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KAP Survey on the Knowledge and the Use of Temporary Anchorage Devices among Orthodontists

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Abstract: ***Introduction:*** *Anchorage control is the most important aspect of orthodontic treatment. The use of TADs for gaining absolute anchorage has become popular among Orthodontists.The aim of this study was to assess the knowledge, attitude and practices of treatment methodology, the biomechanics and features of using mini implants and IZC implants as temporary anchorage devices.*

Materials and Methods: *A questionnaire was designed and used to collect data on the prevalence of the use of temporary anchorage devices. The questionnaire was sent to 60 orthodontists of various age groups and with varying clinical experience and 56 Orthodontists responded. The response rate determined here was 93.3 %. The questionnaire was shared in the form of online forms after explaining the study design and it was designed in such a way that one participant can submit a reply only once.*

Results: *It is evident from this survey that the usage of mini implants as temporary anchorage devices are widely accepted by orthodontists. However, the norms regarding its placement are widely confused and needs further standardization. It was a general opinion among the participants in this study that titanium mini-implants are better. Even though immediate loading can be done using mini- implants, delayed loading was preferred; self-drilling implants were also preferred over pre-drilling implants.*

Conclusion: *Most orthodontists regularly use mini implants for enhancing anchorage during orthodontic treatment. However, there are still many aspects of usage of TADs that require better understanding by the orthodontistslike type of implants, time of loading for achieving good stability and success in using this as an adjuvant anchorage system.*

Keywords: *TADs, Mini Implants, IZC,Temporary Anchorage*

INTRODUCTION

Anchorage is defined as “Resistance to reaction forces that is provided (usually) by other teeth, or (sometimes) by the palate, head or neck (via extraoral force), or implants in bone”[1]. Anchorage has been classified into three types namely maximum anchorage, moderate anchorage and minimum anchorage based on the amount of retraction/protraction required during space closure. Absolute anchorage or Maximum anchorage, defined as 100% resistance against reactive forces is essential in a lot ofcases [2].In such cases anchorage plays a vital component in the success of the treatment. Anchorage planning has a long history dating as back as 1880 where Kingsly used extraoral anchorage to move teeth. E.H.Angle who strongly advocated the non-extraction philosophy also used extra oral anchorage and later Bakers Anchorage. The Tweed Merrifield Appliance technique came up with a set protocol for anchorage preparation where the teeth tipped distally in a sequential manner [3]

The basic techniques for anchorage control previously usedgenerally relied extraoral forces on the anchorage unit (headgear), intermaxillary elastics, tipping movements of the active teeth while simultaneously discouraging tipping of the anchorage teeth. Patient compliance was a mandatory requirement for headgear and elastic wear. Without patient cooperation, the control of tooth movement is lost and treatment outcome may be compromised. Then came the concept of cortical bone anchorage which was widely advocated by Rickets in his BioprogressiveTherapy. In Cortical anchorage preparation, the roots of the anchor teeth are placed close to the cortical bone under a heavy force. Anchoring the roots of the posterior teeth against the dense cortical bone would prevent its movement and thus providing increased anchorage[4]. Further developments led to the use of appliances such as the Trans-palatal arch, Nance palatal arch, Lingual Stabilizing arch etc. to improve anchorage.

Level anchorage system by Terrell .L.Root and E.G.Sagehorn[5], the technique if anchorage control in the Begg, Roth and MBT systems, the Inverse Anchorage System by Jose Carriere[6] were later developments with respect to anchorage preparation. However all these methods were either not fool-proof or they either depended on greater compliance on the part of the patient to wear the elastics/head gears etc. Then came the skeletal anchorage methods like the Zygomatic ligatures, Titanium Mini plates, Mini implants etc. Zygoma ligatures and the Titanium mini plates are very efficient sources of anchorage.However, the technique to place the Zygoma ligatures [7] and Titanium Mini Plates invasive requiring surgical procedures for placement as well as removal. Micro implants offer the least invasive source of anchorage and are an efficient fool proof system if employed properly.

