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# Three Dimensional Descriptive Study of Maxillary Sinus Variation and it's Association with Age and Gender for Implant Placement

Vaishali. S[1] and Kaarthikeyan.G[2]

[1]*Saveetha Dental College and Hospitals Saveetha Institute of Medical and Technical Sciences (SIMATS) Saveetha University, Chennai, India*

[2]*Professor, Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai-600077, India*

## ABSTRACT

The maxillary sinuses (MS) are of particular importance to dentists because of their close proximity to the teeth and their associated structures, so increased risk of maxillary sinusitis has been reported with periapical abscess, periodontal diseases, dental trauma, tooth extraction, and implant placement. Complications of MS are related to its anatomic and pathologic variations. Thus, study was conducted to assess the anatomic variations in MS in association with age and gender by using cone-beam computerized tomography. The aim of this study is assess the variations in maxillary sinus related to implants using cone beam computed tomography. CBCT scans of 25 subjects were collected between the age group of 18 years to 70 years and were analyzed for MS anatomical variation. The linear measurements were performed by selection of the cuts which was based on the presence of certain anatomical landmarks. According to the anatomical fact that the MS is pyramidal in shape with an almost square base oriented medially, the measurements of the sinus dimensions were conducted as follows:1. Linear measurements of the MS height on the sagittal section (craniocaudal extension). 2. Linear measurements of the MS width (mediolateral dimension) and antero-posterior (A-P) dimensions on the axial section. The average height of the right MS is 33.28mm, width is 25.94mm and depth is 34.85mm and average height of the left MS is 33.76mm, width is 26.13 mm and depth is 33.00mm. It was seen that the average height and width of the left maxillary sinus was larger when compared to right maxillary sinus. But the average depth of the right maxillary sinus was larger when compared to the depth of the left maxillary sinus. The size of maxillary sinus increases as age increases, but is not statistically significant ($p>0.05$). The size of maxillary sinus of males was larger when compared to that of females, but is not statistically significant ($p>0.05$).Within the limits of the study it can be concluded that average height of the right MS is 33.28mm, width is 25.94mm and depth is 34.85mm and average height of the left S is 33.76mm, width is 26.13 mm and depth is 33.00mm. Also, the size of MS increases as age increases and size of MS of males is larger than females.

**KEY WORDS:** ANTERIOR POSTERIOR, CONE BEAM COMPUTED TOMOGRAPHY, IMPLANT, MAXILLARY SINUS.

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## INTRODUCTION

The paranasal sinuses are four paired sets of air-filled cavities of craniofacial complexes.The maxillary sinus is the largest of the paranasal sinuses (Van Cauwenberge et al., 2004). It fills the body of the maxilla and is pyramidal in shape .The base is medial on the lateral wall of the nasal cavity. The floor is formed by the alveolar process and part of the palatine process of the maxilla. The apex of the maxillary sinus extends into the zygomatic process of the maxilla. The maxillary sinus serves many functions such as to decrease the weight of the skull, increases voice resonance, protects against blows to the face, insulation of the eyes and roots of the teeth against temperature fluctuations, humidification of inhaled air and contributes to the maxillary growth (Johna, 2006) .Of the four paranasal sinuses the maxillary sinuses (MS) are of particular importance to dentists because of their close proximity to the teeth and their associated structures. So increased risk of maxillary sinusitis has been reported with periapical abscess, periodontal diseases, dental trauma, tooth extraction, and implant placement (Kretzschmar and Kretzschmar, 2003). Complications of maxillary sinus are related to its anatomic and pathologic variations (Zijderveld et al., 2008).

The very close relationship between teeth roots and maxillary sinus (MS) is referred to as "draping." The teeth which are commonly involved are the roots of premolars and molars. Maxillary sinus are small at birth, after birth, it enlarges with the growing maxilla, though it is fully developed following the eruption of permanent dentition. Maxillary sinus anatomy varies from person to person. The main characteristics of these structures are pneumatic. Genetic diseases, environmental conditions, and past infections can affect the process of pneumatization of maxillary sinuses (Ritter et al., 2011). The size of maxillary air sinuses are reported to increase with age. Spurts of maxillary sinus growth occur for both genders from birth to 2 years, from 7.5 to 10 years, and from 10 to 12 years. Thereafter, growth is slow but steady until 14 to 18 years (Ariji et al., 1994).

