COMPARATIVE ASSESSMENT OF CORTICAL BONE THICKNESS AT INFRAZYGOMATIC CREST, BUCCAL SHELF AREA, ANTERIOR MAXILLA FOR PLACEMENT OF BONE SCREWS IN NORMODIVERGENT, HYPODIVERGENT AND HYPERDIVERGENT PATIENTS PROTOCOL FOR CBCT STUDY.

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***Introduction:** Craniofacial morphology is determined by genetics, environmental factors and functional demands. Craniofacial system involves maxillary-mandibular region,and muscles surrounding it. Hard and soft tissues are affected by strain from masticatory forces. Cortical bone adapts to the strain it is subjected. Strain on muscles maintains the form and the mass of the bone. Higher strain induces production of bone while lower strain values lead to bone loss. It is observed that strain on muscles varies in individuals having different facial forms, bite force and malocclusion. Thus, one can relate between muscle function, cortical bone thickness and facial divergence. [1,2] Anchorage can be served by using sites other than teeth without unwanted side effects. With the advent of implants for replacing missing teeth, its use for orthodontic anchorage was also introduced.Temporary anchorage devices (TADS) are the Mini-implants commonly used in orthodontics with versatility, minimally invasiveness and cost effectiveness. Use of TADS as the means of absolute anchorage is one of the most important revolution in anchorage considerations over last few years. [4]*

Although Mini-screws are minimally invasive and easy to insert, it has the disadvantage of early loosening during the course of treatment. More rigid anchorage systems such as miniplates were introduced for placement in the inter-radicular area but their placement required extensive surgical procedures along with raising the flap. Presently use of bone screws for skeletal anchorage is becoming routine in clinical orthodontics.[3]

Orthodontic Bone screws (OBS) are placed at extra-radicular sites. It is observed that the failure rates of OBS are significantly low. Further orthodontic bone screws do not require extensive surgical intervention [5]. TADs are able to solve problems related toanchorage but are less efficient than Bone Screws. The common failure that occurs in TAD's is the root contact and lack of cortical bone thickness. Extra-radicular approach is used because there are no inter-radicular mini-screws to prevent full arch retraction.TADS are not always successful in retracting maxillary buccalsegments.[7] OBS are able to solve problem related to anchorage and are able to bring micro- implantmediated segmental distalisation.They are useful in treatment of the non-extraction cases or retreat cases with anchorage loss.Cases which are time consuming and difficult due to anchorage consideration can be considered for treatment with TADS.OBS are able to conservatively manage complexmalocclusions such as severe crowding, skeletal discrepancies, asymmetries and impactions, intrusion of single tooth to full arch, protraction and retraction of dentition.[5,6]. The stability and success rate of TAD's is primarily determined by the cortical bone thickness of bone in which it is placed. Even 0.5mm difference in cortical bone thickness can have major impact on success rates according to the reports.The preferred extra-radicular sites for placement of bone screw are infra-zygomatic crest and mandibular buccal shelf area. Infra-zygomatic crest is a bony crest in the maxilla extending from buccal plate of alveolar process lateral to the roots of first and second maxillary molars and extends 2cm or more superiorly to the Zygomatico-maxillary suture.[6] The mandibular buccal shelf area is an extension of oblique ridge of mandible, and it is anatomically very safe site for extra radicular TAD's because of the density of cortical bone. Buccal shelf area is extending from lateral to first molar to the external oblique ridge region.[6] Bone screws were successfully used in the anterior segment of maxilla to intrude maxillary segment. It is important to study bony architecture in anterior segment of maxilla and mandible for placement of bone screws.[7]

CBCT is 3D imagining technique and allows accurate and reliable 3D linear measurements of cortical bone thickness. It offers high diagnosticvalue in relatively low radiation dose. CBCT helps to quantify the skeletal anatomy, placement angle of TAD's and amount of bone thickness. [10] In recent years, number of adults seeking Orthodontic treatments has increased. Many of them require camouflage treatment. Knowledge of bone morphology in various areas will guide clinicians in selecting the placement site.[8] The purpose of this study is to evaluate the cortical bone thickness at extra radicular site such as IZC, BS and anterior maxilla in patients having different facial divergence using CBCT.