Mini implants are Temporary Anchorage Devices (TADs) that are used to generate single constant force with mild to moderate magnitude regardless of patient's compliance. Before the advent of mini-implants, active distalization, enhanced anchorage etc. were done using extra oral traction. Unlike dental implants, which acquire their stability via osseointegration, Mini-Screws/Mini Implants obtain maximum stability mechanically via primary retention. There are many factors like the site of placement, the length,type, shape of head, the torque considerations etc. that need to be considered when placing mini implants. Infra Zygomatic Crest Implants are the newer implants that can be used in certain situations like full arch distalizations where they are more suitable than mini implants. Scientific literature has been flooded with studies on micro implants. However how often do Orthodontists use the micro implants in their day to day practice? How knowledgeable are the orthodontists with regards to factors like insertion torque, risk of infections etc? It is with these questions in mind that the current study was designed. The aim of this study was to assess the knowledge, attitude and practices of treatment methodology, the biomechanics and features of using mini implants as temporary anchorage devices.

MATERIALS AND METHODS

The questionnaire (Figure 1 and 2)was designed to assess the knowledge of usage and placement of mini-implants as TADs used during orthodontic treatment. The collection of data was done using a self-applied closed questionnaire. The first 4 questions had beendesignedto find out the prevalence of mini-implants usage. The next set of questions focus on the factors that are significant during placement and regarding their preferences and knowledge of the features of mini implants. The questionnaire was distributed randomly as online forms. The questionnaire was distributed to 60 orthodontists out of which 56 of them answered . The response received for the questionnaire was considered as consent to participate in this study. The response rate was 93.3%. It was ensured that only one response can be given by a single participant.The participation in this study was completely voluntary and data was maintained confidentially.

RESULTS AND STATISTICAL ANALYSIS

Data collected was tabulated in Microsoft excel sheets. The descriptive statistics were used to explain the frequencies. Pie chart representation(Figure 3-18) was used to exhibit the various factors assessed in this study. It was common among orthodontists to use mini-implants in their cases to enhance anchorage. Most of the orthodontists who participated in this study regularly use mini-implants as an adjunct anchorage.

Among the participants, there wasa preferenceof using conventional brackets over self-ligating brackets. Titanium mini-implants were preferred over stainless steel mini-implants as was the preference for delayed loading for mini-implants even when immediate loading could be done. When comparing the dimensions of implants,cylindrical mini-implants were considered to be better in achieving primary stability. The various other parameters and the results have been diagrammatically represented in the pie charts.

DISCUSSION

The success of mini implants are still subject to debate: factors linked to the operator, implant site anatomy (cortical thickness, bone density, and keratinized gingiva); biomechanics applied (quantity, duration, and vectors of the force applied).In considering factors like bone density the densest bone frequently is located in the anterior aspect of the mandible, followed by the premaxilla and the posterior mandible. The least dense bone usually is situated in the posterior maxilla. [8] Bone density is maintained by a balance between bone resorption and new bone growth when the strains are in the physiological range. When the absolute level of strain is below the equilibrium level, new bone growth is not stimulated and a net reduction in bone density occurs over period of time. [9] Mini-implants for orthodontic anchorage may be effective when placed in most areas with equivalent bone density up to 6 mm apical to the alveolar crest. Site selection should be adjusted according to bone density assessment. [10]

Mini implants characteristics depend on shape, length, whether it is predrilling or self-drilling. An implant which is inserted to a known depth, into known thickness of bone at correct torque and angulation will give a better outcome. The diagnostic aid that should be used is a cone beam tomography to check the above-mentioned features. Nanda in his book discusses that it is an added advantage to use self-ligating brackets with mini implants because of the reduced friction offered by the micro implants. The 2-mm twist drill provides this feedback, facilitating delineation of the amount of cortical bone and the density of the trabecular bone. dDense type (Td) is cortical bone that spans the entirety or the majority of the length of the intended implant or a layer of cortical bone followed by a medullary compartment that provides notable drilling resistance when the clinician applies the 2-mm twist drill. This type of bone usually exists in the anterior region of the mandible. dMedium type (Tm) is a layer of cortical bone approximately 2 to 3 mm in length followed by a medullary compartment that provides limited drilling resistance when the 2-mm twist drill is applied. Clinicians often detect Tm in the maxillary anterior region and the posterior mandible but sometimes find it in the anterior region of the mandible. dSoft type (Ts) is a minimal or indiscernible cortical bone layer and poor-quality medullary bone. Ts occurs most often in the posterior region of the maxilla.[19]

