EVALUATION AND COMPARISION OF BONE THICKNESS IN INFRAZYGOMATIC CREST AREA AT DIFFERENT BONE SCREW INSERTION ANGLE AND HEIGHT – A CBCT STUDY

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Abstract:

Introduction: Infrazygomatic Crest Bone Screws are break through in the world of orthodontics for anchorage reinforcement. The size of the Bone screws and the site of placement depend on the bone thickness in the infrazygomatic crest area.
Objective: To evaluate and compare the bone thickness and insertion height at 45°, 50°, 55°, 60°, 65°, and 70°angulation in infra-zygomatic crest region.
Methods: The infrazygomatic crest bone thickness was evaluated on 22 patients using cone beam computed tomography. The measurements were made along the distobuccal root of maxillary first molar at different angulations ranging from 75 to 40 degrees to the occlusal surface of the molar.
Results: Infrazygomatic crest bone thickness is 4.5 mm to 9 mm when measured at an angle of 40° to 70° to the maxillary First molar occlusal plane and 10 to 17 mm above the occlusal plane. The best possible site for bone screw insertion is 10 to 14mm above the occlusal plane at an angle of 65° to 70°.
Application: helps the clinician to accurately place the infrazygomatic crest bone screw for various orthodontic treatments. Reduces the failure rate of the infrazygomatic crest bone screw. Reduces the risk of damage to surrounding structures

Keywords: Infrazygomatic Crest ,Bone Screw ,Cone Beam Computed Tomograph.

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1. Introduction

Conventionally, anchorage reinforcement was achieved using intermaxillary elastics, headgears, trans-palatal arches, and lingual stabilizing arch. Intermaxillary elastics and headgears require patient compliance and patients find them unaesthetic. Trans-palatal arch and lingual stabilizing arches are not effective in anchorage control when used alone [1]. In order to overcome these problems mini-plates and mini-implants were discovered [2] [3]. These skeletal anchorage devices provide absolute anchorage. The use of temporary anchorage devices (TADs) has become very popular, because of its small size, uncomplicated surgical procedure, immediate loading, minimal patient cooperation and multiple insertion sites [4]. In maxilla, infra-zygomatic crest is one of the extra-radicular sites for placing TADs. It has been used to provide anchorage for maxillary canine retraction, anterior retraction, en-mass anterior retraction and intrusion of maxillary posterior teeth.[5] [6] [7] [8]

Infra-zygomatic crest is a palpable bony ridge running between the alveolar ridge and the zygomatic process of maxilla. In younger patients, it is located between the maxillary second premolar and first molar, whereas in adults, it is above the maxillary first molar [9]. The two important factors to be considered during TADs placement are safety and stability. Safety is attributed to avoiding injuries to the adjacent anatomical structures like roots of the teeth, nerves, blood vessels, maxillary sinus and nasal cavity. Stability depends on the amount of cortical bone thickness in the insertion site, which prevents premature loosening and dislodging of the TADs. In order to achieve safety and stability of the TADs it is important to know the anatomy of the insertion site [7]. Even though there are studies assessing the thickness of infra-zygomatic crest (IZC), there is no adequate literature on the bone thickness and morphology of IZC. Therefore, the aim and objectives of this study were to assess the bone thickness in the IZC and also to determine the height and angle of insertion of the bone screw.

Aim:

To evaluate and compare the bone thickness in infra-zygomatic crest at different insertion angle and heights

Objectives:

I) To evaluate and compare the bone thickness at 45°, 50°, 55°, 60°, 65°, 70° angulation in infra-zygomatic crest region.

II) To evaluate and compare the insertion height with respect to the angulations mentioned above.

2. Materials And Methods

Materials

It was a cone beam computed tomographic study involving the CBCTs of 22 orthodontic patients (11 females and 11males) from the Department of Orthodontics and Dentofacial Orthopaedics, Bharati Vidyapeeth Dental College & Hospital. Sangli. The sample size was ‘22’ calculated using G-Power Software, from the data obtained (mean BPA values) from a previous study.

Methodology

- Image showing the infra-zygomatic crest at the distobuccal root tip of the maxillary first molar was oriented in all the sections of the CBCT. Measurements were made in the coronal section using care stream software. After orientation of the image, two reference lines were drawn. First line was a horizontal line that represented the maxillary occlusal plane and the second line was tangent to the buccal surface of the distobuccal root of the molar. The point where the second reference line touches the floor of the maxillary sinus was the sinus point/S point (figure a). Lines with 5 increments from 70° to 40° to the occlusal plane were drawn such that it passes through the sinus point. The bone thickness was measured along these lines from the sinus point to the point where it touches the buccal cortical bone. The point where it touches the buccal cortical bone was named as B1 to B7 for angles from 40° to 75°, respectively. The vertical height of insertion of the bone screws for each insertion angle was measured from the respective B points to the occlusal plane. Measurements were done on both left and right sides of the maxilla (figure b).

