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Sub Sinus Ridge Height at First Molar Region- A Panoramic Radiograph Based Study

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ABSTRACT

Background: Among various replacement options available for maxillary molars, implants necessitate the need to examine available ridge height and width. Panoramic radiographs (orthopantomograms) are routinely used for preliminary determination of ridge height which is helpful in communicating with patients regarding treatment needs and options. This study was designed with the aim to assess the sub sinus ridge height at dentulous and edentulous first molar sites.

Methods: A cross-sectional study was conducted from March to November 2019 among patients visiting the dental college. The orthopantomograms of 455 patients were prospectively collected and analysed using Carestream imaging software (version 7.0.0). Distance from alveolar crest to maxillary sinus was measured in first molar region.

Results: Mean minimal sub sinus ridge height at non-missing maxillary first molar site was 8.16 ± 2.6 mm, whereas for missing maxillary first molar site it was 5.25 ± 2.28 mm and the difference was statistically significant ($p<0.001$). Statistically significant difference among the age groups and minimum subsinus ridge height ($p<0.001$) was observed.

Conclusions: Missing maxillary first molar sites may often require vertical bone augmentation with direct sinus lifting procedures if it has to undergo replacement with dental implants in the representative Nepalese population.

Keywords: Implant; Nepalese; orthopantomogram; panoramic radiography; sinus augmentation

INTRODUCTION

First molars are the first permanent teeth to erupt in the oral cavity. They account for the most frequently extracted teeth among either of the jaws in Nepal[1] and the most common reason being dental caries and periodontal diseases.[2] Sinus pneumatisation and alveolar ridge resorption after teeth extractions result in compromised alveolar bone support required for its replacement.[3] Detailed examination of available ridge height and width is required whenever an implant is opted among the various teeth replacement options available. Studies have assessed the residual ridge height of the posterior maxillary region using anatomic specimens,[4] panoramic radiographs,[5] and even cone-beam computed tomography (CBCT).[6] In this context, the data from the Nepalese population is lacking. Therefore, this study was designed with the aim to assess the sub sinus ridge height at dentulous and edentulous first molar sites on orthopantomograms among the patients visiting a dental teaching hospital in Nepal.

METHODS

Before embarking upon the study, ethical approval was obtained from the Institutional Review Committee (IRC), Kantipur Dental College Teaching Hospital (KDCH). A cross-sectional study was conducted among patients visiting the Department from March to November 2019. The sample size (454) was calculated using the two proportional formula and the reference values were obtained from the study done among Korean individuals.[5]

Convenient sampling method was used in the current study. The patients visiting the department during the study period who had been prescribed panoramic radiographs previously or requiring panoramic radiographs were included in the study. Informed consent was obtained from the study participants for using their radiographs. Each patient was exposed to panoramic X-ray by Carestream (CS9300, Kodak) at 74Kv, 12 mA for

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14.3 seconds exposure time with high resolution that is being used in the radiology unit to record the panoramic radiographs of patient. Patient's head positioning was done according to the manufacturer's specified position of head during the exposure of the radiographs.

The radiographs of the patients with absence of obvious facial asymmetry, no surgical and fracture history, clearly visible maxillary sinuses, clearly visible inferior margins of the zygomatic processes of the maxilla were sorted. The panoramic radiographs were analysed using CS Imaging software (version 7.0.0) in the maxillary first molar region by a single examiner (Figure 1). According to the presence or absence of maxillary first molar, the radiographs were categorised into four different groups: missing maxillary right first molar (MM1), missing maxillary left first molar (MM2), missing both maxillary first molars (MB), both maxillary first molars present (PB). Based on Erik Erikson's stages of aging,[7] participants were categorised into adolescence, young adult, middle adult, and maturity. The distance between the alveolar crest and the maxillary sinus was measured at three different radicular areas in the maxillary first molar region and the minimum of the three recorded values were taken for further analysis.

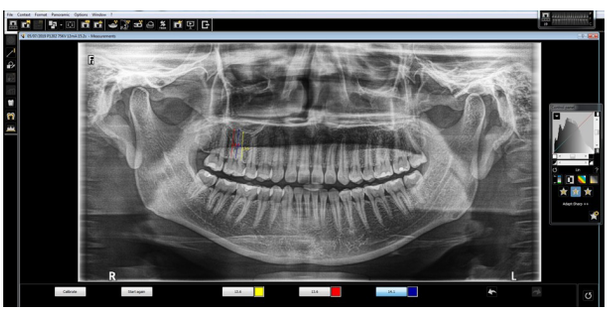

Figure 1. Measurement taken at the region of maxillary first molar using CS Imaging software version 7.0.0.