Primary Research Question: Is there any variation in cortical bone thickness at infra-zygomatic crest, buccal shelf area, and anterior maxilla in normo-divergent, hypo-divergent and hyper- divergent patients?

Primary Hypothesis: There is variation in cortical bone thickness at infra-zygomatic crest, buccal shelf area and anterior maxilla in normo-divergent, hypo-divergent and hyper-divergent patients.

Review of Literature: - Toru Deguchi et al (2006) [11] quantitatively evaluated cortical bone thickness in various locations in the maxilla and the mandible for orthodontic implants using computed tomography. The distances from intercortical bone surface to root surface, and distances between the roots of premolars and molars were also measured to determine the acceptable length and diameter of the Mini-screws for anchorage during orthodontic treatment. CBCT images of 10 patients were evaluated. Cortical bone thickness was measured in the buccal and lingual, distal to first molar, distal to second molar and premaxillary region. Bone thickness was evaluated at differentangles (30°, 45°, 90°) Significantly more cortical bone thickness was observed at buccal region distal to second molar in maxilla, on lingual side than buccal, in mandible than in maxilla.

Cortical bone thickness was 1.5 times at 30° compared to 90°. According to the study the safest location for placement of Mini-screws was mesial or distal to first molar. According to the data acceptable size for Mini-screws is 1.5mm in diameter and 6-8 mm in length.

Tseng et al[12]in 2006 conducted a study. The aim of this study was to explore the use of mini-implants for skeletal anchorage, and to assess their stability and the causes of failure. Forty-five mini-implants, 2mm in diameter with 8, 10, 12, 14 mm were used. Force was applied through elastomeric chains or Ni-TI coil spring after 2 weeks. Mini-implants loosened after loading of orthodontic force. They concluded that mini-implants are easy to insert for skeletal anchorage and could be successful in controlling the tooth movement. The significant reason for implant failure is the location of implant. They concluded that mini-implants are easy to insert for skeletal anchorage and could be successful in control of tooth movement.

Motoyoshi et al (2007) [9] evaluatedrelationship between cortical bone thickness, inter-root distance, distance from alveolar crest to bottom of maxillary sinus and implant placement torque on stability

and success rate of orthodontic Mini-implants. After computer tomography examination, mini- implants 1.6 mm wide and 8mm longwere placed in posterior alveolar bone. The mini-implant was judged a success when orthodontic force could be applied for at least 6 months without pain or clinically detectable mobility. Study included 4 males (11 implants) and 28 females (76 implants) with age between 14.6 to 42.8years. 87 implants had the success rate of 87.4%. Cortical bone thickness was significant in this group. The success rate was much higher in men.Implants were placed with 8 to 10 Ncm torque compared to implants with higher or lower placement torques. They said that prepared site should have a cortical bone thickness of at least 1mm and the placement torque should be controlled up to 10 Ncm.

Tzu Ying Wu et al (2009) [13] evaluated the failure rates and factors associated with the stability of mini-implants used for orthodontic anchorage. They evaluated 166 patients (35 male patients and 131 female patients) who received implants. Total 414 mini-implants were evaluated with diameters ranging from 1.2 to 2.0 mm. The overall failure rate was 10.1% (42 out of 414) with orthodontic force loading for morethan six months. Most failures were due to loosening and occurred within the first 2 weeks. Differences in overall failure rates for the maxilla and mandible (9.3% and 16.3%, respectively) were not statistically significant. A lower failure rate was found for the maxilla with implant diameters equal to or less than 1.4mm (P = .036). The left side had a lower failure rate than the right (6.7% vs 13.9%, P = .019). Length and type of mini-implants, age, and gender were not associated with mini-implant failure. They analysed the clinical variables as host related and implant related factors. The results showed that the left side had lower failure rate than the right side. Length and type of mini-implants, age, and gender were not associated with mini-implant failure.

Jin-Hugh Choi et al (2009) [14] determined bone density at various orthodontic implant sites and compared them according to depth and area. Maxillofacial computed tomography scan was obtained from 30 adults with normal occlusion. Bone density was measured to a depth of 6 mm at 1- mm intervals in 60 interdental areas (30 in the maxilla, 30 in the mandible), and mean bone density was calculated at each site. Bone density decreased with increasing depth particularly in posterior region. Mean bone densities were higher in mandible and were significant on buccal side of the posterior region. They concluded that differences in bone densities should be considered while selecting and placing Mini-screws implants for orthodontic anchorage.

