Occurrence of benign tumors of the paranasal sinuses by computed tomography study in Karnataka

Dr. Chandan G1., Dr. Shwetha Ramu1,2.

1MBBS MD, Assistant Professor, Department of Radiology, Basaveshwara Medical College & Hospital, Chitradurga
2MBBS MD, Assistant Professor, Department of Pathology, Basaveshwara Medical College & Hospital, Chitradurga

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ABSTRACT
Background and Objectives: Diseases of the paranasal sinuses widespread, includes inflammation to neoplasms. These are in close anatomical relationship with head and neck viscera. Hence involvement of these viscera is an important feature. While conventional plain radiography is inaccurate and inadequate in the diagnosis of non-neoplastic and neoplastic conditions. CT imaging provides detailed information of the paranasal sinuses and is now well established as an alternative to standard radiographs. This study is also aimed at helping the otolaryngologist in deciding the management and surgical approach during FESS, thereby reducing the surgical complications.

Materials and Methods: In this study, 104 symptomatic paranasal sinus diseased patients were evaluated by clinical and CT (both axial and coronal sections) findings for the management of patients. All the patients underwent endoscopy or FESS following CT evaluation and findings were correlated.

Results: CT diagnosis had higher sensitivity, specificity, positive predictive value and negative predictive value in diagnosing anatomic variants of PNS, sinonasal polyps, and other neoplastic lesions in comparison to clinical diagnosis. Involvement of the bone by PNS lesions was always demonstrated by the CT, which is the standard imaging modality to demonstrate it accurately.

Interpretation and Conclusion: Benign neoplastic lesions are difficult to diagnose accurately on conventional plain films. CT imaging provides detailed information regarding involvement, location, extent of tumor accurately and is an excellent alternative to standard radiographs.

Key Words: Computed tomography (CT), benign tumors of the paranasal sinuses, Paranasal sinus (PNS), Functional endoscopic sinus surgery (FESS),

INTRODUCTION
Neoplasms of the Paranasal sinuses are widespread. Plain film is inaccurate and inadequate in the diagnosis of non-neoplastic and neoplastic conditions of PNS. Imaging of the PNS has progressed from the realm of conventional radiographs (plain films) almost exclusively into the realms of computed tomography (CT) and magnetic resonance imaging (MRI). Technological advances in these two imaging modalities have provided more precise differential diagnosis and greater detail about the anatomic extent of the diseases of PNS. These provide sufficient information for diagnosis and surgical planning in the PNS diseases.

CT has replaced conventional radiographs as imaging modality of choice for assessment of PNS diseases. CT plays an important diagnostic role in patients with sinonasal disease and determines the treatment. A complete axial and coronal CT scan series provides an excellent and comprehensive evaluation of PNS. Excellent details is available regarding the anatomy, anatomic variants and pathology of PNS.

CT excels over MRI at evaluating fine bone details, assessment of fibro-osseous lesions of PNS and sino facial trauma. It is now mandatory and a medico legal requirement to evaluate PNS and nose before FESS, as this provides a to guide the otolaryngologist during surgery and serves to direct the surgical approach.

NEOPLASMS OF PARANASAL SINUSES
Incidence: The incidence of tumors of paranasal sinuses is around 0.2%. They constitute 3% of cancers of upper respiratory tract. Among 5050 tumors of the upper respiratory tract reported by Asch et al from Armed Forces Institute of Pathology (U.S.A.), 530 cases
occurred in paranasal sinuses and nasal cavity. John G. Batakis observed that the incidence of carcinomas of paranasal sinuses is around 1% of all human malignancies.

Mass and Nectous (1986) reviewing the descriptive epidemiology of neoplasms of paranasal sinuses and nose noted that the highest occurrence is in Japanese population in whom unexplained excess risk is confined to maxillary sinus. Up to 80% of all paranasal sinus cancers arise in the maxillary sinus. Ethmoid sinus is uncommon. But osteoma occurs in this sinus more frequently than in any other sinuses. Sphenoid sinus has the least incidence of tumors.

Sex ratio: Average female to male ratio revealed by various reportsis 1:2 (F:M).

Predisposing factors:
Many theories have been suggested to explain the aetiology of tumors of paranasal sinus. Regarding the origin of osteoma, many theories are existing. Embryogenic, infectious, traumatic factors all account for its origin. A higher incidence among males favour a traumatic cause. Thus persistence of embryonal periosteum in areas where endochondrial and membrane bone meets would explain the frequency with which Osteomas occurring at the junction of ethmoid and frontal bones. Regarding the origin of inverted papilloma, viral aetiology was suggested by Jarvi (1994). Some extrinsic factors also suggested are atmospheric pollution, textile industries, steel factories etc. B. Majumdar (1984) reported high incidence (22%) of inverted papilloma among steel factory workers. The carcinogens suggested by James, Suen, and Cugen include.