Proximity to the root surface, placement in the alveolar mucosa, and improper angulation have been attributed to mini-implant failure. Placement in the alveolar mucosa can result in periimplantitis with failure of the mini-implant. Root proximity can be reduced by angulating the mini-implant to the long axis of the tooth. This facilitates placement of the tip of the mini-implant towards the root apex. This reduces root proximity as well as increases the contact between the mini-implant and the cortical bone with increased stability of the mini-implant.[11] Torque is a significant factor to taken into consideration for achieving stability and success. Cylindrical type screw to have much higher insertion torque at the incomplete screw thread, while the taper type screw showed a much higher insertion torque at the final inclination part of the screw thread. The insertion torque is also affected by the outer diameter, length, and shape in that order.[12]

From a clinical perspective, mini-implants consist of two relevant portions: the head, for which various designs are available (bracket like, rounded with slot, etc.), and the threaded shank, which is generally cylindrical, tapered, or a combination of the two, and may be self-tapping (requires prior drilling of a pilot hole) or self-drilling (does not require a pilot hole). There is no difference between miniscrewpullout strength and cortical thickness .[13] The size of titanium screws as orthodontic anchors, the length of the screw was not associated with its stability if the screw was longer than 5 mm. The diameter of the screw was significantly associated with its stability. [14] The placement of mini-implants in the mandible, considering only the highest bone density as a factor for success, would be more interesting in the more posterior and inferior regions. But this fact does not always occur, because other factors may contribute to loss or unscrewing of the mini-implants. [15]

Cortical thickness has a major impact on higher insertion torques. Predrilling to reduce the resistance in sites with thicker cortical bone, such as the human lower jaw, appears to have low influence on insertion torque when using a pilot hole of inner implant diameter. In univariate analysis, insertion torques and vertical force did not significantly change with the presence of a pilot hole. [16] To enhance primary implant stability, modifications of the drilling protocol are necessary in different bone densities. [17] Self-drilling orthodontic miniscrews showed higher Maximum insertion torque and greater resistance against dislocation than the self-tapping ones.[18]Primary stability of self drilling implants gives a better enhancement as there is disturbance seen in the cortical bone layer created In the pre-drilling implant. When it comes to the question of torque during insertion and removal, the self drilling implant as it has to drill through intact bone in the site of insertion it requires a high torque but during its removal there is lesser torque needed. Whereas when the pre-drilling mini-implants are used the predillling with instrumentation makes it a matter of ease to insert the mini-implant thus needing lesser torque for its placement but during its removal it will need a higher torque as it will hinder with the minor locking with the bone to unscrew it and retrieve. High implant torque leads to increased chances of failure in mandible[21]. Increasing the diameter of the screw in comparison between a cylindrical and tapered implant can increase the primary stability of the mini-implant.[20] The ideal requirements of a stent are that they should enable placement of the mini-implant at the correct occluso gingival height preferably in the attached gingiva; accurate mesiodistal placement of the mini-implant away from the roots of adjacent teeth; an appropriate angulation of the mini-implant to the long axis of the tooth in the transverse plane; easy to fabricate and cost-effective; ease of placement and removal and versatility of use with ease of placement in different areas of the maxilla and mandible.[19]

Maximum load of force that can be applied to one mini -implant is from 250-400gms of force. Maximum anchorage is obtained when the implant will be inserted by 90 degrees parallel to the long axis of the tooth ; this is not possible in practical conditions and hence 45-60 degrees of angulation is acceptable. To achieve the best primary stability, an insertion angle ranging from 60 degrees to 70 degrees is acceptable when implants were inserted at 7 different angles on ilium bone segments and placement was assessed comparing manual placement and placement using robotic arms.[20]During insertion of the implant into the infra zygomatic crest there is always a risk of insertion into the sinus , this can be prevented by maintaining the angulation of the mini implant and also inserting with more insertion torque. Implants of length 2*12 mm are at a higher risk of penetrating into the sinus. There is a risk of root contact and severe tissue damage from a thick mini-implant and the drilling procedure, either of which can induce root resorption or ankylosis. Use of smaller mini-implants may reduce root contact and tissue damage. However, the small mini-implant may need enhancement of its stability.[21] There was no significant difference in the success rate between maxilla and mandible or between right and left implants. There was also no significant difference in the success rate between male and female subjects. There was no significant difference ininsertion placement torque between right and left implants. [22]