The ostium located posterosuperiorly on the medial surface helps in the communication of maxillary sinus with the homolateral nasal fossa. Normal physiology of the Maxillary sinus is highly dependent on the proper function of both the Maxillary sinus ostium and the mucosal lining (Underwood, 1910). Three-dimensional assessment of maxillary sinus pneumatization is of most usefulness, considering the anatomical variability related to the maxillary sinus, its intimate relation to the maxillary posterior teeth and because of all the implications that pneumatization may possess. Anatomic variations within the sinus, such as septa, increase the risk of the sinus membrane perforation during pre-implant surgery in posterior maxilla. Computed tomography (CT) images allow the location of anatomic structures and provide information about bone dimensions and morphology (Dobele et al., 2013).

The advantage of cone-beam computerized tomography (CBCT) is its lower cost, smaller device size, and CBCT can produce an image with significantly less radiation than traditional CT, because it uses an image intensifier, this is particularly important for children (Cha, Mah and Sinclair, 2007). With the development of cone beam computed tomography (CBCT), the errors produced in conventional radiography can be eliminated and the excessive radiation produced in the CT could be reduced. (Kavarthapu and Thamaraiselvan, 2018). CBCT provides excellent tissue contrast, eliminates blurring, and overlapping of adjacent structures. It is important to know the three dimensional variations- height, width and anterior posterior dimension among large populations as this would help in implant dimensions for implant placement (Mehra and Murad, 2004). This is because CBCT shows a great potential for proper preoperative planning and is an indispensable alternative for CT when 3D imaging is mandatory for all dental practitioners.

Providing normative values for paranasal sinus size and their changes with age and gender could be helpful in evaluating the presence of any abnormality. Implant placement becomes difficult in case of chronic periodontitis due to the bone loss that occurs ( Ramesh et al., 2018,) . This could be treated by sinus augmentation procedures like bone grafts, growth factors, etc (Kavarthapu and Malaiappan, 2019).Also, knowing about the average dimensions of maxillary sinus would help the implant manufacturers to have a rough knowledge on the implant dimensions to be manufactured for the people belonging to that particular geographic location and also to place implants without any complications. Previously we have worked on plenty of topics in periodontology (Jain and Nazar, 2018; Ramamurthy, 2018;; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Vijayashree Priyadharsini, 2019). Now we are planning to assess the Three Dimensional descriptive study of Maxillary Sinus variations and its association with age and gender by Cone Beam Computed Tomography for Implant placement.

## MATERIAL AND METHODS

**Study setting:** It is a university setting study, conducted in Saveetha Dental College from November 2019 to January 2020. The pros of the study are flexibility, low cost. The cons of the study are that it is limited to a certain population. CBCT scans of 25 subjects who reported to Saveetha Dental College were collected between the age group of 18 years to 70 years and were analyzed for MS anatomical variation. Approval was obtained from the Institutional Ethical Committee (IEC), Saveetha Dental College. Two examiners were included in the study.

**Sampling:** Simple random sampling was done to minimise sampling bias. It was generalised to South Indian population.

**Data collection:** CBCT scans of 25 subjects who reported to Saveetha Dental College were collected between the

age group of 18 years to 70 years and were analyzed for MS anatomical variation.

The following measurements of maxillary sinus were done:

1. Maxillary sinus Height was measured as the longest distance from the lowest point of the sinus floor to the highest point of the sinus roof in the coronal view.
2. Maxillary sinus Width was measured as the longest distance perpendicular from the medial wall of the sinus to the most lateral wall of the lateral process of the maxillary sinus in the axial view
3. Maxillary sinus Depth (Anteroposterior) was measured as the longest distance from the most anterior to the most posterior point of the medial wall in the axial view.
4. .

