun et al in 1997** concluded that in a typical extraction case it is desired to close the extraction space 60% by retraction of anterior teeth and 40% by forwarding movement of posterior teeth. This can be obtained mainly by three approaches: • One step space closure with a frictionless appliance system. • Two-step procedure by sliding the canine and then retracting the incisors, its referred to as tweed technique • Two-step closure by tipping the anterior part with some amount of friction and then up righting the tipped teeth.[38]

**Melson et al 1997** stated that. the anchorage requirement depends upon the number of teeth to be moved, the type and number of teeth being moved, type of tooth movement, periodontal condition, duration of orthodontic tooth movement, and anchorage value. Anchorage value of tooth is approximately equal to its root surface area of molars and 2nd bicuspids in each arch is roughly equal in surface area to incisors and cuspids.[39]

**Sanders in 1999** conducted a study on periodontics and orthodontics to clarify the inter relationship between orthodontic tooth movement and common periodontal problems; it has been shown that the orthodontic therapy in patients with good oral hygiene and the absence of significant periodontal disorders do not pose any significant periodontal risk. In the presence of poor oral hygiene, however, and under circumstances of certain types of periodontal problems, fixed orthodontic therapy and tooth movement can contribute to significant deleterious periodontal problems.[40]

**McLaughlin RP et al in 2001** stated that, anchorage control can be discussed in mainly three planes: horizontal, vertical, and lateral planes. Anchorage control in all three planes is inter-connected and failure to control one plane can cause problems with another. Anchorage control in the horizontal plane includes the correct antero-posterior position of the teeth at the end of the therapy and involves limiting the mesial movement of the anchor teeth while encouraging the distal movement of the anterior teeth. This can be again divided into Control of anterior segments and posterior segments. Control of anchorage in anterior segment includes Lace backs and bends backs, Bracket prescription with reduced tip and use of very light arch wire forces. Posterior anchorage requirements are usually greater in the upper arch than in the lower arch because of the following reasons ,upper anchor molars move mesially more easily than the lower molars. Anterior teeth in the upper arch are bigger. Anterior brackets have more tip built into them to avoidance of elastic chain ,Upper incisors require more torque control and translatory movement than lower incisors which require distal tipping or up righting.[41]

**Gerdon et al in 2003,** stated that, anchorage loss is a detrimental effect of orthodontic mechanotherapy and one of the basic causes of unsuccessful outcome. Anchor loss can occur in all planes. In sagittal plane, mesial movement of molars and proclination of anteriors can happen. In vertical plane mainly extrusion of molars and bite deepening due to incisor extrusion. In transverse plane buccal flaring due to over expanded arch form and unintentional lingual root torque.[3]

**Melih Y. Sueria et al in 2006,** stated that the lacebacks proved to be effective for distalization of canines. Canine and molar movement was found to be less for this group, but more controlled movements were obtained for the sagittal, vertical, and transverse plane.[42]

**Van Gastel et al in 2007**, reported that dental plaque is the primary cause of gingival inflammation and periodontitis. Conditions that encourage the growth and retention of dental plaque result in a localized gingivitis, which rarely progresses to periodontal disease. Only a few studies report attachment loss during orthodontic treatment. The contradictory findings on the impact of malocclusion and orthodontic appliances on periodontal health may be partly due to the selection of materials and differences in the research methods employed.[43]

**Bollen AM et al in 2008,** suggested that, Orthodontic treatment was related to 0.03 millimeters of gingival recession, 0.13 mm of alveolar bone loss and 0.23 mm of increased pocket depth compared with patients who do not undergoing treatment, and it had been found that the consequences of orthodontic therapy on gingivitis and attachment loss weren't constant across studies. [44]

**Thornberg et al in 2009,** and coworkers had done a study investigate changes in orthodontic treatment after ;Actinobacillus actinomycetem comitans, Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsythia, Eikenellacorrodens, Fusobacteriumnucleatum , Treponemadenticola , and Campylobacter rectus. It has been shown that for six (PI, TF, EC, FN, TD, CR) out of the eight pathogens, the percentages of subjects with high microbial counts increased significantly after six months of treatment, but these returned to pretreatment levels by one years of treatment. No pathogen level was significantly higher after one years of orthodontic treatment.[45]

**Aous Dannan et al in 2010,** conducted a study on ortho perio interrelationship and concluded that, removable appliances offer intermittent tipping forces while fixed appliances create continuous multidirectional forces for torqueing, intrusion extrusion, rotation etc. Resorption occurs on the pressure side and new bone formation on the tension side. Once the pressure is applied to a tooth, there is an initial period of

movement for six to eight days as the periodontal ligament (PDL) is compressed. Compression of the PDL results in blood supply being cut off to an area of the PDL and this produces an avascular cell-free zone, termed as "hyalinized zone". When hyalinization occurs, the tooth movement stopped. Once the hyalinized bone is removed, tooth movement can occur again. Nowadays, it is accepted that proper plaque control procedures before initial orthodontic banding, may minimize the inflammatory lesion during orthodontic therapy.[46]

**Emanuela Ricciottiet al in 2011** assessed the effect of prostaglandins on tooth movement. They concluded that Prostaglandins are lipid autacoids derived from arachidonic acid. They perform homeostatic functions and mediate pathogenic mechanisms, including the inflammatory response. They are formed from arachidonate by the action of cyclooxygenase (COX) isoenzymes and their biosynthesis is blocked by nonsteroidal anti-inflammatory drugs (NSAIDs), including those selective for inhibition of COX-2. prostaglandins may help in both the promotion and resolution of inflammation.[47]

**Brent R. Hoggan et al in 2011,** concluded in his study that, the medial end of the third palatal rugae is considered to be a suitable landmark for model analysis.[48]

**D.Shukla in 2011** et al stated that Orthodontic treatment and tooth movement have a significant effect on the stability of first and second palatal rugae as concluded by previous investigators. The most reliable points which remain stable over a person's life were the medial and lateral third rugae points and these could be used as reference points to evaluate the dental movements.[49]

**Kamachi diravidamani et al in 2011** concluded that, Prostaglandin is the mediators of mechanical stress during tooth movement. They promote bone as well root resorption, decrease collagen formation and all. They stimulate bone resorption by increasing the number of osteoclasts and activating osteoclasts lower concentration of prostaglandins appears to be effective in enhancing orthodontic tooth movement.

Higher concentration always leads to root resorption. Systemic administration is reported to have better effect than locally administrated. Researchers have injected prostaglandins locally at the site of orthodontic tooth movement to enhance the bone remodeling process and the rate of tooth movement. One of the main side effect associated with local injection of Prostaglandins is hyperalgesia due to the release of noxious substance.[50]

**Ildeu Andrade Jr et al in 2012,** when an orthodontic force is applied, the periodontal tissues express extensive macroscopic and microscopic changes, leading to alterations in microenvironments: extracellular matrix, cell membrane, cytoskeleton, nuclear protein matrix, and genome. The capability of adaptive reaction to applied mechanical loading relies on the DNA of periodontal ligament (PDL) and alveolar bone cells. The inflammatory process is a precondition for these modifications to occur, which will lead to tooth movement (OTM). Vascularity and blood flow changes, as well as mechanical alterations in the cytoskeleton of PDL, osteoclasts and osteoblasts, will result in local synthesis and release of mediators, such as chemokines, cytokines, and growth factors. These molecules will induce many cellular responses by various cell types in the periodontium, providing a favorable microenvironment for bone resorption or deposition and, consequently, for OTM. In this inflammation and tissue remodeling sites, cells may also communicate with one another through the interaction of cytokines and other related molecules.[51]

**Irvine R et al in 2012** found that active laceback produced anchorage loss of maxillary first molars whereas passive laceback have no effect on the position of these teeth.[52]

**Ashok K Talapaneni, et al in 2012** concluded in his study that,[41-53]a significant retroclination of upper and lower incisors occurred with MBT prescription after the first phase of orthodontic mechanotherapy while there could be a proclination of labial segments with Roth prescription. Mesial migration of the upper molars was evident in a patient treated with Roth prescription hence reinforcement of molar anchorage is deemed to the necessary in the maxillary arch right from the onset of the orthodontic treatment. Roth prescription was characterized by the significant forward inclination

of the canines, while canine distalized into extraction spaces with no influence on incisal proclination in the MBT prescription.[53]

**M Rajesh etal in 2013**' conducted a study on Comparison of anchorage loss following initial levelling and aligning using ROTH and MBT Prescription and found that, anchor loss was more in ROTH group when compared with MBT group during initial levelling and aligning. This anchor loss can be attributed to many causes like the increased tip in the anterior segment in ROTH prescription compared to MBT that might have resulted in the forward thrust of the incisors to move labially. Lace back creates anchorage loss specifically when the posterior anchorage is not enhanced.[17]

**Samah Al Furiji etal in2014,** stated that**,** Periodontal health is mandatory for any form of dental treatment. Adult patients must undergo regular oral hygiene instruction and periodontal maintenance in order to maintain healthy periodontium. Orthodontic treatment is usually not indicated in patients with periodontal disease or poor periodontal health as the chance of further periodontal destruction is high in those cases. Therefore, assessment of the periodontal health and level of gingival attachment is recommended prior to the treatment. good oral hygiene is mandatory to achieve the best treatment outcome. Oral hygiene instructions should be given before the start of treatment and it should be reinforced during each visit. Gingival inflammation around orthodontic bands leads to pseudo pockets, However, this is usually resolved within weeks of debanding. Orthodontic treatment and the procedures are known to induce both positive and negative local soft-tissue reactions in the gingiva and periodontal ligament. The negative reaction is mainly associated with gingivitis and periodontitis.[54]

**Hong Su et al in 2004** ,described about the factors predisposing to maxillary anchorage loss. The mesial tipping of the first molar considered as the onset of anchorage loss, and changes in the angulation of the first anchor molar are closely related to anchorage loss. This cross-sectional study was aimed to determine how the mesiodistal angulation of the upper first anchor molars changes during general orthodontic treatment and to identify factors leading to these changes in a large sample of patients . The data indicate that the upper first anchor molars tend to be tipped mesially during

treatment, and this is a type of anchorage loss that orthodontists should consider seriously. Compared to treatment-related factors, patients' physiologic factors also have a greater influence on changes in the angulation of the upper first anchor molars during orthodontic. Mesial tipping of the upper first molars, and therefore, anchorage loss, is more likely to occur in adolescent and males, patients with class II malocclusion and patients who have undergone maxillary premolar extraction treatment. [55]

**Paul Gange et al in 2005,** explained in his study about the evolution of bonding . In the early days of orthodontic treatment, brackets were welded to gold or stainless steel bands. Prior to treatment, the orthodontist had to create adequate space around every tooth to accommodate the bands, and then those spaces had to be closed at the finishing state of treatment. This was time-consuming for the orthodontist and not very comfortable for the patient. Banded appliances usually caused gingival trauma when fitted to the teeth, and sometimes decalcification could occur under the band. In 1960s, Dr .George Newman, an orthodontist in Orange, New Jersey, and Professor Fujio Miura, chair of the Department of Orthodontics at Tokyo Medical and Dental University in Japan, pioneered the bonding of orthodontic brackets to enamel surface. Many developments have occurred in the decades that followed in orthodontics, including many new type of adhesives, base designs, new type of bracket materials, more efficient curing methods, self-etching primers fluoride-releasing agents and efficient sealants etc.[56]

