

Sexual dimorphism of maxillary sinus on maxillary molars- A pilot study

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Abstract

Maxillary sinus pneumatization can pose a surgical hazard in terms of oro-antral communications following extraction and endodontic surgery of the posterior teeth and it also increases the risk of introducing foreign bodies, root tips or teeth displacement into the sinus cavity and it is well known to influence orthodontic tooth movement. According to certain studies it is proved that width and height of the maxillary sinus can be used with the other bones to determine the gender of an individual when the skeleton is not complete & it is known that the maxillary sinus shows anatomical variations between various gender. Hence this study was done to determine the gender of the individual based on the proximity of the maxillary sinus. A total no of 10 patients were taken with

the age of above 18yrs of age. From the dental records of each subjects the CBCT images was selected. The CBCT images were viewed using In-vivo software and the vertical relationship between the tooth root apex and floor of maxillary sinus were graded into four types based on Jung classification. Studies have shown that maxillary 1st molar had close proximity with the maxillary sinus. In our study it was found that the maxillary 2nd molar had greater proximity to the maxillary sinus compared to the 1st molar. On comparing the subjects it was found that the roots of the maxillary 1st molar in males had greater proximity to the sinus floor compared to females except the left side mesial root of the maxillary 1st molar where the females had a greater grading than that of males. On comparing the roots of the maxillary 2nd molar males showed a

greater grading compared to female which indicated that the roots of the teeth of males are closer compared to that of females. We conclude that the males have greater root proximity to the maxillary sinus compared to females.

Keywords: maxillary sinus, pneumatization, sinus cavity, root proximity

Introduction

The development of the maxillary sinus starts during the intrauterine fetal life which then continues to develop even after birth. In adults the maxillary sinus is variable in its extension [1,2]. The maxillary sinus varies in its size and shape depending on the age of the individual and its degree of pneumatization.

The inferior wall of the maxillary sinus is a curved structure that is extended between adjacent teeth, or individual roots in about half of the population, the floor of the maxillary sinus is formed by the alveolar process of the maxillary arch [3]. It is noted that the thickness of the floor of the maxillary sinus is reduced in the area's where the roots of the maxillary posterior teeth project the maxillary sinus. It is often noted that the maxillary sinus often expands between the molar roots and results in proximity between them. On radiograph, it seems that the roots of the maxillary molars penetrate into the sinus floor and protrude into maxillary antrum, but instead, it is the maxillary sinus that has extended around the roots of the tooth [4,5].

It is challenging in dentistry to carry out various procedures, especially during endodontic procedure, extraction, Implant placement or surgical removal of the maxillary posterior teeth due to the close proximity of the maxillary posterior teeth to the floor of the maxillary sinus [6].

The proximity of the maxillary sinus to the root of the maxillary posterior teeth poses some surgical hazard following extraction and endodontic procedures such as

oro-antral communications [7] and increased risk of foreign body enlodgement such as root tips or teeth displacement into the maxillary sinus, the proximity of the posterior teeth also influence the orthodontic teeth movement [8,9] the oro-antral communication results in microbial contamination of the maxillary sinus. If the communication remains open or if the infection persist, chronic inflammation of the sinus membrane may result with subsequent permanent epithelization of the oro-antral fistula which is the situation which further increases the risk of sinusitis.

It has been found that the anatomical relationship among maxillary sinus and roots of maxillary posterior teeth plays a significant role in determining the orthodontic tooth movements. When a tooth is protracted through the maxillary sinus floor it may result in tooth root resorption or tipping of the tooth during orthodontic treatment [10]. Therefore the thickness of bone present between the alveolar cortical plate and roots of maxillary molars is found to have a major role in the spread of odontogenic infection which in turn decides the treatment planning [5,8]. Therefore a thorough examination of the relationship of the roots of the posterior teeth & the maxillary sinus is required to be done before carrying out any procedure.

The localised relationship of the teeth relative to the maxillary sinus can be assessed by using different radiographic techniques. With the development in the field of dentistry various radiographic techniques are being used such as the Periapical, panoramic and conventional CT have been recommended to assess the relationship of the roots of the posterior teeth to the maxillary sinus.

On taking the Periapical radiographs [11] into account in assessing the relationship of the roots of the posterior teeth and maxillary sinus it is found that it gives only 2D information of the roots of the posterior tooth.