Pathological Classification Of Tumors In Paranasal Sinuses
Benign tumors:
I. Epithelial tumors:
   1. Papilloma.
      Squamous papilloma
      Inverted papilloma.
   2. Adenoma.
II. Connective tissue tumors:
   • Fibroma. Osteoma.
   • Localized compact osteoma
   • Localized cancellous osteoma
   • Fibrous dysplasia. Angioma. Chondroma
   • Schwannoma, Neurofibroma
   • Myxoma
   • Giant cell reparative granuloma
   • Acinic cell tumor
   • Odontogenic tumors.

BENIGN TUMORS:
Epithelial tumors:
Papilloma (Fig 32): The commonest epithelial (Benign) tumors in the paranasal sinus and lateral wall of nasal cavity is the papilloma arising from schneiderian membrane, which is lining respiratory epithelium of nose and paranasal sinuses. Often behaving as a neoplasm, the schneiderian papillomas probably arise from a proliferation of reserve or replacement of cells located at the basement membrane of mucosa. This proliferation leads on to inverting, fungiform or combination of both growth patterns. Papilloma in the lateral wall may involve multiple sites, sinuses, floor and roof of nasal cavity and nasolacrimal duct and their association with squamous cell carcinoma is well documented. Other terminologies used for this papilloma are:
   1. Ringertz tumor.
   2. Inverted papilloma.
   3. Schneiderian papilloma.

Generally, they are bulkier and firmer than nasal polyps, but lack its translucency. They grow into architectural patterns. 1. Papillary and exophytic 2. Inverted, with an inwardly invaginating epithelial growth into underlying stroma. The later type is more often seen in lateral wall and sinuses. The predominant epithelial growth of the inverted form of papilloma is directed into underlying stroma instead of being a surface proliferation. The common sites of occurrence are: Lateral wall of nose - 68%. Ethmoidal and maxillary sinuses - 27% Sphenoid and ethmoidal- 5%.

Computed Tomography (CT):
They appear as soft tissue attenuation masses. Fungiform type nearly always arise from the nasal septum and are usually solitary and unilateral, and may have the typical irregular veracious surface. Unlike the inverted, fungiform papillomas are not considered premalignant. Inverted papillomas characteristically arise from the lateral nasal wall in the region of the root of the middle turbinate and may extend laterally into the paranasal sinuses, especially the maxillary sinuses and less commonly the ethmoid sinuses. Calcification may be seen in some cases.

Adenoma: Occurs in sinuses, but are rare. It remains capsulated, usually symptomless, but if they arise from the lateral wall of the nose it produces nasal obstruction.
CT: These are soft tissue masses of around 20-40 HU associated rarely with bone expansion, and on contrast
enhancement these tumors show well defined capsule, and no evidence of bone destruction seen.

**Connective tissue tumors:**

**Fibroma:** These are relatively benign lesions of connective tissue covered by hypoplastic epithelium. This tumor has no infiltrative or destructive capability and does not metastasize.

Imaging: Soft tissue mass which does not enhance with contrast, and walls of the sinuses are normal. No evidence of bone destruction is seen. No evidence of calcification or necrotic areas are seen.

2. Osteoma (Fig 31): 70% of the osteomas are in the frontal sinuses, 25% in ethmoid sinuses, and 5% in maxillary and sphenoid sinuses. Handuosa (1952) reported in 35 patients, and recorded the site of origin in relation to various skull bones as determined by the histological appearance of the tumor after removal. They may be: **Ivory:** Composed of hard compact bone.

**Spongy:** Where a cortical plate surrounds mature cancellous bone with a lamellar structure of a mixture of two osteomas, usually found as asymptomatic lesion in adults (15-35 years average) as an incidental radiological findings. Larger lesion may produce pain, and critically placed tumors may be associated with mucoceles. Local bone destruction from pressure can result in pneumocele, meningitis or brain abscess. These are very slowly growing and benign. Theories of origin include embryonal, infection and traumatic factors. Higher incidence is in males. Dive and Bussy (1962) recognized a triad symptoms consisting of soft tissue masses, bone lesions, and colonic polyps called Gardner's syndrome.

**Imaging:** Ossifying fibroma in its early stage appears to be solitary, cyst like and osteolytic, without a prominent periosteal reaction. At a later stage of maturation, lesions are radiopaque and surrounded by a uniform radiolucent rimming. Occasionally sclerotic border may separate the lesion from the adjacent normal bone. On CT scan non-homogeneity is due to regions of sclerotic bone alternating with less dense matrix.