**Shivakrishna et al in 2006,** Anchorage is the word employed in orthodontics to mean resistance to displacement. During orthodontic treatment, the teeth are exposed to forces and moments, and these forces always generate reciprocal forces of the same magnitude but in Opposite direction. in order to avoid undesirable movements and maintain treatment success, these forces must be diverted or resisted. Anchorage should be of the primary consideration before the treatment strap up. The skeletal and dental anchorage should be planned for a better finish and complete success in orthodontics. [57]

**Jie Fangetal in 2006,** stated that PGs are of importance for bone remodeling. PG can alter the activity or numbers of osteoclasts or osteoclast-like cells. Some researchers noted that NSAIDs had some adverse impacts and may inhibit orthodontically induced tooth movement (OTM). Acetaminophen, potassium diclofenac, Rofecoxib, celecoxib, and Indomethacin might slow down the rate of OTM.[58]

**Valeria Jaquis Oreas et al in 2006,** explained in their study about the survival rate of banding as well as bonding. It was a split-mouth randomized clinical in which they compared the survival rate of bonding and banding molar tubes in adult orthodontic patients. Eligibility criteria included adults of age greater than18 years, no caries, restorations, or any kind of fractures in the upper and lower anchor molars. The main detrimental effect was bond failure. They concluded that the survival rate of bonded anchor molars was not statistically different from that of banded anchor molars. in adult patients, bonding orthodontic tubes to anchor molars is similar to banding the anchor molars. However, both procedures show high failure rate in the mandibular arch .[59]

**Pradeep Ashok Kumar Bapna et al in 2007** conducted a study on Maharashtrian population, Elastomeric separators were placed in randomly selected 100 patients for fixed orthodontic mechanotherapy. Visual analog scale was used to register the patient's pain perception during the placement of elastomeric separators and continued subsequently on 1$^{st}$, 2$^{nd}$, 3$^{rd}$, 4$^{th}$, and 5$^{th}$ day.in which they concluded that, the pain associated peaks after 4–48 hr from separator placement, and then reduced to reach its lower grade on the 5$^{th}$ day after separator placement.[60]

**Houb-Dine et al in 2007** reported that**,** miniscrews can be used to correct anchorage Loss. Anchorage management is one among the vital keys in clinical orthodontics**.** Anchorage loss is a haphazard and sudden movement of the anchor teeth can happen during the treatment**.** Not only mesial movement of the molars but also in vertical and transverse too.**[61]**

**S. Haqueet al in 2007** conducted a study on the difference in anchorage loss using the 3D superimposition of study models between cases treated with extraction of

maxillary first and second premolars, and concluded that there is no statistical difference in anchorage loss when comparing the extraction of the maxillary first premolars to the extraction maxillary second premolars.[62]

**Jay Prakash Yadav et al in 2008**, conducted a study to evaluate the amount of separation produced by four types of separators. They are the Elastomeric separator, kesling separator, kansal separator, and Dumbbell separator respectively. The patient was evaluated for 5 days for the amount of separation. Time taken for adequate separation was significant in all 4 separators; dumbbell being the fastest followed by the elastomeric separator. There was no significant difference between Kesling and kansal separator in the time taken to achieve adequate separation.[63]

**Teena Dodeja et al in 2008** concluded that the measurement of anchorage loss on the study model and lateral cephalogram are equally reliable. Thus, the study model can provide an alternative method in the assessment of anteroposterior anchorage loss of maxillary molars during treatment with the pre-adjusted edgewise appliances.[64]

**Pratik Chandra et in 2017** conducted a study to evaluate the horizontal as well as vertical changes in anchor molars after retraction in premolar extraction cases. Thirty patients requiring maximum anchorage after extraction of the first bicuspids were selected for their study. The second molars were banded in arches along with transpalatal arch in the maxillary arch and lingual arch in the mandibular arch given. En mass retraction was carried out using sliding mechanics. Horizontal and vertical positions of the anchor first molars were assessed cephalometrically before retraction and found that there was anchorage loss seen in both horizontal as well as vertical planes. In case of mandibular molars anchorage loss was evident only in horizontal planes not in the vertical plane.[65]

**Sharath Kumar Shetty et al in 2019** conducted a study on Use of Palatal rugae in Assessment of Antero Posterior Tooth Movements found that changes in the anteroposterior position of the maxillary incisors and maxillary molars with reference to the medial end of the third palatal rugae as a stable landmark were investigated in patients who underwent maxillary first premolar extraction. The magnitude of tooth

movement during extraction space closure was used to determine how the space gained by extraction of four first premolars is used by the orthodontist in resolving the patient's malocclusion.[66]

**Dilshad Quraishi et al in 2019**, stated that the rate of retraction was faster and anchorage loss was lower with a labial appliance with lingual force, thus indicating that this new technique of space closure utilizes the biomechanical advantage of lingual force in the conventional labial appliance.[67]

**Woowon Jang et al in 2019, conducted** a study on Anchorage loss assessment of the indirect anchor tooth during adjunctive orthodontic treatments, indirect anchor tooth moved 0.91 ± 0.50 mm and did not exhibit any significant differences in the transverse, vertical, or sagittal directions. Tooth moved significantly more in the mandible than in the maxilla.[68]

**Shetty Et al in 2019** concluded that trans palatal arches may be an alternative for anchorage augmentation and movement of the maxillary first molars in all dimensions, including producing molar rotation and up righting, maintaining transverse dimensions and, maintaining leeway spaces during the transition period.[69]

**Patricia Pigat Schneider et al** in 2019, conducted a study on the comparison of anterior retraction and anchorage control between en masse retraction and two-step retraction, when comparing the closure of space between en mass retraction and Two step retraction, it was concluded that: Both methods were effective to achieve space closure. No significant diferences exist in the amount of retraction of incisors. Magnitudes of incisor and molar
tipping were similar between the two space closure methods.[70]

**Da C Monini et al in 2019** conducted a study to investigate the canine retraction rate and anchorage loss using self-ligating (SL) brackets and normal conventional (CV) brackets. A maxillary and mandibular comparison concluded that Self ligating bracket series did not show faster canine retraction compared with conventional brackets .The maxillary canines showed a greater rate of movement than the man

dibular cuspids however. There is no difference in anchorage loss between the maxillary and mandibular posterior teeth during canine retraction.[71]

**Yasir et al in 2019** conducted a study by comparing the effectiveness of 0.018-inch and 0.022-inch slot MBT bracket systems (3M-Unitek, Monrovia, Calif). Three-dimensional pre- and post reatment digital models were landmarked and measured (R700 scanner and orthoanalyzer software, 3Shape, Copenhagen, Denmark). Antero-posterior position of the first molars was measured using the third medial rugae point as a reference. Anchorage loss (AL) represented the subtraction of the post treatment distance from the pretreatment distance for both anchorage loss right (ALR) and left (ALL) sides. The values were then compared using a two-way analysis of variance. The resuts showed that bracket slot size has no significant influence on the maxillary molar anchorage loss during orthodontic
treatment.[72]

**Ingalill Feldmann et al in 2020 ,**stated that during orthodontic treatment the teeth are exposed to forces and moments, and these acting forces always generate reciprocal forces of the same magnitude but opposite in direction. To avoid unwanted tooth movements and maintain treatment success, these reciprocal forces must be diverted. Orthodontic anchor-age, defined as the ability to resist these unwanted reactive tooth movements, can be provided by other teeth, palate, head, neck, or implants in bone.[1]

**Schawar Malik et al in 2020,** conducted a study on comparison of anchorage loss between conventional and self-ligating brackets during canine retraction and found that there is insufficient evidence to suggest a difference in anchorage loss between the Conventional and Self-ligating groups.[73]

**Huizchhong Cheng et al in 2020** stated that**,** Growth and development might lead to anchorage loss during orthodontic treatment, such as the mesial movement of molars, the compensation characteristics of upper molars following mandibular growth changes, or the angulation of molars before treatment. Different anchorage reinforcement devices are developed to hinder anchorage loss, but the anchorage loss resulting from physiological factors should even be taken under consideration. Partici-

pants of Han ethnicity were randomized into the physiologic anchorage spee-wire system (PASS) group or McLaughlin-Bennett-Trevisi (MBT™) straight-wire group by minimization random allocation method. Compared with the MBT group, the PASS group without additional anchorage reinforcing devices could attain well anchorage control by considering the dentoalveolar compensation of anchor teeth. [74]

**kaladhar Naik et al** in 2020 stated that implant-supported anchor molar possess better anchorage value compared with the conventional molar anchorage. Hence, implant-supported molar can be used as an absolute anchorage system in the en masse retraction of front teeth. [75]

# ***RELEVANCE***

# RELEVANCE

Banding of anchor molars have been carried out in Orthodontic Treatment since historic times. It has claimed its place in Orthodontic treatment ever since due to its superior property such as adhesive reliability and is continued to be used by most of the Orthodontists all over the world. But an often neglected outcome of the banded treatment is increased gingival and periodontal inflammation caused either by itself, the use of separators or the cement used to lute the band and often the lack of providing proper oral hygiene to the posterior area by the patient. The mesial movement of the anchor molars which are observed could be due to the Prostaglandins produced at the inflammation site and this could tamper with the successful outcome of the Orthodontic treatment. Hence I have directed this study towards the advantages of bonding the anchor molars. With the improvement in adhesive properties of the recent bonding agents,bonding the molar tube on the anchor molar have become a popular alternative to banding the molar. This study aims to compare both these techniques and evaluate their effect on anchorage during retraction.

# ***METHODOLOGY***

# METHODOLOGY

## RESEARCH DESIGN

A comparative study designed with pretreatment and post retraction measurements of lateral cephalogram and study models in the upper dental arch of 20 patients undergoing orthodontic treatment, whose anchor molars are bonded on one side and banded on the other side.

## STUDY SETTING

St: Gregorios Dental College Chelad, Kothamangalam.

## SOURCE OF DATA

Patients with in the age group of 14 to 25 years, having either bimaxillary protrusion or Class II division I Malocclusion undergoing orthodontic retraction after first premolar extractions, who reported to the Dept. Of Orthodontics and Dentofacial Orthopedics, St. Gregorios Dental College for correction of their malocclusion.

## SAMPLING:

Sample size is calculated as 20

Sample size formula used: $n = (Z\alpha/2+Z\beta)\ 2\ *2*\sigma2 / d2$

. $Z\alpha/2$ is the critical value of the Normal distribution at $\alpha/2$

$Z\beta$ is the critical value of the Normal distribution at $\beta$

$\sigma$ 2 is the population variance

d is the difference likely to be detected.

After obtaining informed consent, a total of 20 patients aged between 14-25 years were included in the study . A split mouth study was done wherein, one side of the upper anchor molar is banded with standardized preformed bands with buccal tubes and the other side molar is bonded with Standardized bondable buccal tubes.

Group I: Consist of 20 patients with, buccal tubes bonded on one side of upper anchor molars.

GroupII: Consist of 20 patients with one side of the upper anchor molar cemented with bands with buccal tube attached on to it.

**INCLUSION CRITERIA**

- Age -14-25 years.
- Bimaxillary protrusion or Class II division I malocclusion patients undergoing first premolar extraction.
- Mild crowding to no crowding.
- Patients with prominent 3rd palatal rugae

**EXCLUSION CRITERIA**

- Patients requiring arch expansion.
- Patients requiring distalization of molar with auxiliary appliance.
- Patients with systemic diseases.
- patient with other therapeutic extraction treatments.
- Patients who do not require separator placement for banding.

**SAMPLING PROCEDURE:**

**Selection**: Samples were randomly selected between two groups based on the inclusion and exclusion criteria given above.