With the invention of Panoramic radiograph diagnosis was made easy as a single radiograph can provide information of all the teeth and their surrounding structures. Therefore they are frequently used to evaluate teeth and patterns of the craniofacial skeleton, serving as a guide for their diagnosis and treatment planning [9]. Wehrbein and Diedrich studied panoramic radiograph and found that there is correlation between the maxillary sinus and the root length of the maxillary posterior teeth [12]. Although a single radiograph provided a lot of informations regarding the tooth and the surrounding structures it also had some of the disadvantages such as ghost images which are formed on the opposite site of the object, mesiodistal and vertical enlargement of the images are formed thereby adding a major limitation in evaluating the anatomic correlation between tooth roots and alveolar bone when using only a panoramic radiograph[12]. Some of the clinical procedures involving the roots of teeth and their related structures require a single dental X-ray having the best imaging modality with minimal radiation dose. Most drawbacks of single dental X-ray are similar to those of panoramic radiography therefore a better radiographic technique is required to evaluate the proximity of the roots of the posterior teeth and the maxillary sinus. Another disadvantage which was faced by the clinician during estimation of the root proximity is that the panoramic radiograph produced only two-dimensional image of the tooth so they found that the three-dimensional image proved to be more beneficial in evaluating the tooth and their surrounding structures when compared to the two-dimensional imaging.

With the development of three-dimensional imaging CT scan was developed to overcome the lack of cross-sectional information, superimposition, distortion, and other magnificational errors which are noted in conventional radiographic technique. The three-

dimensional imaging had greater reliability in estimating the root proximity to the maxillary sinus and also had greater ability to explore the interior of the cranium and in estimating the volumes of different anatomical compartments such as the maxillary sinus and the nasal cavity. But the only disadvantage with the CT imaging is that large dosage of ionizing radiation is delivered by the medial CT scan that is it delivers 1.5-12.3 times greater radiation than CBCT scans [13,14,15], therefore in order to reduce the amount of absorbed radiation dosage CBCT technologies has been developed.

Various authors [16-17] used CT, panoramic radiograph, CBCT to study the proximity of the roots of the maxillary posterior teeth to the floor of the maxillary sinus [11-12]. Recent studies [18-21] evaluate this relationship using CBCT, and performed classification of the proximity of the maxillary sinus to the posterior teeth without establishing a comparison to the two-dimensional technique. Hassan et al [22] in their study compared the CBCT, periapical radiograph and panoramic radiograph to estimate the reliability of the panoramic and periapical radiograph in estimating the proximity of the roots of the maxillary posterior teeth to the maxillary sinus. Ok et al [23] studied the maxillary premolar and molar root proximity to the floor of the maxillary sinus. According to Shahbazian et al. [3], in their study used CBCT and panoramic radiograph to study the proximity of the floor of the maxillary sinus to the maxillary posterior teeth and found that the CBCT provided more information than the panoramic radiograph.

Therefore in this study we used the CBCT imaging to estimate the proximity of the maxillary sinus to the roots of the posterior tooth.

Material and methods

This is a retrospective study which was performed on Korean population in the department of Orthodontics,

Saveetha Dental College and Hospital, Chennai, A total no of 10 patients were taken with the age of above 18yrs of age. From the dental records of each subjects the CBCT images was selected. All the CBCT images were taken.

Inclusion criteria

- patients with complete permanent dentition
- no pathology or radiology showing marked disruption in the apical third of roots,
- no signs of tooth extraction or surgery
- no evidence of supernumerary teeth.

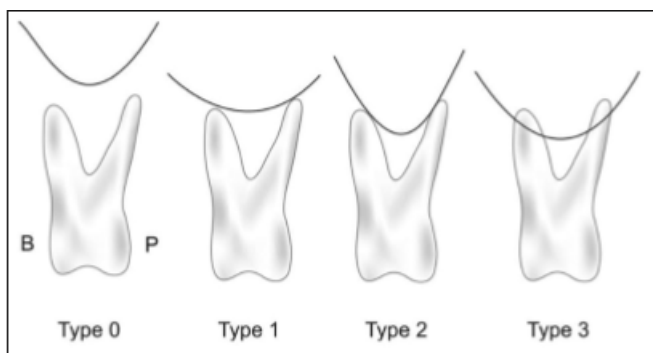
Exclusion criteria

- Patients under 18 yrs of age,
- mixed dentition stage,
- evidence of surgery or extraction,
- evidence of supernumerary teeth.