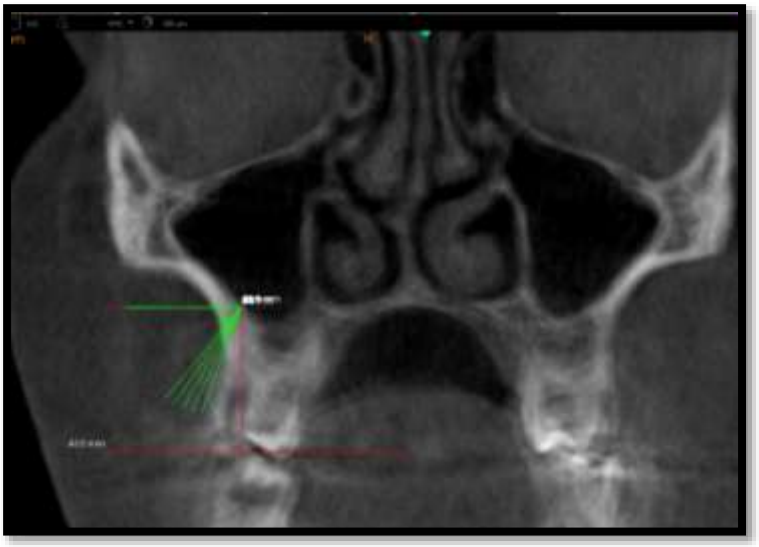

Fig (a)

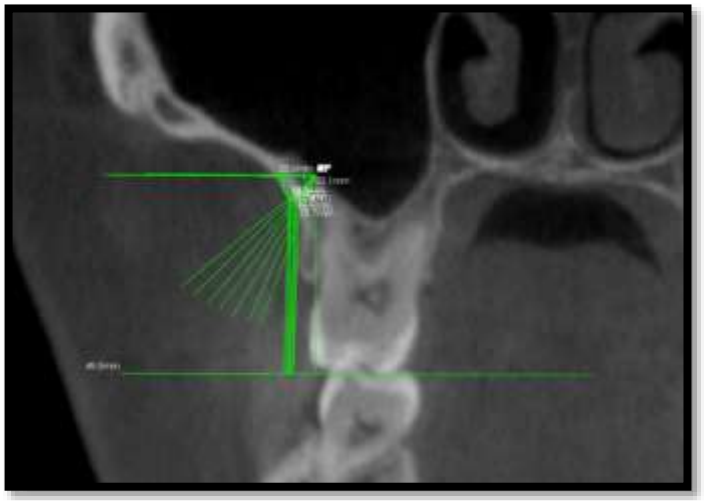

Fig (b)

3. Results

Angle	Side	mean	standard error	standard deviation
40	right	3.36	0.04711736	0.221
	left	3.4	0.03816293	0.179
45	right	3.8	0.04200054	0.197
	left	3.81	0.05436618	0.255
50	right	4.45	0.04029494	0.189
	left	4.58	0.22322115	1.047
55	right	4.9	0.03198011	0.15
	left	5.5	0.03794973	0.178

60	right	5.4	0.04775696	0.224
	left	5.6	0.04178734	0.196
65	right	6.3	0.05415298	0.254
	left	6.5	0.04860976	0.228
70	right	7.4	0.07334105	0.344
	left	7.33	0.0590566	0.277

Table I: Mean, Standard Deviation and Standard Error for insertion height at right and left side

Angles	Sides	Mean	Standard deviation	Standard error
70	right	10.35	0.17	0.036244122
	left	10.41	0.19	0.040508136
65	right	11.18	0.2	0.042640143
	left	11.23	0.21	0.04477215
60	Right	12.19	0.23	0.049036165
	Left	12.22	0.19	0.040508136
55	Right	12.45	0.211	0.044985351
	Left	12.56	0.18	0.038376129
50	Right	13.52	0.17	0.036244122
	Left	13.64	0.21	0.04477215
45	Right	14.4	0.19	0.040508136
	Left	14.4	0.2	0.042640143
40	Right	14.7	0.32	0.068224229
	Left	15.27	0.19	0.040508136

Table II: Mean, Standard Deviation and Standard Error for the bone thickness at right and left side

Angles (degree)	df	Sig (2 tailed)	Mean difference	standard error difference
40	42	0.059589888	-0.09	
				-0.019188064
45	42	0.09878987	0.009	
				0.001918806
50	42	0.658884355	-0.13	
				-0.027716093
55	42	0.898741555	-0.15	
				-0.031980107
60	42	0.365545455	-0.19	
				-0.040508136
65	42	0.098795566	-0.18	
				-0.038376129
70	42	0.089898888	-0.07	
				-0.01492405

Table III: Independent sample t-test for bone thickness on right and left side.