## MATERIALS AND MESURMENTS:

**Materials used in the study:**

1. Pretreatment and post retraction study models of patients.
2. Pretreatment and post retraction lateral cephalograms of patients.
3. Orthodontic elastomeric separators. (Fig.1)
4. Preformed bands with standardized weldable buccal tubes (Fig .2)
5. Standardized bondable buccal tube. (Fig.3)

6. Orthodontic cements (Fig .4)
7. Orthodontic brackets (Fig.5)
8. Orthodontic arch wires (Fig .6)
9. Modules and ligature wire (Fig.7)
10. Acetate tracing paper, Ruler, protractor, lead pencil(Fig.8)
11. Divider. (Fig.9)
12. Bonding agent, etchant, composite(Fig.10)
13. Curing unit (Fig .11)
14. Dontrix gauge (Fig.12)
15. L shaped jig for landmark identification. (Fig.13)

**Fig.1: Elastomeric Separators.**

**Fig. 2: Preformed Orthodontic Bands, weldable buccal tubes**


**Fig .3: Bondable buccal tubes.**


**Fig .4: Orthodontic cement.**


**Fig .5: Orthodontic brackets**

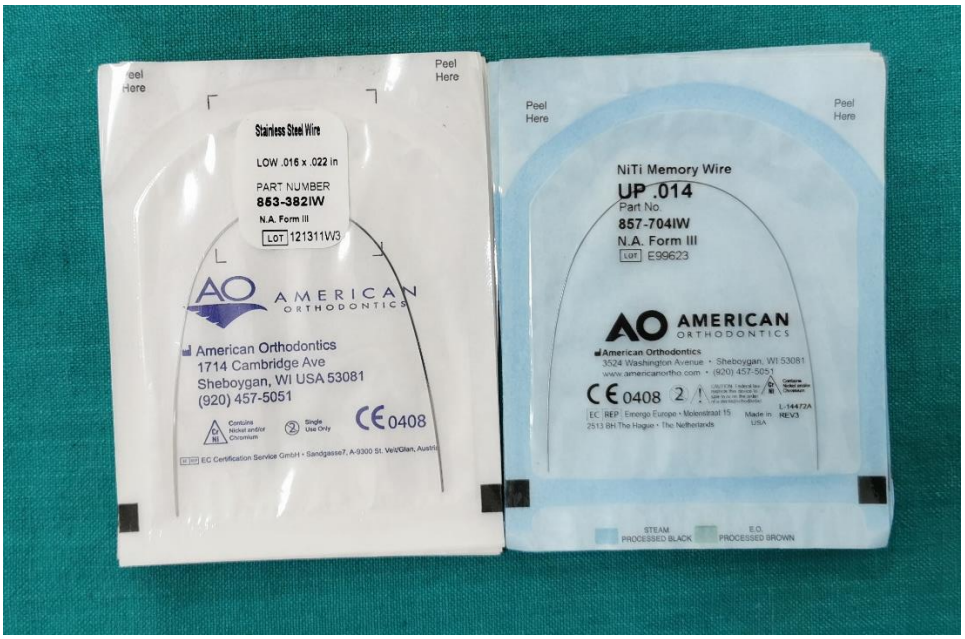



**Fig.6: Orthodontic arch wire**


**Fig.7: Modules and ligature wire**


**Fig .8: Lead Pencil, Ruler, Protractor, Acetate Tracing Sheets**

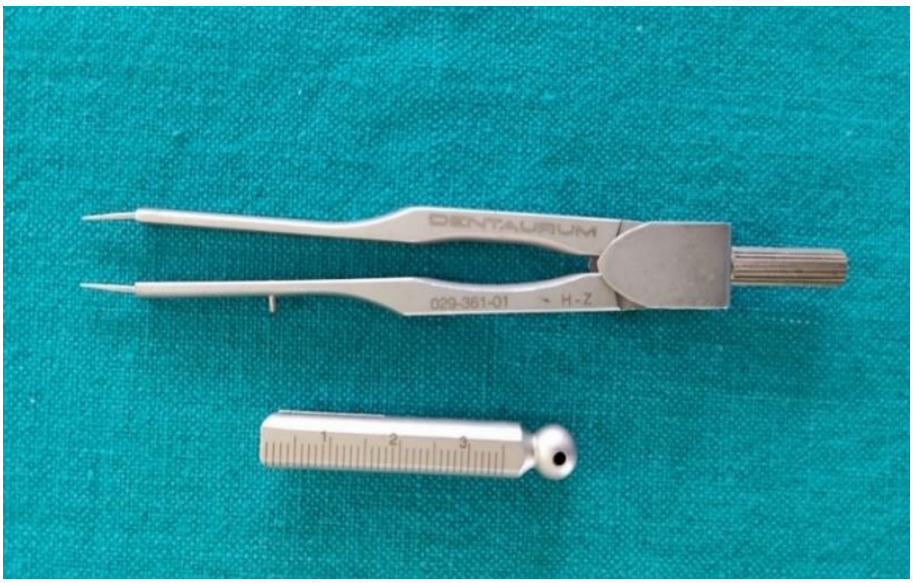



**Fig. 9: Divider**


**Fig.10: Etchant, Bonding agent, composite.**

**Fig .11: Curing unit.**

**Fig.12: Dontrix gauge.**

## PROCEDURES:

20 patients from the Department of Orthodontics were selected after obtaining their written Consent forms. Cases were started with straight wire appliance system (MBT 0.022 slot). On one side, maxillary anchor molar was bonded with buccal tube and on the other side, the anchor molar was banded with standardized preformed bands with buccal tube welded onto it, after separator placement. Lateral cephalograms and Study models were taken at the beginning of the treatment (T1) and at the end of re-traction phase(T2). All the cephalograms were recorded under standardized condition with a Cephalostat (DENSPLY SIRONA ORTHOPHOS XG) (Fig.16) with the same exposure parameters (kVp -64, 16mA ,14.5 s). The X-rays were printed using (CARESTREAM DRY VIEW LASER 5700 IMAGES). These cephalograms and study models were analyzed for comparing the position of anchor molars.

### Evaluation of lateral cephalogram:

Pretreatment and post retraction lateral cephalograms of the patients were taken. To differentiate between the right and left molars on the lateral cephalogram, a 0.017"x 0.025" stainless steel wire was shaped in the form of an "L" with 7mm of vertical height and 10 mm of horizontal length (Fig.13). The horizontal portion of the L-Jig inserted from the mesial side of buccal tube on the Right side (Fig. 14) and from the distal side of the buccal tube on the Left side (Fig.15).

**Fig.13: L - shaped jig.**

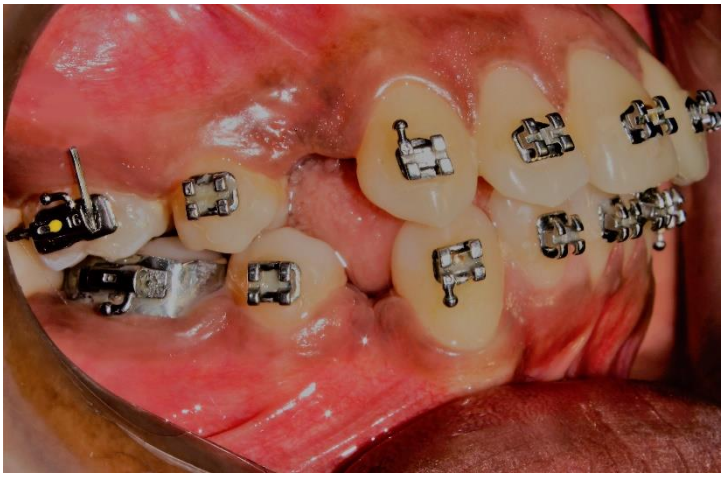


**Fig .14: L - shaped jig on right bonded molar.**

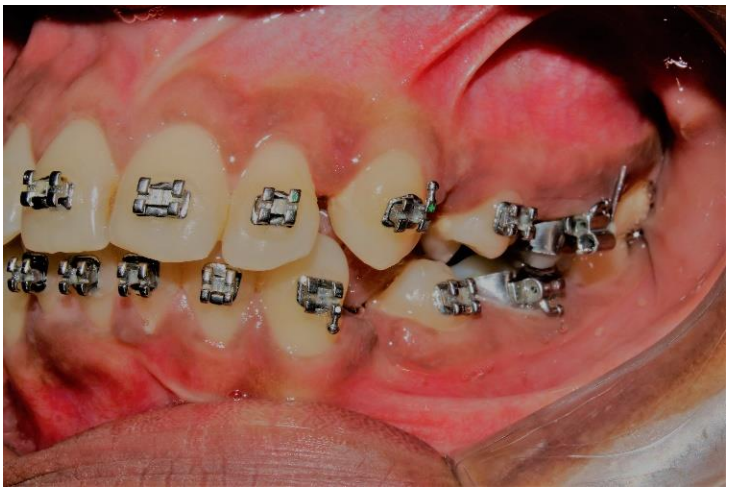


**Fig .15: L - shaped jig on the left banded molar.**

Analysis of the lateral cephalogram was done. At first the SN line and occlusal plane (OP) were drawn. Then a perpendicular line from the occlusal plane to the Sella- Tursica point known as occlusal plane perpendicular (OP-p) was drawn. The right metal stub and left metal stub is marked on the cephalogram. The linear horizontal distance was measured from occlusal plane perpendicular (OP-p) to the right and left metallic stubs (C1 andC2). All cephalograms were traced manually using acetate paper and black lead tracings pencils by the same operator

Retraction was carried out by sliding mechanics with active tiebacks on a 0.019" x 0.025" SS wire till the extraction space was closed in the upper arch. This was recorded as the post retraction stage and a cephalogram was taken for comparative analysis. Pre-treatment values were subtracted from the post retraction values to obtain the amount of anchor loss. Then the mean anchor loss was calculated for each group. Anchorage loss was then compared between banded and bonded molars.