The CBCT images were viewed using In-vivo software and the vertical relationship between the tooth root apex and floor of maxillary sinus were graded into four types based on Jung classification (2009) [Figure 1].[7]

- Type 0: The maxillary sinus floor is located above the root apex
- Type 1: The root apex touches the floor of maxillary sinus
- Type 2: The floor of maxillary sinus is interposed between roots
- Type 3: Apical protrusion is observed over the maxillary sinus floor.

Figure 1



The gradings were compared and graphs were plotted.

Results

On comparing the proximity of the roots of the molars to the maxillary sinus based on gender it was found that in females on comparing both right and left side of both 1st and 2nd molar's we found that except the right-side mesial root of the maxillary 1st molars all the roots on both right and left side of the maxillary 1st molar had a closer proximity to the maxillary sinus compared to the 2nd molar. On comparing the proximity of both the 1st & 2nd molar roots between male & female we found that In maxillary 1st molar the males have greater proximity to the sinus floor compared to females except the left side mesial root of the maxillary 1st molar where the females had a greater grading than that of males. On comparing the roots of the maxillary 2nd molar males showed a greater grading compared to female which indicated that the roots of the teeth of males are closer compared to that of females. On comparing the grading of the roots of the 1st & 2nd molar depending on their close proximity to the maxillary sinus it was found that the maxillary 2nd molar had greater proximity to the maxillary sinus compared to the 1st molar. Figure 2: Comparing the right & left mesial root of the maxillary 2nd molar in females

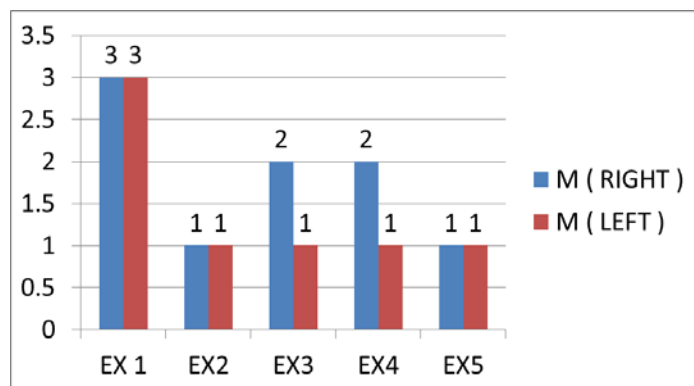


Figure 3: Comparing the right & left root of the maxillary 2nd molar in females

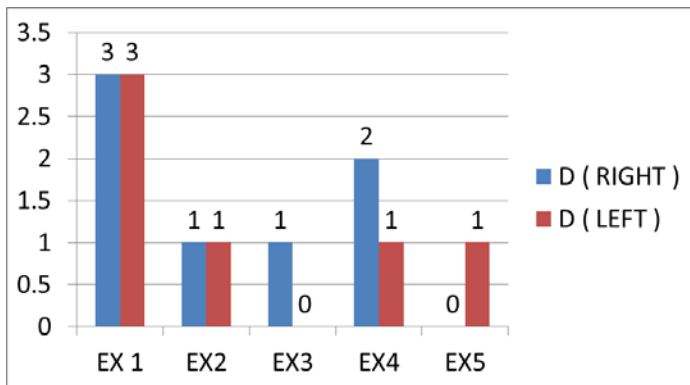


Figure 4: Comparing the right & left palatal root of the maxillary 2nd molar in females

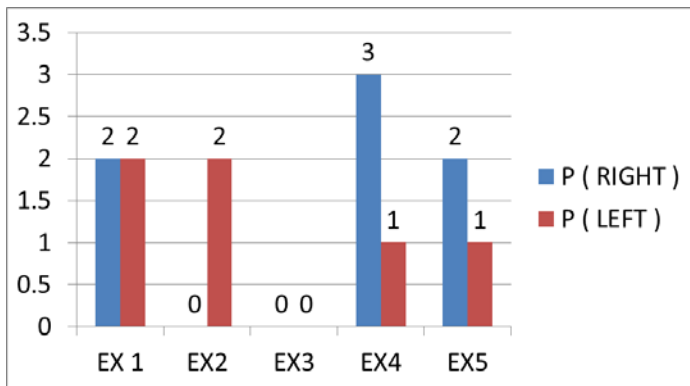


Figure 5: Comparing the right & left mesial root of the maxillary 1st molar in females

