Clinical Medicine Insights: Ear, Nose and Throat

ORIGINAL RESEARCH

Magnetic Resonance Imaging Versus Computed Tomography and Different Imaging Modalities in Evaluation of Sinonasal Neoplasms Diagnosed by Histopathology

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Abstract

Objective: The study purpose was to detect the value of magnetic resonance imaging (MRI) compared to computed tomography (CT) and different imaging modalities as conventional radiology in evaluation of sinonasal neoplasms diagnosed by Histopathology.

Methods: Thirty patients (16 males and 14 females) were complaining of symptoms related to sinonasal tract. After thorough clinical and local examination, the patients were subjected to the following: conventional radiography, CT, MRI, and histopathological examination.

Results: The nasal cavity was the most commonly involved site with sinonasal malignancies followed by the maxillary sinuses. The least commonly affected site was the frontal sinuses. Benign sinonasal tumors were present in 14 cases. The most common benign lesion was juvenile nasopharyngeal angiofibroma (6 cases), followed by inverted papilloma (3 cases). While malignant sinonasal tumors were present in 16 cases, squamous cell carcinoma was present in 5 cases, and undifferentiated carcinoma, in 3 cases. Lymphoepithelioma and non-Hodgkin lymphomas were present in 2 cases each, while adenocarcinoma, chondrosarcoma, adenoid cystic carcinoma, and rhabdomyosarcoma were present in 1 case each.

Conclusion: MRI with its superior soft tissue contrast and multiplanar capability is superior to CT in pretreatment evaluation of primary malignant tumors of sinonasal cavity.

Keywords: magnetic resonance imaging, computed tomography, sinonasal tumor

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Introduction

Tumor and tumor-like lesions of the sinonasal tract may be classified (1) as benign or malignant, (2) as carcinoma, sarcoma, adenocarcinoma, or lymphoma, (3) according to the tissue of origin (eg, epithelial, bone, lymphoid, or mesenchymal), or (4) as a combination of above.[1]

Because many sinonasal tumors are accompanied by underlying or superimposed chronic inflammatory or allergic disease, tumors may be easily overlooked.[2] Although computed tomography (CT) can distinguish tumor from associated inflammatory disease, differentiation may be difficult.

Today, with magnetic resonance imaging (MRI), it is possible in most sinonasal tumors to differentiate inflammatory reactions and retained secretions from the bulk of the tumor because the high water content of the inflammatory condition results in a marked increased signal on T2-weighted scans. In contrast, the overwhelming majority of sinonasal tumors are highly cellular, and, therefore, they have intermediate signal intensity on T2-weighted images.[3,4]

The aim of the study is evaluating patients with sinonasal neoplasm, using MRI, CT and histopathology.

Patients and Methods

Ours was a prospective study conducted on 30 patients selected among patients referred to the radiodiagnosis department for radiological examination of the sinonasal tumors. Included were 16 males and 14 females; their age ranged from 6 to 79 years (mean 29.4 years). These patients presented with a wide variety of clinical symptoms: nasal obstruction (7 cases), epistaxis (10 cases), unilateral exophthalmos (3 cases), and facial swelling (10 cases).

All patients included in this study were subjected to complete physical examination, routine blood tests, chest radiography, and pelvic abdominal ultrasound examination. All provided their written informed consent to participate.

With respect to plain radiography, occipito-mental views were done for all patients with the addition of other views that were adjusted by the site of the patient complaint.

CT examination of the paranasal sinus was performed for all patients with slice thickness 3 mms and interspace 3 mms in both axial and coronal planes without and with intravenous (IV) contrast injection, using both soft tissue window (50/200) and bone window level and width (100/1500).

Magnetic resonance images were performed using a 0.5 Tesla scanner using spin echo pulse sequence. T1-weighted images were obtained with repetition time (TR) of 600 to 800 ms and echo time (TE) of 20 to 25 ms. T2-weighted images were obtained with TR of 2000 to 2500 ms and TE of 30 to 38 ms. The slice thickness was 5 mm, number of excitation was 4, and the acquisition matrix was (256 × 256) or (192 × 256). T1-weighted images were performed in sagittal, axial, and coronal orientation while T2-weighted images were done in axial and coronal sections. Both CT and MRI machines were from General Electric (General Electric Healthcare, Waukesha, WI- USA).

Postcontrast studies were performed using gadolinium-DTPA in a dose of 0.1 to 0.2 mmol/kg body weight (IV injection). Axial, coronal, and sagittal post contrasts were obtained.

Biopsy (incisional and excsional) specimens from all tumors were taken and fixed in 10% formaline and then paraffin embedded and stained with hematoxylin and eosin (H&E). The slides were revised by a pathologisist for histopathological diagnosis.

Radiological data (CT and MRI studies) were analyzed by a single diagnostic radiologist who did not know the final diagnoses of the patients. Both radiological studies were presented to him at same time. Also, the histopathological reports were done by a patholgist H.M.T.