**Fig .16: Cephalostat**

**Fig. 17:Patient at Natural Head Position**

# CEPHALOMETRIC LINES AND PLANES

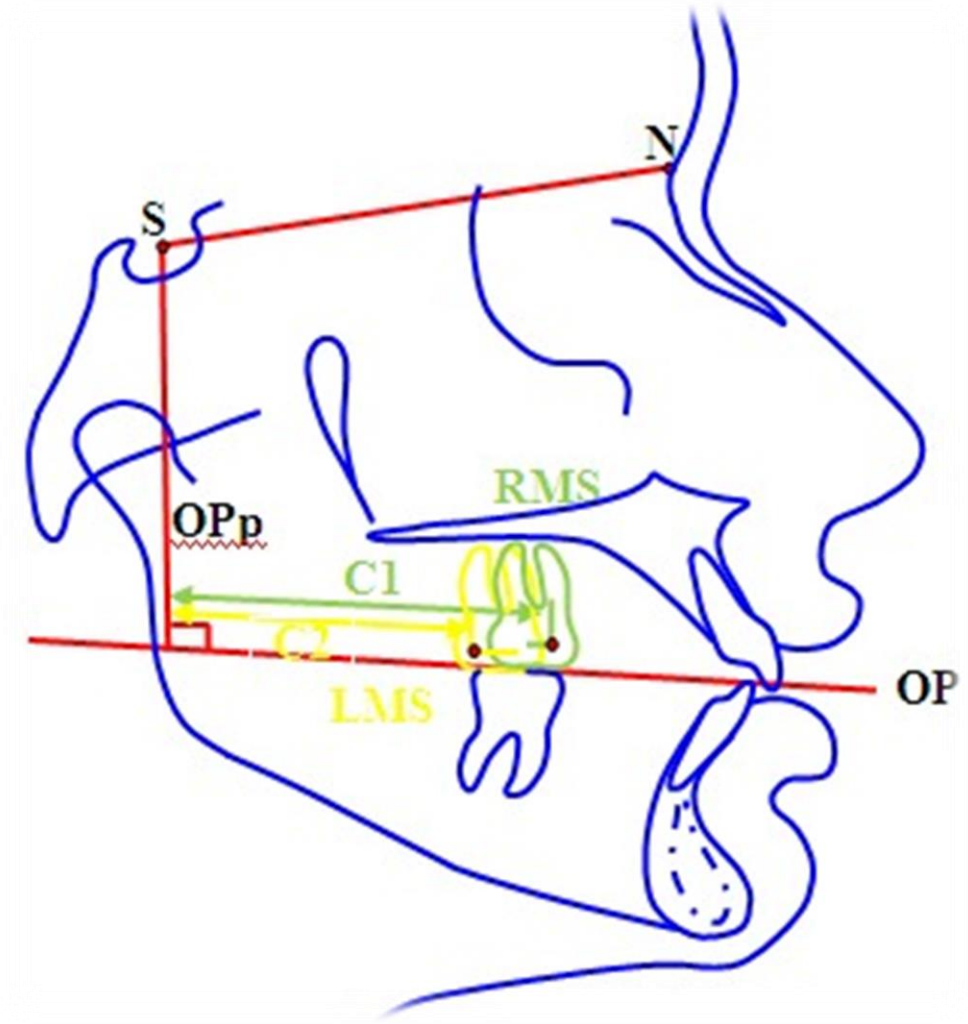



**Fig.18: Cephalometric lines and planes with L-jigs in place.**[17]

| SL.No | Planes | Description |
|---|---|---|
| 1 | SN(SellaNasion plane) | The line through N and S . The line was used for orientation of all head films |
| 2 | Op (Occlusal plane) | The line passing through the incisal edges and tips of the occluding surface of the posterior teeth |
| 3 | OPp ( Occlusal plane perpendicular) | A line perpendicular to the occlusal plane through sella |
| 4 | C1 | linear distance from right molar to OP-p |
| 5 | C2 | Linear distance from left molar to OP-p |

**Table 1.A Cephalometric Lines And Planes[17]**

## Evaluation of dental study models

Pretreatment and Post retraction study models of the upper arch of the patients were made. A line was drawn through the anterior raphe point and the posterior raphe point, to construct a median reference line (MRL). Perpendicular lines were constructed from the mesial contact point of the right upper first molar and the left upper first molar to the median reference line. The medial point of the 3rd rugae is marked on both the right (Rr) and left (Lr) sides. The linear distance was measured between the third right medial rugae (Rr) to the line drawn perpendicular to the mesial contact point of right upper 1st molar intersecting at median reference line (dR) and third left medial rugae (Lr) to a line drawn perpendicular to the mesial contact point of left upper 1st molar intersecting at median reference line (dL). (Fig.19)

The post retraction values were subtracted from the pretreatment values to determine the anchor loss of the molars on each side.

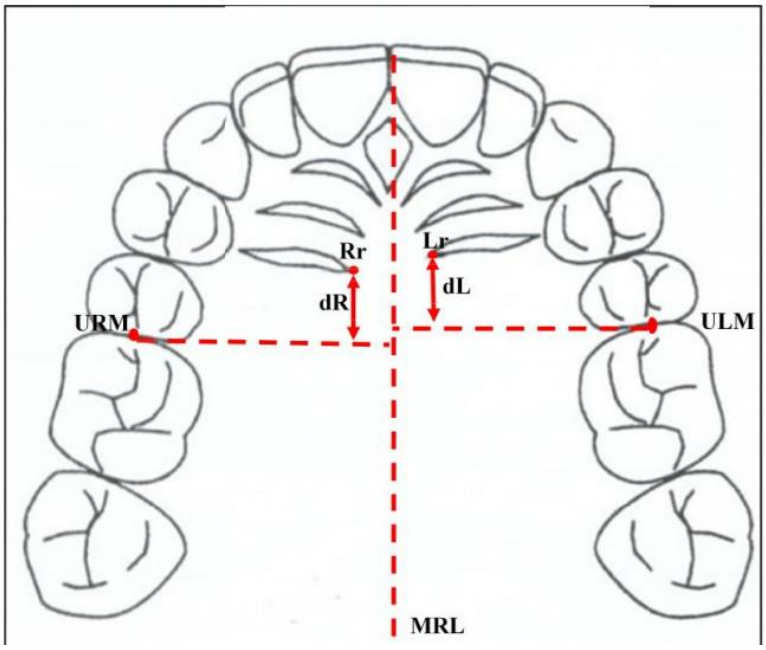



**Fig .19: Dental study model analysis[17]**

| Sl.No | Planes | Description |
|---|---|---|
| 1 | MRL line | Line connecting anterior raphe point to the posterior raphe point |
| 2 | URM | Perpendicular line from mesial contact point of the upper right first molar to the medial refference line |
| 3 | ULM | Perpendicular line from mesial contact point of the upper left first molar to the medial refference line |
| 4 | dR | perpendicular line from third right rugea to URM line |
| 5 | dL | Perpendicular line from third left rugea to ULM line |

**Table 1.B lines and planes in model analysis[17]**

## PLAN OF ANALYSIS

Data was analyzed using the statistical package SPSS 22.0 (SPSS inc., Chicago) and level of significance was set at $p<0.05$. Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using shapiro wilkinson test. Inferential statistics to find out the difference between and within the groups was done using student t test.

## ETHICAL CONSIDERATION

Study was carried out after obtaining clearance from ethical committee (Ethical clearance certificate no:SGDC/152/2018/3381/4.) as well as informed consent were obtained from individual parents/patients before the treatment.

# TREATMENT STAGES

## Group 1(Bonded group)

Fig .20: Pretreatment(T1)

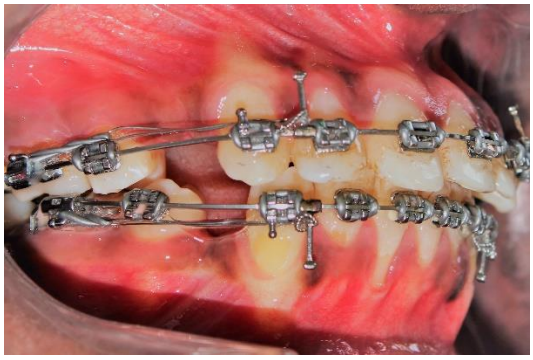


Fig.21: Initiating Retraction

Fig 22:6 Months through Retraction

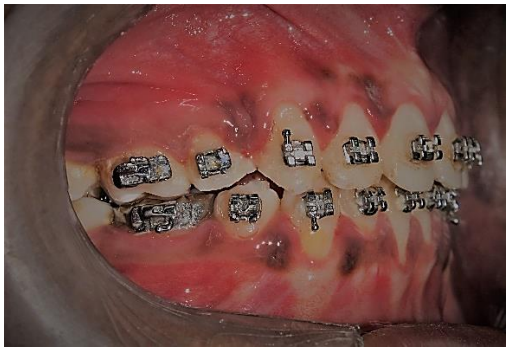


Fig 23: Post Retraction (T2)

**Group 2(Banded group)**

Fig .24: Pretreatment(T1)

Fig.25: Initiating retraction

Fig 26: 6 months through retraction

Fig 27: Post retraction (T2)