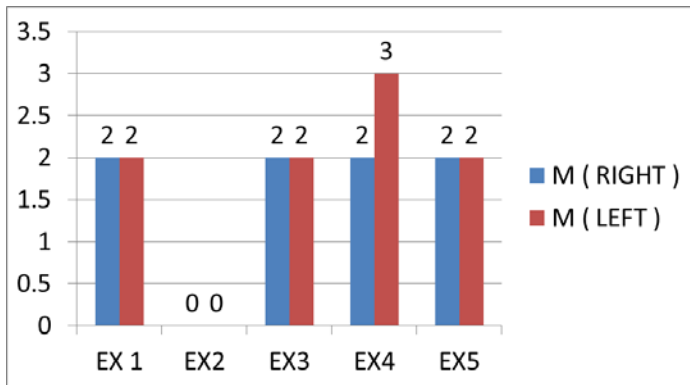


Figure 6: Comparing the right & left distal root of the maxillary 1st molar in females

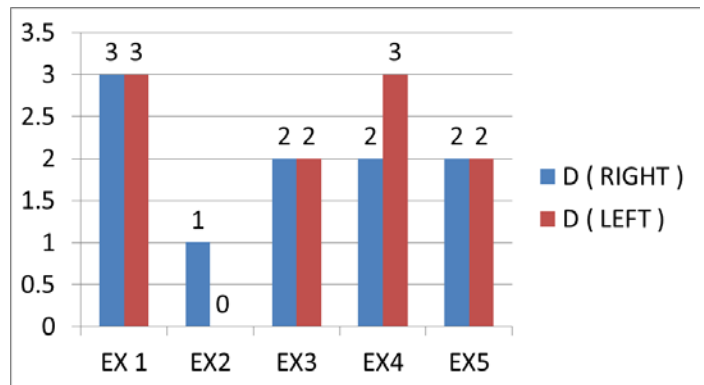


Figure 7: Comparing the right & left palatal roots of the maxillary 1st molar in females

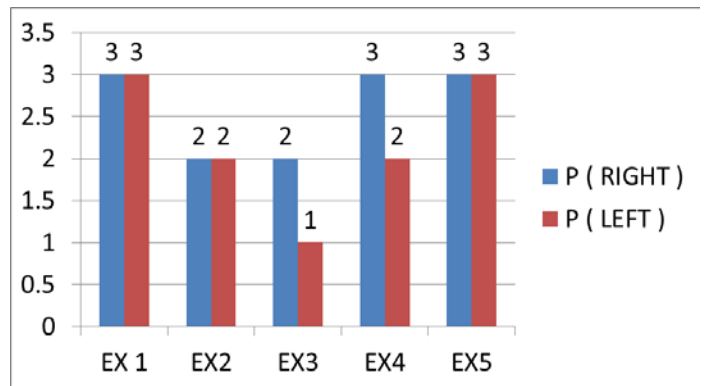


Figure 8: Comparing the right & left mesial root of the maxillary 2nd molar in males

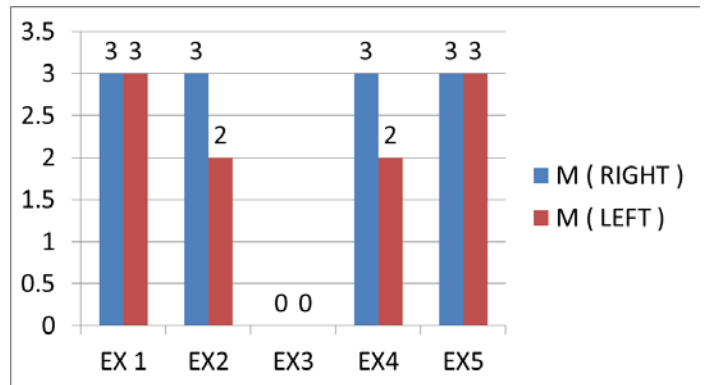


Figure 9: Comparing the right & left distal root of the maxillary 2nd molar in males