**Analysis:** The statistical analysis was performed using the Statistical package for Social Sciences version (SPSS) 20. Differences in mean values between groups were analysed using descriptive statistics, while correlation studies were performed using the Pearson's correlation coefficient. Values were deemed significant if $p < 0.05$.

Table 1. Shows mean and standard deviation values of right Maxillary sinus dimensions. It is seen that the average height of the right MS is 33.28mm, width is 25.94mm and depth is 34.85m

| Dimensions (in mm) | N | Mean | Std. Deviation |
|---|---|---|---|
| Right MS height | 25 | 33.28 | 1.27 |
| Right MS width | 25 | 25.94 | 0.82 |
| Right MS depth | 25 | 34.85 | 1.58 |

Table 2. Shows mean and standard deviation values of left Maxillary sinus dimensions. It is seen that the average height of the left MS is 33.76mm, width is 26.13 mm and depth is 33.00mm.

| Dimensions (in mm) | N | Mean | Std. Deviation |
|---|---|---|---|
| Left MS height | 25 | 32.76 | 1.79 |
| Left MS width | 25 | 26.13 | 0.83 |
| Left MS depth | 25 | 33.00 | 1.29 |

## RESULTS AND DISCUSSION

In relation to the average size of the right maxillary sinus it was seen that the average height of the right MS is 33.28mm, width is 25.94mm and depth is 34.85mm. [ Table 1]. In relation to the average size of the left maxillary sinus it was seen that the average height of the left MS is 33.76mm, width is 26.13 mm and depth is 33.00mm [Table 2]. It was seen that the average height and width of the left maxillary sinus was larger when compared to right maxillary sinus. But the average depth of the right maxillary sinus was larger when compared to the depth of the left maxillary sinus.

Figure 1: Shows association between age and mean dimensions of right Maxillary Sinus. X axis denotes the age group and Y axis denotes the mean dimensions of right maxillary sinus. (Right MS height, Pearson Chi square= 63.988, p =0.680 (>0.05), Right MS width , Pearson Chi square= 64.271, p =0.184 (>0.05) and Right MS depth, Pearson Chi square =82.639, p=0.552 (>0.05), hence not statistically significant) .It is seen that the size of right maxillary sinus (height, width and depth ) increases as the age increases, but was not statistically significant.

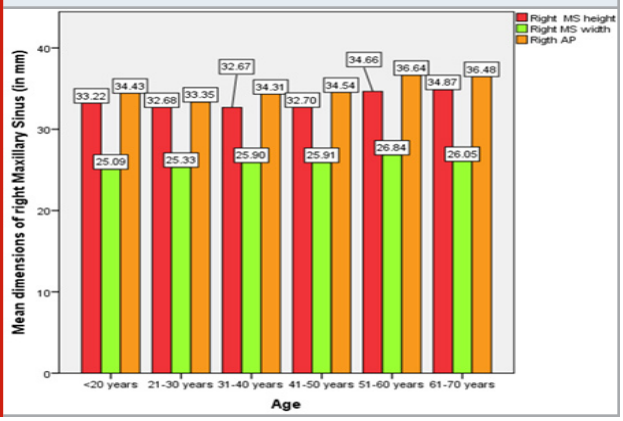
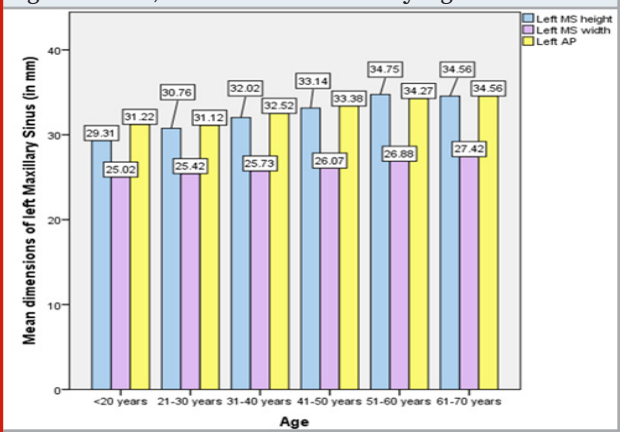



