Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

Importance of Angulation of Micro-Implants in Various Growth Pattern Patients -An Original Research

Dr.RinkuAdwani Nathani[1], Dr. Sonia Sharma[2], Dr.Apurva Pathak[3], Dr.Shweta Suresh Bhayade[4], Dr.Vaibhav Khare[5], Dr. Kumar B. Niwlikar[6]

[1]Associate Professor, Dept.of Orthodontics and DentofacialOrthopedics, Vyws Dental College and Hospital, Camp Amravati, Maharashtra. drrinkuadwani@gmail.com
[2]Senior Lecturer, Dept.of Orthodontics and DentofacialOrthopedics, Triveni Institute of Dental Sciences, Hospital and Research Centre, Bilaspur, Chhattisgarh. drsoniasharma12@gmail.com
[3]Senior Lecturer, Dept.of Orthodontics and DentofacialOrthopedics, Triveni Institute of Dental Sciences, Hospital & Research Center, Bilaspur, Chhattisgarh. apurvapathak37@gmail.com
[4]Senior Lecturer, Dept. of Pedodontics and Preventive Dentistry, Nanded Rural Dental College and Research Center, Nanded, Maharashtra. shwetabhayade1105@gmail.com
[5]Associate Professor, Department of Orthodontics and DentofacialOrthopedics, Triveni Institute of Dental Sciences, Hospital and Research Centre, Bilaspur, Chattisgarh. vaibhavkhare000@gmail.com
[6]Associate Professor, Dept. Of Orthodontics and DentofacialOrthopedics, Nanded Rural Dental College and Research Center, Nanded, Maharashtra. kumarniwalikar9@gmail.com

Corresponding Author: Dr.RinkuAdwaniNathani, Associate Professor, Dept.of Orthodontics and DentofacialOrthopedics, Vyws Dental College and Hospital, Camp Amravati, Maharashtra. drrinkuadwani@gmail.com

ABSTRACT

Aim: We aimed to evaluate the associations between craniofacial growth pattern with interradicular distances (IRDs), cortical widths (CWs), and jaw heights (JHs) and angulation of mini-implants.

Methodology: Cone-beam computerized-tomography data pertaining to 60 Class-I patients were divided into 3 growth groups: normal, horizontal, and vertical. IRDs and CWs were measured for bimaxillary canines to second molars, on buccal and lingual sides, at three transverse planes (1, 3, and 5 mm apically to the alveolar crest). JHs were measured in both jaws, between canines and second molars. The role of growth patterns and other variables were analyzed; also safe zones were mapped with statistical substantiation. With the help of stent and a drill, The angulation of placement of the mini-implant was at 70° to the long axis of the tooth.

Results: IRDs were greater in the mandible, males, at points more distant from the ridge crest, and on the lingual side. Cortexes were thicker in the horizontal growth pattern, mandible, males, older patients, and lingual sides. JHs were greater in vertical growth pattern, mandible, and males. The cone beam computed tomography image showed the mini-implant at an angle of 70° to the long axis of the tooth.

Conclusion: Cortex might be thicker in patients with a horizontal growth pattern. Height might be greater in vertical growth pattern. Interradicular distances might not be affected by growth pattern.

Keywords: mini-implants; orthodontics; periodontics; anatomy; anthropology; morphometrics.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

