Cloud Publications
International Journal of Advanced Otolaryngology
2013, Volume 1, Issue 1, pp. 01-11, Article ID Med-69

Research Article | Open Access

Advance of CT Scan as an Important Imaging Tool in Evaluation of Nasal Polypoidal Masses

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Publication Date: 31 July 2013

Article Link: http://medical.cloud-journals.com/index.php/IJAOto/article/view/Med-69

Abstract This research is focused on to study the CT scan imaging profile of nasal polypoidal lesions and characteristic imaging features of different nasal polypoidal lesions. It studies the comparison between compare clinical and CT Scan Imaging diagnostic consistency in Non-neoplastic and neoplastic polypoidal lesions. A prospective non randomized study conducted over a period of 1 year. Fifty patients with unilateral or bilateral nasal polypoidal lesions were studied. Plain and contrast enhanced CT sequences of nose, paranasal sinuses, orbit and brain with 3-5mm thin slices of axial and coronal views were obtained on soft tissue and bone window settings. Unilateral involvement of sinuses was found in (50%) and bilateral involvement of sinuses was found in (48%) patients. Maximum soft tissue attenuation of 60-70HU was found in (48%) patients. Widening, ballooning or destruction of the osteomeatal complex was revealed in 100% of our patients while evidence of fungal disease with double density sign was present in (10%) patients. Intraorbital extension with destruction of lamina papyracea was found in (6%) and destruction of sinus wall with expansion or thinning was noted in (20%). Extension to the anterior cranial fossa via the cribriform plate and middle cranial fossa via the sphenoid sinus was found in (6%) cases each. Pressure erosion on the septum (4%) cases each. Comparison of clinical and radiological findings in our study showed that there were (82%) patients in whom the radiological findings were consistent with that of the clinical suspicion. However in (18%), there was a difference in opinion.

Keywords *Nasal Polypoidal Masses, Computed Tomography (CT) Scan Imaging, Radiology in Nasal Polypoidal Masses*

1. Introduction

Nasal polyposis is a relatively common condition found in 1-4% of the general population and in high percentage among some selected group of patients. The polyps are found in 36% patients with aspirin intolerance, in 7% of those with asthma, in 20% of those with cystic fibrosis and 2% of those with chronic rhinosinusitis [1]. The characteristic radiological changes of nasal polyposis are familiar to

ENT surgeons and radiologists. However in a proportion of patients, the changes are much greater and include widening of the ethmoid labyrinth and nasal cavity, widening, ballooning or destruction of Osteomeatal complex, destruction of the sinus wall with expansion or thinning, Intraorbital extension, extension to the anterior and middle cranial fossa and mucocoele formation. Radiographic evidence of thickened mucosa, sinus opacification, attenuation, bone remodeling, calcification, characteristic radiological signs (double density sign) and bone erosion helps to diagnose different diseases. These changes have not been well documented even though they occur quite frequently.

With this aim we carried out this study to know the CT Imaging profile of nasal polypoidal lesions, to study the characteristic imaging features of different nasal polypoidal lesions and compared clinical and CT Imaging diagnostic consistency in non-neoplastic and neoplastic polypoidal lesions.

2. Materials and Methods

The prospective non randomized study was conducted on patients of all ages and of either sex presenting with nasal polypoidal lesions in the Department of ENT, MGM Medical College and Hospital, Kamothe, Navi Mumbai for a period of 1 year. Fifty patients with unilateral or bilateral nasal polypoidal lesions were studied.

Patients included were:

a. Cases clinically and radiologically diagnosed as having unilateral or bilateral nasal polypoidal lesions
b. Patients with recurrent nasal polyps
c. Patients who had developed any complications due to sinonasal pathology

Patients excluded were:

a. Patients presenting with congenital masses
b. Patients presenting with nasal mass of intracranial origin

Radiological examination with CT scan (N.C.C.T.), P.N.S. axial, coronal and sagittal sections was done. C.T. scan with contrast was done in cases of recurrences and suspected vascular lesions. Plain and contrast enhanced CT sequences of nose, paranasal sinuses, orbit and brain with 3-5 mm thin slices of axial and coronal views were obtained on soft tissue and bone window settings. CT scans were then evaluated by senior radiologist. Patients did not undergo scanning during the active coexisting rhinosinusitis to avoid masking any underlying anatomic anomalies.