Figure 2: Shows association between age and mean dimensions of left Maxillary Sinus. X axis denotes the age group and Y axis denotes the mean dimensions of left maxillary sinus. (Left MS height, Pearson Chi square= 16.098, p =0.149 (>0.05), Left MS width, Pearson Chi square= 12.876, p =0.425(>0.05) and Left MS depth, Pearson Chi square =19.028, p=0.154 (>0.05), hence not statistically significant). It is seen that the size of left maxillary sinus (height, width and depth ) increases as the age increases, but was not statistically significant

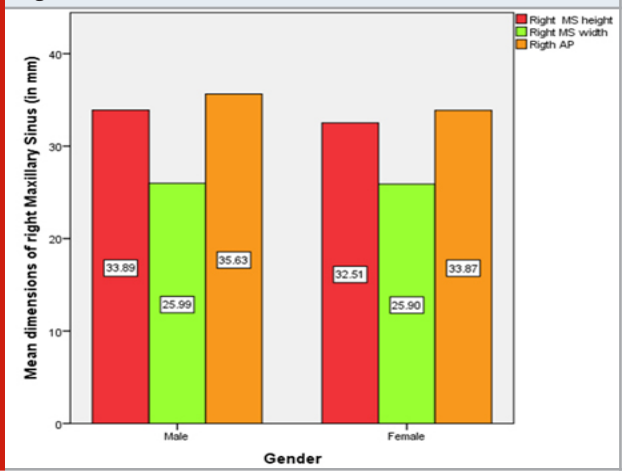



In relation to the association between age and mean dimensions of right maxillary sinus it is seen that the size of right maxillary sinus (height, width and depth ) increases as the age increases, but was not statistically

significant .(Right MS height, Pearson Chi square= 63.988, p =0.680 (>0.05), Right MS width , Pearson Chi square= 64.271, p =0.184 (>0.05) and Right MS depth, Pearson Chi square =82.639, p=0.552 (>0.05), hence not statistically significant) [Figure 1]. In relation to the association between age and mean dimensions of left maxillary sinus it is seen that the size of left maxillary sinus (height, width and depth ) increases as the age increases, but is not statistically significant (Left MS height, Pearson Chi square= 16.098, p =0.149 (>0.05), Left MS width , Pearson Chi square= 12.876, p =0.425(>0.05) and Left MS depth, Pearson Chi square =19.028, p=0.154 (>0.05), hence not statistically significant) [Figure 2].

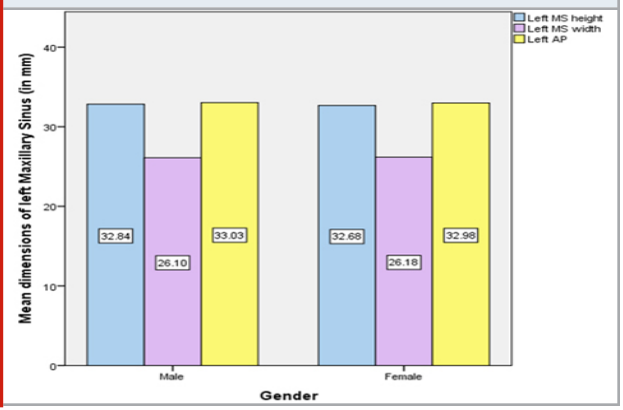
In relation to the association between gender and mean dimensions of right maxillary sinus it is seen that the size of right maxillary sinus (height, width and depth ) of males was larger when compared to females, but was not statistically significant. (Right MS height, Pearson Chi square= 17.898, p =0.211 (>0.05), Right MS width , Pearson Chi square= 612.351, p =0.338 (>0.05) and Right MS depth, Pearson Chi square =20.942, p=0.229 (>0.05), hence not statistically significant) [Figure 3]. In relation to the association between gender and mean dimensions of left maxillary sinus it is seen that the size of the left maxillary sinus (height, width and depth ) of males was larger when compared to females, but was not statistically significant .(Left MS height, Pearson Chi square= 22.971, p =0.346 (>0.05), Left MS width , Pearson Chi square= 14.177, p =0.655 (>0.05) and Left MS depth, Pearson Chi square =18.236, p=0.507 (>0.05), hence not statistically significant) [Figure 4].

