CT Scan Evaluation of the Maxillary Sinus Pathologies: Intrinsic and Extrinsic

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INTRODUCTION
Maxillary sinus is at the crossroads of dentistry and otorhinolaryngology as it occupies a strategic position connected directly to nasal cavity and related indirectly to the oral cavity and maxillary alveolus. It is therefore imperative that even the oral maxillofacial radiologist has to be well versed with the pathologies of maxillary sinus and there can be no escape from this additional responsibility.

Conventional views such as PA Caldwell view, Water’s view, true lateral view and OPG, all depict the maxillary sinus, but these views have the drawback of excessive superimposition, inability to study all borders clearly, lack of clarity, absence of radiographic evidence of soft tissue involvement, etc. Therefore it requires a diagnostic imaging modality which can enable the clinician/radiologist with sufficient information regarding the presence and the extent of the lesion for deciding the surgical approach for the best required results and CT 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 our field of maxillofacial radiology but it has become a vital time saving, safe and painless investigation in the evaluation of maxillofacial complex. A total number of 25 patients of maxillary sinus pathologies (intrinsic and extrinsic) were included in the study and were subjected to detailed case history, clinical examination, conventional radiography and CT scan. The results obtained in our study are discussed and compared with other similar studies.

AIMS AND OBJECTIVE
The main motivation behind this study was to appreciate and to learn to interpret maxillary sinus and allied pathologies using this fascinating imaging modality with the following aims and objectives in mind.

• To study the changes in the maxillary sinus and associated structures in sinusitis cases on CT scan
• To study and to record the radiographic changes caused by cystic (intrinsic/extrinsic) pathologies of the maxillary sinus on the CT scan
• To study and to record the radiographic changes caused by various neoplasms (benign and malignant) originating in or involving the maxillary sinus, as seen on the CT scan
• To study the CT scan changes in and around the maxillary sinus caused by Fibro-osseous lesions
• To correlate between the CT scan findings and histopathological diagnosis.

MATERIAL AND METHODS
It was the desire of the operator to study and record CT scan changes in the maxillary sinus pathologies or pathologies of the allied structures. The study comprised of 25 patients who reported to the department of Oral Diagnosis, Medicine and Radiology, Government Dental College and Hospital, Mumbai.

Selection of Cases
• Those patients who had the complaint of pain, swelling and discharge and any other signs and symptoms in the maxillary arch were scrutinized.
• Those cases who showed clear cut clinical and radiographic signs and symptoms of maxillary sinus involvement or encroachment were only included in the study.
• The selection of the patients was done at random irrespective of age, sex, race, religion and socioeconomic status.

All the patients included in the study were subjected to detailed case history, thorough clinical examination with special

Abstract
The pathologies affecting the maxillary sinus and related structures namely cyst, tumors and infections become difficult to diagnose/localize due to the existing complex arrangement of various bone forming maxillofacial complex. CT has become an indispensable tool in the diagnosis of maxillary sinus pathologies. However, being a fairly recent technology, we (oral and maxillofacial radiologist) have not gained expertise in the interpretation of this fascinating imaging modality. Considering all these factors, one is compelled to accept the fact that not only is CT, a valuable tool in our field of maxillofacial radiology but it has become a vital time saving, safe and painless investigation in the evaluation of maxillofacial complex. A total number of 25 patients of maxillary sinus pathologies (intrinsic and extrinsic) were included in the study and were subjected to detailed case history, clinical examination, conventional radiography and CT scan. The results obtained in our study are discussed and compared with other similar studies.

Keywords: Maxillary sinus, CT scan, maxillofacial radiology.
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stress on antral pathologies. Nasal cavity of the patient also examined and when indicated, the help of ENT surgeon was sought to study the nasal cavity. After thorough and meticulous clinical examination a provisional diagnosis was made.

Radiographic Examination
It included IOPA radiographs and extraoral (PA Water’s view and orthopantomogram) to confirm or rule out maxillary sinus pathologies, involvement or encroachment. Water’s views were taken on Medico-imaging system, and OPG taken on ‘Planmeca Proline series 2002.

Only those cases that showed clear cut radiographic evidence of maxillary sinus involvement or encroachment were included in this study and were subjected to routine blood investigations. Patients who presented with signs and symptoms of infection were prescribed antibiotics, analgesics, mouth washes, and steam inhalation for a period of 5 to 7 days depending on the severity of the condition. After that, all the patients were subjected to CT scan examination after obtaining written informed consent.