RESULTS

A total number of 454 orthopantomograms (48.5% females and 51.5% males) were analysed in this study. Participants with missing maxillary right first molar were 10.8%, missing maxillary left first molar were 16.5 %, missing both maxillary first molars were 17.4% and 55.4% had both the maxillary first molars present. Among the participants, the least were adolescence (1.5%) and the highest was middle adults (53%) (Figure 2). Among the participants with missing first molars (n = 203), only 28% (n=56) of the participants responded for the reason for maxillary first molar loss, and others couldn't recall the reason. Among the respondents (n = 56), dental caries was found to be the major reason for tooth loss, followed by periodontitis. The mean of minimal sub sinus ridge height at the non-missing maxillary first molar site was found to be 8.16 ± 2.6 mm, whereas for missing maxillary first molar site was found to be 5.25 ± 2.28 mm and the difference was found to be statistically significant (p<0.001), when independent t-test was applied (Table 1). The difference was found to be statistically significant even for separate analysis on the right and left sites.

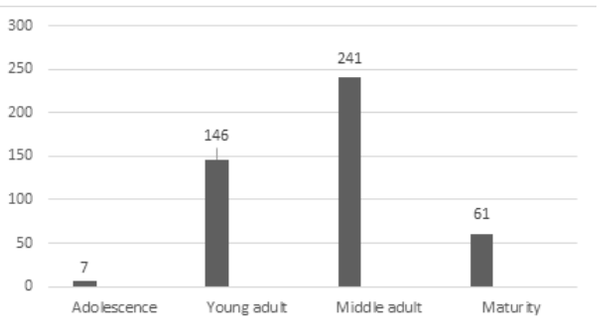

Figure 2. Age wise population distribution.

Table 1. Comparison of minimum ridge height among missing and non-missing maxillary first molars.

Maxillary first molar	Total number of participant n (%)	Mean ± Standard Deviation	Standard Error Mean	p-value
Right missing	128 (28.13)	5.27 ± 2.36	0.21	<0.001
Right present	327 (71.87)	8.16 ± 2.57	0.14	
Left missing	154 (33.84)	5.25 ± 2.21	0.18	<0.001
Left present	301 (66.15)	8.17 ± 2.64	0.15	

ANOVA test using Tukey post-hoc showed a significant difference among age groups and minimum subsinus ridge height (p<0.001). On post-hoc analysis, the mean difference was seen significantly higher in young adults as compared to middle adults and also between young adults and maturity for both (right and left) sites (p<0.001)(Table 2 and 3). Independent samples T-test showed no statistically significant difference between the mean minimum sub sinus ridge height and gender (Table 4).

Table 2. Difference in mean sub sinus ridge height among different age categories for right side.

Age categories		Mean Difference	Standard Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Adolescence	Young adult	-1.21	1.04	0.65	-3.88	1.46
	Middle adult	0.53	1.03	0.95	-2.12	3.18
	Maturity	1.41	1.07	0.55	-1.34	4.17
Young adult	Adolescence	1.21	1.04	0.65	-1.46	3.88
	Middle adult	1.74	0.28	0.00	1.01	2.46
	Maturity	2.62	0.41	0.00	1.57	3.67
Middle adult	Adolescence	-0.53	1.03	0.95	-3.18	2.12
	Young adult	-1.74	0.28	0.00	-2.46	-1.01
	Maturity	0.88	0.38	0.10	-.11	1.87
Maturity	Adolescence	-1.41	1.07	0.55	-4.17	1.34
	Young adult	-2.62	0.41	0.00	-3.67	-1.57
	Middle adult	-0.88	0.38	0.10	-1.87	0.11

Table 3. Difference in mean subsinus ridge height among different age categories for left side.

Age categories		Mean Difference	Standard Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Adolescence	Young adult	-0.1	1.05	0.78	-3.71	1.72
	Middle adult	0.59	1.04	0.94	-2.1	3.29
	Maturity	1.65	1.09	0.43	-1.1	4.45
Young adult	Adolescence	0.1	1.05	0.78	-1.7	3.71
	Middle adult	1.59	0.28	0.00	0.86	2.33
	Maturity	2.64	0.41	0.00	1.58	3.71
Middle adult	Adolescence	-0.59	1.04	0.94	-3.29	2.1
	Young adult	-1.59	0.28	0.00	-2.33	-0.86
	Maturity	1.05	0.39	0.04	0.05	2.06
Maturity	Adolescence	-1.65	1.09	0.43	-4.44	1.15
	Young adult	-2.64	0.41	0.00	-3.71	-1.56
	Middle adult	-1.05	0.39	0.04	-2.06	-0.05

Table 4. Difference in mean minimum ridge height in right and left maxillary first molar among genders.