Yang-Ku Lee (2010) [15] determined the histological reaction of the root and bone as a mini-implant approaches the root. Two types of mini-implants were inserted into buccal alveolar bone of 4 beagles (2males and 2 females). Root resorption increased when implants were 0.6mm closer to root in root and PDL contact group. They were classified as near-root group, PDL contact group, root contact group, and root perforation group. Cementum resorption, dentin resorption, cementum repair, cementum growth, ankylosis, root cracking, and root fracture were seen in root contact and root perforation group. Root fracture, root cracking was seen in implants placed closed to roots. Cementum growth or root resorption was seen in PDL and root contact group despite proximity to the root. Root resorption and root ankylosis occurred in root perforation group, on the side opposite the insertion. There is always a risk of tissue damage and root contact from mini-implants and drilling procedure. Smaller mini-implants may reduce this problem but needs enhancement of its stability.

W.K Tsui, Chua, Cheung (2012) [16]has done a systematic review to investigate usefulness and clinical effectiveness of skeletal anchorage devices to determine the most effective bone anchor system for orthodontic tooth movement. Literature on bone anchorage devices was selected from PubMed and the Cochrane Library from January 1966 to June 2010. Fifty five publications regarding miniplates, Mini-screws, palatal implants and Dental implants as orthodontic anchorage were identified for further analysis. Bone anchorage devices were found to have relatively high success rates and had the ability to provide absolute anchorage for orthodontic tooth movement. Significant tooth movement could be achieved with low morbidities and good patient acceptance. They concluded that bone anchorage system can achieve effective orthodontic movement with low morbidities.

FulyaOzdemir, Murat Tozlu, and DeryaGermec-Cakan (2012) [17] determined the cortical bone thickness of alveolar process in patients with low, normal and increased facial heights. 155 images of adult patients (20-45 years old) were assigned to the low angle, normal and high angle groups. The thickness of buccal cortical plates of maxilla and mandible, and the palatal cortical plates of the maxilla weremeasured. There was no statistically significant difference between the groups regarding mean ages, sex, and sagittal facial types. High angled patients showed significantly lower values in all mini-implant insertion site in both maxillary and mandibular alveolar bones. Lowest values were for high angle group, followed by normal group and then low angle group. They concluded that thin cortical plates in high-angle patients are risky during mini-implant insertion. Therefore, it is important to assess the bone thickness to avoid failures during procedures.

Michele Cassetta et al (2013) [18]evaluated differences in alveolar cortical bone thickness and density between interarticular sites at different levels from the alveolar crest and assessed differences between adolescents (12-18years of age) and adults (19-50 years of age), males and females, upper and lower arch, anterior and posterior region of jaws and buccal and oral side. 48 Caucasians orthodontic patients were selected for oral surgery purposes . Cortical bone thickness and density at 13 inter-radicular sites at four bone levels were assessed. Statistically significant differences in alveolar cortical bone thickness and density between age, gender, sites and sides were found. Adults had thicker alveolar bone compared to adolescents. Alveolar bone thickness and density was more in males than females, in mandible than in maxilla, in posterior than the anterior, and on buccal side. There is an increase of thickness and density from crest to base of alveolar crest.

Shilpa Kalra, Tulika, Priyank, Anup (2014) [19] compared the accuracy of two-dimensional radiographs with cone beam computed tomography (CBCT) for mini-implant placement. The ideal sitefor placement was determined for 40 sites (in 13 patients aged 14-28 years) between secondpremolar and first molar by using CBCT. There were two groups, CBCT group and RVG group. In CBCT group implants were placed using CBCT as a guide. In RVG group Implants were placed using 2-dimensional radiograph and a custom-made guide. To determine accuracy of implant placement postplacement CBCT scans were obtained. There was a statistically significant difference observed between the twogroups for deviation from ideal height of placement of mini-implants. Deviation in mesiodistal positioning and angular deviation showed non-significant difference. Three out of 20 mini-implants showed root contact in mandible in RVG group due to narrower inter-radicular space. Considering the cost and radiation exposure with the two techniques the use of 2D radiographs with surgical guide for routine mini-implant placement is recommended. Mais Medhat Sadek, NohaEzatSabet and Islam Tarek Hassan (2016) [20] studied the differences in cortical bone thickness among the subjects with different vertical facial dimensions. 48 CBCT scans were selected for this study from 114 pre-treatment CBCT scans. Patients were categorised as low, high, normal angle cases using lateral cephalograms. Cortical bone thickness at 4mm and 7mm from alveolar crest was measured in entire tooth bearing areas of maxilla and mandible. Significant differences were seen with high angle cases having narrower inter radicular cortical bone thickness compared to average and low angle cases.