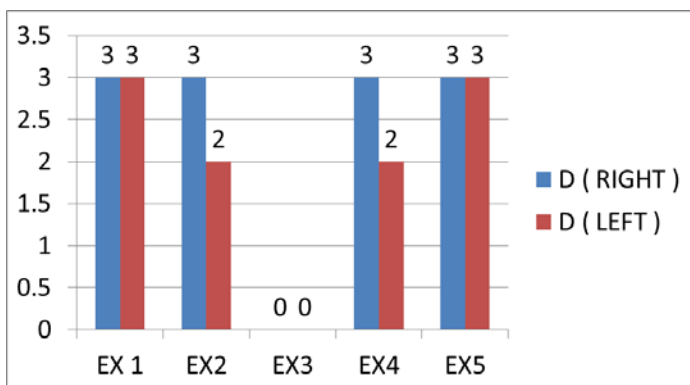


Figure 10: Comparing the right & left palatal root of the maxillary 2nd molar in males

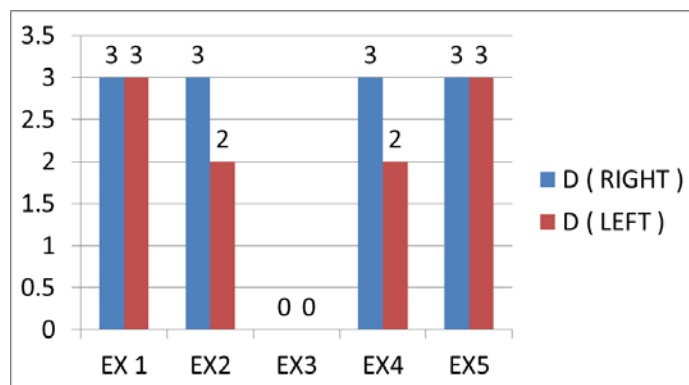


Figure 13: Comparing the right & left palatal root of the maxillary 1st molar in males

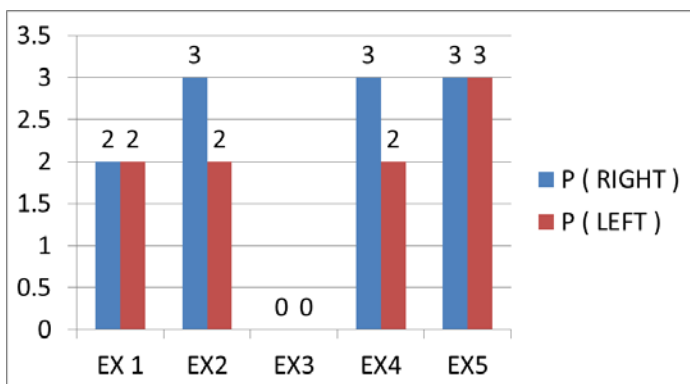
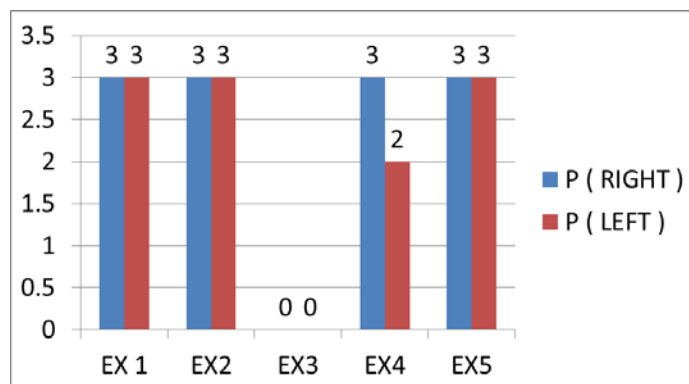


Figure 11: Comparing the right & left mesial root of the maxillary 1st molar in males



Discussion

The anatomical pneumatization and the relationship of the maxillary sinus to the alveolar process is a complex phenomenon due to the variable extension of the maxillary sinus. The anatomical relationship of the floor of the maxillary sinus to the roots of the posterior teeth play a major role in the treatment planning mainly during surgical procedures, orthodontic treatment as it can result in the infection of the maxillary sinus or root resorption of the posterior tooth during orthodontic tooth movement when the tooth is being moved along the maxillary process. There are a wide range of studies which discusses about the relation of the sexual dimorphism and the maxillary sinus pnematization out of which various studies have used the volumetric and quantitative analysis of the maxillary sinus to determine the gender and very few studies have used the “Jung’s classifications “on the proximity of the roots of the posterior teeth to the