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CBT influenced the stresses in the cancellous bone, but could not directly influence the stresses in the cortical bone. For CBT < 1 mm, the cancellous bone models exhibited von Mises stresses exceeding 6 MPa, and the cortical bone models without cancellous bone showed von Mises stresses exceeding 28 MPa. Greater CBT values were associated with higher mini-implant success rates. [26] The placement torque of screwswith root contact was greater than that of screws with no root contact.Damping capacity of screws with root contact was significantly greater than that of screws with no root contact. [26] Fibrous tissues that develop around stainless steel screw threads increase risk of implant failure, by reducing the bone-to-implant contact. [25] Miniscrew implants (MSIs) are established skeletal anchorage devices routinely used in orthodontic practice. [26] The placement of mini-implants thus require wide knowledge of biomechanics and anatomy ,well planned surgical preparation in order to achieve good stability and success when they are placed for obtaining skeletal anchorage. Therefore it of utmost importance to the orthodontist to correctly select the type of anchorage device based on the requirements of the patients and the required mechanisms.

CONCLUSION

The conclusion from this survey was that there is wide acceptance of the use of mini-implants in increasing anchorage for orthodontic treatment. Whereas the knowledge regarding biomechanical aspects of various features is not certain. These parameters can't be well established and there are considerations that vary from site to site, also depends on features of the plant like the length, shape, self or pre-drilling implants etc. of the implant. There needs to be a protocol to define the norms of various features. It is on almost at half-half frequencies that these orthodontists determine features on torque and loading related questions.

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FIGURES:

Figure 1

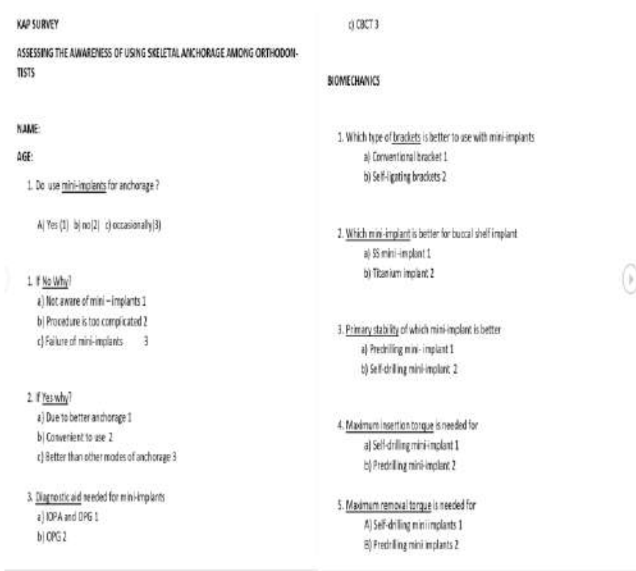
KAP SURVEY
ASSESSING THE AWARENESS OF USING SKELETAL ANCHORAGE AMONG ORTHODONTISTS
NAME:
AGE:
1. Do use mini-implants for anchorage ?
A) Yes (1) b) no (2) c) occasionally (3)
1. If No Why?
a) Not aware of mini –implants 1
b) Procedure is too complicated 2
c) Failure of mini-implants 3
2. If Yes why?
a) Due to better anchorage 1
b) Convenient to use 2
c) Better than other modes of anchorage 3
3. Diagnostic aid needed for mini-implants
a) IOPA and OPG 1
b) OPG 2
c) CBCT 3
BIOMECHANICS
1. Which type of brackets is better to use with mini-implants
a) Conventional bracket 1
b) Self-ligating brackets 2
2. Which mini-implant is better for buccal shelf implant
a) SS mini-implant 1
b) Titanium implant 2
3. Primary stability of which mini-implant is better
a) Predrilling mini- implant 1
b) Self-drilling mini-implant 2
4. Maximum insertion torque is needed for
a) Self-drilling mini-implant 1
b) Predrilling mini-implant 2
5. Maximum removal torque is needed for
A) Self-drilling mini implants 1
B) Predrilling mini implants 2

