Annals of Medical Research
DOI: 10.5455/annalsmedres.2019.01.019 2019;26(5):811-6

Original Article

Evaluation of maxillary sinus anatomical variation and pathologies through cone-beam computed tomography in patients with impacted third molars in the maxilla

Numan Dedeoglu

Inonu University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Malatya, Turkey

Abstract

Aim: The aim of this study was to compare between the frequency of anatomical variation and pathology in the maxillary sinuses having the impacted third molars in the maxilla adjacent to the dental arch and the maxillary sinuses adjacent to the dental arch having the erupted third molars.

Material and Methods: A total of 284 cone beam computed tomography (CBCT) images of the maxillary sinuses, 141 of which are adjacent to the impacted third molar teeth in the maxilla, and 143 of which are adjacent to the erupted third molar teeth, were retrospectively evaluated. In the CBCT images, the pathology, septa, accessory ostium, overpneumatization, Haller cell and teeth root relation with sinus were evaluated in each maxillary sinus.

Results: There were no statistically significant differences in the frequency of pathology (p = 0.402), septa (p = 0.904) and overpneumatization (p = 0.798) between the maxillary sinuses adjacent to the impacted third molar dental arch and the erupted third molar dental arch. However, there was a statistically significant difference in the frequency of accessory ostium (p = 0.032) and Haller cells (p = 0.025) between the maxillary sinuses adjacent to the impacted third molar dental arch and the maxillary sinuses adjacent to the erupted third molar dental arch.

Conclusion: In the present study, the frequency of accessory ostium and Haller cells in the maxillary sinuses adjacent to impacted third molar dental arches of the maxilla was found to be lower than in the maxillary sinuses adjacent to erupted third molar dental arches.

Keywords: Anatomical Variation; Maxillary Sinus; Third Molar Teeth.

INTRODUCTION

Maxillary sinus is the first developing paranasal sinuses, and with the eruption of third molars, the development is completed in approximately 20 years of age (1). The sinus floor is formed by the alveolar process of the maxillary bone and may be associated with the some teeth roots of the maxilla and with the sinuses that may have various sizes (2). Before extraction of the third molar teeth of maxilla, the anatomical localization of teeth must be determined in terms of surgical approach method and the risk of sinus perforation (3). An acute infection may develop after an asymptomatic period due to a third molar teeth displacement into the sinus as a result of perforation (4). Because of the risk of any infection that may develop in the future, the teeth displaced into the sinus should be surgically removed (5).

However, maxillary sinus pathology may develop before surgery. Some of the paranasal sinus anatomical variations may cause susceptibility to infection, or others may cause complications during surgery (6,7).It is stated that variations related to the maxillary sinus, the accessory maxillary ostium, and the Haller cells may cause sinusitis (7,8). Haller cell is also known as infraorbital ethmoid cell, located in the medial of the orbit base and originates from anterior ethmoid cells (9).It has an important role in mucociliary activity because it is involved in the lateral of maxillary infundibulum, for this reason, it may be predisposing for recurrent maxillary sinusitis (9). Accessory maxillary ostium is indicated that it may cause sinus infection due to the direct circulation of mucus into the maxillary sinus, which normally goes from the natural ostium to the nasal cavity (10). As an anatomical variation

Received: 11.01.2019 **Accepted:** 15.02.2019 **Available online:** 25.02.2019
Corresponding Author: Numan Dedeoglu, Inonu University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Malatya, Turkey, **E-mail:** dedenu@gmail.com

overpneumatization was defined as pneumatization of maxillary sinus more than normal (11,12). The clinical significance of this variation is indicated more about implant and endoscopic surgery (11,12).

In the literature, there are studies on impacted third molar teeth in the maxilla, which evaluate the relationship between the root tips of these teeth and the sinus (2,13, 14). However, in the presence of impacted third molar teeth in the maxilla, the pathologies and anatomical variations in neighboring maxillary sinuses were not evaluated in these studies.