Debora Loli (2017) [21]conducted a review which aimed at evaluating the failure rates of the TADs implant and the reasons for the failure. A systematic review was performed on principal medical databases. The failure rates of TADs implants reported in literature vary from 0% to 40.8% with an overall mean value of 13.8%. The failures rates of TADS are higher in mandible than in maxilla. Failures can be mainly due to problems such as thin or low density of cortex, narrow screw with risk of fracture, operator related problems, excessive pressure etc.

C. H. Chang, Joshua S. Y. Lin, H. Y. Yeh (2018) [22] evaluated management of challenging malocclusion conservatively with no extractions or orthognathic surgery. Extra alveolar anchorage is achieved at three intraoral sites namely Mandibular buccal shelf area, infrazygomatic crest (IZC) and anterior ramus. MBS and IZC bone screws effectively anchor the conservative correction of severe dental and skeletal malocclusions. Extra alveolar anchorage corrects crowding by retracting the posterior segments to increase arch length. Bone screws for orthodontics anchorage are placed outside the alveolar process to avoid root interference as teeth and arches are moved.

Chris Chang et al (2019) [23] compared the failure rates of stainless steel (SS) versus titanium alloy (TiA) bone screws placed in infra-zygomatic crest(IZC) area.Totalof 386 consecutive patients (76 male, 310 females; mean age 24.3 years, range 10.3–59.4 years) received IZC BSs (SS or TiA) via a double- blind, split-mouth design. BS penetrated attached gingiva (AG) or moveable mucosa (MM) with 5 mm of soft tissue clearance. All BS were immediately loaded and reactivated monthly with 14 oz (397 g or 389 cN) applied directly to the upper arch-wire bilaterally for 6 months to retract the maxilla to correct Class II or bimaxillary protrusion. Of 722 devices, 49 (6.3%) failures, 27SS (7%) and
22 TiA (5.7%). There was no significance between SS and TiA failures relative to left/right, unilateral/bilateral and age at failure. Increased failure rates were noted for SS subgroups: attached gingiva and right side. 21 patients had unilateral failure and 14 had bilateral failure. The overall success rate indicates that both IZC and TiA are clinically acceptable for IZC bone screws.

Roberta BasañezAleluia Costa et al (2020) [24] evaluated bone height and thickness in mandibular buccal shelf region and to compare differences between anatomical sites according to gender, side and vertical and sagittal skeletal patterns using multislice computed tomography (MSCT) of 94 subjects (51 females and 43 males). There was increase in bone thickness in the posterior and basal directions. Hypodivergent and class III subjects showed significantly greater bone thickness. Significantly greater bone height was found mesial to second molar in class III subjects compared to class I subjects. And in hyperdivergent males compared to hypodivergent males. They concluded that the region distal to second molar is the most appropriate for the insertion of extra alveolar Mini-screws in terms of bone thickness. Hypodivergent and Class III subjects showed greater bone thickness in the mandibular buccal shelf region.

C. H. Chang, Lexie Y. Lin, Roberts (2020) reported to review modern strategies for managing the barriers and facilitators for E-A TAD anchorage by demonstrating: (a) simple yetpowerful biomechanics, (b) minimally invasive clinical procedures and (c) application to clear aligner therapy. They concluded that infra-zygomatic crest (IZC), Mandibular buccal shelf area (MBS) orthodontic bone screws are reliable and well-established devices that expand the scope for conservative treatment of severe and complex malocclusions. This article is a review of extra alveolar anchorage possibilities that will encourage clinicians to take the plunge. Comfort level is addressed by documentation of simplified placement procedures, low failure rates and lack of the iatrogenic problems. It is clear that extra-radicular bone screws will substantially impact the future of orthodontics and dentofacial orthopedics.

