

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 signs and 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 one patient each. 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 seeking implantations. Dental CT imaging is one of the most valuable diagnostic tools to help the clinicians diagnose and suggest the patients to the receive appropriate care.

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

Introduction

Maxillary sinus is one of the 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 the oral maxillofacial radiologist be well versed with the defects of maxillary sinus (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 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 clearly resolved with these radiographs (Jung *et al* 2007, Lyon *et al* 1973, Ruprecht *et al* 2009, Soikkonen *et al* 1995). Therefore, it requires a diagnostic imaging modality 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 maxillofacial complex. The advantages for dental CT are less radiation exposure dose, a time saving and safety, when compared to medical CT.

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 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 radiographic examination with panoramic 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 experienced 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 the 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 recording 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 based on Ruprecht *et al* 2009 that indicated the mucosal lining of the paranasal sinuses are normally about 1 millimeter 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 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

Two hundred and ten Thai patients with 123 female and 87 male patients including age group are summarized in Table 1. The youngest patient was 21 year 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 patients sinuses and 56 female patients sinus with the total of abnormal images findings in both genders of 158 sinuses (37.62%). Significantly the male patients had more

abnormal image findings than the female patients. No significant difference of abnormal image findings was found between age groups. Number and type of the abnormal findings appeared in the maxillary sinuses are shown in table 4. Among 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 of 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 pseudo cyst 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.

Discussion

It has been widely accepted that the use of Dental CT imaging was one of the common 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 statistical significance with these abnormal image findings in with a male gender bias, but no statistical difference between age groups.

The prevalence of abnormal image findings in males 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) and somewhat lower than the previous study (Scarfe 2006) 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). 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 millimetres (Chen *et al* 1999, Havas *et al* 1988, Obayashi *et al* 2004, Vallo *et al* 2010). In cidental findings such as mucosal thickening ca be associated with some kind of irritation, such as odontogenic pathology or allergic phenomena (Vallo J *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). 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 usually 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 measurement, 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 patients 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 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). Furthermore, 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 association with dentigerous cyst 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 an abnormal 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 of asymptomatic Thai patients emphasizes how important it is for the maxillofacial radiologist to undertake a comprehensive interpretation of the whole volume 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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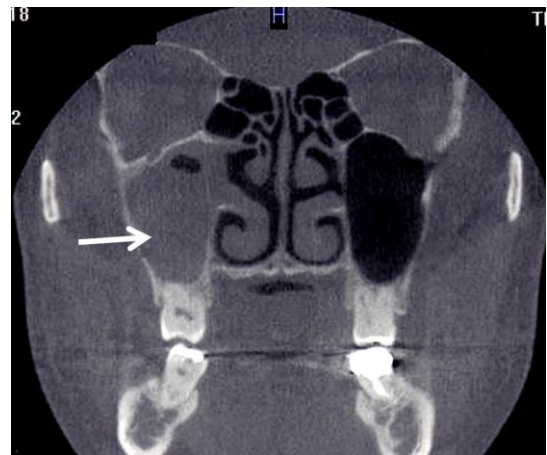


Figure 1a



Figure 1b

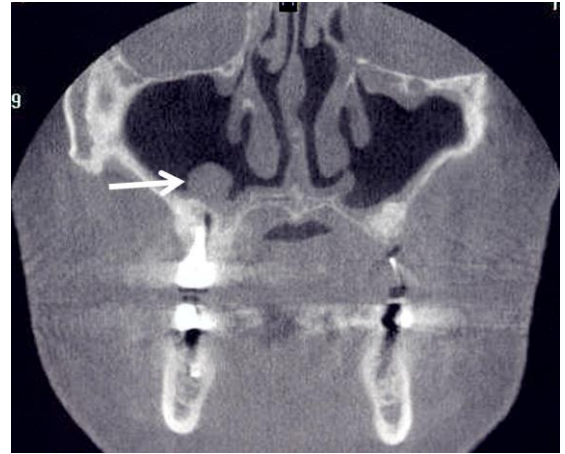


Figure 3

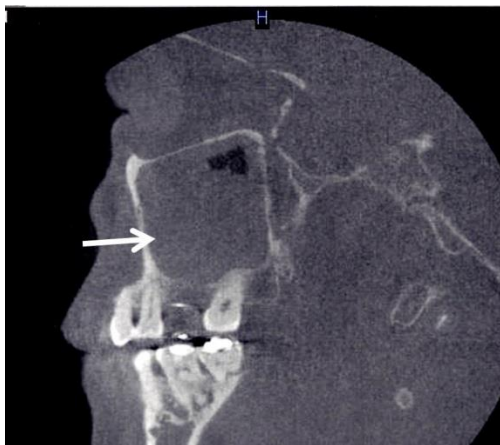


Figure 1c



Figure 4

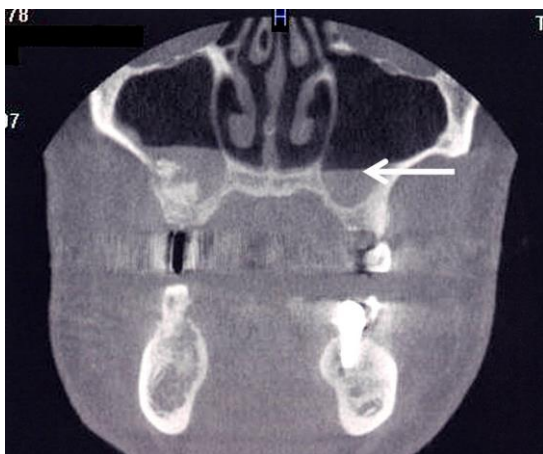


Figure 2



Figure 5

Legend of illustrations

- Figure 1. Dental CT images in three different planes (1a-1c) 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 grafting associated with the sinus lifted procedure of the left maxillary sinus.

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 findings related to age group (n=210)

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 related 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%)