CT Scan Examination
CT scan of the paranasal sinus was carried out at “CT and MRI center” at Sir JJ Group of Hospitals, Mumbai. CT scan was done with Siemens Somatom plus 4.

Preparation of the Patient
The patients were asked to remove outdoor coats in the gantry room along with dentures/appliances, wigs, earrings, hair pins and hearing aids if worn. There were also informed to be fasting 4 hours prior to scan to reduce vomiting.

Positioning of the Patient
Two reference base lines were used for positioning:
• A line drawn from outer canthus of the eye to the mid point of external auditory meatus.
• Reid’s base line: A line drawn from the lower border of the orbits to the superior border of the external auditory meatus.
• The maxillary sinus and other paranasal sinuses were scanned in two positions; Axial and Coronal.

For axial scanning, the patient’s head was moved inside the gantry and laser positioner was used to center the patient by coinciding the mid-sagittal plane with laser beam.

Patient was instructed to remain steady during the entire procedure of CT scanning. Pads were put next to the cheek to maintain stability during the scanning session and lead apron was used for the patient’s protection. After positioning the patient, his/her name, age, registration no and unit name was entered into the computer. Scanning was commenced after forming a scout view of the area under investigation.

For Coronal Scans
Patient was laid down in prone or supine position with head fixed or extended in such a way that beam falls perpendicular of the orbito-meatal line. Stabilization was achieved by using coronal head supports or existing table or shoulder support. Using similar protocol, thin slices were taken in coronal plane and documentation of images was done segment wise. After that, documented images from the monitor were sent to the digital camera at the automatic processor through fiberoptic cable. Images were focused on a CT scan films with the information were obtained.

Contrast Medium
Introduction of intravenous contrast media into the patient may enhance certain structures more clearly, e.g. vascular lesions. It is used effectively to find out the approximation to the vital structure and to decide if there are any low/high density areas within that organ. There is more tendency towards concentration of iodine in these vascular tumors highlighting the lesion.

Like all iodine based intravenous contrast agents, there is always a possibility of toxic effects; therefore the risk vs benefit factor must be carefully weighed by the clinician/radiologist.

Contrast medium used:

Adults: 76% urografin (sodium diatrizoate), Trivideo-400 (Sodium iodothalamate), Head and face scans–60 ml bolus, Neck scans 80 ml (40 ml bolus + 40 ml dynamic).

Children: 60% urografin (Trivideo 200) dose 1.5 to 2 ml/kg body weight.

The CT scan so obtained were studied in great detail and the findings were noted down under the heading in the proforma.

RESULTS AND DISCUSSION
A total number of 25 patients of maxillary sinus pathologies (intrinsic and extrinsic) were included in the study and were subjected to detailed case history, clinical examination, conventional radiography and CT scan. The findings were recorded in the proforma.

As the basic aim of this study was to record and to appreciate CT scan changes of pathologies in and around maxillary sinus, a wide spectrum of patients were included under different headings as shown in Table 1. As the total number of patients (total 25) is too small, no conclusion can be drawn about the prevalence of maxillary sinus pathologies however, in this study maximum number of cases seen were of cysts (extrinsic and intrinsic) followed by malignancies, sinusitis, benign tumors and fibro-osseous lesions.

Table 2 shows characteristic CT findings in 10 cases of cysts. Out of 10 odontogenic cysts encroaching on the maxillary sinus, most were radicular cysts (8) followed by dentigerous cyst and odontogenic keratocyst. As seen from the CT scan eight cases of cystic lesion showed persistence of corticated margin of the sinus. This is the general observation that, being slow growing lesion, is unlikely to cause a break in the continuity of central cortex and the same can be easily verified for all the borders of the Antrum using axial and coronal CT scan (Fig. 1). One of the two cases which did not show corticated margin was a radicular cyst of unusually large size and showing evidence of secondary infection (Infected radicular cyst).
second case was that of mucopyocele, which is a super infection of the mucocele, which is normally confined to the antrum but because of the severe infection has caused osteolysis of the posterior wall of the maxillary antrum. Displacement of the adjacent structures such as maxillary antrum and nasal cavity, etc was very well-appreciated in all cases of the cysts except in two cases of intrinsic cyst (Fig. 1). Calcification was not seen in any of the cases of cystic lesion except one. The solitary case which showed the calcification was that of mucopyocele which is known to show dystrophic calcification. Out of four cases studied association with unerupted teeth were seen in 3 cases of dentigerous cyst and 1 case of odontozenic keratocyst (OKC). Other remaining cysts did not show unerupted teeth were three radicular cysts and two were intrinsic cyst.