Demographic profile and relevant data was recorded in a standard proforma. Data was entered in SPSS version 11, a computer based software programme. Mean and standard deviation were computed for qualitative variables like age. Statistical test of significance were applied in this study.

3. Results

1. Radiological Profile of Nasal Polypoidal Lesions

Table 1(i): *Involvement of Sinuses by Nasal Polypoidal Lesions*

S. No.	Involvement of Sinuses	No. of Sinuses	Total
1.	Unilateral		
	Right	14	14
	Left	11	11
2.	Bilateral	24	24
3.	None	1	1

Table 1(ii): *Unilateral Involvement of different Sinuses by Nasal Polypoidal Lesions*

S. No.	Involvement of Sinuses	Right	Left	Total
	Unilateral			
1.	Maxillary	14	9	23
2.	Frontal	4	4	8
3.	Ethmoid	5	5	10
4.	Sphenoid	3	3	6
	Total	**26**	**21**	**47**

*Total includes multiple sinuses on unilateral side

Table 1(iii): *Bilateral Involvement of Different Sinuses by Nasal Polypoidal Lesions*

S. No.	Involvement of Sinuses	Total
	Bilateral	
1.	Maxillary	45
2.	Ethmoid	33
3.	Sphenoid	24
4.	Frontal	18
	Total	120

*Total includes multiple sinuses on bilateral sides

Bilateral sinus involvements were seen with Maxillary sinuses (45 in bilateral) the commonest involved sinuses followed by ethmoids (33 in bilateral).

Table 1(iv): *Soft Tissue Attenuation of Sinuses by Nasal Polypoidal Lesions*

S. No.	Soft Tissue Attenuation	No. of Patients
1.	0-20 HU	1
2.	20-30 HU	8
3.	30-40 HU	3
4.	40-50 HU	4
5.	50-60 HU	7
6.	60-70 HU	24
7.	70-80 HU	1
8.	80-90 HU	1
9.	>90 HU	1

Maximum soft tissue attenuation of 60-70HU was found in 24(48%) patients.

Table 1(v): *Radiological Findings of Nasal Polypoidal Lesions*

S. No.	Radiological Findings		No. of Cases	Percentage
1.	OMC	Widened	28	56
		Ballooned	20	40
		Destroyed	2	4
2.	Radiological signs	Pedicle sign	9	18
		Double density	5	10
		Ground glass appearance	3	6
3.	Intraorbital extension with expansion of the sinus		3	6
4.	Sinus wall expansion with thinning		5	10
5.	Destruction with medial wall of the maxillary sinus		5	10
6.	Extension to the anterior cranial fossa via cribriform plate		3	6
7.	Extension up to the middle cranial		3	6

	fossa via the sphenoid sinus		
8.	Parapharyngeal/Infratemporal	2	4
9.	Nasopharynx/oropharynx	3	6
10.	Pressure effect on the septum	2	4
11.	Destruction of the septum	4	8
12.	DNS	34	68
13.	Anatomical variation	5	10

Widening, ballooning or destruction of the osteomeatal complex was revealed in 50(100%) of our patients, while evidence of fungal disease with double density sign was present in 5(10%) patients. Intraorbital extension with destruction of lamina papyracea was found in 3(6%) and destruction of sinus wall with expansion or thinning was noted in 10(20%). Extension to the anterior cranial fossa via the cribriform plate and middle cranial fossa via the sphenoid sinus was found in 3(6%) cases each. Pressure erosion on the septum 2(4%) cases each.

2. Comparison of Clinical and Radiological Findings

Table 2(i): *Comparison of Clinical and Radiological Findings in Non-Neoplastic Polypoidal Leisons (N=40)*

S. No.	Clinical Diagnosis	No. of Patients	Radiological	No. of Patients	Total Consistent	Total Inconsistent
1.	Sinonasal polyps					
	Ethmoidal polyps	25	Sinonasal polyps	21	21	
			Other Diagnosis			
			Invasive Fungal polyp	1		1
			Inverted papilloma	1		1
			Chronic Sinusitis	1		1
			Mucoperiotseal thickening with Chronic sinusitis	1		1
	Antrochoanal polyps	6	Antrochoanal polyp	6	6	
	Allergic fungal poyps	6	Allergic fungal polyps	4	6	
			Invasive fungal polyps	2		
2.	Rhinoscleroma	1	Wegener's granuloma	1	1	
3.	Rhinosporidiosis	1	Granuloma	1	1	
4.	Mucocele	1	Frontoethmoidmucocele	1	1	
	Total	**40**		**40**	**36**	**4**