# EXTRA ORAL PHOTOGRAPHS

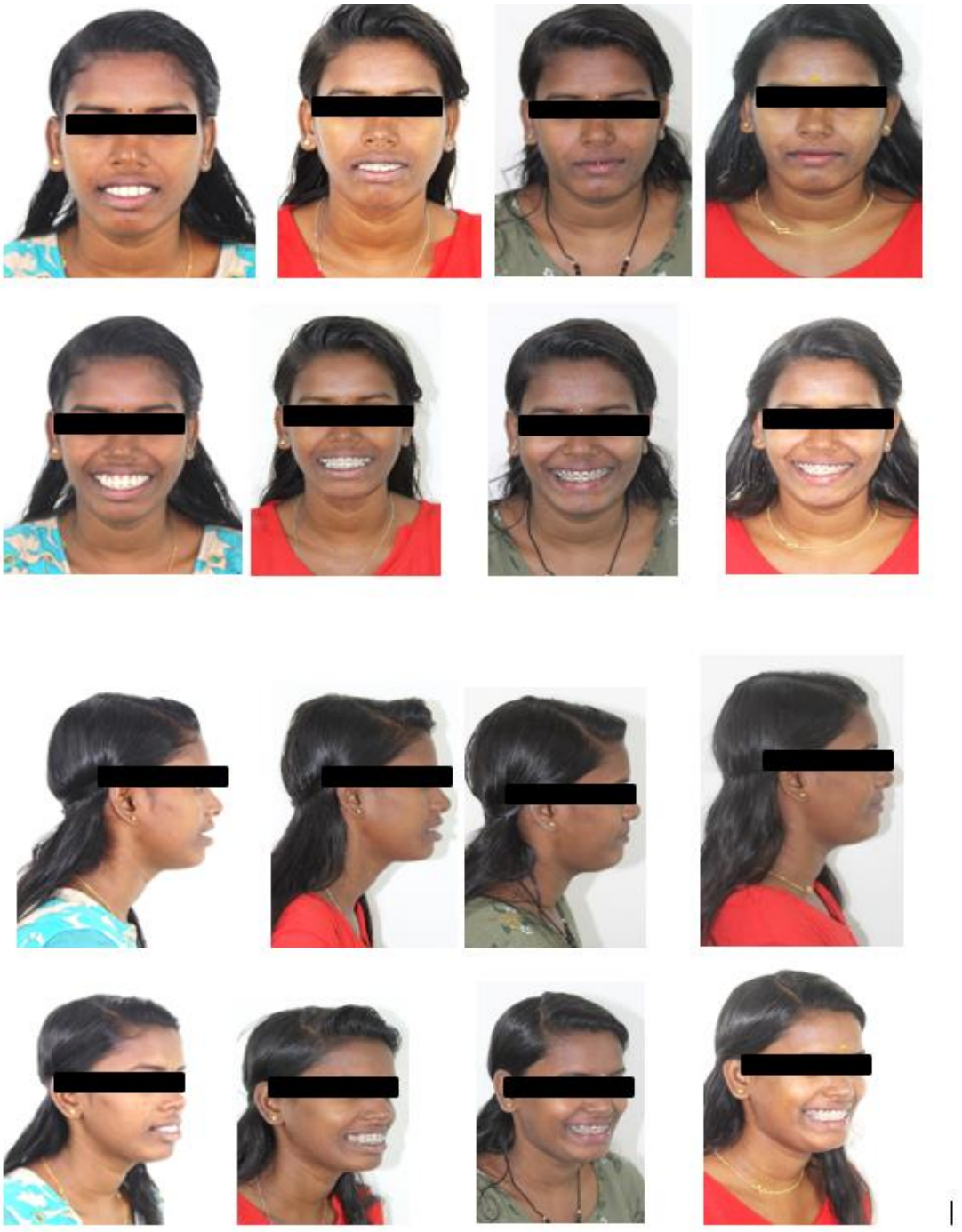


Fig .28: Extra oral photographs

# LATERAL CEPHALOGRAMS

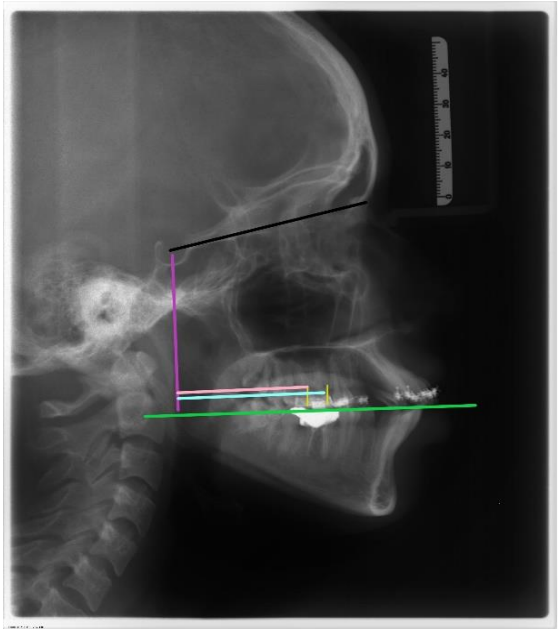


**Fig .29: Pre treatment Lateral Cephalogram (T1)**

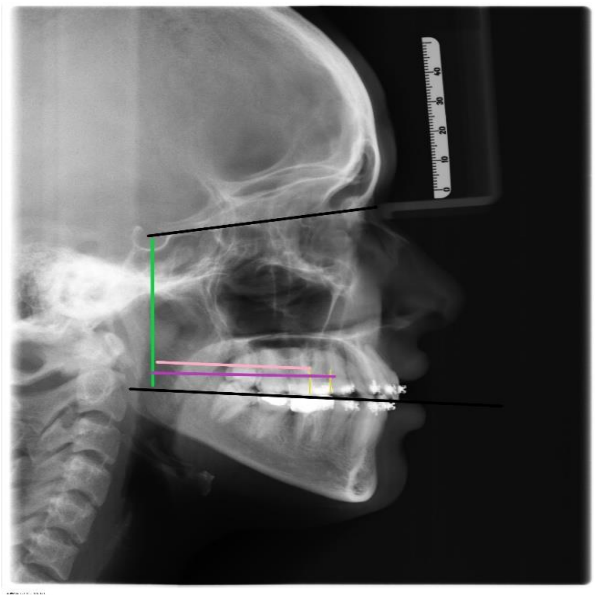


**Fig .30: Post retraction Lateral Cephalogram (T2)**

# STUDY MODELS

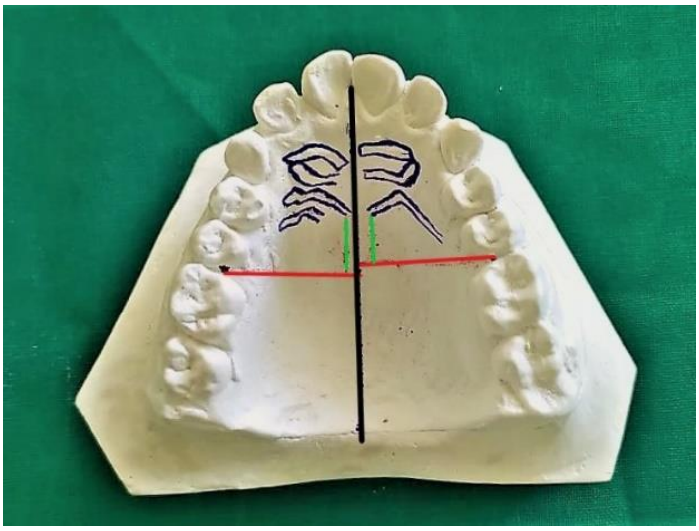


**Fig .31: pretreatment study model(T1)**

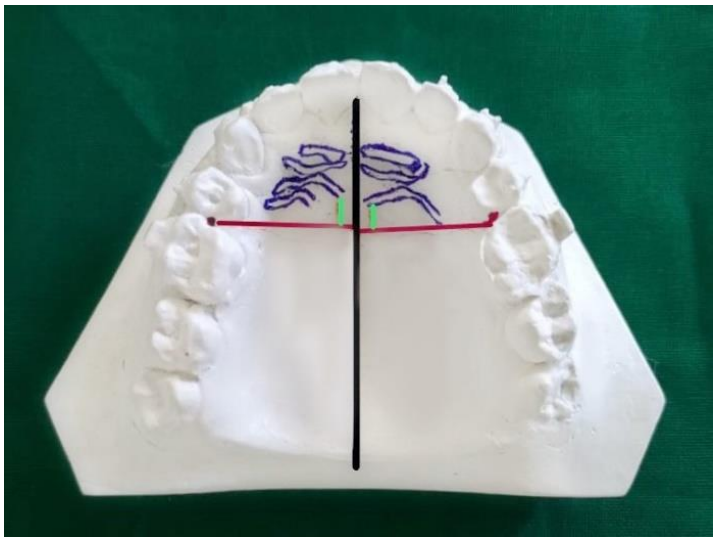


**Fig. 32: Post retraction study model (T2)**

# ***RESULTS***

# RESULTS

A total of 20 patients with bimaxillary proclination or class II division I malocclusion undergoing retraction after first premolar extractions were enrolled in this study. A split mouth technique was utilized with banding the upper first permanent anchor molar on one side and bonding molar tubes on the other side. Anchorage loss was assessed and statistically analyzed by the values obtained from pre-treatment and post retraction study models and lateral cephalograms.

# STATISTICAL ANALYSIS

Data was analysed using the statistical package SPSS 22.0 (SPSS inc., chicago, il) and level of significance was set at $p<0.05$. Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using shapiro wilkinson test. Inferential statistics to find out the difference between and within the groups was done using student t test.

# MODEL ANALYSIS- BONDED GROUP

| **(UPPER RIGHT MOLAR TO MEDIAN REFERENCE LINE)** (mm) | | |
|---|---|---|
| | **Pre treatment** | **Post retraction** |
| **Mean** | 11.461 | 10.307 |
| **Standard deviation** | 1.05 | 1.18 |
| **T value** | **2.82** | |
| **P value** | **0.008*** | |
| **Mean difference** | **1.154** | |
| **Percentile difference** | **10.1%** | |

**P<0.05 is statistically significant*(student t test)**

**Table 1.C study model analysis bonding group.**

# STUDY MODEL ANALYSIS-BANDED GROUP

| UPPER LEFT MOLAR TO MEDIAN REFERENCE LINE) (mm) | | |
|---|---|---|
| | **Pre treatment** | **Post retraction** |
| **Mean** | 10.269 | 8.269 |
| **Standard deviation** | 1.231 | 1.393 |
| **T value** | **4.173** | |
| **P value** | **0.0003*** | |
| **Mean difference** | **2.00** | |
| **Percentile difference** | **19.47%** | |

**p<0.05 is statistically significant*(student t test)**

**Table 1.D- Study model Analysis Banding Group.**

# CEPHALOMETRIC ANALYSIS-BONDED GROUP

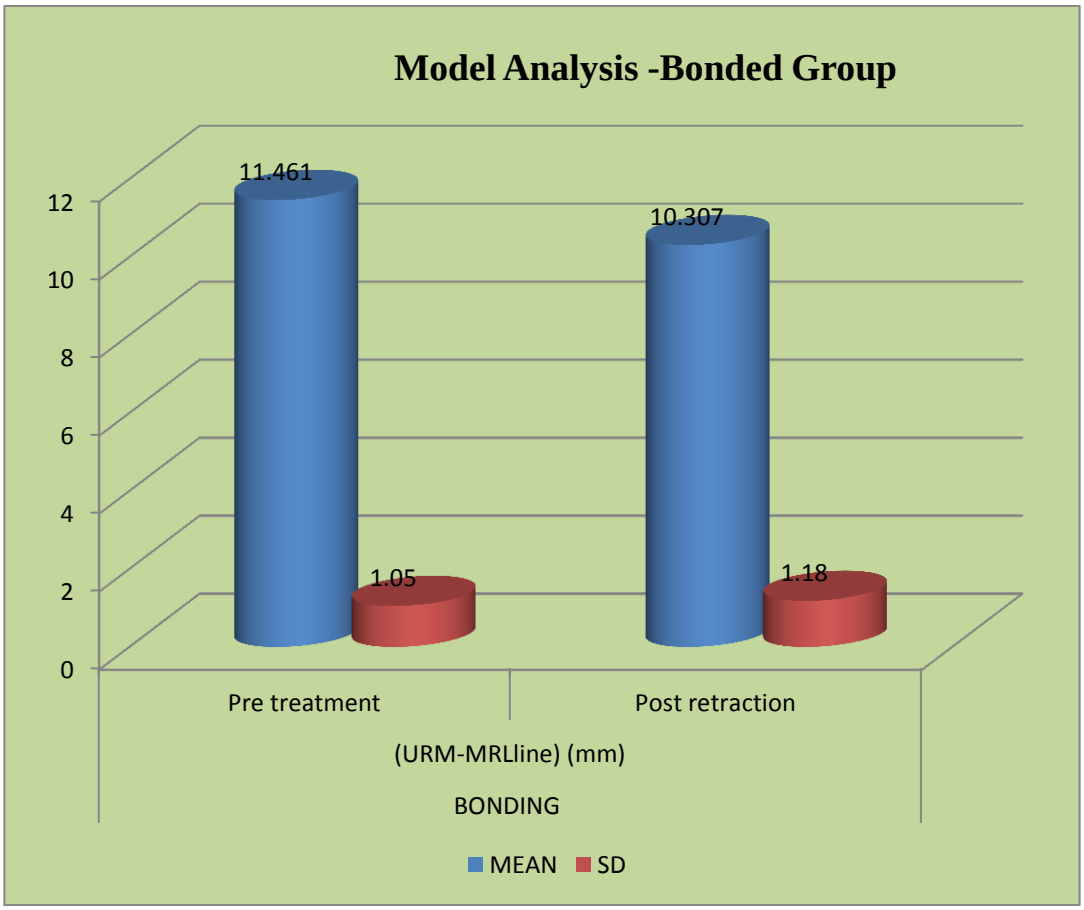
| **LINEAR DISTANCE FROM OP-P THROUGH SELLA TO RIGHT MOLAR(MM)** | | |
|---|---|---|
| | **Pre treatment** | **Post retraction** |
| Mean | 41.307 | 43.5 |
| standard deviation | 4.32 | 4.23 |
| T value | **1.404** | |
| p value | **0.171** | |
| Mean difference | **2.193** | |
| Percentile difference | **5.3%** | |