Site	Gender	Total Number of Sites n (%)	Mean ± Standard Deviation	Standard Error Mean	p-value
Right	Male	235 (51.65)	7.49 ± 3.02	0.20	0.28
	Female	220 (48.35)	7.20 ± 2.61	0.18	
Left	Male	235 (51.65)	7.30 ± 3.05	0.20	0.38
	Female	220 (48.35)	7.06 ± 2.65	0.18	

DISCUSSION

Replacement of missing teeth with dental implants requires adequate alveolar bone support, which may be jeopardised by alveolar ridge resorption after tooth extraction and sinus pneumatisation in the maxillary posterior region.[3] Pneumatisation of the sinus is a process that may be influenced by a number of factors including heredity and disuse atrophy. The dimensions of the maxillary sinus can be affected by the environmental factors, genetic diseases and past infections like chronic sinusitis.[8] Wehrbein and Diedrich have reported a direct relation between the amount of sinus expansion after teeth extraction and the projection length of roots into the sinus.[9] The extraction of the maxillary molar teeth results in dimensional changes with bone loss of the sinus floor.[10] Bone height can decrease alongside maxillary sinus extension into the alveolar process.[11] Sharan and Madjar reported that the sinus volume became larger when two or more adjacent posterior teeth were

extracted.[12] Sinus pneumatisation has also been reported if mandibular posterior teeth have been missing for an extended period of time due to supraeruption of opposing maxillary posterior teeth.[13]

Several techniques are used to assess the sub sinus ridge height.[13,14] Panoramic radiographs are widely available, relatively inexpensive and allow the visualisation of various anatomic structures.[13] It can even determine the vertical augmentation requirements adequately but the overall, radiographic interpretation and diagnostic accuracy depend upon the opinion of the observers.[15] Its drawbacks include overlapping of the anatomical structures, distortion, magnification and inadequate resolution.[10] Although CBCT provides multiplanar images, higher radiation doses[16] and additional costs limit the use of CBCT in routine practice.[17] It has also been observed that planning based on CBCT may result in a more invasive augmentation than actually required.[15]

In the current study, the sub sinus ridge height at the non-missing maxillary first molar site was found to be 8.16 ± 2.60 mm, whereas for missing maxillary first molar site was found to be 5.25 ± 2.28 mm and the difference was found to be statistically significant. Similar findings have been reported in diagnostic panoramic radiographs of Korean edentulous patients aged 60-90 years, where the average residual bone height in the posterior maxilla was found to be below 5.85 mm.[5] Another study,[4] in which the vertical sections were cut in the molar region of 47 anatomic specimens found that the mean ridge heights ranged between 9.30 and 3.23 mm.

Sinus floor augmentation procedure which is highly predictable in terms of both graft and implant survival[18] is the method employed to overcome the ridge height insufficiency in the posterior maxilla. Ridge height thresholds are commonly adopted in clinical decision making for sinus floor elevation. Ridge heights of 7-9 mm are indicated for short implants (implant length < 8 mm) or transalveolar sinus floor elevation and a threshold of 5 mm are conventionally adopted for sinus floor elevation with a lateral approach.[6] The findings from the present study indicate that the patients with missing maxillary first molar may often require vertical bone augmentation with direct sinus lifting procedures and those with non-missing maxillary first molar sites can be managed with short dental implants or even with indirect sinus lift whenever it has to undergo replacement with dental implants. Other approaches for the management of ridge height deficiency in the posterior maxilla include placement of angulated implants[19] as well as zygomatic implants.[20] Seong et al[21] noted a 54.2% prevalence of sinus augmentation in conjunction with the maxillary posterior implants.

Statistically, a significant difference was found among the different age groups in this study. The finding is in agreement with the study done by Tolstunov et al who reported that the older edentulous patients tend to demonstrate a higher rate of bone resorption in the maxilla which causes the enlargement of the sinuses.[22] Other studies[5,23] have reported no significant differences among the different age groups.

The rate of residual bone resorption is not constant, it is rapid between six months and two years after tooth extraction and tends to stabilise thereafter.[24] So, the time elapsed since extraction rather than age is a major determinant for residual ridge height.[12] This constraint could not be addressed in the current study.

It was observed that the males had a higher sub sinus ridge height than females. However, no statistically significant difference was noted between the gender which is in accordance with the findings of Liang[5] whereas Mercier[25] has reported that males have greater facial height and amount of resorbable bone after extraction. Hence, the clinicians should pay greater attention when planning implants in females.

As it is done in a single dental hospital in a small sample, the findings cannot be generalised to the overall population.

CONCLUSIONS

Based on the findings of the current study, it can be stated that missing maxillary first molar sites often require vertical bone augmentation with direct sinus lift procedures whenever dental implants are planned in the representative Nepalese population. The determination of ridge height based on panoramic radiographs helps in treatment planning for implant therapy. Further studies determining the ridge dimensions should be conducted in large populations in the future to determine the treatment needs for tooth replacement in Nepal.

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