The aim of the present study is to compare between the frequency of pathologies and anatomical variations in maxillary sinuses adjacent to impacted third molar dental arches of the maxilla and maxillary sinuses adjacent to erupted third molar dental arches using the cone-beam computed tomography (CBCT) records.

MATERIAL and METHODS

This retrospective study was approved by Inonu University Scientific Research and Publication Ethics Committee (2018/6-23).

In the present study, 284 maxillary sinus CBCT images of 178 patients were evaluated. Ninety of these 178 patients had the impacted third molars in the maxilla, and 88 of them had the erupted third molars in the maxilla. The study consisted of 19-30 years-old patients. In the patients, each half-maxilla dental arch was evaluated with the adjacent maxillary sinus.

All the walls of maxillary sinus, the teeth arches and alveoli bone from central teeth to third molar teeth were identified as working areas in each half-maxilla. CBCT images of patients with the presence of supernumerary teeth, teeth loss and deficiency, presence of implant and bone graft, presence of large pathologies such as cyst or tumor that disrupts the anatomy of the study area, preoperative surgery in maxillary sinus, presence of maxillary third molar teeth where apical foramen does not occur completely and syndromes or diseases affecting bone metabolism were excluded from the study.

The images of patients who applied for CBCT scanning for various reasons at Inonu University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology between 2011and 2018 were evaluated retrospectively.

Obtaining CBCT Images

The images obtained by cone beam technique using the NewTom 5G (Verona, Italy) CBCT device, which was operated as standard with 110 kVp and maximum 20 mA, were evaluated. During the CBCT scans, the patients were in the supine position. The scanning time was 18 seconds and the images with an 18×16 or 15×12 cm imaging area (FOV=field of view) were used. The voxel values of the images were 0.3, 0.25 and 0.2 mm.

Evaluation of CBCT Images

The CBCT images were evaluated by an experienced oral radiologist using the NNT (New NewTom) software. By examining especially coronal sections on multiplanar reformat images, the pathology of each maxillary sinus, septa, accessory ostium, over-pneumatization, third molar teeth root sinus relationship, other teeth root sinus relationship and the presence of Haller cells were recorded according to the maxillary sinuses adjacent to impacted and erupted third molar dental arches.

a)Identification of impacted third molar teeth in the maxilla: According to modified Archer (15) classification, if the third molar teeth are at the same level with the second molar occlusal plane of the lower tubercle peak, it is defined as the erupted teeth (class A). If the third molar teeth was placed on the second molar occlusal plane of the lower molar teeth or placed on the apical level of the second molar root tip or above the apical (class B, C, D), it was accepted as impacted teeth (Figure 1).

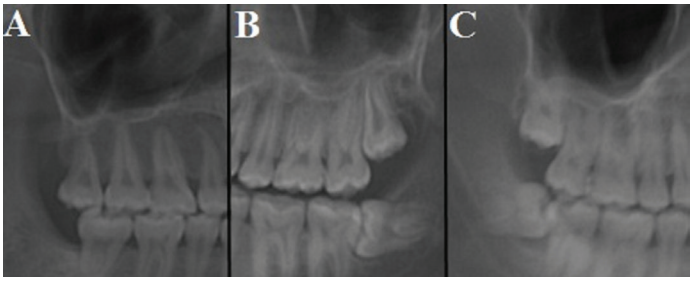

Figure 1. The erupted third molar teeth is shown at the same occlusal level (A) with the second molar teeth, while the impacted third molar teeth are shown below the second molar teeth occlusal level (B, C)

b)Identification of the relationship between the teeth roots and sinus: The roots of the teeth penetrating into the sinus is considered to be associated with the sinus, but the teeth whose root tips contacted with the sinus base and the teeth located in the alveolar bone below the sinus floor were considered to be not related with sinus (2) (Figure 2).