**Chondroma and chondrosarcoma:**

Chondromas arise from primordial cell nests. They may develop at any site. But ethmoidal sinus is the most common location. Often asymptomatic and found incidentally, they may cause obstruction and disfigurement. A chondroma is seen well demarcated from surrounding tissue.

They are slow growing, and do not metastasize. But expansion with loss of bone, and malignant degeneration into chondrosarcoma may occur. Gross total excision is required.

Imaging: Ossifying fibroma or fibrous osteoma or osteofibroma: Ossifying fibroma is a benign, gradually expansile and fairly encapsulated tumor. This tumor was reported as early as in 1865 in British literature. More commonly occurs between 30-40 years of age with women more often than men are affected. The lesions usually arise in close proximity to the root of the teeth. The most commonly involved bone appears to be the mandible, with high affinity to the molar teeth. Tumor is well vascularized stroma containing various amounts of calcified materials. Calcification may appear as irregular bony structures and spicules. These are slow growing and non invasive, and do not metastasize.

**Imaging:**

Chondroma/chondrosarcomas are slow growing, but form destructive soft tissue mass lesions with radiologically characteristic amorphous calcification even on plain films. Sharply marginated lytic bone change with stippled calcification can mimic that of meningioma. On CT, chondromas have values that are similar to muscle, and shows densely calcified mass, often showing a whorled pattern (with central hypodensity) and capped by soft tissue mass that is not calcified.

**D. Inflammatory Polyps:** CT shows expansion of nasal fossa filled with soft tissue density polypoid masses. With central high density and peripheral rim of low attention. Sinuses also opacified with extension into orbits may be seen. Characteristically, bilateral involvement usually distinguishes it from malignancy.

**Angiofibroma (Jwamk nasopharyngeal angiofibroma)**

It is a benign vascular tumor occurring almost exclusively in pre-pubescent or pubescent males. It accounts for less than 0.05% head and neck tumor (waliman et al 1981). Its incidence being 1 in 50,000 (chandler et al, pharyngeal angiofibromas, staging and management, Anals of otology Rhinology Laryngology 93:323-320) Intracranial extension has been observed in 20-30% patients. These tumors are highly vascular and
non encapsulated polypoid mass that is histologically benign but highly aggressive. The triad of epistaxis, nasal obstruction and presence of a nasopharyngeal mass strongly indicates an angiofibroma.

Imaging: The site of origin of the tumor is thought to be the nasopharyngeal region at the pterygopalatine fossa or sphenopalatine foramen. Involvement of pterygopalatine fossa is seen in approximately 90% of patients as asymmetry in the size or widening of this structure, and an obliteration of the fat plane between the pterygoid plates and the back of the maxillary sinus. The tumor may extend anteriorly and superiorly into the maxillary sinus, nasal cavity, sphenoid and ethmoid sinuses, or superiorly into the cranial fossa through foramen rotundum and pterygoid canal through superior orbital fissure. Contrast enhanced CT examination reveals a polypoid and infiltrating, markedly enhancing mass that involves the nasopharynx without extension. On dynamic scanning they reveal intense early enhancement characteristic of highly vascular lesions. Ideally angiography should be performed to demonstrate the major feeding vessels which are more often the internal maxillary artery and ascending pharyngeal artery.

Figure 1: Anterior and Lateral view of Paranasal sinuses Fig 3 : Osteomeatal Unit : 1. Inferior turbinate, 2. Middle turbinate, INF-Infundibulum, M-Maxillary Sinus, F-Frontal sinus, U-Unscinate process, B-Bulla ethmoidalis, O-Maxillary sinus ostium, * - Frontal recess

Figure 2: Coronal and Axial CT images showing maxillary sinus. (Doted lines indicate maxillary sinus ostium)

METHODOLOGY
This study was a prospective study of 104 patients with disease of PNS. The study was done as per the mentioned Aims and Objectives.

Source of Data: The main source of data for this study was 104 patients referred from Department of Otorhinolaryngology, Department of Head and Neck Surgery, with clinically suspected paranasal sinus diseases. This consisted prospective correlational descriptive clinical study of 104 patients with pathological lesions of paranasal sinuses between 2008 to 2010.

Inclusion Criteria: Patients presenting with history of headache, nasal obstruction, nasal discharge, anosmia, postnasal discharge, epistaxis.
Exclusion Criteria:
1. All other lesions mimicking paranasal sinuses diseases.
2. Patients with maxillofacial / head trauma.
3. Pregnant women.
4. Children less than 5 years of age.
5. Psychiatric patients.
6. Non cooperative patients.