Figure 2

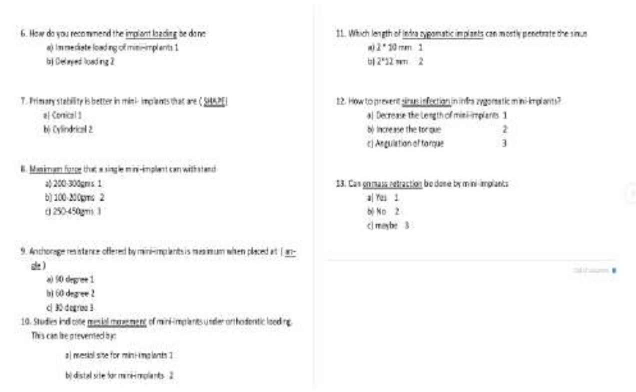
6. How do you recommend the implant loading be done
a) Immediate loading of mini-implants 1
b) Delayed loading 2
7. Primary stability is better in mini- implants that are (SHAPE)
a) Conical 1
b) Cylindrical 2
8. Maximum force that a single mini-implant can withstand
a) 200-300gms 1
b) 100-200gms 2
c) 250-450gms 3
9. Anchorage resistance offered by mini-implants is maximum when placed at (angle)
a) 90 degree 1
b) 60 degree 2
c) 30 degree 3
10. Studies indicate mesial movement of mini-implants under orthodontic loading. This can be prevented by:
a) mesial site for mini-implants 1
b) distal site for mini-implants 2
11. Which length of infra zygomatic implants can mostly penetrate the sinus
a) 2 * 10 mm 1
b) 2*12 mm 2
12. How to prevent sinus infection in infra zygomatic mini-implants?
a) Decrease the Length of mini-implants 1
b) Increase the torque 2
c) Angulation of torque 3
13. Can enmass retraction be done by mini-implants
a) Yes 1
b) No 2
c) maybe 3