Angles (degree)	df	Sig (2 tailed)	Mean difference	Standard error difference
40	42	0.466598888	0.06	0.016325
45	42	0.465967332	0.05	0.015465
50	42	0.463235259	0.8	0.023565
55	42	0.461172023	1.2	0.1125655
60	42	0.458872971	1.9	0.1988798
65	42	0.156665464	1.6	0.165987
70	42	0.45464465	0.9	0.198987

Table IV: Independent sample t-test for insertion height on right and left side.

Table V: Independent sample t-test to compare bone thickness between males and females.

Angles (degree)	df	Sig (2 tailed)	Mean difference	standard error difference
40	42	0.69589888	0.25	
				0.053300179
45	42	0.056465421	0.35	
				0.074620251
50	42	0.654825446	2.1	
				0.447721504
55	42	0.987788555	1.5	
				0.319801075
60	42	0.365442546	1.25	
				0.266500895
65	42	0.056595566	0.95	
				0.202540681
70	42	0.06598888	2.2	
				0.469041576

Angles	n	Min	Max	mean	standard deviation
70	44	10.1	10.7	10.3931818	0.189733874
65	44	10.8	11.6	11.2090909	0.20552619
60	44	11.9	12.6	12.2023256	0.212118983
55	44	12.1	13	12.5090909	0.203250541
50	44	13.2	14.9	13.5909091	0.203250541
45	44	14.1	15.9	14.4068182	0.194574942
40	44	15.2	17.2	15.0227273	0.368443386

Table VI: Descriptive statistics for insertion height.

Angles	n	Min	Max	mean	standard deviation
40	44	2.9	3.6	3.1	0.321926022
45	44	3.1	4	3.8	0.190067202

50	44	3.8	4.9	4.5	0.235655466
55	44	4.2	5.3	4.9	0.656548989
60	44	4.8	6.1	5.8	0.236565465
65	44	5.1	7.1	6.5	0.265487988
70	44	6.5	8.5	7.2	0.899755466

Table VII: Descriptive statistics for bone thickness.

The tables I and II represent the mean, standard deviation and standard error for the bone thickness and insertion height on right and left sides separately. Independent sample t-test was done to compare the values between right and left side.The tables III and IV indicate that there is no statistical difference between the right and left side values for bone thickness and insertion height. Therefore, the measurements on the right and left side was combined together and descriptive statistics was done for the modified data.Independent sample t-test to compare bone thickness among gender showed there was no significant difference in bone thickness between males and females for a confidence interval of 95% (table V).

The infrazygomatic bone thickness and insertion height of the bone screw varied with the bone screw insertion angles. For an insertion angle of 40 to the occlusal plane, bone thickness was 3.1 +/- 0.32 mm and insertion height was 17.32 +/- 1.69 mm whereas for an angle of 70 bone thickness was 7.4 +/- 1.18 mm and insertion height was 11.24 +/- 1.74 mm. As the bone screw insertion angle increases, the bone thickness increases and insertion height decreases. The ANOVA results indicated that there was statistical difference in the thickness of the bone at various angles and insertion height (P-value < 0.05).

4. Discussion

In the present study we noted that the bone thickness of ranges from 3.0 mm to 7.8 mm in the infra-zygomatic crest region when measured at angle of 40° to 70° to the occlusal plane at 10 to 17 mm above the occlusal plane. Bone thickness decreases as the distance from the occlusal plane increases. This was also reported by Liou et al [11] and Baumgaertel [12] in their studies. Liou et al [11]. observed a bone thickness of 5 to 9 mm when measured at an angle of 40° to 70° to the maxillary occlusal plane and 13 to 17 mm above the maxillary occlusal plane. According to Liou et al [11], inserting the bone screw at an angle of 75° to the maxillary occlusal plane is technically difficult and the chances of injury to the root and bone stripping is high. In contrast, inserting the bone screw at an angle of 40° to the maxillary occlusal plane is technically easy and chances of slippage, damage to the root and bone stripping is less, but the bone depth at this angulation is far less with chances of alveolar or buccal mucosa irritation. To avoid mucosal irritation, it is recommended to insert the bone screw in the keratinized gingiva or the mucogingival junction. Taking these into consideration, the best possible site for the bone screw insertion in the infra-zygomatic crest region is above the distobuccal root of the maxillary first molar, 10 to 14 mm above the occlusal plane of the first molar, inserted at an angle of 65° to 70° to the occlusal plane. As reported by Baumgaertel and Hans [12] , 6 mm or more can penetrate the maxillary sinus when inserted in the infra-zygomatic crest region. Whereas, in the present study we observe that an IZC screw of length 9 to 11 mm can be used without sinus penetration. This was concluded taking into consideration the IZC bone thickness as well as soft tissue thickness in the insertion site.

5. Conclusion

Infrazygomatic crest bone thickness is 4.5 mm to 9 mm, when measured at an angle of 40° to 70° to the maxillary first molar occlusal plane and 10 to 17 mm above the occlusal plane. The best possible site for bone screw insertion is 10 to 14 mm above the occlusal plane at an angle of 65° to 70°, with no injury to the adjacent

anatomical structures, no mucosal irritation and adequate stability for the bone screw.

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