Dental CT images of maxillary sinuses in asymptomatic patients

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Abstract

Objectives : The purpose of this study was to evaluate the Dental CT image findings of the maxillary sinuses of the Thai asymptomatic patients at the Department of Radiology, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

Materials and methods : Dental CT images of 210 Thai patients without any signsand symptoms of the sinuses defects seeking for the dental implant placement during 2007-2010 were collected retrospectively and evaluated. All images were taken by P-mode imaging procedure and assessed by three observers in axial, coronal and sagittal planes. SPSS program and Chi-square Test were used for the statistic analysis

Results: The abnormal image findings of the maxillary sinuses were found in 158 sinuses of 104 patients. Thickening or mucositis of sinuses mucosa was the most frequent findings in 34.04%, fluid in the sinuses 1.67%, and mucous pseudocysts 1.43% respectively. An embedded tooth of the third upper molar and a fragment of bone grafting were found in two patients. Gender was significantly associated with these abnormal image findings as male more than female ($p \leq 0.05$)

Conclusion: About one-third of those asymptomatic patients in this study have shown the abnormal Dental CT image findings of the maxillary sinuses. Most of the findings were not seriously effected for the patients whom seeking for the implantations. Dental CT imaging is one of the valuable diagnostic tools to help the clinician to diagnose and suggest the patients to the appropriate care.

Key words: maxillary sinus, dental CT , cone beam CT

Introduction

Maxillary sinus is one of the critical structures of dentistry and medical sciences as it occupies a strategic position connected to nasal cavity and related indirectly to the oral cavity. It is therefore imperative that even the oral maxillofacial radiologist has to be well versed with the defects of maxillary sinus and there can be no escape from this additional responsibility (Patle et al 2010). Maxillary sinus is also the precaution area for the implant placement of the maxillofacial region. Conventional radiographs alone can only be shown in the two-D images of the sinus. Plain radiographs as panoramic and postero-anterior of maxillary sinus, all depict the details of maxillary sinus , but these radiographs have the excessive superimposition, inability to study all borders. Walls of the maxillary sinus including the mucosa can not be appeared with these radiographs (Jung et al 2007, Lyon et al 1973, Ruprecht et al 2009, Soikkonen et al 1995). Therefore it requires a diagnostic modality imaging which can enable the clinician and radiologist with sufficient information regarding the present and extent of defects for the best appropriate management. The multiplanar images acquired by computed tomography (CT) provide an opportunity for radiologists to inspect the entire volume of the acquired image and the anatomic variations and abnormalities that can be found in the image volume. It meets the demands

effectively and efficaciously. Considering all these factors one is compelled to accept the fact that not only is CT, a valuable tool in the field of maxillofacial radiology (Patle et al 2010).

Recently, dental computed tomography (dental CT) or cone beam computed tomography (cone beam CT or CBCT) was widely used in dentistry to evaluate the quantity and quality of the alveolar bone bone prior or after the implant placement. It can perform three-D images both of hard and soft tissue changes of the sinuses The same as medical CT. It is an alternative technique of medical CT to evaluate such the defects of the maxilofacial complex. The more advantage for dental CT is less radiation exposure dose, a vital time saving and safe compared to those medical CT or CT. However, this responsibility is frequently neglected when interpreting images of areas at a distance from the dentoalveolar region, such as the full anatomical aspect of the maxillary sinus (Ruprecht et al 2009).

Dental CT imaging machine was first introduced and implemented in Thailand in 2004 at the Department of radiology, Faculty of Dentistry, Chulalongkorn University. None of research regarding the dental CT image findings of maxillary sinus has been done or evaluated in Thailand before.

The purpose of this study was to evaluate the Dental CT image findings of the maxillary sinus of the Thai asymptomatic patients and to identify the occurrence of maxillary sinus abnormalities. The image findings as the frequency, type, location of the abnormal findings that related to the age group and gender were also included.

Materials and methods

Dental CT images of 210 patients without any sign and symptom of maxillary sinus defects seeking for dental implant placement were selected randomly and studied. The clinical findings were collected retrospectively from the files of the patients during 2004-2007 at the Department of Radiology, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand. The research protocol was approved by the Ethical Committee of the Faculty of Dentistry, Chulalongkorn University. All data of the patients included medical history about signs and symptoms of maxillary sinuses, physical examination. The dental history included previous tooth (teeth) extraction that related to the maxillary sinus, and previous dental treatments.All 210 patients had the radiographic examination with P-mode imaging procedure with CB Work program of the dental CT machine (CB Mercuray- Hitachi Company, Tokyo, Japan). The images of each patient were evaluated at the work station by using the same screens via the diagnostic computer monitor (Totoku Monochrome LCD Monitor ME355i2, Totoku Electric Co Ltd, Japan).