Figure 3: Shows association between gender and mean dimensions of right Maxillary Sinus. X axis denotes the gender and Y axis denotes the mean dimensions of right maxillary sinus.(Right MS height, Pearson Chi square= 17.898, p =0.211 (>0.05), Right MS width , Pearson Chi square= 612.351, p =0.338 (>0.05) and Right MS depth, Pearson Chi square =20.942, p=0.229 (>0.05), hence not statistically significant) . It is seen that the size of the right maxillary sinus (height, width and depth ) of males was larger when compared to females, but was not statistically significant.




In the present study, it was found that the average height and width of the left maxillary sinus was larger when compared to right maxillary sinus. But the average depth of the right maxillary sinus was larger when compared to the depth of the left maxillary sinus. This was in line with the study by Sahlstrand et al(Sahlstrand-Johnson et al., 2011)where similar results were observed. However this was contradictory to the study by Emirezeoglu et al (Emirzeoglu et al., 2007) where the average height and width of right maxillary sinus was more when compared to that of left maxillary sinus. Also the average depth of left maxillary sinus was more when compared to that of right maxillary sinus. The probable reason for this varying results could be differing sample size and geographic location.

Figure 4: Shows association between gender and mean dimensions of left Maxillary Sinus. X axis denotes the gender and Y axis denotes the mean dimensions of left maxillary sinus.(Left MS height, Pearson Chi square= 22.971, p =0.346 (>0.05), Left MS width , Pearson Chi square= 14.177, p =0.655 (>0.05) and Left MS depth, Pearson Chi square =18.236, p=0.507 (>0.05), hence not statistically significant) . It is seen that the size of the left maxillary sinus (height, width and depth ) of males was larger when compared to females, but was not statistically significant.




In relation to the association between age and mean dimensions of maxillary sinus, it was seen that both right and left maxillary sinus size increases as age increases. This was in line with the study by Jasim et al (Jasim and Al-Taei, 2013) and Baweja et al (Baweja, Dixit and Baweja, 2013) The physiological reasons would be at birth, the size of maxillary sinus is small, which enlarges as age increases. Similarly to accommodate the increased size of maxilla, size of maxillary sinus increases. However in old age, there is no increase in size of maxilla, but size of maxillary sinus increases. The reason could be as age progresses, tooth loss is common. So as the premolars and molars are lost and not replaced, resorption of the posterior maxillary ridge occurs and also the floor of the maxillary sinus dips down due to the pneumatization process (Sinus gets filled with air-filled cavities), where volume and size of the maxillary sinus increases. In case of pneumatized sinus and ridge resorption, sinus augmentation can be done prior to placement of implants

with various techniques like bone grafts and PRF (Platelet Rich Fibrin) (Kaarthikeyan, Jayakumar and Sivakumar, 2019; ). This augmentation procedure requires a lot of biomaterials and is a cumbersome exercise.(Ramesh, Ravi and Kaarthikeyan, 2017)

In relation to the association between gender and mean dimensions of maxillary sinus, it was seen that both right and left maxillary sinus size was larger in males when compared to females. This was in line with the study by Uthman et al(Uthman et al., 2011). However contradictory findings were found in study by Teke et al (Teke et al., 2007), where he observed that depth of maxillary sinus of females were large when compared to males. The probable reason could be differing sample size and geographic location. The reason why maxillary sinus of males were larger when compared to females was stated by Dean et al (Dean, 1991) in his study, where he stated that males need to have correspondingly bigger lungs to support their relatively more massive muscles and body organs. Also, males need a larger airway, which begins with the nose and nasopharynx.

In other words, physiological changes in nasal cavity size and shape occur as a direct result of respiration-related needs, such as warming and humidifying inhaled air. The increase in the size of the maxillary sinus is attributed to its location in the naso-maxillary complex. Many factors like age, ethnic,racial differences, body stature,physique and pneumatization process attributes to these differences. The limitations of the study include small sample size, single centered study. The future scope of this study is to do extensive research with large sample size to know about the average dimensions of maxillary sinus would help the implant manufacturers to have a rough knowledge on the implant dimensions to be manufactured for the people belonging to that particular geographic location and also to place implants without any complications.