maxillary sinus to determine the gender. The present study is a retrospective study which was performed on 10 subjects and the relationship of the roots of the maxillary posterior teeth to the maxillary sinus were graded based on “Jung’s classification” and the gender was determined. There are different types of radiographic methods which were used to assess the close proximity of the roots of the posterior teeth to the floor of the maxillary sinus. Various studies [24] done by different authors used different types of radiographs to detect the proximity of the maxillary sinus to the roots & it was proved that the 2D radiographs such as periapical radiographs, panoramic radiographs are less reliable in evaluating the proximity of the roots of the posterior teeth to the maxillary sinus compared to the 3D radiographs. Studies such as Freisfeld et al [25] compared panoramic radiographic with the 3D radiograph and found that the 3D radiography has better reliability compared to the 2D radiography. In our study we detected the proximity of the maxillary sinus to the roots of the posterior teeth using CBCT image.

The maxillary sinus is pyramidal in shape with its apex located at the zygoma. The anatomical shape and extent of the maxillary sinus can be clearly identified on 3D radiographs of the maxillary sinus. In our study we used CBCT images and compared the proximity of the maxillary sinus to the roots of the posterior teeth and they were graded based on the classification. It was found that the maxillary 2nd molar had greater proximity to the maxillary sinus compared to the 1st molar. There are various other studies which have compared the proximity of the maxillary molars to the sinus but in most of the studies quantitative measurements of the maxillary sinus were used to determine the tooth proximity to the maxillary sinus. Various studies showed different results stated as follows but the most common statement given by various authors was that the maxillary 2nd molar had

greater proximity to the floor of the maxillary sinus but very few studies have stated that the maxillary 1st molar has closer proximity. Hamdy et al [21] in his study he assured the maximum craniocaudal extension of the maxillary sinus which was located around the 2nd molar. Nimigean et al [22] in his study he found that the lowest point of the sinus floor was related to the 2nd molar. Whereas Arijji et al [23] in his study he found that the maxillary 1st molar had close proximity with the maxillary sinus. Killey & Kay et al [24] in his study he found that the 2nd molar had the greatest proximity to the maxillary sinus followed by the 1st molar. Kilic et al [25] in his study he found that the bucco-distal root of the 2nd molar is more closer to the maxillary sinus. In our study we found that in females on comparing both right and left side of both 1st and 2nd molar’s we found that except the right side mesial root of the molars all the roots on both right and left side the maxillary 1st molar had a closer proximity to the maxillary sinus compared to the 2nd molar.

There are various tools to determine gender of an individual it is said that the maxillary sinus also prove to be a variable tool in determining the gender of an individual. According to certain studies [19] it is proved that width and height of the maxillary sinus can be used with the other bones to determine the gender of an individual when the skeleton is not complete & it is known that the maxillary sinus shows anatomical variations between various gender. Teke et al [20] in his study he used quantitative measurements to determine gender of an individual and he found that the height of the maxillary sinus in males is bigger than the height of the maxillary sinus of females. Other studies [1,2,18] found that the volume of the maxillary sinus is largely in males compared to that of females. Balaji et al in his study he used linear measurements of the maxillary sinus for gender determination and reported that the dimensions of

the maxillary sinus is larger in males compared to that of females. Antonie et al [18] in his study demonstrated the presence of sexual dimorphism in the maxillary sinus by using the height and length of the maxillary sinus and he found that the males showed greater values compared to that of females. Sindhu et al [15] in his study he compared the area and perimeter of the maxillary sinus to demonstrate the sexual dimorphism and he found that the males had a larger area of the maxillary sinus compared to that of females. The above are the various studies which used the volumetric measurements to demonstrate the sexual dimorphism using maxillary sinus and the overall result showed that the values of the males were greater than that of the values of females which is in accordance with the results of our study but in our study we used grading depending upon the proximity of the maxillary sinus floor to the roots of the posterior teeth and found that on comparing males and female all the roots of 1st and 2nd molar on both left and right side. In maxillary 1st molar the males have greater proximity to the sinus floor compared to females except the left side mesial root of the maxillary 1st molar where the females had a greater grading than that of males. On comparing the roots of the maxillary 2nd molar males showed a greater grading compared to female which indicated that the roots of the teeth of males are closer compared to that of females.

Conclusion

In our study we found that the males have greater root proximity to the maxillary sinus compared to females. However due to small sample size and ethnic variations the results may vary. Therefore further studies with higher sample size and on the Indian population is required.

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