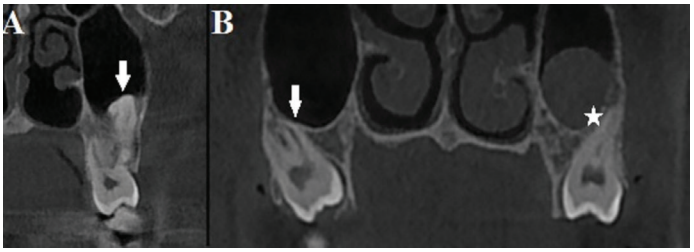

Figure 2. Third molar teeth root penetrating into the sinus (with arrow in A), teeth root contacting with the sinus base (with arrow in B) and teeth root away from the sinus base (with asterisk in B) are shown

c) Identification of Maxillary Sinus Pathologies:The retention cysts (16), which is the dome-like opacity in the maxillary sinus, mucosal thickening than 3 mm (17), and polypoid lesions (18) of sinus mucosa was considered to be pathology (Figure 3). Patient records showing large inflammatory lesions such as polyps, opacification, which are large enough to disrupt the sinus anatomy, were removed from the study.

d) Identification of Maxillary Sinus Septa: The cortical bone protrusion extending from the lateral or inferior sinus wall into the sinus was evaluated as septum (19) (Figure 4a).

e)Identification of the accessory ostium: In addition to the natural ostium, the extra ostium in the medial sinus wall was considered as accessory ostium (20) (Figure 4b).

f) Overpneumatization: The maxillary sinus pneumatization can expand into the hard palate in the infero-medial direction, into the lateral zygomatic bone, towards the posterior ethmoid cells (21). The maxillary sinuses extended into the zygomatic bone and into the end of the third molars of alveolar process in the hard palate were evaluated as overpneumatization (Figure 4c).

g) Identification of Haller Cells: Cells that develop in the medial of roof of the maxillary sinus and in the medial of the orbital sub-wall were evaluated as Haller cells (9) (Figure 4d).

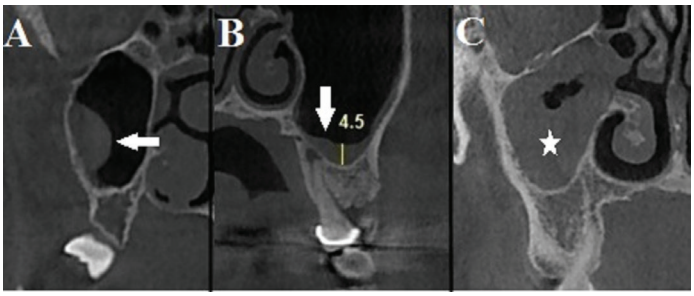

Figure 3. Retention cyst (with arrow in A), mucosal thickening greater than 3 mm (with arrow in B) and polypoid lesion (with asterisk in C) are shown