**Table 1. E- Cephalometric analysis. Bonding**

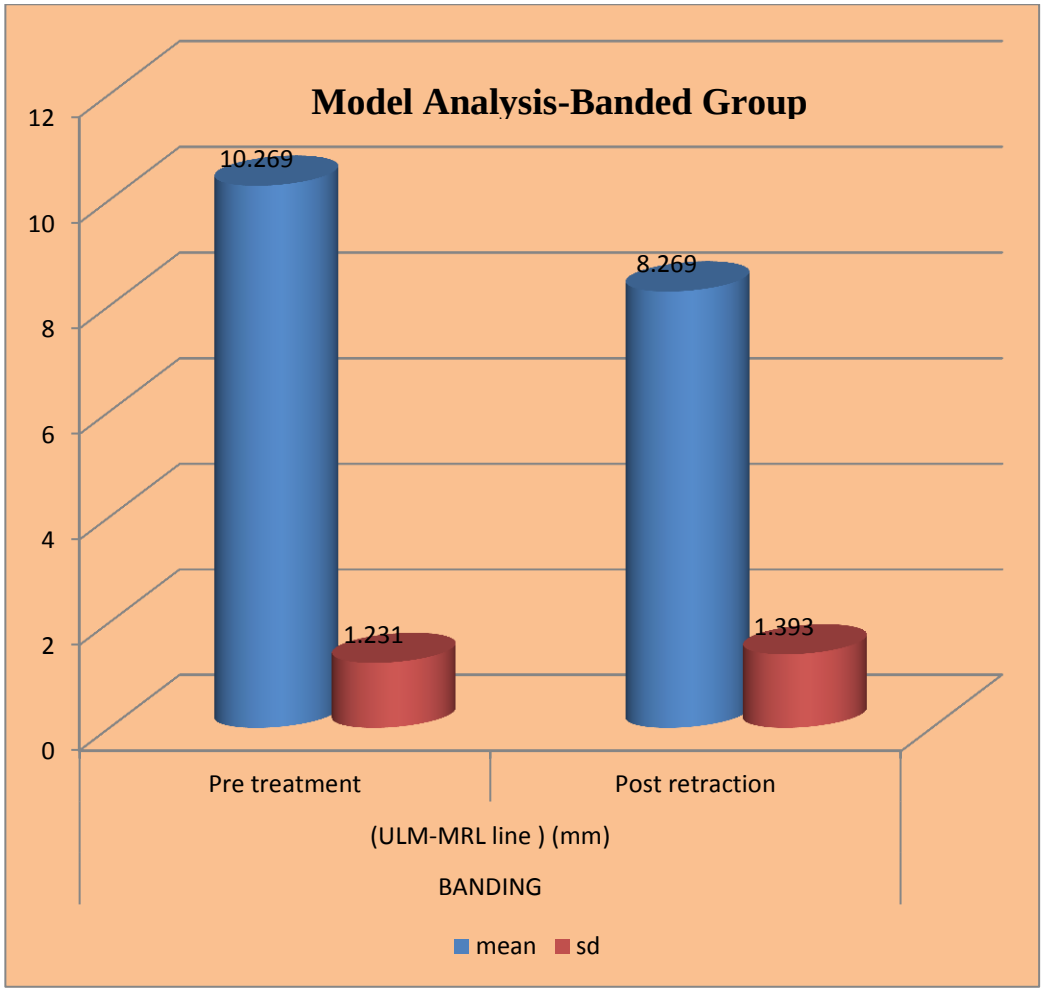
# CEPHALOMETRIC ANALYSIS-BANDED GROUP

| **LINEAR DISTANCE FROM OP-P THROUGH SELLA TO LEFT MOLAR**(mm) | | |
|---|---|---|
| | **Pre treatment** | **Post retraction** |
| Mean | 36.807 | 39.807 |
| standard deviation | 3.04 | 2.295 |
| T value | **36.64** | |
| p value | **0.0001*** | |
| Mean difference | **3** | |
| Percentile difference | **8.15%** | |

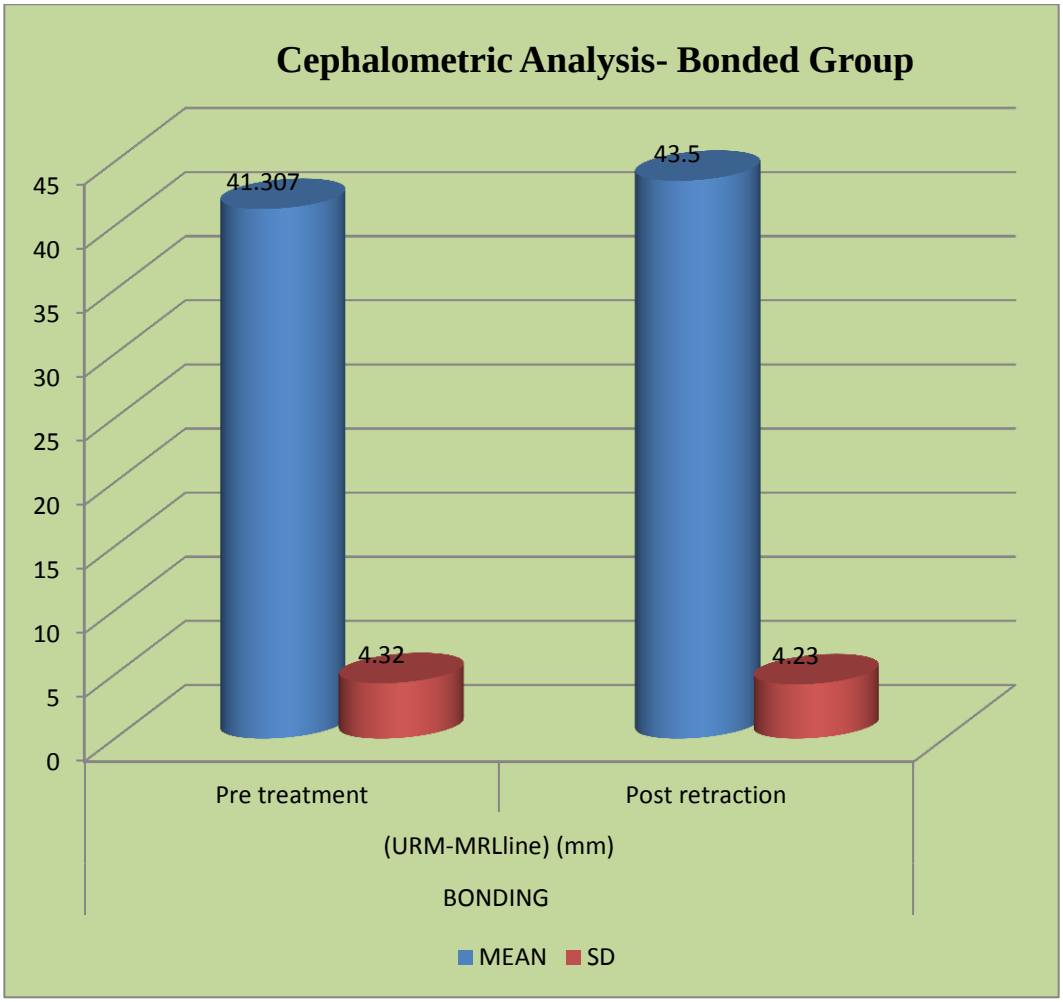
**Table 1.F Cephalometric Analysis – Banding**



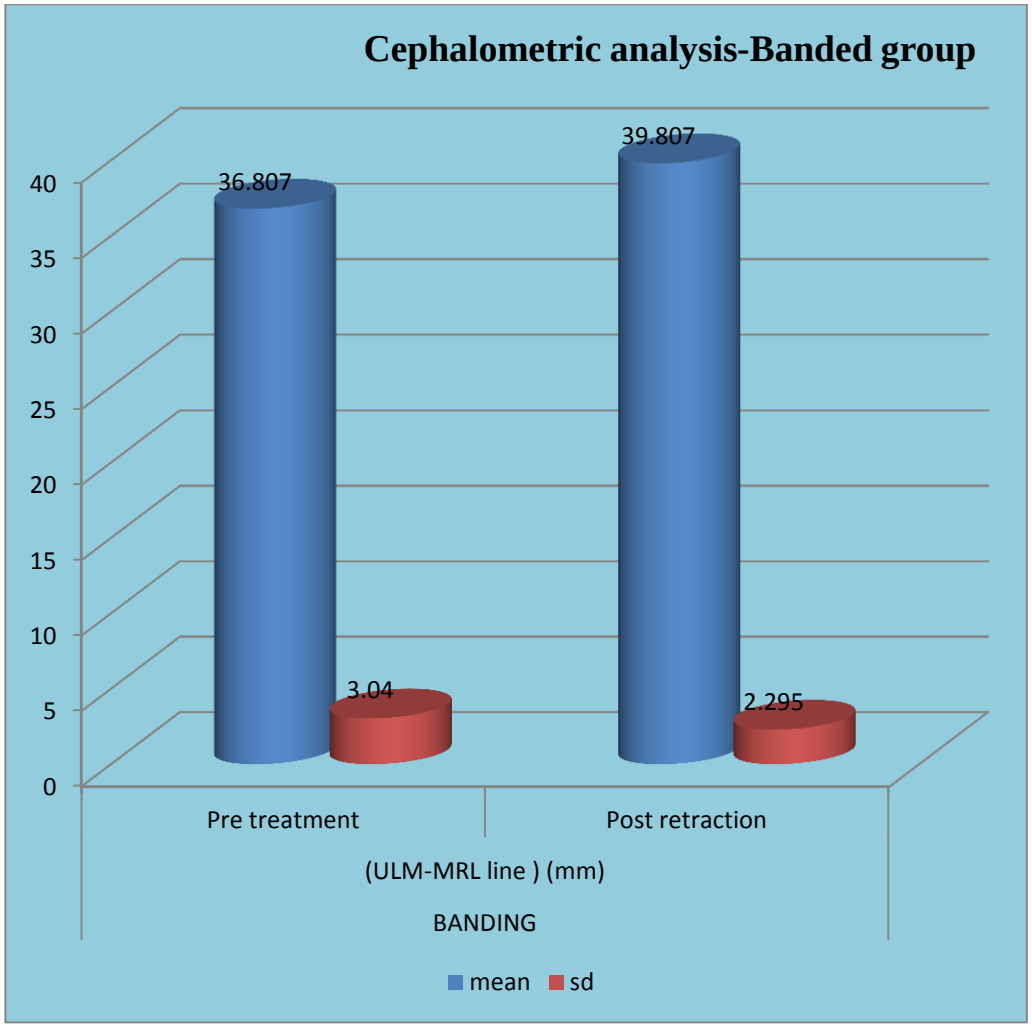

**Graph 1. A: Study model analysis of bonded group**




**Graph 1.B: Study model analysis of banded group**




**Graph 1.C Cephalometric analysis bonded group**




**Graph 1.D: Cephalometric analysis banded group**

# INTERPRETATION OF STATISTICAL ANALYSIS

**Model analysis:**

Anchorage loss assessment via model analysis is presented in Table 1.C and Table 1.D. Comparison using t test shows significant difference within bonding and banding groups($p<0.05$) from pretreatment to post retraction period. Although two groups reported significant difference, banding group (19.47%) showed more anchorage loss compared to bonding group (10.1%).

The post- retraction value (URM-MRL) was reduced to 10.307 mm with a standard deviation of 1.18 mm from the pre-treatment value of 11.467 mm. (Table 1.C). ULM-MR values reduced to 8.269 mm with a deviation of 1.3966 mm from10.269 mm with a standard deviation of 1.231 mm (Table 1. D). This suggests that the anchor molar shifted more mesially on the banded side relative to the molars on the bonded side and the value was statistically significant. Mean anchorage loss on the bonding side was 1.154 mm and 2mm for the banding side with a percentage difference of 10.1 and 19.47 respectively.

**Cephalometric analysis:**

Comparison using T test shows significant difference within banding group($p<0.05$) than the bonding group. Linear distance from OP-p through Sella to the right molar showed 2.193 mm hike from the pretreatment value, which initially was 41.307 with a standard deviation of 4.32 (Table 1.E).

In case of banding group, OP-p through sella to the left banded molar showed a mean difference of 3 mm from the initial value of 36.807 mm with a standard deviation of 3.04 mm (Table 1.F) From this analysis, it is proved that molars on the banded side moved mesially by 3 mm and on the bonded side by 2.193 mm with a percentage of 8.15 and 5.13 respectively. All these values suggest that anchorage loss was more on banded molar group compared to bonded molars, keeping all other parameters constant.

# ***DISCUSSION***

# DISCUSSION

Function, stability and esthetics are the primary goals of orthodontic treatment. In order to achieve these goals, the prime consideration is to have good control over the orthodontic tooth movement and also to resist or redirect the undesired reciprocal forces. Anchorage loss during orthodontic treatment results in unsought treatment outcome. Hence anchorage conservation is one of the inevitable steps in orthodontic mechanotherapy. Despite the same treatment strategy and mechanotherapy each patient shows different tendency towards anchorage loss, which influences the treatment results. So anchorage preparation should preferably be predictable before the treatment itself.