Table 2(ii): *Comparison of Clinical and Radiological Findings in Neoplastic Polypoidal Leisons (N=10)*

	Benign					
1.	Inverted Papilloma	1	Invasive polyp/malignancy	1		1
2.	Angiofibroma	1	Angiofibroma	1	1	
3.	Haemangioma	1	Granuloma	1	1	
4.	Olfactory neuroblastoma	1	Fibrous dysplasia	1		1
	Malignant					
1.	Malignancy of the maxilla	5	Well differentiated Squamous cell Carcinoma of the nose	3	3	

			and Paranasal sinus			
			Invasive Sinonasal malignancy	1		1
			Sinonasal polyposis	1		1
			Inverted papilloma	1		1
2.	Lymphoma	1	Papilloma	1		1
	Total	**10**		**10**	**5**	**5**

Comparison of clinical and radiological findings in our study showed that there were 41(82%) patients in whom the radiological findings were consistent with that of the clinical suspicion. However in 9(18%), there was a difference in opinion. This difference was statistically significant (p value <0.001).

Out of 40 patients with clinically non-neoplastic benign polyps, consistent radiological findings were given in 36(90%) patients. Of the 10 patients with clinically neoplastic lesions, similar radiological opinion was given in 5(12.5%) patients. This difference was also statistically significant (p value <0.0001). Clinically suspected 6 cases each of Antrochoanal and Allergic fungal polyps were diagnosed in all 6(100%) cases radiologically.

4. Discussion

CT appearance of nasal polypi appears as rounded bodies of soft tissue arising from the mucosal surfaces of nose and paranasal sinuses as shown in Figure 1. They can be clearly differentiated from the surrounding inflamed mucosal lining and nasal secretion as they are more radiodense and appear brighter. Most polyps have a mucoid attenuation (10-18HU) on CT [2]. Rarely a pedicle attaching the polypoidal mass to the nasal mucosal lining can be seen in the CT scan (pedicle sign). Nasal polypi never cause bone erosion. Pressure effects of nasal polyp can be evidently seen in imaging. These effects include local bone remodeling causing a scalloping effect. Nasal polypi don't show enhancement on injection of contrast media.

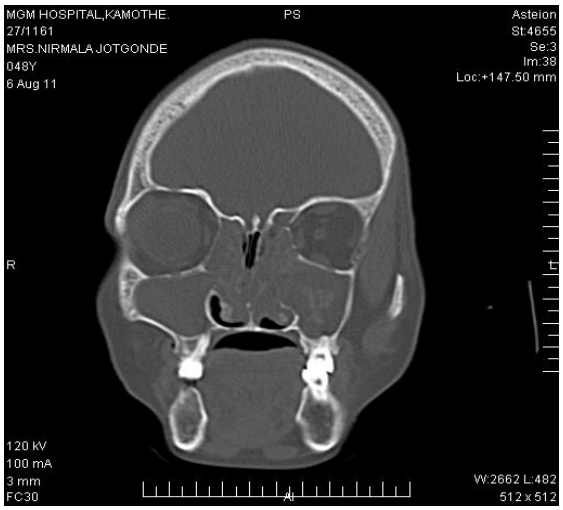

Figure 1: *Soft Tissue Attenuation of 60-70HU Suggestive of Polyps on Bilateral Maxillary, Ethmoid and Frontal Sinuses with Extension in the Nasal Fossa*

Ethmoidal polyps arising from the ethmoidal sinuses are multiple. They can be visualized in the CT as multiple polypoid lesions. In a proportion of patients the changes are much greater and include widening of the ethmoid labyrinth, bone thinning and expansion, and mucocele formation [3]. Widening, ballooning or destruction of osteomeatal complex was noted in 36.36% in the study by Abid

R., et al [4]. Similar findings were reported in 34.6%, 30% and 12% in the study by Agarwal S., et al., Thahim K., et al. and Mukherji S.K., et al. respectively [5, 6, 7]. Several studies have quoted the incidence of bony erosion with spread of pathology into the adjacent anatomic areas as 20% [8].