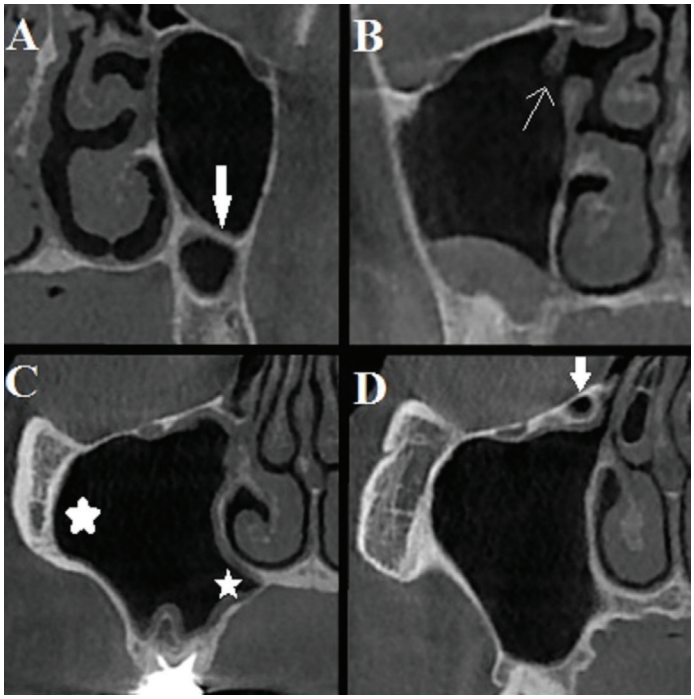

Figure 4. Septa (with arrow in A), accessory ostium (with arrow in B), overpneumatization (extending pneumaization to the hard palate and zygomatic bone) (with asterisk in C) and Haller cell (with arrow in D) are shown

Statistical analysis

The data obtained in the present study were analyzed with the IBM SPSS Statistics version 22 package software.

Shapiro Wilk's test was used for determining the normal distribution because of the unit number. The significance level of results was determined as 0.05; $p<0.05$ means that variables are not in a normal distribution, $p>0.05$ means that the variables are in normal distribution.

Pearson Chi-square analysis was applied while the relationships between the groups of nominal variables were analyzed.

When examining the differences between the groups, Mann Whitney U Test was used because the variables did not come from normal distribution.

When interpreting the results, 0.05 was used as the level of significance; there was a significant relationship in the case of $p<0.05$ and no significant relationship in the case of $p>0.05$.

RESULTS

In the present study, a total of 284 maxillary sinuses belonging to a total of 178 patients were evaluated, 128 of which (45.1%) were from 81 male patients, and 156 of which (54.9%) were from 97 female patients. In 90 patients with impacted third molar in the maxilla, 64 (45.4%) maxillary sinuses of 42 male patients and 77 (54.6%) sinuses of 48 female patients, were evaluated. In a total of 88 patients with erupted third molar in the maxilla, 64 (44.8%) maxillary sinuses of 39 male patients and 79 (55.2%) sinuses of 49 female patients, were evaluated (Table 1).

The range of the patients' age was 19-30 years, and the mean age was 24.09±2.85 years. The age range of the patients with impacted third molar teeth was 19-30 years, and the mean age was 23.8±2.95 years. The age range in patients with erupted third molar teeth was 20-30 years, and the mean age was 24.39±2.73 years (Table 2).

Table 1. There was no statistically significant relationship between groups and gender (p>0,05)

Gender	Maxillary sinus with impacted third molar	Maxillary sinus with erupted third molar	Chi-square test
	n(%)	n(%)	p
Female	48(54.6)	49(55.2)	0.914
Male	42(45.46)	39(44.8)	
Total	90(100)	88(100)	

Table 2. There was no statistically significant difference in age values between the groups. (p>0,05)

Age						Mann Whitney U Test
	n	Mean	Min	Max	SD	p
Maxillary sinus with impacted third molar	141	23.8	19	30	2.95	0.350
Maxillary sinus with erupted third molar	143	24.39	20	30	2.73	

Of the 284 maxillary sinuses, 96 (33.8%) were found to have pathology. While the frequency of pathology was found to be 36.2% in the group of maxillary sinuses adjacent to the impacted third molar dental arch, this value was found to be 31.5% in the maxillary sinuses adjacent to erupted third molar dental arches. No statistically significant difference was found between these two groups (p=0.402) (Table 3).

Table 3. Frequencies and statistical differences between groups in terms of pathology and anatomical variations are shown

Evaluated pathology and anatomical variations	Maxillary sinus with impacted third molar	Maxillary sinus with erupted third molar	Total n(%)	Chi-square test
	n (%)	n (%)	n:284(%100)	P value
Pathology	51(36.2)	45(31.5)	96 (%33.8)	0.402
Septa	20(14.2)	21(14.7)	41 (%14.4)	0.904
Accesory ostium	33(23.4)	50(35)	83 (%29.2)	0.032*
Over pneumatisation	60(42.6)	63(44.1)	123 (%43.3)	0.798
Teeth root sinus relation	94(66.7)	30(21)	124 (%43.7)	0.000*
Haller cell	34(24.1)	52(36.4)	86 (%30.3)	0.025*

Forty-one (14.4%) of 284 maxillary sinuses were found to have the septa.While the frequency of septa was 14.2% in the maxillary sinuses adjacent to impacted third molar dental arches of the maxilla group, it was 14.7% in the maxillary sinuses adjacent to erupted third molar dental arches group. No statistically significant difference was found between these two groups (p=0.904) (Table 3).