According to Graber, the term anchorage is referred to as "the nature and degree of resistance to displacement offered by an anatomic unit [76]while Gardiner et al defined it as "the site of delivery from which a force is exerted.[77] On the other hand, Lewis defined anchorage simply as "the resistance to unwanted tooth movement.[78]

Banding and bonding the molars with buccal tubes are done in most of the cases during fixed orthodontic therapy. This study aims to compare the effect of bonding and banding the molars on anchorage preservation. It is a split mouth study design in which anchorage loss is measured from lateral cephalograms and study models. According to Risa Usumi et al [90]forces of occlusion can affect the rate of orthodontic tooth movements. Patients with crossbite or any deviation during closure were excluded from this study. Pre adjusted edgewise appliance system employ different methods to conserve the anchorage like headgears, lace backs, bend backs, Trans palatal arch, bonding second molars, TADs etc. The present study employs cinch backs only to mitigate the potential side effect of appliance system. Cinching the arch wire immediately behind the anchor molar might prevent the forward tipping of the anterior teeth. This is in support with the study done by McLaughlin.[37 .]

Roth and MBT are the most commonly used prescription in orthodontic practice. It was found that the force exerted due to the additional built in tip was transmitted to the posterior segment, taxing the posterior anchorage.[17]Therefore, anchor loss was seen in both Roth and MBT techniques, more vividly in the Roth prescription. In the presented study all the patients were bonded with MBT brackets in order to avoid bias.

From Cephalometric analysis it was found that molars on the banded side showed more mesial migration compared to the molars on the bonded side. Linear distance from occlusal plane perpendicular through the sella point to the anchor molars were considered for this study, because sella tursica is considered to be one of the stable landmark used in cephalometry . On evaluation of lateral cephalogram, it was found that upper anchor molars moved mesially by 3 mm in the banded group, but it was only 2.193 mm for bonded group, with a percentage of 8.15% and5.3% respectively, indicating that anchorage loss was more on banded side.

Linear distance from OP-p through Sella to the right bonded molars showed 2.193 mm hike from the pretreatment value of 41.307mm with a standard deviation of 4.32 mm . On banded group, OP-p through Sella to the left banded molar showed a mean difference of 3 mm from the initial value of 36.807 mm with a standard deviation of 3.04 mm. All these values suggest that anchorage loss was more on banded molar group compared to the bonded molars, keeping all the other parameters constant.

Separation of teeth to create space for banding is the first step in orthodontic fixed appliance therapy. Banding usually lead to pain in patients whereas bonding is relatively painless procedure. Painless procedures have proved to build trust within the patients.[89]

Banding the molars usually leads to gingival and periodontal inflammation and releases prostaglandins[34] at the site of inflammation and thereby accelerates orthodontic tooth movement. Mechanical loads and irritations on periodontal ligament cells are known to induce expression of cyclooxygenase-2 (cox-2) enzyme. It facilitates formation of Prostaglandins. Prostaglandin is an inflammatory mediator and a paracrine hormone that acts on nearby cells and stimulates bone resorption by increas-

ing directly the number of bone forming cells(Osteoblasts). They are proved to be one of the regulators of osteoclast formation. Exogenous PGE1 treatment usually increases RANKL mRNA expressions in Periodontal ligament cells.[91] In vivo and in vitro experiments were conducted to show clearly the relation between Prostaglandins, applied orthodontic forces, and the acceleration of orthodontic tooth movement. Yamasaki et al was one among the first to investigate the effect of local administration of prostaglandin on monkeys and rats. Experiments have shown that local injections of exogenous Prostaglandins over a period of time caused acceleration of tooth movements in rats. It has also been reported that the administration of PGE1 in the presence of calcium stabilizes root resorption while accelerating the tooth movement.[92]

Anchor loss is more critical in the maxillary than in the mandibular arch due to the fact that the lower anterior teeth are smaller when compared to the upper anterior teeth and the tip values are higher for upper teeth. Mesial inclination of the upper molars are higher than that of the lower molars which facilitates upper molar to move mesially more readily than the lower molar.

Another possible reason could be the density of the bone surrounding the tooth. It is suggested that teeth move more in spongy bone than teeth which are placed in dense cortical bone. Since the maxilla is more cancellous in nature, anchor loss is likely to be more in maxilla as compared to that of the mandible which shows more cortication. This is in agreement with the study done by Dr. Robert Murray Ricketts.[27] Gingival and periodontal inflammations are less on bonded group compared to that of the banded side

because of the fact that bonded buccal tubes are not in contact with the gingiva.

Third palatal rugae is considered to be a stable landmark to precisely evaluate the anteroposterior molar and incisor movements. This is based on the studies done by Bailey LT etal[79], Almeida MA et al[80], and Hoggan BR.[81.] Aravind Sivaraj et al reported that the orientation pattern of rugae is formed by the 12th to 14th weeks of prenatal life and remains stable till the oral mucosa deteriorate after death. Muthusubramanian et al had mentioned in their study that palatal rugea being equivalent to the fingerprint.[83]The palatine rugae possess unique characteristics that could be

used in certain circumstances where in it is difficult to identify the crimes, based on fingerprints or other records. Palatine rugae are stable and unique to every individual.[82]

Reuer et al concluded that orthodontic treatment changes can be evaluated considering third palatal rugae pattern as a stable landmark.[84]Park et al highlighted the importance of rugea pattern in cleft lip and palate patients.[85]Third rugae was used for assessing mesial movement of anchor molars in this study.

On study model evaluation, it was found that the banded side showed more anchorage loss compared to the bonded side. In the bonded group anchor molars moved mesially by 1.154 mm on an average while on the banded side it was about 2 mm, with a percentage of 10% and 19% in sequence. A median reference line was constructed by connecting the most anterior and posterior raphe points. Median reference line along with third palatal rugae were considered for assessing the mesial molar movement.

There values suggest that Separator placement followed by banding of the molars might be the reason for mesial movement of the anchor molars. It is evident that banding of the anchor molar with buccal tube cause periodontal/gingival irritations than bonding the molars with buccal tube. Usually gingival impingement can be reduced by trimming the molar bands occlusocervically. This creates rough edges that may aggravate the plaque accumulation if not done properly. Mouth washes have been found to decline the microbial load and thereby gingival inflammation. One of the drawbacks of bonding the molars with buccal tube is the occasional bond failure which can be overcome by using proper bonding technique.

One of the major concerns for Orthodontics has been the development of methods that could adequately control anchorage for the selective movement of individual tooth or group of teeth. In light of this, orthodontists have developed a variety of strategies and techniques to augment the anchorage by engaging various methods to inhibit or prevent movement of the anchor teeth. Some of them being use of headgear ,[86]inclusion of second molars, usage of Class II elastics, anchor bends and curves, Trans palatal arch,[87] alpha and beta bends in loop mechanics [88]or temporary anchorage devices etc. The inclusion of the second molar is a simple

method to reinforce anchorage in day to day orthodontic practice.

Sometimes intra oral anchorage is insufficient to achieve the desired orthodontic tooth movements. To overcome this problem, extra oral anchorage can be used to augment the intraoral anchorage. Head gears can be utilized for this purpose, It can be classified according to the point of origin and decide direction of force: such as Cervical-Anchorage derived from the nape of neck., Occipital-Anchorage obtained from the back side of the head. Parietal-Anchorage is obtained from the upper side of the head'. Anchorage consideration depends on many factors such as number and type of the teeth being moved, mechanism of space closure, periodontal condition, skeletal parameters, eruption status of the third molars etc. In order to avoid bias, this study followed uniform mechanics and conditions such as active tie backs, uniform bracket prescriptions, equal application of force on both sides about 150 gm, sliding mechanics Patients with normal growth pattern. Anchorage value of all teeth were approximately equal to its root surface area. In this study second molars are not included because it may have added the anchorage value.

Braun et al in his study about the friction and anchorage control strategies made certain observations. In a typical extraction case it is desired to close the extraction space 60% by retraction of anterior teeth and 40% by forward movement of posterior teeth. This can be obtained by three mechanisms. First, One step space closure with a frictionless appliance. Second, a twostep procedure by sliding the cuspids initially, followed by retracting the incisors. (same as tweed technique). Third, a twostep closure in which the anterior segment is tipped with some amount of friction and then up righting them later on.

Vertical control is one of the main consideration during retraction procedures. Trans palatal arch is one of the anchorage augmentation method in a day to day orthodontic practice. This offers the option of expansion, rotation, contraction, and torqueing of the molars by activating the TPA accordingly. Present study has not utilized these kind anchorage augmentation methods.

Anchorage loss is considered to be a potential side effect of orthodontic mechanotherapy and one of the major causes of unsuccessful treatment outcome and it can occur in all the three planes of space. Mesial movement of molars and

proclination of anteriors in the sagittal plane, extrusion of molars and anterior teeth in the vertical plane, buccal flaring due to over expanded arch form and unintentional lingual root torque and lingual dumping of molars in the transverse plane etc are some of them. Present study evaluated the anchorage loss in the sagittal plane only.

Orthodontists throughout the years have made efforts to find biomechanical techniques to control anchorage. Tweed[93], Holdaway[94] and Merrifield[95] developed different types of anchorage conservation methods to increase the efficacy of orthodontic treatment. Retraction mechanisms and bracket types[96]have also been developed to improve tooth movement and anchorage conservation. Bio progressive technique by Ricketts et al takes advantage of bone morphology and its reactions to applied forces. They suggested that by placing the roots of the anchor teeth against the dense and laminated cortical bone, tooth movement can be delayed and anchorage enhanced.

Anchorage preparation should be a prime consideration while a treatment plan is formulated. The skeletal and dental anchorage should be judiciously planned for a better treatment outcome. In addition to all the other factors discussed earlier, banding the molar may play a major role in anchorage loss. To reinforce anchorage, it is better to bond molars. Further studies are required to quantify the prostaglandins and inflammatory mediators released at these site and their influence in anchorage loss.

**Table 2 A: Comparative analysis on the advantages and disadvantages of banding versus bonding of molars during fixed appliance therapy can be summarized in the following table**

| | BANDING | BONDING |
|---|---|---|
| **Advantages** | • Adhesive reliability is more<br>• Failure of banding is less compared to bonding<br>• Attachments can be easily welded to orthodontic bands<br>• Easily adapted to tooth irrespective of their contour and surface texture | • Less chair side time<br>• No associated gingival or periodontal inflammation<br>• Bonded molars are more hygienic compared to banded molars<br>• Esthetic in nature, less coverage of tooth surface<br>• Increased patient compliance<br>• Anchorage loss is minimal for bonded molars |
| **Disadvantages** | • Increased gingival inflammation and periodontitis<br>• Anchorage loss is more<br>• More chance for plaque accumulation and dental caries<br>• Poor esthetics<br>• Increased chairside time.<br>• Less hygienic compared to bonding. | • Chances of bond failure<br>• Bonding may be affected by the tooth contour and texture |

## LIMITATIONS OF THIS STUDY

1. Prostaglandins and inflammatory mediators released at the site of inflammation were not quantified in this study.

2. Since the study was conducted in an in-vivo clinical setup, the exact amount of forces acting and the molecular mechanisms behind it still remains as a mystery.

3. Study is not carried out in the mandibular arch.

4. Usage of mouthwash and painkillers during the treatment period can subside the inflammation and it might have affected the results of this study.

5. Due to the painless effects on the bonded side some patients demanded to replace the bands with bondable buccal tubes.