Cortical bone thickness has been evaluated for placement of mini-screws. There are very less studies related to bone screws and appropriate cortical bone thickness required for its placement at extra radicular sites. With the advent of orthodontic bone screws and its various advantages it has become necessary to study cortical bone thickness at different extra-radicular sites.

Primary Objective: - To assess and compare cortical bone thickness at infra-zygomatic crest, buccal shelf area and anterior segment of maxilla for placement of bone screws using CBCT in normo-divergent, hypo-divergent and hyper-divergent patients.

Methodology

Study Design: Observational Cross-sectional study.

Study Setting: Interdepartmental; Department of Orthodontics and Dentofacial Orthopedics. Department of Oral Medicine and Radiology.

Study population: Individuals coming to the Department of Orthodontics and Dentofacial Orthopedics.

Sample size: Level of significance = 5%, Power = 80%, Type of test = two-sided

Formula of calculating sample size is: Sample size for two independent samples (outcome variable on ratio scale and testing null hypothesis n= 2 $\boldsymbol{S2}(\boldsymbol{Z1}+\boldsymbol{Z2})\ \mathbf{2}\ (\boldsymbol{M1}-\boldsymbol{M2})\ \mathbf{2}$ n= 2 $(\mathbf{1.64}+\mathbf{0.84})\ \mathbf{2}\ (\mathbf{0.55})\ \mathbf{2}$ n= 36 F tests

ANOVA: Fixed effects, omnibus, one-way Analysis: A priori: Compute required sample size Input: Effect size f = 0.55 α err prob = 0.05 Power (1-β err prob) = 0.80 Number of groups = 3 Output: Non-centrality parameter λ = 10.89 Critical F = 3.284 Numerator df = 2 Denominator df = 33 Total sample size = 36 Actual power = 0.812 Page 11 A power analysis was established by G*Power, version 3.0.1(Franz Fauluniversitat, Kiel, Germany). Total calculated sample size of 36 CBCT (12 per facial growth pattern type; 3 study groups which would yield 80% power to detect significant differences, with effect size of 0.55 and significance level at 0.0

Sampling Technique: Convenience sampling technique

Method of selection:

INCLUSION CRITERIA:

- Subjects seeking orthodontic treatment which may require placement of bone screws
- Subjects with age 18 or greater than 18 years of age requiring critical anchorage for orthodontic treatment.
- Patients with full complementof teeth except for third molars.
- . • Properly exposed CBCT volumes where images are of good contrast.
- No previous orthodontic treatment
- Permanent dentition
- Mild to moderate dental crowding without periodontitis

EXCLUSION CRITERIA:

- A significant medical or dental history (e.g use of bisphosphonates, bone altering medications, syndromic individuals or diseases).
- Severe facial or dental asymmetries.
- Patients with missing teeth.
- Patients with missing or unerupted permanent teeth in the quadrant measured.
- Patients undergone orthognathic surgeries.
- Vertical or horizontal periodontal bone loss.

• Periapical or peri-radicular pathologies or radiolucencies of either periodontal or endodontic
Origin.
• Distorted CBCT images.

Operational definition:

• Orthodontic Bone screws (OBS): OBS are type of intraoral temporary anchorage devices that provide anchorage using extra-radicular site by penetrating oral mucosa and seats firmly in basal bone.
• Normo-divergent: According to Tweeds, subjects with normal Frankfort's mandibular plane angle i.emean is 20.8 + 6.2° for male and 23.9 + 4.3 for females shows facial divergence known as Normo-divergent
. • Hypodivergent: According to Tweeds, subjects with Frankfort's mandibular plane angle less than 20° shows facial divergence known as hypodivergent.
• Hyperdivergent: According to Tweeds, subjects with Frankfort's mandibular plane angle greater than 28° shows facial divergence known as hypodivergent.
• CBCT: CBCT stands for cone beam computed tomography, is a variation of computed tomography
(CT). The CBCT used in dentistry rotate around patient, and captures data using cone shaped X-ray beam. These data reconstruct a 3Dimensional image of required region.