The radiographic findings on the CT scan observed in our study involving maxillary sinus are in general agreement with the findings of Alfred C Weber, Som PM and Bila Niuk LT.

Table 3 shows CT scan findings of malignant tumors involving maxillary sinus. Out of five patients studied four were of squamous cell carcinoma and one was of non-Hodgkin’s lymphoma. One patient was treated case of squamous cell carcinoma. All cases showed soft tissue mass density on the CT scan where as in one case which was a treated case of squamous cell carcinoma (postmaxillectomy), did not show the same as the CT scanning was performed to rule out recurrence. Bone erosion and extension in to the facial planes/spaces by the tumor mass was the finding in almost each case (Fig. 2). None of a case in our study showed lymph node involvement.
and new bone formation, whereas partial sinus opacification was observed in all cases except one which was a treated case. Four cases showed mild to moderate enhancement after injection of contrast medium (Fig. 2).

As stated by Lund VS in 1983,5 KW Seivers in 2000,6 Colin Parson7 and kondo M,8 malignant tumors (squamous cell carcinoma) on CT scan appears as a hyperdense, inhomogenous destructive soft tissue masses, breach in the continuity of the antral wall, extending into the adjacent fascial space and planes and mild to moderate enhancement.

Out of 5 cases included in our study, four cases showed findings similar to Lund VS in 1983,5 KW Seivers in 2000,6 Colin Parson7 and kondo M.8 As stated by Peter M Som,9 June M Unger10 and Anton N Hasso,11 the postoperative appearance of the antral cavity following resection of the malignancy depends on the interval between surgery and CT examination. During first 2 to 4 weeks after an operation, the surgical cavity may have irregular margins caused by healing and/or inflammation, 4 to 6 weeks postoperatively the margins should be smooth, and focal nodularity probably represents the occurrence of tumor or indicates fibrous mucosal scarring and is an indication for biopsy. The solitary case of postmaxillectomy showed a focal nodular mass, the patient was then referred back to oncology center.

Table 4 shows CT scan finding in sinusitis cases. Out of five cases, three presented with oroantral communication secondary to traumatic extraction. Mucosal thickening was seen in three cases where as air-fluid level was seen in all cases except one which was a case of fungal sinusitis (Fig. 3). Blocking of osteomeatal complex seen in four cases. Deviated nasal septum was the common finding except in one case where it was missing (fungal sinusitis) (Fig. 3). Two cases showed simultaneous involvement of sphenoidal and ethmoidal sinus. None of our case showed thickening of bony walls (sclerosis).

As stated by David M Yousem in 199312 and KW Sievers et al in 2000,8 CT scan findings suggestive of chronic sinusitis includes mucosal thickening/sinus opacifications, bone remodeling, polyposis, and bone thickening secondary to osteitis from adjacent chronic mucosal inflammation.

<table>
<thead>
<tr>
<th>CT Changes</th>
<th>Case No. 1</th>
<th>Case No. 2</th>
<th>Case No. 3</th>
<th>Case No. 4</th>
<th>Case No. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue mass</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Breach in the continuity of antral walls/erosion</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Extension into nasal cavity/other sinuses</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Extension into fascial spaces/planes</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Lymph node involvement</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Contrast enhancement</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Partial sinus opacification</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>New bone formation</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
As stated by David M Yousem in 1993 the deviated nasal septum and large paradoxical turbinates have been implicated as possible cause of middle meatus obstruction. The presence of air fluid level on CT scan of the sinuses is more typically associated with the acute sinusitis than other chronic inflammatory diseases.

All the three cases of benign tumors shows buccopalatal expansion and displacement of the antral walls (Table 5). Calcifications were observed in two cases and association with impacted tooth was seen in one case. It is difficult to differentiate on the basis of Hounsfeild unit between cystic fluid and soft tissue mass of benign tumor. If the cystic contents are very viscous it may show Hounsfeild value of soft tissue. Ability to determine the exact content of such lesion is probably the most important plus point of MR compared to CT scan. A case of Adenomatoid Odontogenic Tumor (AOT ) showed calcifications which were though to be because of calcifications in the amyloid material and a cementifying fibroma showed altered trabecular pattern.