Accessory ostium was found in 83 (29.2%) of 284 maxillary sinuses. While the frequency of accessory ostium was 23.4% in the maxillary sinuses adjacent to impacted third molar dental arches, it was 35% in the group of maxillary sinuses adjacent to erupted third molar dental arches. When these two groups were compared, a statistically significant difference was found (p = 0.032) (Table 3).

Overpneumatization was found in 123 (43.3%) of the 284 maxillary sinuses. While the frequency of overpneumatization was 42.6% in the maxillary sinuses adjacent to impacted third molar dental arches, this value was found as 44.1% in the group of maxillary sinuses adjacent to erupted third molar dental arches. No statistically significant difference was found between these two groups (p=0.798) (Table 3).

In 124 (43.7%) of the 284 maxillary sinuses, there was a relationship between the third molar teeth root and the sinus. In the maxillary sinuses adjacent to impacted third molar dental arches, the frequency of the relationship between the teeth and the sinus was 66.7%, whereas this value was 21% in the maxillary sinuses adjacent to erupted third molar dental arches. When these two groups were compared, a statistically significant difference was found (p = 0.000) (Table 3).

In 116 (40.8%) of the 284 maxillary sinus, the relationship between the sinus and the other teeth roots apart from the third molar teeth was encountered. In the maxillary sinuses adjacent to impacted third molar dental arches, the frequency of the relationship between the other teeth roots and the sinus was 41.4%, whereas this value was 40.6% in the maxillary sinuses adjacent to erupted third molar dental arches. No statistically significant difference was found between these two groups (p = 0.1). However, the relationship between the sinus displaying overpneumatization and the other teeth roots apart from the third molar teeth was 78.9%, this value was found to be 11.8% in sinuses with normal pneumatization. Statistically significant differences were found between these two groups (p=0.000).

Haller cells were found in 86 (30.3%) of 284 maxillary sinuses. While the frequency of Haller cells was 24.1% in the maxillary sinuses adjacent to impacted third molar dental arches, this value was found to be 36.4% in the group of maxillary sinuses adjacent to erupted third molar dental arches. Statistically significant differences were found between these two groups (p=0.025) (Table 3).

DISCUSSION

The anatomical structures of the maxillary sinus are very important for dentistry applications (16). If the maxillary third molar teeth enter the maxillary sinus during teeth extraction, it must be surgically removed to prevent infection (22). It is useful to know the pathologies and anatomical variations of the sinus by dentists for such a condition or when the third molar teeth root is entered into the sinus due to the teeth extraction.

It is important to determine the anatomical variations, pathologies and the relationship between the third molar teeth and the sinus of the root through CBCT which is an important imaging method in dentistry (14,16).CBCT is close to Computed Tomography (CT) in terms of imaging quality of the maxillary sinus. It is also useful to display the bone tissue of the sinus with high resolution isotropic voxels at lower doses (23).