INTRODUCTION

The extraoral anchorage is a bit cumbersome to use & causes injury which in then affects patients compliance to use it. Also, the term ‘Absolute anchorage’ can be achieved when the anchorage unit remains completely stable, which is doubtful in traditional orthodontics mechanics. The skeletal Anchorage is Absolute anchorage which is achieved with the advent of mini-implants. With the use of Mini-implants for the anchorage, maximum anchorage is possible with the reduction in the unwanted side-effects. The osseointegrated implant (endosteal) was the first one to be used for the purpose of orthodontic anchorage. They worked well providing the orthodontic anchorage, but they have limited application in terms of orthodontic use. They were basically needed to be used in edentulous spaces, which were not available in routine orthodontic cases. The generally accepted protocol for successful and predictable placement of mini-implants includes atraumatic surgical technique, short healing period, biocompatible materials, and patient management. To encourage regeneration and osseointegration, rather than repair with fibrous encapsulation, a primary healing environment at the bone-implant surface should be created.[1-3] As early as 1945, Gainsforth&Higley introduced the concept of implant supported anchorage. They used Vitallium screws & SS wires in the ramal area of the mandible in dogs to bring about the retraction of upper canines. However, initiation of orthodontic force resulted in the loss of screw in 16 to 31 days. This is considered to be the first published case of an implant for orthodontic anchorage.[4]In 1970, Leonard Linkow used an implant for replacement of missing molar. The case report was described by him which stated use of endosseous blade implant to anchore rubber bands that was used to retract maxillary anterior teeth.[5] In 1964, Branemark and associates had reported the use of titanium optical chambers implanted into femur of a rabbit. The chamber was developed for in vivo in situ microscopic study of bone marrow. Their result showed that it was possible to secure a firm anchorage of titanium to the bone with no adverse effect. They then placed titanium endosseous implant into healed extraction site in upper and lower jaws of dogs.[6] In 1984, Robert & fellow researchers collaborated the findings of Branemark in an extensive study of titanium implants in rabbits. 6 – 12 weeks after placing titanium screws in a rabbit femur, Robert result indicated that titanium implants developed a rigid osseous interface and continuously loaded implant remains stable within the bone. The study concluded that titanium endosseous implants provides firm osseous anchorage for orthodontics &dentofacial orthopedics.[7]In 1988, Creekmore used Vitallium implant for anchorage for intruding upper anterior teeth. In 1997, Kaomi introduced mini implant system. Maino et al, introduced spider screw system implant for skeletal anchorage. KyuRhim Chung developed C micro implant system.[8]Among the factors related to mini-implant success, alveolar bone thickness, cortical thickness, interradicular distances, soft-tissue anatomy, sinus and nerve locations, and bone quality should be assessed. The thickness of the cortical bone might have a direct effect on success, because the primary stability comes from a tight implant-bone contact, and not from osseointegration. Selecting implantation sites with thicker cortical bone and in locations with sufficient interradicular distances seem necessary for both preventing premature loosening of the implants and avoiding root damage. The cortical bone thicknesses has been investigated and mapped at probable sites for mini-implant placement. Root proximity is another critical factor when placing a mini-implant of about 1.2–2.0 mm diameter, since at least 1 mm might be needed between the mini-implant and the surrounding structures. Hence, it might be a crucial determinant of mini-implant success. A third factor potentially relevant to the space available for mini-implant placement is the jaw height that is the height of alveolar and basal bones together.[9]

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

AIM OF THE STUDY

We aimed to evaluate the associations between craniofacial growth pattern with interradicular distances (IRDs), cortical widths (CWs), and jaw heights (JHs) and angulation of mini-implants

METHODOLOGY

The sample of this retrospective cohort study consisted of cone-beam computed tomography (CBCT) data taken previously from 60 surgical/implantation patients, for treatment purposes only. Ethical approval was obtained from the research committee of the institution, and patient information was handled according to the Helsinki Declaration.3D reconstructions and lateral cephalometry simulation of the CBCT data were used to identify skeletal and molar relationships and craniofacial anomalies. Excluded were cases of classes II or III [either skeletal or dental] or with cleft palates / lips. Patients with normal vertical growth patterns would have an FMA between 20 and 30 degrees, plus a gonial angle between 118 and 128 degrees. In patients with horizontal growth patterns, the FMA would be less than 20 degrees and the gonial angle would be less than 118 degrees, while in vertical growth patterns, the FMA and gonial angle would be respectively above 30 and 128 degrees. Patients were subsequently evaluated and included, until three groups of 20 patients each, with different growth patterns were pooled. All patients were only skeletal class I, with an average overbite of 3.54 ± 0.29 mm.Orlus self-drilling mini-implant which is 1.4 mm in diameter and 7 mm in length was first placed perpendicular to the buccal surface for initial penetration. If insertion was attempted at an angle without initial purchase, there was a possibility of mini-implant slipping during insertion.Interdental bone cortices between the distal aspect of the maxillary canine and the mesial aspect of the maxillary second molar were recorded. Measurements were made at three points 1 mm, 3 mm, and 5 mm apically to the crest of the alveolar ridge. Three slices of axial planes 1, 3, and 5 mm apically to the crest of the alveolar ridge were created. In each axial plane, the interradicular distance between two neighboring teeth was measured. The jaw height was measured as the vertical distance between the crest of the alveolar ridge to the palatal plane (in the maxilla) and to the mandibular plane (in the mandible), on the axes bisecting the interradicular spaces. Descriptive statistics and 95% confidence intervals (CI) were calculated for different categories and one-way ANOVA test was used for analysis.