In the radiologic literature, the ACP has been largely ignored. Radiologically it appears like a dumbbell because of the constriction at the ostial exit point. The medial wall of the maxillary sinus bows into the nasal cavity clearly visualized on CT.

Sphenochoanal polyps are less frequent than antrochoanal polyps, although they may have been underdiagnosed in the past, due to the use of plain X-ray, which cannot determine from which sinus the choanal polyp originates [9]. CT examination demonstrates the origin of choanal polyps and eliminates the risk of a wrong sinus being opened. CT is an essential tool in this task.

In mucocele the affected sinus is completely opacified, and the margins expanded and usually thinned as shown in Figure 2. Areas of complete bony resorption may be present resulting in bony defect and extension of the mass into adjacent tissues. The content of the sinus is variable, depending on the degree of hydration, ranging for near water density, to hyperdense as secretion become increasingly thick and dehydrated.

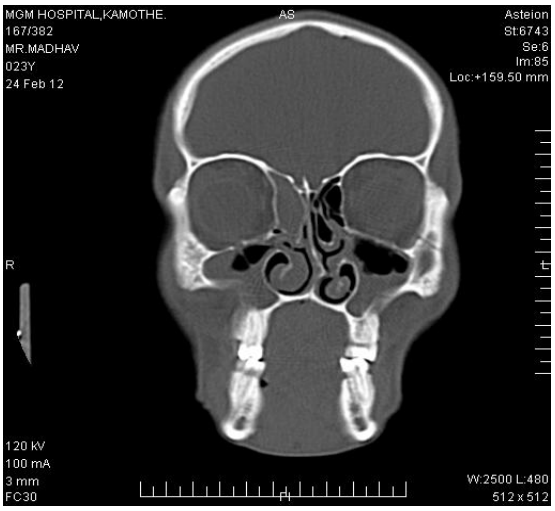

Figure 2: *Soft Tissue Attenuation Mass of 70-80 HU Suggestive of a Mucocele in Right Frontal and Anterior Ethmoid Sinuses*

The allergic fungal polyps are the most correctly diagnosed radiological condition. The unenhanced CT scan shows the characteristic heterogenecity of density within the involved sinus, which has been given many names such as the ‘starry-sky’, ‘ground glass’ or ‘serpiginous’ patterns, but commonly referred to as ‘double density’ sign, as revealed in Figure 3. This by far describes this typical radiological appearance the best [10]. This is due to the high percentage of hyperdense signal in the sinus cavities (caused by calcium salts). Fungus with double density sign was found in 34.54% patients in the study by Abid R., et al. [4].

Figure 3: *Soft Tissue Attenuation of 60-70HU Suggestive of Polyps in Left Maxillary, Ethmoid and Fronta Sinuses with Characteristic Heterogenecity of Density within the Involved Sinus, Which Has Been Referred to As 'Double Density' Sign*

Intrasinus calcification on CT with aspergillosis is characteristic feature of fungal sinusitis and is present in 60-77% of cases. Calcification in fungal cases is primarily centrally located in the maxillary antrum, whereas the calcification in non fungal cases is usually peripheral, near the wall of the maxillary sinus. Other CT features of fungal sinusitis include bone change of sinus wall, a focal mass with increased density in the sinus, and infiltration of adjacent soft tissue or bone destruction in the case of invasive fungal sinusitis.

Sinus mycetoma may cause a focal area of increased attenuation that is usually centered within a diseased sinus. In diagnosing sinus fungus balls with CT scanning, a high index of suspicion is necessary and pathologic confirmation is mandatory, according to a study by Dhong et al. [11]. The investigators found that the sensitivity of CT evaluation of fungus balls was 62%, and specificity was 99%.

The radiologic features of Juvenile Nasopharyneal Angiofibroma are 1) a large soft-tissue mass in the nasopharynx extending into the areas of the pharyngeal structures 2) anterior bowing of the posterior wall of the maxillary antrum of the involved side, best seen on lateral projection 3) bony erosion of contiguous structures. Kania et al. investigated the diagnostic accuracy of contrast-enhanced CT to detect residual disease after surgical excision of JNAF [12].

CT scanning is the initial modality of choice to evaluate the extent of disease in Inverted Papillomas. The changes on CT scanning are distinctive but not pathognomic and include a unilateral polypoid mass enlarging the nasal fossa and usually displacing the nasal septum. Calcification within the mass due to trapped bone is evident in 4% of such scans and may be associated with bone erosion due to pressure atrophy (not malignancy) in up to 50% of cases. Bony erosion can be present with IP in as much as 44%, but raises concern over potential malignant change [13].