## CONCLUSION

Within the limits of the study it can be concluded that average height of the right MS is 33.28mm, width is 25.94mm and depth is 34.85mm and average height of the left MS is 33.76mm, width is 26.13 mm and depth is 33.00mm. The average height and width of the left maxillary sinus was larger when compared to right maxillary sinus. But the average depth of the right maxillary sinus was larger when compared to the depth of the left maxillary sinus. Also, the size of Maxillary Sinus increases as age increases and size of Maxillary Sinus of males is larger than females. So knowing about the average dimensions of Maxillary Sinus, would help the implant manufacturers to have a rough knowledge on the implant dimensions to be manufactured for the people belonging to that particular geographic location and also to place implants without any complications.

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**Author's Contribution:** First author Vaishali.S performed data collection, analysis and interpretation and wrote the manuscript. Second author Kaarthikeyan contributed to conception, study design, analysis, interpretation and critically revised the manuscript. All the authors have discussed the results and contributed to the final manuscript.

**Conflict of Interest:** None

## REFERENCES

Ariji, Y. et al. (1994) 'Age changes in the volume of the human maxillary sinus: a study using computed tomography', Dento maxillo facial radiology, 23(3), pp. 163–168.

Arjunkumar, R. (2018) 'Nanomaterials for the Management of Periodontal Diseases', in Chaughule, R. S. (ed.) Dental Applications of Nanotechnology. Cham: Springer International Publishing, pp. 203–215.

Baweja, S., Dixit, A. and Baweja, S. (2013) 'Study of age related changes of maxillary air sinus from its anteroposterior, transverse and vertical dimensions using Computerized Tomographic (CT) scan', International Journal of Biomedical. cabdirect.org. Available at: https://www.cabdirect.org/globalhealth/abstract/20133089475.

Cha, J.-Y., Mah, J. and Sinclair, P. (2007) 'Incidental findings in the maxillofacial area with 3-dimensional cone-beam imaging', American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics, 132(1), pp. 7–14.

Dean, D. (1991) 'Facial growth, 3rd ed. By D. H. Enlow. Philadelphia: W. B. Saunders. 1990. 576 pp. $79.00 (cloth)', American Journal of Physical Anthropology, pp. 90–92. doi: 10.1002/ajpa.1330860111.

Dobele, I. et al. (2013) 'Radiographic assessment of findings in the maxillary sinus using cone-beam computed tomography', Stomatologija / issued by public institution 'Odontologijos studija' ... [et al.], 15(4), pp. 119–122.

Emirzeoglu, M. et al. (2007) 'Volumetric evaluation of the paranasal sinuses in normal subjects using computer tomography images: a stereological study', Auris, nasus, larynx, 34(2), pp. 191–195.

Ezhilarasan, D., Apoorva, V. S. and Ashok Vardhan, N. (2019) 'Syzygium cumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells', Journal of oral pathology & medicine: official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology, 48(2), pp. 115–121.

Jain, M. and Nazar, N. (2018) 'Comparative Evaluation

of the Efficacy of Intraligamentary and Supraperiosteal Injections in the Extraction of Maxillary Teeth: A Randomized Controlled Clinical Trial', The journal of contemporary dental practice, 19(9), pp. 1117–1121.

Jasim, H. H. and Al-Taei, J. A. (2013) 'Computed tomographic measurement of maxillary sinus volume and dimension in correlation to the age and gender (comparative study among individuals with ...', Journal of Baghdad College of. platform.almanhal.com. Available at: https://platform.almanhal.com/Files/2/70932.

Johna, S. (2006) 'Gray's Anatomy: The Anatomical Basis of Clinical Practice Elsevier / Churchill Livingstone, 2005, ISBN 0-443-06676-0', World Journal of Surgery, pp. 1624–1625. doi: 10.1007/s00268-006-0109-2.