RESULTS

There were 34 females and 26 males, distributed as: 11 females and 9 males in the normal growth pattern, 11 females and 9 males in the horizontal growth pattern, and 12 females and 8 males in the normal growth pattern. The average patient age was 33.73 ± 8.09 years (range: 17-46). The mean ages were 34.95 ± 7.667 in the normal growth pattern, 32.30 ± 9.393 in the horizontal growth pattern, and 33.95 ± 7.251 in the vertical growth pattern. The difference between the mean ages of different groups was insignificant ($P = 0.587$, ANOVA).A cone beam computed tomography was also taken to check the position of the mini-implant in the three planes of space. In the mesiodistal direction the mini-implant was found to be away from the roots of the adjacent teeth. In the transverse plane the angulation of the miniimplant was measured and was found to be 20° (Table 1)

Table 1- Interradicular distances and cortical widths measured at different points from the crest of the alveolar ridge based on ANOVA test

Variable	Distance (mm)	Mean	SD	F	P

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

InterradicularDistance	1	4.8131	0.8739	35.9	0.000
	3	5.0040	0.9743		
	5	5.2016	1.1451		
Cortex Width	1	0.9288	0.3682	303.5	0.00000
	3	1.2415	0.4224		
	5	1.3967	0.4745		
Inclination angle (°)		84.40±1.35			<0.001

***** SD, standard deviation; CI, confidence interval

DISCUSSION

Vertical facial morphology is an important determinant of orthodontic treatment, as it can influence the treatment goals, prognoses, and plans, through its effect on the growth prediction, anchorage system, bite force, and functions. Vertical dimensions of the face might be strongly associated with one's genetics and oral respiratory / masticatory functions during childhood; they might also be associated with alterations in jaw morphology, including alterations in the cortical bone shape, thickness, and mineralization (as a function of muscular forces and occlusal loads) all of which might be associated with mini-implant success.[10]In this sample, the interradicular distance seemed unaffected by the vertical growth pattern of the face, or by gender. Men had thicker cortical bones and higher jaw heights compared to women. Cortical width might also be affected by the type of vertical growth, being thicker in the horizontal growth pattern compared to the normal pattern, which itself was thicker than vertical growth pattern. Jaw height might be subtly higher in vertical growth pattern compared to horizontal pattern, but the difference between horizontal and vertical growths with the normal pattern was not significant. The interradicular distances were longer in the mandible, compared to the maxilla. Both the variables cortical width and jaw heights as well were greater in the mandible, compared to the maxilla. And both of these variables were greater on the lingual bone plate, compared to the buccal side. Park et al. found that implant with 1.2-mm diameter had a higher success rate compared to a 2-mm mini-implant. The left side had a higher success rate compared to the right side. He suggested that placement of the miniimplant high in the upper oral mucosa had a greater success rate compared to a lower level in the upper oral mucosa and upper attached gingiva. The 30° to 40° angulation had a higher success rate compared to the 90° and 10° to 20°.[11]An angulation of 30° to 40° has also been proposed by several other authors to increase the surface contact between the mini-implant and the cortical bone. An angulation of 20° has been suggested by Wilmes. A greater angulation can result in increased stress during placement and removal of implant because of the greater amount of cortical bone the mini-implant has to penetrate.[12-15]Unlike dental implants which need osteointegration as the phase II of implant stability, a phase I initial stability as a function of proper mechanical lock is the key factor to overall success of microimplant anchorage. A proper mechanical interlock is itself affected the three factors: implant design, the technique of placement, and bone quality. Bone quality is itself affected mostly by the cortical thickness, as most the compression and tension forces are directly exerted to the cortical bone. A proper stability might be provided by a cortical thickness of 1.0 mm. According to some authors, it is the minimum requirement. As another advantage, a

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

thicker cortex might reduce the risk of implant tip and prevent potential damage to the neighboring root. This extent of cortical thickness was available at many sites inspected in this study, and also in alveolar process, palate, and retromolar area reported in another study.[16,17]Some authors have reported less-than-1mm cortical bones at various implantation sites. A reason for the controversy over the cortical width being sufficient or less than 1 mm might be ethnical differences (which besides its own direct effect, it also might be associated with different growth patterns). Furthermore, sampling methods such as using cadavers, dry skulls, live patients, or in different measurement sites might account for the differences. Moreover, gender distributions of the samples might matter, as it was shown in this study that males have thicker cortices compared to females.[18]Basal bone might be used for miniscrewplacement when the root proximity does not allow inserting the implant in the alveolar ridge. The current study found a slight but generalizable difference between the bone heights of patients with vertical versus horizontal growth patterns. Our results indicated that the jaw height would be greater both in the maxilla and mandible of patients with vertical growth pattern, compared to the patients with horizontal growth pattern. Among the few studies in this regard, the closest result to this study was that of Sadek et al who stated that in both the maxilla and mandible, high-angle group had larger anterior dentoalveolar height with no significant differences in posterior alveolar height. The other two studies have reported that patients having horizontal growth pattern might have a greater mandibular height than those with the vertical growth pattern.[19]