Figure 3

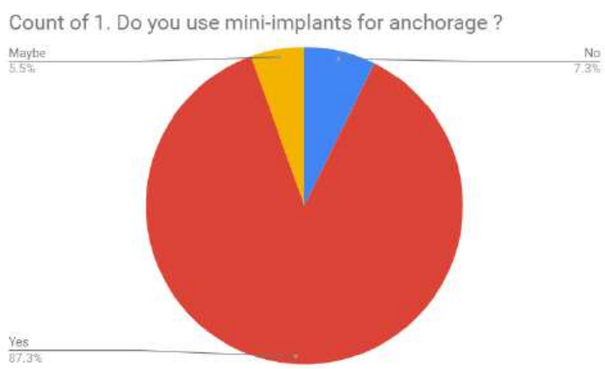

Figure 4

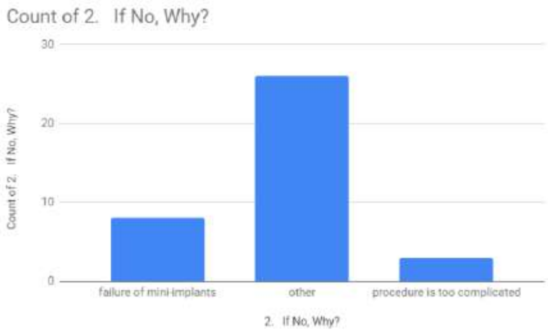

Figure 5

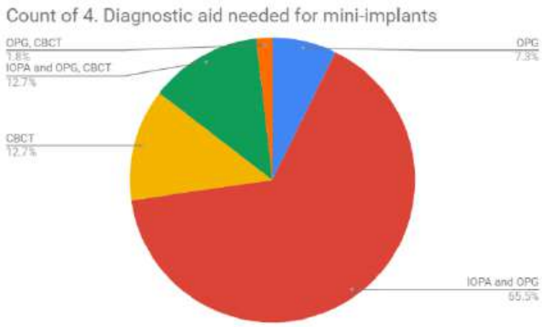

Figure 6

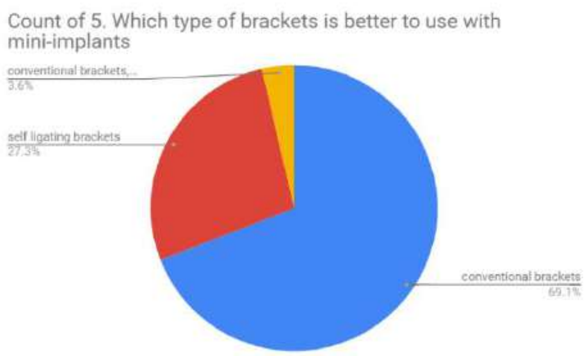

Figure 7

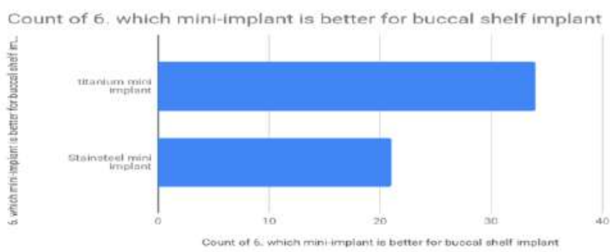

Figure 8

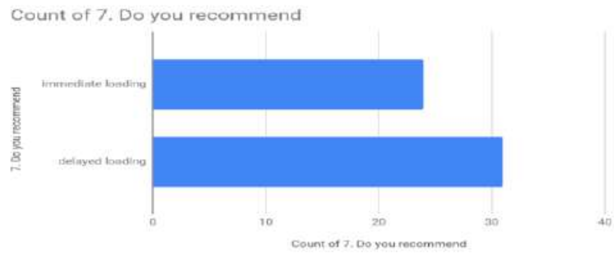

Figure 9

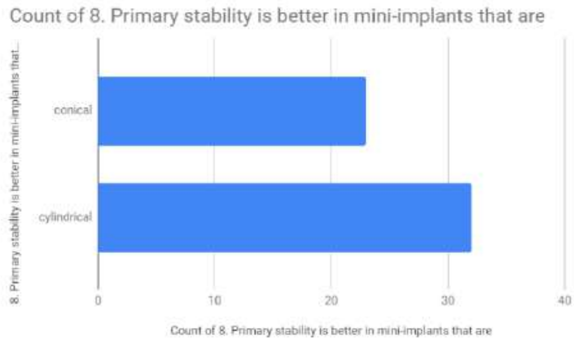

Figure 10

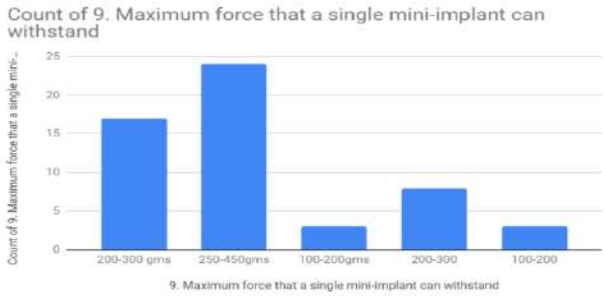