Method of collection of data:
After taking the detailed history and relevant clinical examination was done and they were referred to Department of Radio Diagnosis, they were evaluated with CT PNS (both coronal and axial CT series).
Diagnostic nasal endoscopy was carried out in most of the cases under general anaesthesia. Endoscopic sinus surgery: tailored according to the CT scan was carried out mainly concentrating on sinus drainage, collection of mucopus, destruction of bones. Any mass lesions were debrided or biopsy taken for histopathological examination and fungal culture in selected cases.
CT PNS findings were compared with endoscopic/ endoscopic sinus surgery findings. Statistical analysis was done using statistical software, Microsoft Word and Excel have been used to generate graphs, tables etc.
Sensitivity and specificity of CT findings were calculated using endoscopic/ endoscopic sinus surgery findings as standard with reference to mucosal thickening, polypoidal/mass lesions, involvement of adjacent bones and soft tissue.Finally clinical diagnosis was correlated with CT diagnosis using Chi-square test.

RESULTS
A prospective co relational descriptive clinical study of 104 patients who underwent CT PNS was done and correlated with the final diagnosis after FESS and HPR.

<table>
<thead>
<tr>
<th>HPR</th>
<th>Number (n=104)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflammatory polyp</td>
<td>32</td>
<td>30.8</td>
</tr>
<tr>
<td>Fungal sinusitis</td>
<td>8</td>
<td>7.7</td>
</tr>
<tr>
<td>Mucocele</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Angiofibroma</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Inverted papilloma</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Poorly differentiated carcinoma</td>
<td>1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Out of 104 patients, biopsy of 59 patients was sent for histopathological examination. Inflammatory polyps were most common (30.8%) followed by nonspecific inflammation (11.5%). The least common histopathological finding was malignancy (0.9%).

Graph 1: Histopathological Reports
DISCUSSION
In the recent past, it is accepted that CT is the best imaging method of demonstrating neoplasms in the paranasal sinuses. Previous studies have shown poor correlation of plain X-ray with CT. Plain films is unreliable and no longer routinely indicated for the evaluation of paranasal sinus disease. Clinical assessment be used to evaluate acute sinus infection and CT used for the investigation of persistent and chronic sinus disease refractory to medical therapy. CT evaluates the osteomeatal complex anatomy, which is not possible with plain radiographs. Removal of disease in osteomeatal complex region is the basic principle of FESS, which is best appreciated on CT scan.

CT and Endoscopy/FESS correlation:
Endoscopic findings were almost all correlated with CT findings except in fungal sinusitis. The findings of CT were similar to endoscopy/FESS findings in 99(95.2%) of patients and different in 5(4.8%) patients. All the false positive or false negatives are related to fungal sinusitis. Except the fungal sinusitis, sensitivity and specificity of CT was almost 100%.

On correlating CT diagnosis with final diagnosis, Polyps have sensitivity of 96.9% and specificity of 98.6%. For diagnosing benign lesions CT has 100% sensitivity, specificity, positive predictive value and negative predictive value with 100% accuracy. P value in all instances was < 0.05 i.e. <0.01, indicating the significance of the findings.

Thus, CT plays an important role in diagnosing and also adding important findings for the better management of the patients with paranasal sinus diseases.

BENING LESIONS OF PARANASAL SINUSES

![Image](image-url)

Figure 3: (a) Low attenuating soft tissue mass seen occupying the left frontal sinus with thinning of the walls but no erosion. (b) The lesion is seen extending into the anterior cranial fossa – CT features favours left frontal sinus MUCOCLE with extension into the anterior cranial fossa

![Image](image-url)

Figure 31: Left frontal sinus IVORY OSTEOMA
INVERTED PAPILLOMA

Figure 4: Isodense soft tissue mass occupying the right maxillary, right nasal cavity, right ethmoid sinus, right frontal sinus and right sphenoid sinus is seen. The lesion is enlarging the osteometal complex and is involving the right nasopharynx → CT features favor inverted papilloma.

CONCLUSION:
1. CT is the modality of choice in imaging the paranasal sinuses for evaluating the chronic diseases and associated complications.
2. CT is the modality of choice in evaluating the bone erosion or destruction.
3. CT evaluation of PNS in symptomatic patients helps in planning the further management of the patient.
4. CT helps in staging the PNS disease and its extension and involvement of surrounding structures.

Both CT and MRI with their unique features for better depiction bone details and soft tissue details respectively, carry their own importance and play a complimentary role to each other in identifying the pathological conditions of paranasal sinuses.

REFERENCES: