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Assessment of bone thickness at infrazygomatic crest: A CBCT study

J Sridevi [1,*] and R Saravanan [2]

[1] *Department of orthodontia, CSI college of dental science and research 129, east Velistreet Madurai, Tamil Nadu, India.*
[2] *Department of pedodontia, CSI college of dental science and research 129, east Veli street Madurai, Tamil Nadu, India.*

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Abstract

Objective: To evaluate the bone thickness at infrazygomatic crest as a site for orthodontic mini-implant insertion.

Materials and methods: Fifty CBCT images were collected from a CBCT centre. Slice data were analysed and measurements were done at three sites. The measurements were made at three different angles. These measurements were repeated both on the right and left sides of IZC 6 AND IZC 7. The data were analysed using two sample t test and Mann Whitney U test.

Results: The maximum bone thickness was evident at IZC 7 region (7.88mm) and in IZC 6 the bone thickness was (7.0 mm). The bone thickness measured at an angulation of 150 from cemento enamel junction showed increased bone thickness available at infrazygomatic region irrespective of roots. As the angulation increased bone thickness decreased. There was no difference between right and left side.

Conclusion: The cortical bone thickness between right and left side of IZC 6 and IZC 7 was similar and statistically insignificant. The thickness at mesiobuccal root of IZC 6 was less when compared to IZC 7. Similarly, at the distobuccal root. Hence the ideal site would be IZC 7or our population without compromising the primary stability. The result of this study indicated that the average cortical bone thickness at IZC 7 was greater than IZC 6. The mean thickness at IZC 7 (7.88 mm) but at IZC 6 (7 mm).

Keywords: Mini Screws; Primary Stability; Infrazygomatic Crest; Cone Beam Computed Tomography; Skeletal Anchorage; Mini Plates

1. Introduction

The adoption of mini-implants as an absolute anchorage has become an integral part of modern orthodontics practice 1-3. Conventional approaches require the use of auxiliary devices such as inter maxillary elastics and or head gears but a negative aspect is that these devices depend on patient compliance. Thus, the need to eliminate this undesirable side effect and at same time maximize the anchorage demand led to the development of skeletal anchorage system.

The anchorage site suitable for single mini-screw insertion for corrections in the vertical dimension have appeared in the literature: the infrazygomaticcrest (Kurodaetal.2004; Liou et al. 2007) The infra zygomatic crest is the extra radicular placement site in maxilla for orthodontic mini screws and mini plates. This extra radicular approach is widely utilized because there is no inter radicular mini screw to prevent enough full arch retraction.The four major applications of IZC's are maxillary arch distalization, molar intrusion, molar mesialization,impaction or transposition5-8. IZC is a pillar of cortical bone in the buccal process of maxilla connecting to the zygoma. Clinically it is a palpable bonyridge that

*Corresponding author: J Sridevi

extends 2cm or more superiorly to the zygomatic maxillary suture and the inferior portion can be subdivided into IZC6 and IZC7. The most striking feature of IZC is that provides bicortical fixation.

According to John-jin-jonglin who reported that soft tissue irritation is a common problem when the inferior aspect of the screw touches or near the mucosa10-11. The average thickness of attached gingiva is about 1.00mm and that of cortical bone is 1.1 -1.3mm therefore 8mm screw is adequate to engage the cortical plate and secure primary stability12-14. A study conducted by Liou et al investigated the bone thickness above the mesiobuccal root of maxillary first molar and suggested that sufficient bone thickness to accept 6mm implant oriented 85-70 degree to theocclusal plane. However, to date not much is known about bone thickness at IZC in Indian population. Therefore, the purpose of study is to investigate the available bone thickness at IZC6 and IC7.

2. Materials and methods

2.1. Sample

The sample consisted of 50 CBCT images collected from a CBCT centre at Madurai. The inclusion criteria include patients within the age group of 16-50, intact maxillary jaws and presence of maxillary second bicuspids, maxillary first molar and second molar. Patients with any underlying bone pathologies were excluded.

2.2. Imaging technology

The slices were reconstructed at three sides on either side. Orientedperpendicular to the buccal bone surface and parallel to the long axis of the maxillary first molar.

- Mesiobuccal root of maxillary first molar (MB)
- Middle of buccal furcation of the maxillary first molar
- Distobuccal root of the maxillary first molar

2.3. Measurements

On each slice, measurements were made at three sites. Reference lines were drawn. Cementoenamel junction was taken as the horizontal reference line. The vertical reference line was drawn tangent to mesiobuccal or distobuccal root for which measurement was to be made. The intersection point of the tangent line and floor of the maxillary sinus was taken as S point. Taking these reference lines as guide lines three measurements were made for every 15 degree increment. These measurements were repeated for IZC 6 and IZC 7 both right and left sides.

In the furcation area only one measurement was done from CEJ to middle of mesiobuccal and distobuccal root at the minimum safety distance of 2.5 mm between the roots. Measurements were carried out twice with a two week time intervals.

2.4. Statistical analysis

All data analyses were carried out using SPSS. The significance level for all the tests was set at $P<0.05$. Paired Student's t-test was used to analyse for differences between measurements of the left and the right side. No statistically significant differences were found. The bone thickness at IZC6 and IZC7were estimated using two sample t test.

3. Results

The bone thickness at mesiobuccal root of IZC 7 was found to be more than IZC 6. The mean thickness was found to be 7.82 mm. Similarly, the bone thickness at distobuccalroot of IZC 7 was found to be more than IZC 6. The mean bone thickness was found to be 7.99 mm.The bone thickness at IZC 7 was found to be more when compared to IZC 6. No statistically significant differences were found between right and left side measurements. The bone thickness measured was found to be maximum at an angulation of 15 0 from cementoenamel junction. As the angulation increased the bone thickness was reduced. (Table 1,2,3)

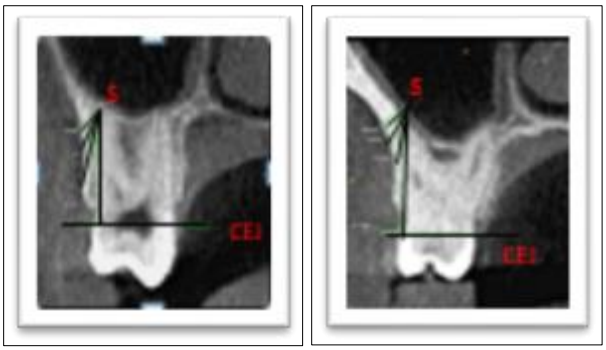

Figure 1 CBCT image showing the planes of measurements

Table 1 Comparison of Mesiobuccal between izc6 and izc7

Groups	N	Mean (SD)	P value [T]
IZC6	51	7 (1.59)	0.0124
IZC7	51	7.82 (1.65)	

3.1. T-Two sample t test

From the above table it is understandable that the mesiobuccal values are higher in IZC7 and there is a difference between the IZC6 and IZC7. The difference is also statistically significant. Ie., P=0.0124 < 0.05

Table 2 Comparison of Distobuccal between izc6 and izc7

Groups	N	Mean (SD)	P value [T]
IZC6	51	7.1 (1.76)	0.0173
IZC7	51	7.99 (1.91)	

3.2. T-Two sample t test

From the above table it is understandable that the distobuccal values are higher in IZC7 and there is a difference between the IZC6 and IZC7. The difference is also statistically significant. Ie., P=0.0173 < 0.05

Table 3 Comparison of furcation between izc6 and izc7

Groups	N	Mean (SD)	P value [M]
IZC6	49	12.57 (2.92)	0.558
IZC7	32	12.54 (3.02)	

3.3. M-Mann Whitney U test

From the above table it is understandable that the furcation values are little higher in IZC6 but there is no significant difference between the IZC6 and IZC7. The difference is also not statistically significant. Ie., P=0.558> 0.05

4. Discussion

The major factor associated with primary stability and placement torque of a mini-implant was the quantity of cortical bone.A thicker bone allows greater mini screw biting depth, more osseous contact and better primary stability of the mini screw9.IZC has two cortical plates. They are buccal plate and sinus floor.This anatomic advantage allows for bicortical fixation and possibly contributes to better stability of the mini screw. However, placement of mini-implantsin

the IZC is often limited by vital anatomic structures, especially maxillary sinus4.The approximate bone thickness measured at infrazygomatic crest region was found to be between 5mm and 8 mm from previous studies.

Cementoenamel junction was taken as the horizontal reference line. Though this reference line was difficult to visualize, this line does not change like the occlusal plane depending upon malocclusion.The vertical reference line was tangent to the root. This reference line depends upon the angulation of root and inclination of molars. Therefore, evaluation of these factors brings about successful placement of mini-implants. Three angulations were made from CEJ at 15 degree increments. The maximum bone thickness measured was at 15 degree from CEJ.As the angulation increases the bone thickness decreases. Hence ideal angulation for insertion of mini-implants in this study suggested 15 degree from CEJ to acquire maximum stability.

In furcation area, the lowest measurement was done from CEJ .Themeasurement was taken at the level where the width of the furcation reached and remained at 2.5mm or more, which appears to be the minimal inter-radicular distance required to insert a mini-screw of 1.5mm or less in diameter (Maino et al. 2005)[15-17].The infrazygomatic crest space was a rectangular osseous volume that was limited by certain distinct borders. The buccal border of the infrazygomatic crest space was represented by the course of the outer surface of the zygomatic process of the maxilla and the most apical regions of the alveolar process. The cranial border was characterized by the floor of the maxillary sinus and/or the floor of the nasal cavity. The medial border consisted of the lingual root of the maxillary first molar, the lingual surface of the alveolar process and the surfaces of the nasal cavity. The caudal border consisted of the mesio- and disto-buccal roots of the first permanent molar.

These anatomical structures that constituted the borders of the IZC showed with marked individual variation, which explainstherelatively high SDsinthebone depth measurements. Root length, pneumatization of the maxillary sinus, bucco-lingual inclination of the maxillary first molar, alveolar processes height and depth and morphology of the buccal furcation were probably the most important variables that determined how much bone depth was available for mini-screw insertion.

The overall success rate of mini-implants in the infrazygomatic crest was 96.7%, and 78.3% penetrated into the sinus.The incidence of penetration of infrazygomatic crest mini-implants into the sinus may be high. Penetration through double cortical bone plates with limitation of the penetration depth within 1 mm is recommended for infrazygomatic crest mini-implant anchorage

5. Conclusion

The cortical bone thickness between right and left side of IZC 6 and IZC 7 was similar and statistically insignificant. The thickness at mesiobuccal root of IZC 6 was less when compared to IZC 7. Similarly, at the distobuccal root. Hence the ideal site would be IZC 7 for our population without compromising the primary stability. The result of this study indicated that the average cortical bone thickness at IZC 7 was greater than IZC 6. The mean thickness at IZC 7 (7.88 mm) but at IZC 6 (7 mm).

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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