Figure 11

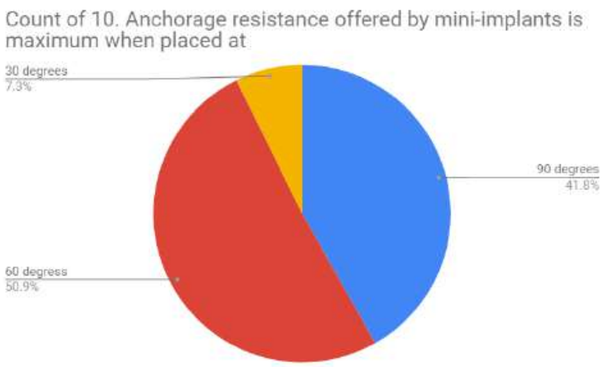

Figure 12

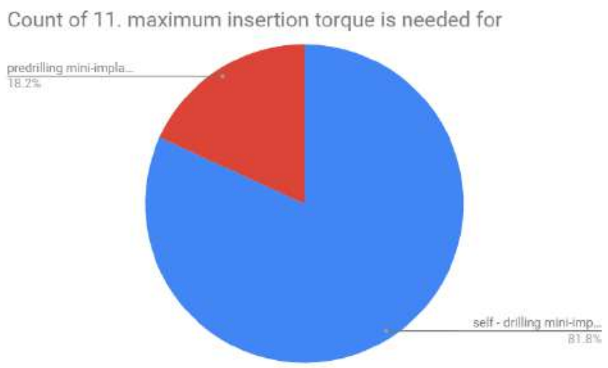

Figure 13

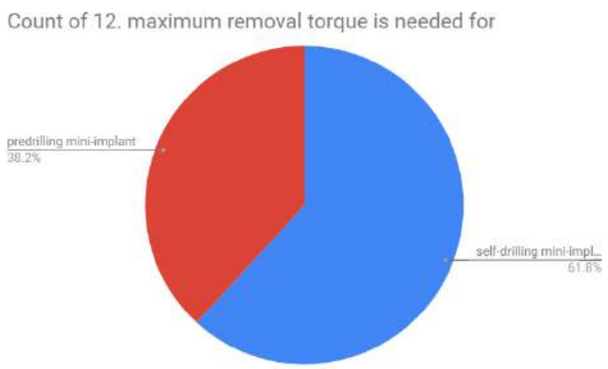

Figure 14

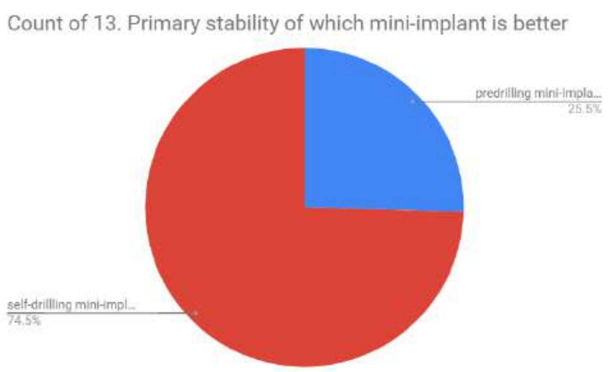

Figure 15

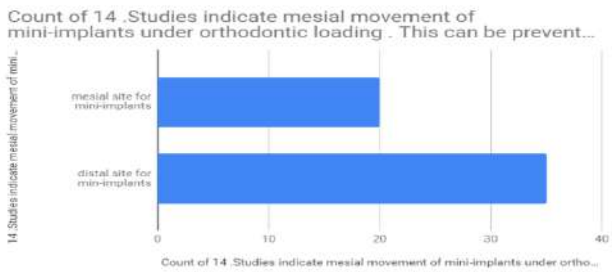

Figure 16

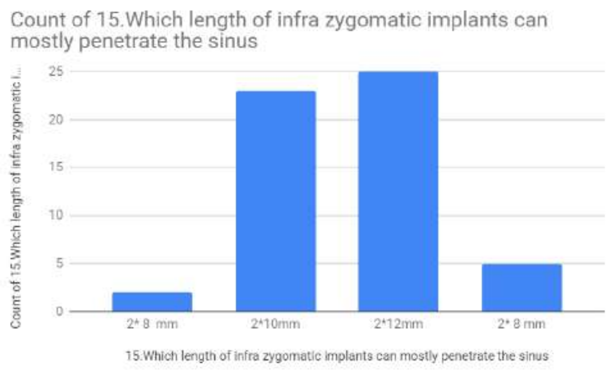

Figure 17

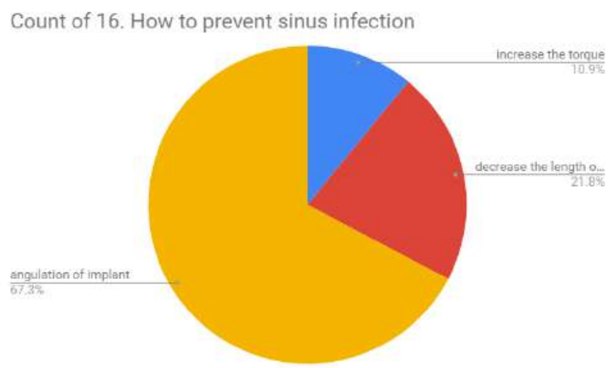

Figure 18