All cases of the patients were evaluated by two dental students at the same time under the guidance of one experience radiologist. Two dental students evaluated the images two times in a period of one month. The calibration among the two to view the images were made prior the study. The dental students were informed and recommended to review the anatomical structures of the maxillary sinus prior this study. All data of both right and left maxillary sinuses were evaluated in three different views as sagittal, axial and coronal planes. The defects of the maxillary sinuses were the configuration, contents, intact of the sinus wall, changes of the mucosa and foreign bodies. The criteria to measure the thickness of sinus mucosa was base on Ruprecht et al 2009 that indicated the mucosal lining about 1millimeter thick . Fluid level including the diameter of the cyst like lesion appeared in the sinuses were measured linearly line of three different views in the unit of millimeter with the function of CB Work Program. For the statistic analysis, SPSS program as Chi-square Test was used to evaluate correlations between those gender and age, $p \leq 0.05$ was considered to indicate significant different.

Results

Dental CT images of all 210 Thai patients with 123 female and 87 male patients including age group are summarized in Table1.The youngest patient was 21 years old and the oldest were 89.The mean age of the patients was 54 in male and 52 in female. The largest age group in this study was 51-60 years of age, followed by 41-50 and 61-70 years of age respectively.

The normal and abnormal findings of the maxillary sinuses related to the age group are shown in Table 2.The abnormal image findings of the maxillary sinuses mostly presented in the

age group of 51-60 years of age in 84 patients with totally of all age groups in 106 patients

The number of normal and abnormal image findings related to the gender in 210 patients have shown in Table 3. The abnormal image findings of the maxillary sinuses were found in 102 male patient sinuses and 56 female patient sinuses with the totally the abnormal image findings in both genders of in 158 sinuses (37.62%) .Significantly the male patients had more abnormal image findings than female patients. No significant difference of abnormal image findings was found between age group. Number and type of the abnormal findings appeared in the maxillary sinuses are shown in table 4.

Table 1 Number of the patients related to age group and gender (n=210)

Ages	Gender		Total
	Male	Female	
21-30	2	2	4
31-40	7	13	20
41-50	19	37	56
51-60	37	47	84
61-70	18	19	37
>71	4	5	9
Total	87(41.43%)	123(58.57%)	210(100%)

Table 2 Normal and abnormal image finding related to age group (n=21

Ages	Image findings		Total
	Normal	Abnormal	
21-30	1	3	4
31-40	9	11	20
41-50	27	29	56
51-60	45	39	84
61-70	18	19	37
>71	4	5	9
Total	104(49.52%)	106(50.48%)	210(100%)

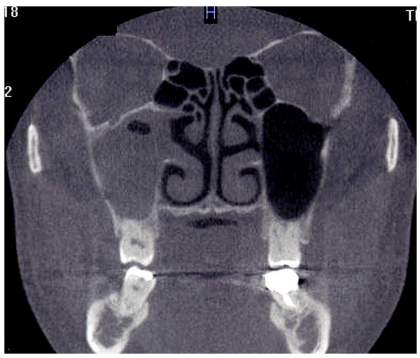
Table 3 Number of the normal and abnormal image findings presented in the maxillary sinuses relates to gender(n=420)

Image findings	Gender		Total
	Male	Female	
Normal	72	190	262(62.38%)
Abnormal	102	56	158(37.62%)
Total	174(41.43%)	246(58.57%)	420(100%)

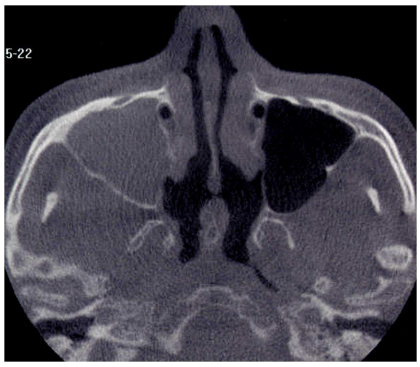
Table 4 Number and type of the abnormal findings appeared in the maxillary sinuses (n=420)