6. As the anchorage loss is multifactorial it is not practically possible to keep all the other parameters constant.

7. Anchorage loss was clinically evident in vertical plane irrespective of banding or bonding the upper anchor molars.

## FUTURE OF THIS STUDY

- Prostaglandins can be considered as a boon as well as a curse in orthodontics. The detrimental effect of prostaglandins can be redirected for accelerating the orthodontic treatment there by saving treatment time.

- For maximum anchorage cases it's advisable to bond the upper first and second molars, in order to get better anchorage control rather than following the traditional banding procedures.

- By analyzing the molecular mechanisms and prostaglandins at the site of inflammation we can quantify the orthodontic tooth movement.

# ***CONCLUSION***

# CONCLUSION

- Both banded and bonded molars are effective in anchorage control, while retracting the upper anteriors.
- Anchorage control was more effective in bonded molar group.
- Anchorage loss was observed more in banded group.

The present study concluded that there is anchorage loss irrespective of banding or bonding the anchor molars. But the magnitude of anchorage loss was higher for the banded group compared to the bonded group. That may be due to the inflammatory process and prostaglandin release associated with the same. With the recent improvement in the adhesive capacity of the orthodontic bonding agents, bonding molars take as anchor molar seems to have definite advantages over banding the molars.

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# ***ANNEXURES***

**Annexure 1. Linear distance from OP-p through Sella to right molar (mm) (BONDED MOLAR GROUP)**

| Sl.NO | Linear distance from OP-p through Sella to right molar (mm) bonded molar | |
|---|---|---|
| | Pre treatment | Post retraction |
| 1 | 42 | 43 |
| 2 | 36 | 37 |
| 3 | 39 | 42 |
| 4 | 38.5 | 42 |
| 5 | 37 | 40 |
| 6 | 47 | 47.5 |
| 7 | 49 | 51 |
| 8 | 39 | 44 |
| 9 | 43 | 45 |
| 10 | 45 | 46 |
| 11 | 40 | 42 |
| 12 | 48 | 51 |
| 13 | 39 | 40 |
| 14 | 39 | 41 |
| 15 | 37 | 41 |
| 16 | 45 | 48 |
| 17 | 41 | 42 |
| 18 | 39 | 42 |

**Annexure 2. Linear distance from OP-p through Sella to left molar (mm) (BANDED MOLAR GROUP)**

| NO | Linear distance from OP-p through Sella to left molar (mm) -banded molar | |
|---|---|---|
| | Pre treatment | Post retraction |
| 1 | 36 | 39 |
| 2 | 42 | 43.5 |
| 3 | 33 | 38 |
| 4 | 33 | 38 |
| 5 | 32 | 34 |
| 6 | 44 | 46 |
| 7 | 44 | 45 |
| 8 | 32.5 | 35 |
| 9 | 35 | 36 |
| 10 | 40 | 43 |
| 11 | 35 | 37 |
| 12 | 32 | 40 |
| 13 | 35 | 37 |
| 14 | 33 | 35 |
| 15 | 28 | 34 |
| 16 | 44 | 46 |
| 17 | 44 | 45 |
| 18 | 41 | 46 |

**Annexure 3: Linear distance from right 3rd rugea to reference line in bonded group**

| NO | Linear distance from right 3 rd. rugea to reference line (URM-MRLline) (mm) | |
|---|---|---|
| | Pre treatment | Post retraction |
| 1 | 12 | 11 |
| 2 | 11 | 9 |
| 3 | 12 | 10 |
| 4 | 13 | 9 |
| 5 | 11 | 11 |
| 6 | 12 | 11 |
| 7 | 9 | 8 |
| 8 | 10 | 9 |
| 9 | 11 | 10 |
| 10 | 11 | 8 |
| 11 | 13 | 12 |
| 12 | 10 | 10 |
| 13 | 12 | 11 |
| 14 | 12 | 12 |
| 15 | 13 | 11 |
| 16 | 11 | 11 |
| 17 | 12 | 12 |
| 18 | 11 | 12 |

**Annexure4: Linear distance from left 3rd rugea to reference line in banded group**

| NO | Linear distance from left 3 rd. rugea to reference line (UlM-MRLline) (mm | |
|---|---|---|
| | Pre treatment | Post retraction |
| 1 | 12 | 10.5 |
| 2 | 11 | 8 |
| 3 | 10 | 6.5 |
| 4 | 11 | 9 |
| 5 | 10 | 8 |
| 6 | 11 | 9 |
| 7 | 8.5 | 6 |
| 8 | 9 | 8 |
| 9 | 9 | 6.5 |
| 10 | 11 | 9 |
| 11 | 12 | 10 |
| 12 | 8 | 7.5 |
| 13 | 10 | 9.5 |
| 14 | 10 | 9 |
| 15 | 10 | 9 |
| 16 | 11 | 9 |
| 17 | 10 | 6 |
| 18 | 11 | 8 |

Annexure 5:

## INFORMED CONSENT

I……aged.....……year,Son/Daughter/of.....,,hereby give my consent to be a part of "A comparative study of banded molars versus bonded molars on anchorage during alignment and retraction phase held at Department of orthodontics ,St Gregorios dental college Chelad, Kothamangalam. I have been informed in detail in the language known to me, about the study. My participation in the study is entirely voluntary and my decision not to participate will not have any negative effect on my dental care. I understand that my identity details will be kept confidential and I hereby grant permission /consent to Department of Orthodontics and Dentofacial Orthopedics, to take and use photographs and/ or digital images of me for use in dissertation and for academic publications. I declare that I am of sound mind and is giving this consent with my own decision &willingness and not under the compulsion or pressure by any of the hospital staff/ doctors, after having read and understood the contents of consent form.

Parent signature/Thumb impression with date:

Patients signature/Thumb impression with date:

Address:

Contact no:

WITNESS SIGNATURE

1. DR…….
   DR……. (Postgraduate Student)
   (Professor &Guide)

## സമ്മതപത്രം

സെന്റ് ഗ്രിഗോറിയോസ് ഡെന്റൽ കോളേജിൽ ഓർത്തഡോൺഡിക്സ് വിഭാഗം നടത്തുന്ന കം പാരിറ്റീവ് സ്റ്റഡി ഓഫ് ബോണ്ടഡ് വേഴ്സസ് ബാന്റഡ് മോളാർസ് ഡ്യൂറിംഗ് അലയൻമെന്റ് ആന്റ് റിട്രാക്ഷൻ ഫേസ് ആന്റ് ഇൻ വൈവോ സ്റ്റഡിയിൽ എന്നെ/എന്റെ മകന് /മകളെ പങ്കെടിപ്പിക്കുവാൻ എനിക്ക് സമ്മതമാണ്. പഠനത്തെ കുറിച്ചുള്ള എല്ലാ വിവരങ്ങളും എനിക്കറിയാവുന്ന ഭാഷയിൽ എന്നോട് വിവരിച്ചിട്ടുണ്ട് ഏതു നിമിഷവും പഠനത്തിൽ നിന്നും പിന്മാറാമെന്നും ഇത് തുടർന്നുള്ള ചികിൽസയെ ബാധിക്കില്ല എന്നും ചികിത്സ വിവരങ്ങളുടെ സ്വകാര്യത നഷ്ടപ്പെടാതെ സൂക്ഷിക്കുമെന്നും ഉറപ്പു നൽകിയിട്ടുണ്ട്. ഇതിന്റെ ഭാഗമായി ഫോട്ടോഗ്രാഫ്സ് എടുക്കുന്നതിനും റിസർച്ച് പ്രസിദ്ധീകരണങ്ങളിൽ പബ്ലിക് ചെയ്യുന്നതിന്നും എനിക്ക് സമ്മതമാണ്.

പേര്/ഒപ്പ്/വിരലടയാളം:.....

രക്ഷകർത്താവിന്റെ പേര്/ഒപ്പ്/വിരലടയാളം:.....

തിയതി:.....

പരിശോധകന്റെ പേര്/ഒപ്പ്:.....
അഡ്രസ്സ്:.....
.....
.....

സാക്ഷിയുടെ പേര്/ഒപ്പ്:.....

ഡോക്ടർ
പി.ജി സ്റ്റുടന്റ്

ഡോക്ടർ
പ്രൊഫസർ /ഗെയ്ഡ്

Annexure: 6

## Ethical committee certificate

**ST. GREGORIOS DENTAL COLLEGE**

UNDER THE MANAGEMENT OF MJSCE TRUST, PUTHENCRUZ

CHELAD , KOTHAMANGALAM, ERNAKULAM DIST, KERALA - 686681

**ETHICAL CLEARANCE CERTIFICATE**

**SGDC/152/2018/3381/4** **Date:- 20-12-2018**

**To,**

**Dr. Jayasree J prakash**

**St. Gregorios Dental College**

**Chelad, Kothamangalam**

**Dear Dr. Jayasree J prakash**

**Subject: Ethics Committee Clearance Reg.**

**Protocol- A comparative study of banded molars versus bonded molars on anchorage during alignment and retraction phase – An *in vivo*study .**

**After the Institutional Ethics Committee (TEC) held on 19th of December 2018, this study was examined and discussed. After the consideration, the committee had decided to approve and grant clearance for the aforementioned study.**

**The members who attended the meeting at which the protocol was discussed were:**

1. **Dr. CKK Nair – Former BARC science**
2. **Dr. OmmenAju Jacob – Dean, St. Gregorios Dental College, Chelad**
3. **Dr. Cinu Thomas A – Scientist, Senior Lecturer, Department of Pharmaceutical Sciences Center for Professional and Advanced Studies**
4. **Rv. Fr. Shanu K. Paulose**
5. **Lissy Jose – Former Member Women's Welfare Association**
6. **Adv. Jose Aranjani – Advocate**
7. **Dr. Sauganth Paul – Senior Lecturer, Department of Biochemistry, St. Gregorios Dental College**
8. **Dr. EapenCherian – Secretary**
9. **Dr. Jain Mathew – Principal and Head of the Department, Department of Conservative Dentistry and Endodontics**
10. **Dr. George Francis – Head of the Department, Department of Prosthodontics Crown & Bridge**
11. **Dr. BinaoyKurian – Head of the Department, Department of Orthodontics & Dentofacial Orthopeadics**

**Dr. CKK Nair**
**Chairman Institutional Ethics Committee**
**St. Gregorios Dental College, Chelad**

St. Gregorios Dental College Chelad - 686 681

**Dr. EapenCherian**
**Secretary**

Phone : 0485-2572529, 530, 531, 2571429, Fax : 0485-2572530,
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I humbly acknowledge honorable **Dr. Jain Mathew** Principal, St: Gregorios Dental College, for constant encouragement and support and generous permission to use the college facilities. I consider myself fortunate for being associated with such an esteemed institution.

I sincerely admire the contribution of all my fellow colleague: **Dr. Aparana Anand & Dr. Sheethal Sara Varghese** for all the support, during the course of entire study.

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I feel a deep sense of gratitude to **my Amma and Chachan**, who formed part of my vision and taught me the good things that really matter in life.

- Dr. Jayasree J Prakash

# LIST OF ABBREVATIONS

| ABBREVIATIONS | DESCRIPTION |
|---|---|
| Fig | Figure |
| mm | Millimeter |
| SD | Standard deviation |
| T1 | Pretreatment |
| T2 | Post retraction |
| Op-P | Occlusal plane perpendicular |
| URM | Upper right molar |
| ULM | upper left molar |
| MRL | median reference line |
| Lr | Left median rugae |
| dr | Right median rugae |
| TAD | Temporary Anchorage device |
| TPA | Trans palatal arch |