In Rhinoscleroma on CT scan the nose is frequently invaded. Characteristic lesions are homogenous with well-defined borders and without enhancement [14]. Lesions varying from localized mucosal thickening to obliterative soft tissue extending from the septum to the lateral wall, opacification of sinuses and in extreme cases bone and cartilage involvement may also be present.

Non-specific mucosal thickening or antral opacification are typical early features in Wegener's granuloma, followed by nasal septal thinning and granulomatous ulcerated change. Bony destruction

is also frequently demonstrated on CT including a necrosed septum (saddle nose deformity), though the sinus may atrophy and the maxillary bone progressively ossify [15]. On CT aggressively progressing ossifying fibroma appear as expansile mass covered by a thick shell of bone density with a multiloculated internal appearance and a content of varying density.

Figure 4 shows a mixed radiolucent density non-enhancing lesion indenting the medial maxillary, medial orbital and right orbital roof with significant sclerosis and mass effect with opacification of anterior ethmoid suggestive of an ossifyng fibroma.

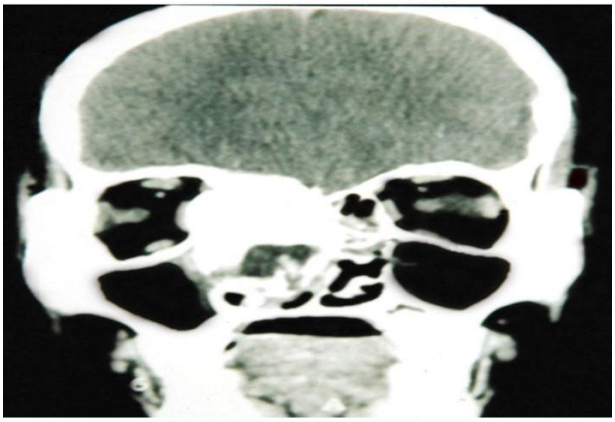

Figure 4: *Contrast Enhanced Coronal CT Scan of the Paranasal Sinus Revealing A Mixed Radiolucent Density, Non-Enhancing Lesion In the Right Nasal Passage Indenting the Medial Maxillary Sinus Wall, Medial Wall of the Right Orbit , Causing Upward Indentation of Right Orbital Roof and Significant Sclerosis with Mass Effect and Opacification of Anterior Ethmoid Sinus*

Nose and paranasal sinus malignancies have irregular margins with thickened mucosa and a mass exhibiting variable enhancement following contrast infusions. Disruption of fascial planes beyond the sinus walls is the most characteristic CT sign for the identification of malignancy [16] as shown in Figure 5. CT scan with contrast should be routinely done in schwannomas as some of these are very vascular [17].

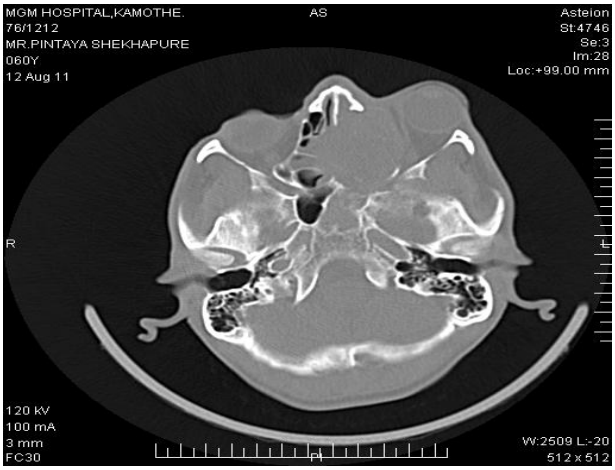

Figure 5: *Invasive Enhancing Mass Right Maxillary Sinus Destroying The Medial Wall Extending Into Left Nasal Fossa. Destroys Postero-Lateral Wall of Left Maxillary Sinus and Protrudes Into Pterygopalatine and Infratemporal Fossa. Extends Into Left Ethmoid Sinus and Destroys The Lamina and Encroaches Upon Left Eyeball and Muscles Causing Proptosis. Further Extends Into Left Spenoid, Frontal Sinus, Destroys the Orbital Plate of Frontal Bone and Extends Into Left Frontal Lobe*

From a radiological standpoint, leiomyosarcoma in the sinonasal tract are bulky lesions that remodel the bone and show slight to moderate enhancement [18].