As stated by Alfred C Weber CT findings of extrinsic benign tumor reveals a homogeneous, hypo to isodense soft tissue expansile lesion, complete opacification and extending into the adjacent structures but preserving fat planes. Our findings in 3 cases of extrinsic benign tumor are consistent with finding given by Alfred C Weber.

Table 4: Findings of sinusitis on the CT scan

<table>
<thead>
<tr>
<th>CT Changes</th>
<th>Case No. 1</th>
<th>Case No. 2</th>
<th>Case No. 3</th>
<th>Case No. 4</th>
<th>Case No. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oroantral communication</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Mucosal thickening/opacifications</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Fluid collection/soft tissue shadow</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Intact osteomeatal complex</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Deviated nasal septum</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Missing</td>
<td>–</td>
</tr>
<tr>
<td>Turbinate hypertrophy</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>Missing</td>
<td>+</td>
</tr>
<tr>
<td>Other sinuses involvement</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Thickening of bony walls of antrum</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 5: CT scan findings in benign tumor

<table>
<thead>
<tr>
<th>CT Scan Changes</th>
<th>Case No. 1</th>
<th>Case No. 2</th>
<th>Case No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue mass causing expansion of alveolar cotex</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Displacement of the antrum</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Extension to the adjacent structures</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Presence of calcification</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Association with unerupted teeth</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 6: CT scan findings in fibro-osseous lesions (fibrous dysplasia)

<table>
<thead>
<tr>
<th>CT Scan Changes</th>
<th>Case No. 1</th>
<th>Case No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bony cortex expansion</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Encroachment of the maxillary antrum</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Altered trabecular pattern</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Extension to other structures and bones</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Note for tables 1 to 6: ‘+’ indicates presence of findings and ‘–’ indicates absence of finding.

Out of 25 cases included in this study on case of intrinsic cyst was in a asymptomatic patient and 4 cases of sinusitis who opted for medical line of treatment and/or did not consent for biopsy. Hence histopathological report was not possible in these cases. One treated case of SCC of maxillary antrum, already had a biopsy report before being subjected to postoperative CT scan hence this case also was not included. In only one case, CT scan diagnosis was suggestive of dentigerous cyst whereas histopathological diagnosis was consistent with odontogenic keratocyst. CT scan analysis of the remaining cases suggested the following possible diagnosis, of cyst (9), benign tumor (3), malignant tumor (5) and fibrous dysplasia (2). These patients were subjected to biopsy and histopathological findings confirmed the CT scan evaluation. In our study, there was high degree of accuracy in the CT scan findings as correlated to histopathological findings.
CONCLUSION

- The CT scan findings of extrinsic cystic lesion was a well demarcated, hypodense expansile lesion, with persistence of corticated margin with clear cut displacement of adjacent anatomical landmarks.
- The CT scan findings of intrinsic cysts was that of a circular or dome shaped soft tissue mass without any change in the wall of the antrum unless it was extensive or infected (mucopyocele).
- CT scan plays a crucial role in depicting the extension of the lesion and its relation to adjacent anatomical structures in all possible directions.
- The CT scan appearance of maxillary sinusitis in this study was that of mucosal thickening, opacification, involvement of osteomeatal complex and the deviated nasal septum and turbinate hypertrophy.
- The CT scan appearance of malignancy presented as hyperdense, inhomogeneous soft tissue masses with erosion of the antral walls destroying and invading the adjacent structures such as nasal cavity, orbit, pterygopalatine fossa, other sinuses and extending into the adjacent facial spaces and planes with mild to moderate contrast enhancement.
- The extrinsic benign tumors in this study presented as homogenous, expansile lesion causing complete or partial opacification of the antrum, extending into to the neighboring structures but preserving the fat planes and may contain trabeculae, septae and calcification.
- The CT findings of fibrous dysplasia cases included in our study appeared as, a heterogeneously dense lesion, expanding the maxillary alveolus and extending into the antrum thereby reducing the air space. The trabecular pattern showed alteration resembling “ground glass” or “orange peel pattern”.
- CT scan evaluation of 19 cases subjected to histopathological examinations showed high degree of accuracy.

ACKNOWLEDGMENTS

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REFERENCES