According to Som (24), there is no thickening of the sinus mucosa under normal conditions. Mucosal thickening of >3 mm is generally considered as pathological (17). The polypoid lesions of the maxillary sinus are known as mucus retention cyst and antrochoanal polyps (16). Mucus retention cysts are dome-shaped opacities occurred due to obstruction of mucus-secreting glands in maxillary sinus walls (16). Antrochoanal polyps are benign polypoid lesions of the sinus mucosa (18). Ritter et al. (25) studied on patients with the mean age of 44.19±20 years in the range of 8-107 years. In their study using CBCT, the incidence of total pathology in the maxillary sinus was 56.3%. In our study, the age range of the patients with impacted and erupted maxillary third molar teeth was 19-30, and the mean age was 24.09±2.85. Although the frequency of pathology in the maxillary sinuses adjacent to impacted third molar dental arches (36.2%) was

higher than the group of maxillary sinuses adjacent to erupted third molar dental arches (31.5%), no statistically significant difference was found between the two groups (p=0.402).

The presence of septa in the maxillary sinus leads to an increased risk of membrane perforation in the sinus lift (26).The development of such a perforation may cause acute or chronic sinusitis or cause bone resorption (27). Becker et al. (28) found that the incidence of septa was 7.1%, and Zijderveld et al. (29) found as 48%. In our study, the frequency of septa was found to be 14.4%. The frequency of septa in the group of maxillary sinuses adjacent to impacted third molar dental arches (14.2%) was similar to the group of maxillary sinuses adjacent to erupted third molar dental arches (14.7%), and no statistically significant difference was found between the two groups (p=0.904).

Accessory maxillary sinus ostium is one of the anatomical variations and may have a role in the development of chronic maxillary sinusitis (8). Yenigün et al. (8) encountered accessory maxillary sinus ostium in 19% of the patients with an average age of 36.21±15.50. In the same study, they found that the accessory maxillary sinus ostium was statistically higher in mucosal retention cyst, mucosal thickening,and maxillary sinusitis (8). Some researchers have indicated that the accessory maxillary sinus ostium may develop after acute maxillary sinusitis, but it is not known whether it is congenital or not (30). Ali et al. (7) found that the prevalence of accessory maxillary sinus ostium in patients with an average age of 37 (16-85) was 23.7%. In the same study, the relationship between accessory maxillary ostium and sinusitis was found to be statistically significant (7). In the present study consisted of 19-30 patients with mean age of 24.09±2.85 years, the prevalence of accessory ostium was 29.2%. The incidence of accessory ostium in the maxillary sinuses adjacent to impacted third molar dental arches (23.4%) was less than in maxillary sinuses adjacent to erupted third molar dental arches (35%) and there was statistically significant difference between the two groups (p=0.032).

The presence of overpneumatization clinically increases the risk of orbital perforation in endoscopic sinus surgery (12). Kalavagunta and Reddy (12) found the incidence of overpneumatization as 8%, and Pelinsari Lana et al. (16) found as 83.2%. In our study, the frequency of overpneumatization was 43.3%. In the maxillary sinuses adjacent to impacted third molar dental arches, the frequency of overpneumatization was 42.6% and in the group of maxillary sinuses adjacent to erupted third molar dental arches was 44.1% (p=0.798).

Knowing the relationship between the teeth root sinus is of critical importance in the treatment of third molar dental surgery and sinus pathology (14). Demirtaş and Harorlı (14)found the ratio of teeth root and sinus relationship as 73% (vertical type III+IV+V) using CBCT in patients with impacted third molar teeth. In our study, the frequency of dental root sinus in third molar teeth sinuses was 43.7%. In the maxillary sinuses adjacent to impacted third molar dental arches, the frequency of teeth root sinus (66.7%) was found to be much higher than the maxillary sinuses adjacent to erupted third molar dental arches (21%), and there was a statistically significant difference between the two groups (p=0.000). In the present study, the two groups with impacted and erupted third molar were compared, the relationship between the other teeth roots with the sinus was evaluated, and no differences were found between the two groups. However, when the relationship between roots and sinuses with overpneumatization and the other sinuses apart from the third molar teeth is evaluated, it was found a significant difference (p = 0.000). According to this result, the teeth root sinus relation was higher in sinuses with clinically overpneumatization.