On CT scan chondrosarcomas present with a soft tissue mass expanding and destroying bone and typically 89% showing areas of nodular or plaque-like calcification. The contrast enhancement is seen at the periphery of the tumour and the central chondromatous core does not enhance [19].

In Olfactory Neuroblastomas, in early stages the tumour may be seen in the superior part of nasal cavity with associated opacification of ethmoid sinus. In advanced lesions there may be destruction of ethmoid, maxillary sinuses, middle and inferior turbinates.

CT scan in small cell neuroendocrine carcinoma (SNEC) reveals signs of malignancy in presence of bone destruction, extensive spread of growth with erosion of meninges and infiltration in brain.

Plasmacytoma of the sinonasal tract appear on CT as a well defined mass often has expansile characteristics and is associated with bone remodelling, as well as bone erosion.

Radiologically Unilateral disease was present in 25(50%) and 24(48%) patients had bilateral disease in our stucy. In both Unilateral as well as bilateral sinus involvements, Maxillary sinuses (23 in unilateral and 45 in bilateral) were the commonest involved sinuses followed by ethmoids.

Approximately half the cases (51% as studied by Mukherji et al. [7]) occur unilaterally, and many others show asymmetric involvement (78% as studied by Mukherji et al. [7]) by the disease on two sides. Evidence of fungal disease with double density sign was present in 5(10%) patients. Intraorbital extension with destruction of lamina papyracea was found in 3(6%) and destruction of sinus wall was noted in 5(10%). Extension to the anterior cranial fossa via cribriform plate and middle cranial fossa via sphenoid sinus was found in 3(6%) cases. Pressure erosion on the septum was seen in 2(4%) cases each. Several studies have quoted the incidence of bony erosion with spread of pathology into the adjacent anatomic areas as 20% [7]. Whether this erosive effect represents a direct manifestation of the progression of the disease, or a different pathological entity within AFRS, has yet to be proven.

Comparison of clinical and radiological findings in our study showed that there were 41(82%) patients in whom the radiological findings were consistent with that of the clinical suspicion. However in 9(18%), there was a difference in opinion. Out of 40 patients with clinically non-neoplastic benign polyps, consistent radiological findings were given in 36(98%) patients. Of the 10 patients with clinically neoplastic lesions, similar radiological opinion was given in 5(12.5%) patients. Clinically suspected 6 cases each of Antrochoanal and Allergic fungal polyps were diagnosed in all 6(100%) cases radiologically.

A similar study by Chopra H. [20] had 70% patients in which radiological findings were consistent with that of clinical suspicion and in 30% with a difference in opinion. Of the 41patients with clinically non-neoplastic benign polyps, consistent radiological findings were given in 33(80.5%). Of the nine patients with clinically neoplastic lesions similar radiological opinion was given in only 2 patients (22.2%).

The allergic fungal polyps were the most correctly diagnosed radiological condition. This was due to high percentage of hyperdense signal in the sinus cavities (caused by calcium salts) detected on CT scan PNS. The diagnosis of antrochoanal polyps and non- specific sinonasal polyps was correctly established in most of the cases. There was a difference of opinion between the clinician and the radiologist in about 4(10%) cases.

Clinically neoplasia was suspected in patients with recurrent epistaxis, dentition problems, facial deformity, trismus, cranial neuropathies or orbital extension. Nose and PNS malignancies have irregular margins with evidence of thickened mucosa and a mass exhibiting variable enhancement following contrast infusions. Disruption of fascial planes beyond the sinus walls is the most characteristic CT sign for the identification of malignancy.

But the correct diagnosis of neoplastic lesions was established only in 5(12.5%) of cases (5 out of 10). This was most probably due to the fact that there was no evidence of bone erosion or extra sinus mucosa involvement in these cases.

5. Conclusion

To conclude CT of the nose and paranasal sinuses is still the ideal imaging method to investigate nasal and paranasal sinus diseases with a high sensitivity signifying the importance of radiological assessment in all cases of nasal polyposis. Radiology proves to be indispensable in cases of nasal polyps as it provide a road map to the endoscopic surgeon and warns one of any existing or impending complications.

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