Kaarthikeyan, G., Jayakumar, N. D. and Sivakumar, D. (2019) 'Comparative Evaluation of Bone Formation between PRF and Blood Clot Alone as the Sole Sinus-Filling Material in Maxillary Sinus Augmentation with the Implant as a Tent Pole: A Randomized Split-Mouth Study', Journal of long-term effects of medical implants, 29(2), pp. 105–111.

Kavarthapu, A. and Malaiappan, S. (2019) 'Comparative evaluation of demineralized bone matrix and type II collagen membrane versus eggshell powder as a graft material and membrane in rat model', Indian journal of dental research: official publication of Indian Society for Dental Research, 30(6), pp. 877–880.

Kavarthapu, A. and Thamaraiselvan, M. (2018) 'Assessing the variation in course and position of inferior alveolar nerve among south Indian population: A cone beam computed tomographic study', Indian journal of dental research: official publication of Indian Society for Dental Research, 29(4), pp. 405–409.

Kretzschmar, D. P. and Kretzschmar, J. L. (2003) 'Rhinosinusitis: review from a dental perspective', Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics, 96(2), pp. 128–135.

Mehra, P. and Murad, H. (2004) 'Maxillary sinus disease of odontogenic origin', Otolaryngologic clinics of North America, 37(2), pp. 347–364.

Murthykumar, K., Arjunkumar, R. and Jayaseelan, V. P. (2019) 'Association of vitamin D receptor gene polymorphism (rs10735810) and chronic periodontitis', Journal of investigative and clinical dentistry, 10(4), p. e12440.

Ramamurthy, J. (2018) 'COMPARISON OF EFFECT OF HIORA MOUTHWASH VERSUS CHLORHEXIDINE MOUTHWASH IN GINGIVITIS PATIENTS: A CLINICAL TRIAL', Asian J Pharm Clin Res, 11(7), pp. 84–88.

Ramesh, A. et al. (2018) 'Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study', Journal of periodontology, 89(10), pp. 1241–1248.

Ramesh, A. et al. (2019) 'Esthetic lip repositioning: A cosmetic approach for correction of gummy smile - A case series', Journal of Indian Society of Periodontology, 23(3), pp. 290–294.

Ramesh, A., Ravi, S. and Kaarthikeyan, G. (2017) 'Comprehensive rehabilitation using dental implants in generalized aggressive periodontitis', Journal of Indian Society of Periodontology, 21(2), pp. 160–163.

Ravi, S. et al. (2017) 'Additive Effect of Plasma Rich in Growth Factors With Guided Tissue Regeneration in Treatment of Intrabony Defects in Patients With Chronic Periodontitis: A Split-Mouth Randomized Controlled Clinical Trial', Journal of periodontology, 88(9), pp. 839–845.

Ritter, L. et al. (2011) 'Prevalence of pathologic findings in the maxillary sinus in cone-beam computerized tomography', Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics, 111(5), pp. 634–640.

Sahlstrand-Johnson, P. et al. (2011) 'Computed tomography measurements of different dimensions of maxillary and frontal sinuses', BMC medical imaging, 11, p. 8.

Teke, H. Y. et al. (2007) 'Determination of gender by measuring the size of the maxillary sinuses in computerized tomography scans', Surgical and radiologic anatomy: SRA, 29(1), pp. 9–13.

Underwood, A. S. (1910) 'An Inquiry into the Anatomy and Pathology of the Maxillary Sinus', Journal of anatomy and physiology, 44(Pt 4), pp. 354–369.

Uthman, A. T. et al. (2011) 'Evaluation of maxillary sinus dimensions in gender determination using helical CT scanning', Journal of forensic sciences, 56(2), pp. 403–408.

Van Cauwenberge, P. et al. (2004) 'Anatomy and physiology of the nose and the paranasal sinuses', Immunology and allergy clinics of North America, 24(1), pp. 1–17.

Vijayashree Priyadharsini, J. (2019) 'In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens', Journal of periodontology, 90(12), pp. 1441–1448.

Zijderveld, S. A. et al. (2008) 'Anatomical and surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures', Journal of oral and maxillofacial surgery: official journal of the American Association of Oral and Maxillofacial Surgeons, 66(7), pp. 1426–1438.