Abnormal findings	Side of the maxillary sinuses		Total
	Right	Left	
Thickening of sinus mucosa	69	74	143(34.05%)
Fluid level	2	5	7 (1.67%)
Cystic lesion	2	4	6 (1.42%)
Embedded tooth	1	-	1 (0.24%)
Foreign body	1	-	1 (0.24%)
Total	75 (17.86%)	83 (19.76%)	158 (37.62%)

Among those the abnormal dental CT image findings, thickening of the maxillary sinus mucosa or mucositis was the most frequent abnormal finding in 43.04% (Figure 1) followed by sinus fluid in 1.67% (Figure 2) and mucous pseudocyst in 1.43% (Figure 3) respectively. An embedded tooth of the upper third molar was found in one sinus (Figure 4) the same number as a disinfected fragment of bone grafting from the surgical procedure of the sinus lift or sinus augmentation (Figure 5). Most of the thickening of the sinus mucosa presented in the floor of the maxillary sinus. The average thickness of sinus mucosa thickening in three different planes was 17.90 millimeters. The average height of the fluid level in sinus measured from the coronal plane was 18.85 millimeters. Most of sinus pseudocyst also appeared in the floor of maxillary sinus the same as the thickening of the mucosa with the average and the diameter of 13.30 millimeters.



a



b

c

Figure 1. Dental CT images in three different planes (a-c) revealed thickening of sinus mucosa (mucositis) appeared in the maxillary sinus. Some cases the mucositis almost fulfilled within the sinus.

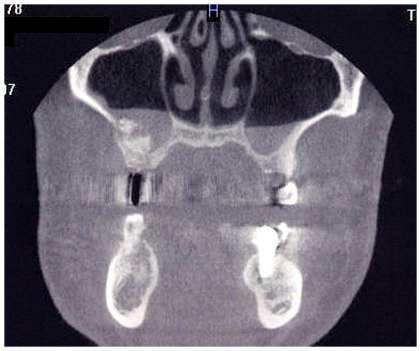


Figure 2. Dental CT image in the coronal plane revealed fluid level in both maxillary sinuses.

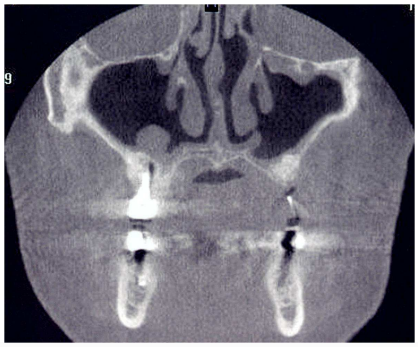


Figure 3. Dental CT image in the coronal plane revealed mucous pseudocyst in the left maxillary sinus.

Figure 4. Dental CT image in the sagittal plane revealed an embedded tooth in the left maxillary third molar appeared in the posterior wall of the sinus.

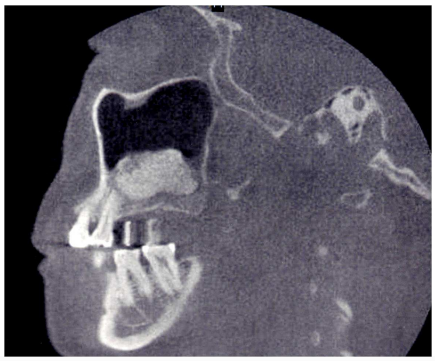


Figure 5. Dental CT image in the sagittal plane revealed bone gragting associated with the sinus lifted procedure of the left maxillary sinus.

Discussion

It has been widely accepted that the use of Dental CT imaging was one of the modality imaging techniques in recent years in terms of diagnostic imaging in dentistry. However, an interpretation of dental CT images requires familiarity with the anatomy of the area under investigation, an understanding of the spatial relationships of the image volume, a knowledge of the defects, anatomical variations and other