In the literature, the Haller cell is described as an ethmoid cell in the orbital lamina of the ethmoid bone, under the orbital bulla, where the maxillary sinus ostium is opened (31,32). In our study, the Haller cell was considered as the maxillary sinus variation because the cell located in the maxillary sinus. When the Haller cells are expanded, they cause the narrowing of the osteomeatal complex and may be the cause of maxillary sinusitis (33). Capelli and Gatti (34) found the incidence of Haller cells to be 45.7%. In the same study, the association between Haller cells and sinusitis was not found to be statistically significant (34). However, Ali et al. (7) found the incidence of Haller cells as 36.3%. In the same study, the relationship between Haller cells and sinusitis was found to be statistically significant. In our study, the frequency of Haller cells was 30.3%. In the maxillary sinuses adjacent to impacted third molar dental arches, the incidence of Haller cell (24.1%) was less than the maxillary sinuses adjacent to erupted third molar dental arches (36.4%) and there was a statistically significant difference between the two groups (p=0.025).

CONCLUSION

As a result, the risk of sinus perforation may increase because the teeth roots had more relationship with the sinus in the patients with impacted third molar. In such a case, the incidence of pathology in the sinus was similar compared to those with erupted third molar teeth. Accessory ostium and Haller cell incidence as maxillary sinus anatomic variation was less in the patients with impacted third molar in the maxilla than in the patients with erupted third molars. In addition, the relation between the teeth roots and sinus was higher in maxillary sinuses with overpneumatization.

Competing interests: The authors declare that they have no competing interest.
Financial Disclosure: There are no financial supports
Ethical approval: This retrospective study was approved by Inonu University Scientific Research and Publication Ethics Committee (2018/6-23).