CONCLUSION

The facial growth pattern might influence the ‘cortical bone thickness’ and ‘bone height’, but not the interradicular distance. Cortical bone might be the thickest in patients with a horizontal growth pattern, and the thinnest in those with a vertical growth pattern. Both the posterior maxillary and mandibular heights are greater in patients with vertical growth patterns compared to patients with horizontal growth patterns. The cone beam computed tomography image showed the mini-implant at an angle of 70° to the long axis of the tooth.

REFERENCES

1. Cope JB. Temporary anchorage devices in orthodontics: a paradigm shift. SeminOrthod 2005;8:3-9.
2. Feldmann I, Bondemark L. Orthodontic anchorage: a systematic review. Angle Orthod 2006;76:493-501.
3. Kyung HM, Park HS, Bae SM, Sung JH, Kim B. Development of orthodontic micro implants for intraoral anchorage. J ClinOrthod 2003;37:321-328.
4. Gainsforth BL, Highley LB. A study of orthodontic anchorage possibilities in basal bone. Am J Orthod 1945; 31:406-17.
5. Linkow LI. The endosseous blade implant and its use in orthodontics. Int J Orthod 1969; 18:149-54.
6. Branemark PI, Breine U, Adell R. Intraosseous anchorage of dental prostheses. I. Experimental studies. Scand J PlastReconstrSurg 1969; 3:81-100.
7. Roberts WE, Smith RK,Y. Silberman Y, Mozsary P-G, Smith RS. Osseous adaptation to continuous loading of rigid endosseous implants. Am J Orthodont 1984; 86:95-111.
8. Creekmore TD, Eklund MK. The possibility of skeletal anchorage.JClinOrthod 1983; 17:266-69.
9. Park J, Cho HJ. Three-dimensional evaluation of interradicular spaces and cortical bone thickness for the placement and initial stability of microimplants in adults. Am J OrthodDentofacialOrthop 2009;136:314.e1-12; discussion -5.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 10831 - 10836
Received 25 April 2021; Accepted 08 May 2021.

10. Ozdemir F, Tozlu M, Germec-Cakan D. Cortical bone thickness of the alveolar process measured with cone-beam computed tomography in patients with different facial types. Am J OrthodDentofacialOrthop 2013;143:190-6.
11. Park HS, Jeong SH, Kwon OW. Factors affecting the clinical success of screw implants used as orthodontic anchorage. Am J OrthodDentofacialOrthop. 2006; 130:18–25.
12. Park HS, Bae SM, Kyung HM, Sung JH. Micro-implant anchorage for treatment of skeletal class I bialveolar protrusion. J ClinOrthod. 2001;35:417–22.
13. Lee JS, Park HS, Kyung HM. Micro-implant anchorage for lingual treatment of a skeletal class II malocclusion. J ClinOrthod. 2001; 35:643–47.
14. Park HS, Kwon OW, Sung JH.Uprighting second molars with micro-implant anchorage. J ClinOrthod. 2004; 38:100–03.
15. Kyung HM, Park HS, Bae SM, Sung JH, Kim IB. Development of orthodontic micro-implants for intraoral anchorage. J ClinOrthod. 2003; 37:321–28.
16. Yang L, Li F, Cao M, et al. Quantitative evaluation of maxillary interradicular bone with cone-beam computed tomography for bicortical placement of orthodontic mini-implants. Am J OrthodDentofacialOrthop 2015;147:725-37.
17. Wilmes B, Su YY, Drescher D. Insertion angle impact on primary stability of orthodontic mini-implants. Angle Orthod 2008;78:1065-70.
18. SilvestriniBiavati A, Tecco S, Migliorati M, et al. Three-dimensional tomographic mapping related to primary stability and structural miniscrew characteristics. OrthodCraniofac Res 2011;14:88-99.
19. Swasty D, Lee J, Huang JC, et al. Cross-sectional human mandibular morphology as assessed in vivo by cone-beam computed tomography in patients with different vertical facial dimensions. Am J OrthodDentofacialOrthop 2011;139:e377-89.