Methods of measurement

1. Ethical committee clearance was obtained.
2. After obtaining informed written consent a thorough case history will be taken to meet the inclusion criteria.
3. Study will include Cone beam computed tomography (CBCT) of 36 subjects, selected from the Department of Orthodontics and Dentofacial Orthopedics following the inclusion criteria
. 4. The CBCT images will be obtained using SIRONA ORTHOPHOS-SL with optimum radiation dose and analysis will be done using XELIS software.
5. The reference used for determining the difference between patient's facial divergence was determined by angle formed by lower border of mandible through gnathion with FH plane. This criterion was selected because it can be evaluated clinically with greater ease.
6. Greater the aperture of this angle greater the facial height and conversely the smaller angle smaller the vertical facial height.
7. All the measurements were performed by the same operator.
8. Facial divergence will also be confirmed by CBCT generated lateral cephalograms and will be
classified as: Normo-divergent, hypodivergent and hyperdivergent using Tweeds analysis.
9. These 3 groups will have 12 subjects each.
10. This classification will be based on Mandibular plane angle (Tangent to lower border of Mandible and FH plane) calculated using CBCT generated Lateral cephalograms. The subjects will be
classified as hyperdivergent or hypodivergent if they had mandibular plane angles greater than 29°

or less than 21°, respectively. These angles represent subjects who fall beyond +1 SD of the normative values of Tweed· [25,26] Measurement of cortical bone thickness at Infrazygomatic crest,

Buccal shelf area [1,2,27]

1. Cortical bone thickness will be measured as Bucco-lingual dimensions of cortical bone measured perpendicular to bone surface from its outer surface to border of cortical bone.
2. Sagittal slice will be used to locate the sites of interest at 4mm, 7mm, 10mm from alveolar crest for individual tooth and measured.
3. The slice will be oriented so that vertical reference line will bisect the plane of interest and will be parallel to long axis of roots.
4. The axial slice will then be used to ensure that reference line bisected the area of interest.
5. The cortical plate thickness will be measured by using the coronal slice.
6. The slices will be oriented such that the shortest distance defining the buccal and lingual cortices will be measured.
7. Measurement will be at following planes:
   - Mesial to molar (6M)
   - Middle of the crown through the furcation area (6 Middle)
   - Through crown at the posterior plane distal to the root of 6 (6D)
   - Interradicular bone between the molars (6-7 IR)
   - Mesial plane of 2nd molar (7M)
   - Middle of the second molar (7 Middle)
   - Distal to 2nd molar Measurement of cortical bone thickness at anterior segment of mandible 1. Measurements will be performed on the sagittal slice at 3mm, 5mm and 7mm from alveolar crest in labial-palatal direction perpendicular to the long axis of the tooth.

2. Planes selected for measurements will be
   - Distal to left lateral incisor
   - Mesial left lateral incisor
   - Distal to left central incisor
   - Mesial left central incisor
   - Distal to central incisor
   - Mesial right lateral incisor
   - rDistal to right lateral incisor

Study instruments and Data collection tools:

1. CBCT generated lateral cephalograms
2. CBCT records
3. Periodontal probe

Method of data Collection:

Records obtained radiographically:

1. CBCT generated Lateral cephalograms will be used to classify the subjects in 3 groups based on their Frankfort mandibular plane angle i.e.Normodivergent, Hypodivergent and hyperdivergent.

2. Cone beam computed tomographic images to assess the cortical bone thickness of infrazygomatic crest, buccal shelf area, anterior segment of maxilla and mandible areas for placement of bone screws in class II and III patients.

Data Management and Analysis Procedure: Statistical analysis will be performed using Statistical Package for Social science (SPSS) version 21 for

Windows (SPSSInc, Chicago, IL). Descriptive quantitative data will be expressed in mean and standard deviation respectively. Data normality will be checked by using Shapiro – Wilk test. Confidence interval is set at 95% and probability of alpha error (level of significance) set at 5%. Power of the study set at 80%. Inter group comparison of cortical bone thickness at infrazygomatic crest, buccal shelf area, anterior maxilla in three facial growth patterns will be performed using One- way ANOVA F test followed by Tukey's post hoc test for pairwise comparison.

- **Data Analysis plan and Methods:**

This will be recorded for all the patients in the study.