Numan Dedeoglu ORCID: 0000-0003-0892-3654

REFERENCES

1. Misch CE. Contemporary implant dentistry, 2nd edition. St.Louis: CV Mosby Co, 1999.

2. Kilic C, Kamburoglu K, Yuksel SP, et al. An assessment of the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using dental cone-beam computerized tomography. Eur J Dent 2010;4:462-7.
3. Rothamel D, Wahl G, d'HoedtB, et al. Incidence and predictive factors for perforation of the maxillary antrum in op-erations to remove upper wisdom teeth: prospective multicentre study. Br J Oral Maxillofac Surg 2007;45:387-91.
4. Killey HC, Kay LW. Possible sequelae when a tooth or root is dislodged into the maxillary sinus. Br Dent J 1964;21:73-7.
5. Patel M, Down K. Accidental displacement of impacted maxillary third molars. Br Dent J 1994;177:57-9.
6. Dedeoğlu N, Altun O, Bilge O, et al. Evaluation of anatomical variations of nasal cavity and paranasal sinuseswıth cone beam computed tomography. Nobel Med 2017;13:36-41.
7. Ali IK, Sansare K, Karjodkar F, et al. Cone-beam computed tomography analysis of accessory maxillary ostium and Haller cells: Prevalence and clinical significance. Imaging Sci Dent 2017;47:33-7.
8. Yenigun A, Fazliogullari Z, Gun C, et al. The effect of the presence of the accessory maxillary ostium on the maxillary sinus.Eur Arch Otorhinolaryngol 2016;273 4315-9.
9. Mathew R, Omami G, Hand A, et al. Cone beam CT analysis of Haller cells: prevalence and clinical significance. Dentomaxillofac Radiol 2013;42:20130055.
10. Matthews BL, Burke AJ. Recirculation of mucus via accessory ostia causing chronic maxillary sinus disease. Oto-laryngol Head Neck Surg 1997;117:422-3
11. Sicher H, Dubrul EL. Oral Anatomy, 3rd edition. St Louis:CV Mosby, 1975.
12. Kalavagunta S, Reddy KT. Extensive maxillary sinus pneumatization. Rhinology 2003;41:113-7.
13. Kruger E, Thomson WM, Konthasinghe P. Third molar outcomes from age 18 to 26: findings from a population-based New Zealand longitudinal study. 0Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;92:150-5.
14. Demirtas O, Harorli A. Evaluation of the maxillary third molar position and its relationship with the maxillary sinus: a CBCT study. Oral Radiol 2016;32:173-9.
15. Lim AAT, Wong CW, Allen JC. Maxillary third molar: patterns of impaction and their relation to oroantral perfora-tion. J Oral Maxillofac Surg 2012;70:1035-9.
16. Pelinsari LJ, Moura Rodrigues CP, deCarvalho M, et al. Anatomic variations and lesions of the maxillary sinus detect-ed in cone beam computed tomography for dental implants. Clin Oral Implants Res 2011;23:1398-03.
17. White SC, Pharoah MJ. Oral Radiology– Principles and Interpretation, 5th edition. St. Louis: MO Mosby, 2004.
18. Pruna X, Ibanez JM, Serres X, et al. Antrochoanal polyps in children: CT findings and differential diagnosis. Europe-an Radiology 2000;10 849-51.
19. Maestre-Ferrín L, Galán-Gil S, Rubio-Serrano M, et al. Maxillary sinus septa: a systematic review. Med Oral Patol Oral Cir Bucal 2010;15:383-6.
20. Na Y, Kim K, Kim SK, et al. The quantitative effect of an accessory ostium on ventilation of the maxillary si-nus. Respir Physiol Neurobiol 2012;181:62-73.
21. Lang J. Clinical Anatomy of the Nose, Nasal Cavity and Paranasal Sinuses , New York:Thieme Medical Publishers Inc 1989.
22. Durmus E, Dolanmaz D, Kucukkolbsi H, et al. Accidental displacement of impacted maxillary and mandibular third molars. Quintessence Int 2004;35:375-7
23. Ludlow JB, Ivanovic M. Comparative dosimetry of dental CBCT devices and 64-slice CT for oral and maxillofacial radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:106-14.
24. Som PM. CT of paranasal sinus. Neuro Radiol 1985;27:189-201.
25. Ritter L, Lutz J, Neugebauer J, et al. Prevalence of pathologic findings in the maxillary sinus in cone-beam computer-ized tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:634-40.
26. Vogiatzi T, Kloukos D, Scarfe WC, et al. Incidence of anatomical variations and disease of the maxillary sinuses as identified by cone beam computed tomography within the field of dental medicine. A systematic review Int J Oral Maxillofac Implants 2014:29:1301-14.
27. Abrahams JJ, Hayt MW, Rock R. Sinus lift procedure of the maxilla in patients with inadequate bone for dental implants. Radiographic appearance AJR Am J Roentgenol 2000;174:1289-92.
28. Becker ST, Terheyden H, Steinriede A, et al. Pro-spective observation of 41 perforations of theSchneiderian membrane during sinus floor elevation. Clin Oral Implants Research 2008;19:1285-9.
29. Zijderveld SA, van den Bergh JP, Schulten EA, et al. Anatomical and surgical findings and complicationsin 100 con-secutive maxillary sinus floor eleva-tion procedures. Journal of Oral and Maxillofa-cial Surgery 2008;66:1426-38.
30. Genc S, Ozcan M, Titiz A, et al. Development of maxillary accessory ostium following sinusitis in rabbits. Rhinology 2008;46:121-4.
31. Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope 1991;101:56-64.
32. Kennedy DW, Zinreich SJ. The functional endoscopic approach to inflammatory sinus disease: current perspective and technique modifications. Am J Rhinol 1988;2:89-96.
33. Stackpole SA, Edelstein DR. The anatomic relevance of the Haller cell in sinusitis. Am J Rhinol 1997;11:219-23.
34. Capelli M, Gatti P. Radiological Study of Maxillary Sinus using CBCT: Relationship between Mucosal Thickening and Common Anatomic Variants in Chronic Rhinosinusitis. Journal of Clinical and Diagnostic Research : JCDR 2016;10:07-10.