abnormalities which affect the maxillofacial region and that was very important when formulating a differential diagnosis (Carter et al 2008, Ruprecht et al 2009). Maxillary sinus abnormalities were highly prevalent in our male patient sample of asymptomatic patients. It was also shown that there was a statistic significance with these abnormal image findings in with a male bias, but no statistical significance between age groups. The prevalence of abnormal image findings was in concordance to the previous study of Rege et al 2012. Several studies have reported a great variability in the prevalence of incidental findings in the maxillary sinuses of asymptomatic subjects when multiplanar images are used. Medical CT scanning studies found abnormalities in approximately 30% of cases (Diament et al 1987, Havas et al 1988, Rege et al 2012) and CBCT studies reported a prevalence ranging from 24.60% to 68.30% (Carmeli et al 2011, Cha et al 2007, Scarfe et al 2006) In our study, we detected incidental abnormalities in 37.62% of the cases. That quite similar to the some studies (Carmeli et al 2011, Cha et al 2007, Ritter et al 2011) [7, 9, 36] and somewhat lower than the previous study (Scarfe 2006) [39] that found in 68.30%. These discrepancies in abnormality rates may be due to several factors, such as dissimilarities in the sampling criteria, variations in image interpretation and diagnostic criteria and influence of the climate among differences geographical areas (Bolger et al 1991, Diament et al 1987, Gracco et al 2012, Rege et al 2012).The most frequent abnormal image finding of the maxillary sinus in our study is the thickening of the sinus mucosa or mucositis in 34.05% that quite similar to the other studies (Carmeli et al 2011, Cha et al 2007, Jung et al 2007, Rodrigues et al 2009, Scarfe et al 2006, Soikkonen et al 1995) and higher than those previous studies by using conventional radiography. The average thickness of sinus mucosa thickening in three different planes of our study was 17.90 millimeters. The criteria to measure the thickness of the sinus mucosa was based on the previous study that indicated the mucosal lining of the paranasal sinuses are normally about 1 millimeter thick. Furthermore normal sinus mucosa is not visualized on radiographs; however, when the mucosa becomes inflamed from either an infectious or allergic process, it may increase in thickness 10 to 15 times, which may be seen radiographically (Chong et al 1998).[11] In addition, there is no consensus in the literature on the amount of mucosal thickening considered abnormal. Some studies have suggested measurements ranging from 2 to 6 millimeters (Chen et al 1999, Havas et al 1988, Obayashi et al 2004, Vallo et al 2010). Incidental findings such as mucosal thickening can be associated with some kind of irritation, such as odontogenic pathology or allergic phenomena (Vallo et al 2010). Nonvital posterior maxillary teeth, periodontal abscesses, retained roots, embedded or impacted teeth, extensively carious teeth and oro-antral fistula could be etiological factors in pathologies of odontogenic origin (Chen et al 1999). Restorative dentistry as endodontic treatment and implantation may be the factors that cause the thickening of the sinus mucosa reported in some literatures (Gordts et al 1997, Jung et al 2007). The mucositis may occur from chronic periodontitis of the maxillary teeth but it can be relieved after the periodontal therapy (Conner et al 2000, Engstrom et al 1988, Falk et al 1986).A dental CT examination of the maxilla anatomy is commonly requested to evaluate the need of a surgical sinus lift for implant placement in the posterior maxilla. However, when mucosal thickening is observed at the maxillary sinus floor, it is unclear if this finding lacks clinical significance or is an important clue for sinus dysfunction and a higher risk for sinusitis and augmentation failure. In these circumstances, the dental surgeon frequently asks for the advice of an ENT specialist. Unfortunately, for both professionals there is no available data to predict sinus function by the degree of mucosal thickening (Havas et al 1988). This abnormality is frequently investigated in exams for implant treatment planning. The presented of straight lined level opacification considered as the air-fluid level of maxillary sinus were found in 1.67 % in our study. However, this kind of opacification can also be found in abnormalities other than sinusitis, such as mechanical trauma, barotraumas and hemorrhage (Moskow 1992). The question of whether a radiographic fluid level within the maxillary sinus (radiographic sinusitis) represents a true pathologic process can be perplexing clinical issue, especially in the obtunded patient (Madani et al 2009).[28] It is possible to confirm the one is viewing an air-fluid interface by tilting and making another radiograph. This changes the orientation of the fluid level, which eliminates any doubt as to its fluid nature. However, when attempting to verify this, sufficient time should be allowed between the first and second exposures for the fluid level to change (Chong et al 1998). In addition, a final diagnosis of sinusitis may also be considered when clinical signs and symptoms are present and such factors were not evaluated in this study. Mucous retention cysts or retention pseudocysts were found in 1.43%. This result is lower than