JAW AREA TYPE OF FACIAL DIVERGENCE SITE CORTICAL BONE THICKNESS MAXILLA INFRAZYGOMATIC CREST At 4mm At 7mm At 10mm 6Mesial 6Middle 6 Distal 6-7 IR 7Mesial 7Middle 7 Distal MANDIBLE BUCCAL SHELF AREA 6Mesial 6Middle 6 Distal 6-7 IR 7Mesial 7Middle 7 Distal MAXILLA ANTERIOR SEGMENT Distal to left lateral incisor Mesial to left lateral incisor Mesial to right central incisor Distal to right central incisor Mesial to right lateral incisor Distal to right lateral incisor.

8.Dissusion: Anchorage management is essential for orthodontic success. Orthodontic bone screws (OBS) provide skeletal anchorage and are used to retract the dentition or rotate either of the arch. It is one of the current concepts to manage complex malocclusions such as crowding, skeletal discrepancies, impactions etc. These screws are placed in extra-radicular sites unlike Mini-screws which are placed in inter-radicular areas. So, evaluating the cortical bone thickness in patients with different growth patterns becomes necessary. Previous studies have investigated the bone thickness two dimensionally. But for accurate diagnosis and reliability CBCT images should be used to study three-dimensional structure of alveolar bone. Tseng et al [12] in 2006[2] conducted a study. The aim of this study was to explore the use of mini implants for skeletal anchorage, and to assess their stability and the causes of failure. Forty-Five mini-implants, 2mm in diameter with 8, 10, 12, 14 mm were used. Force was applied through elastomeric chains or Ni-TI coil spring after 2 weeks. Mini-implants loosened after loading of orthodontic force. They concluded that mini-implants are easy to insert for skeletal anchorage and could be successful in controlling the tooth movement. The significant reason for implant failure is the location of implant. They concluded that mini-implants are easy to insert for skeletal anchorage and could be successful in control of tooth movement. Jin-Hugh Choi et al (2009) [14] determined bone density at various orthodontic implant sites and compared them according to depth and area. Maxillofacial computed tomography scan was obtained from 30 adults with normal occlusion. Bone density was measured to a depth of 6 mm at 1- mm intervals in 60 interdental areas (30 in the maxilla, 30 in the mandible), and mean bone density was calculated at each site. Bone density decreased with increasing depth particularly in posterior region. Mean bone

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CONCLUSION: Cortical bone thickness will be assessed to be related with different facial growth patterns. For IZC bone screw ideal site of placement lies higher and lateral to 1st and 2nd molar region. Buccal shelf bone screws can be placed lower and lateral to 2nd molar region and for anterior maxilla OBS can be inserted between central and lateral incisor as per various 2D dimensional studies.The CBCT study will compare/confirm the findings about bone thickness at IZC and MBS area as assessed in previous two-dimensional studies.

Clinicians should be aware of bone thickness in different facial growth patterns to avoid iatrogenic errorsThe present 3D CBCT study will help the clinician in placement of bone screws more precisely as related to face pattern.
Study period - Approximately 18-20 months.

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Gantt chart: - GANTT CHART: Study period is 18-20 months approximately.
ACTIVITIES YEAR 2020-2021 YEAR 2021-2022 YEAR 2022-2023 Sept / Oct Nov/ Dec Jan / Feb Mar / Apr May / June July / Aug Sept / Oct Nov / Dec Jan / Feb Mar / Apr May / June July / Aug Sept / Oct Nov / Dec Jan / Feb Mar / Apr May / June July / Aug Identification of research problems IEC clearance Formulation and synopsis submission Synopsis approval Literature search Data collection Data analysis and interpretation Results and conclusions Thesis write up and submission
Annexure I: CASE RECORD Patient's name – Age /Sex – Date of birthOPD no/ SMI no – Postal address
Chief complaintFamilial malocclusion history: Habit History: Past medical History: Past Dental
history: Extra-oral examination: Facial heightFacial symmetryFacial profile ,Lips ,Dental midlineNasolabial AngleMentolabial sulcus
Intraoral examination: 1.Soft tissue examination/GingivaFrenal Attachment/Probing Depth of Pockets,
Examination of teeth: Molar/Canine Relation,Overjet/Overbite,Spacing/ Crowding/ Arch-FormSymmetry ,Stains/,Calculs,Radiographic examination: Bone loss at Mandibular buccal shelf area,
Infrazygomatic crest, Anterior maxilla
Provisional Diagnosis: Diagnosis: Treatment:
Annexure II: CONSENT FORM