the other studies (Barsley et al 1984, Cha et al 2011, Gardner 1984, Gardner et al 1986, Hadar et al 2000, Julian 1999, Scarfe et al 2006) Pseudocysts were diagnosed as homogeneous, dome-shaped, non-corticated soft tissue opacities with a smooth and well-defined outline in the maxillary sinus (Chong et al 1998). These pseudocysts usaully form on the floor of the sinus, although some may form on the lateral walls or the roof. They may vary in size from that of a fingertip to completely filling the sinus. For the meaurement, the diameter of pseudocysts in our study varied from 8.20 to 18.40 millimeters with the average diameter of 13.30 millimeters and most of them presented on the floor of the sinus with the few exception two presented on the lateral wall. The maxillary sinus pseudocyst usually persists unchanged or disappears for no apparent reason. The treatment of this condition is not necessary because the lesion is limited in growth and not destructive (Barsley et al 1984, Chong et al 1998, Gardner 1984 .Gardner et al 1986, et al 2000, Julian 1999). The teeth adjacent to the sinus pseudocyst should be thoroughly evaluated and any areas of odontogenic infection should be eliminated. If the diagnosis is questionable, or if symptoms are present, the patient should be referred to an ear, nose and throat (ENT) specialist for evaluation. The patient with a sinus pseudocyst should be informed that the lesion is present and be reassured concerning the benign nature of the lesion. Because the majority of pseudocysts regress spontaneously, periodic radiographic examination can be used to follow the lesion. In case of the patents with sinus pseudocyst needed to have such implantation. There was a controversy about the implant placement with sinus augmentation in a sinus with pseudocyst. Even pseudocyst on the maxillary sinus has previously been a contraindication for sinus augmentation (Armstrong 1999) but there were some reports presented the successfulness of surgical procedure of sinus augmentation in a patient with sinus pseudocyst (Mardiger et al 2007, Ziccardi et al 1999). So the decision for such this procedure for the clinician has to be considered in order to prevent the complications after the surgical treatment and some special factors related to the surgery are being concerned.Our study is also found one ectopic upper third molar at the posterior wall of the sinus. This finding is very rare compared to those other impacted teeth found in the mandible and maxilla. There was no report of clinical sign and symptom of this patient, the following check up and appropriate management of this patient should be planned. Ectopic tooth eruptions in maxillary sinus are usually asymptomatic and found incidentally during routine clinical or radiological investigation. Facial pain, epistaxis, purulent rhinorrhoea, headache, swelling and epiphora related nasolacrimal duct obstruction can also be seen (Tang et al 2011).Furthemore, there were the complications associated with the ectopic eruption of the third molar will lead to develop maxillary sinusitis, odontogenic cyst such as dentigerous cyst or in some severe cases will turn to be benign odontogenic tumors (Beriat et al 2011, Chong et al 1998, Felice et al 1995, Mohan et al 2011). The occurrence of an ectopic tooth in the maxillary sinus and association of a dentigerous cyst with it is a rare phenomenon and may be asymptomatic initially with clinical manifestations, in some patient the adjacent structures may be affected. Ectopic teeth within the maxillary sinus are often removed via a Caldwell-Luc procedure.(Beriat et al 2011, Felice et al 1995, Kasat et al 2012, Mohan et al 2011, Tang et al 2011) In our study, sinus augmentation with bone graft was found in one patient and revealed as normal image finding. Perforation of the sinus membrane during sinus augmentation procedures is the most common complication reported, with an incidence rate of approximately 30% (Barone et al 2006, Becker et al 2008, Hernandez-Alfro et al 2008, Pjetursson et al 2008, Wang et al 2009). In many patients, sinusitis develops secondary to iatrogenic sinus membrane perforation. When the perforation occurs, bone graft particles that advanced through the oral flora could migrate into the sinus. However, sinusitis is caused by only a small portion of iatrogenic perforations. A long term follow up and radiographic examination prior and after sinus augmentation with implant placement is recommended in order to avoid such the complications.

Conclusion

The occurrence of abnormalities in the one-third of the maxillary sinuses in asymptomatic Thai patient emphasizes how important it is for the maxillofacial radiologist to undertake a comprehensive interpretation of the sinus. Even Dental CT image findings in our study have shown there were no serious effects But there were incidental abnormal findings. The clinician has to select the appropriate imaging technique to help the diagnosis of the maxillary sinus in conjunction with clinical signs and symptoms. Furthermore, Dental CT imaging is one of the valuable diagnostic tools to help the clinician to

diagnose and suggest the patients to have such the appropriate care.

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