Results

This was a prospective study done in the Ear, Nose, and Throat departments of Minia University Hospital and Alazher University Hospital (Assuite branch) from February 1, 2009, through November 30, 2011. The study was approved by the research ethics committees of both universities.

Sinonasal lesions were divided into benign lesions (14 patients) and malignant tumors (16 patients).

The most common benign lesions were juvenile nasopharyngeal angiofibroma (6 patients) and inverted papilloma (3 patients) as shown in Table 1. All 6 cases of juvenile nasopharyngeal angiofibroma were stage I or stage II as the tumor was confined to nasopharynx and the nasal cavity.

Figure 1 shows the hisopathological picture of the inverted papilloma. Figure 2 shows CT and MRI films of the inverted papilloma.

There were different pathological types of sinonasal malignant tumors as shown in Table 2.

Squamous cell carcinomas were confirmed in 5 patients and undifferentiated carcinoma in 3 patients by histopathologic examination. Each malignant tumor may affect more than one site.

All sinonasal tumors were equally detectable on CT and MRI. However, MRI performed better than CT in other categories (Table 3). In all cases, tumor margin was better on MRI due to the ability of MRI to differentiate between tumor on one hand and retained inflammatory fluid in the sinuses and inflamed sinonasal mucosa on the other. For the same reason, MRI was better than CT in evaluating the site of origin in 3 tumors, while in the other 27 tumors, CT and MRI were equal (Table 3).

Figure 3 shows the histopathology of squamous cell carcinoma, and Figure 4 shows CT as well as MRI images of the same tumor.

MRI was better than CT in the evaluation of the extension of all tumors. In all cases (30/30), MRI was better than CT in differentiating tumor tissue from retained secretions and inflamed sinonasal mucosa by virtue of difference in their signal intensities. On T2-weighted images, sinonasal inflammatory lesions had a bright signal that could easily be differentiated from the relatively lower tumor signal. In one case of squamous cell carcinoma, MRI suggested intratumoral hemorrhage, which was seen on T1-weighted images as an area of hyperintensity (relative to the brain and muscles). On T2-weighted images, this area was hypointense to both the brain and the tumor. This area did not enhance, while the tumor enhanced markedly. On the other hand, CT showed no evidence of such hemorrhage.

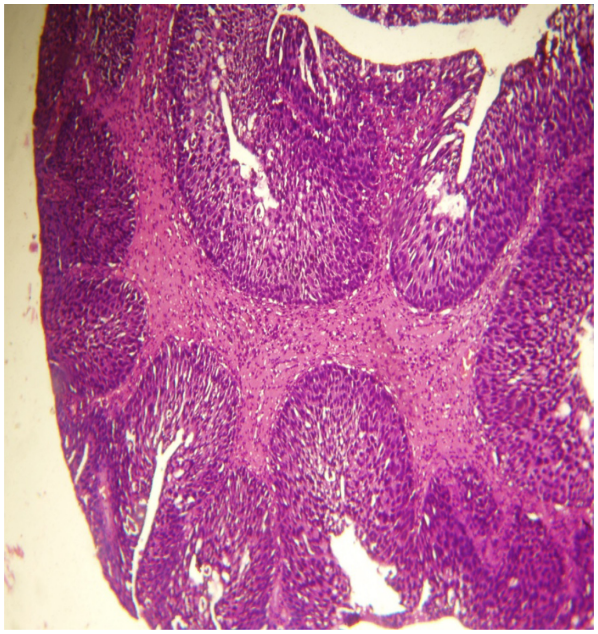

Figure 1. The microscopic picture of inverted papilloma.

Gadolinium-DTPA injection was of value in all cases, in which it improved evaluation of tumor extent and margin. However, T2-weighted images provided the same information as post gadolinium T1-weighted images.

Our series showed that 9 out of 30 cases (30%) had destruction of the skull base and extension intracranially elevating the dura and brain with no parenchymal invasion. CT was as equal to MRI in detecting this destruction. Destruction of the skull base encountered with squamous cell carcinoma, undifferentiated carcinoma, adenoid cystic carcinoma, adenocarcinoma, and rhabdomyosarcoma.

Discussion

The imaging modalities for paranasal sinuses starting with plain radiographs as first line and ending with CT and MRI play a vital role in mapping out the extent of the disease affecting paranasal sinuses.[5,6]

For neoplastic sinonasal pathology, MRI has largely replaced CT because of its greater sensitivity for intracranial extension and better ability to differentiate tumor and inflammation. The need for optimal mapping of sinonasal neoplasms has led to the ascendancy of MRI in this setting.

Primary sinonasal malignancies constitute only 3% of head and neck malignancies and only 0.2% to 0.8% of all malignancy.[7]

In the present study, there was no significant difference between presenting symptoms in tumor and inflammatory lesions. Lloyd et al[8] found that clinical symptoms of sinonasal neoplasms are indolent and similar to that of sinusitis. So, the neoplasms often extend into deep tissue at time of presentation.[8]

Shanker et al[9] stated that juvenile nasopharyngeal angiofibroma affects adolescent males. These findings coincide with our studies, as there were six patients with angiofibroma; all were males and their

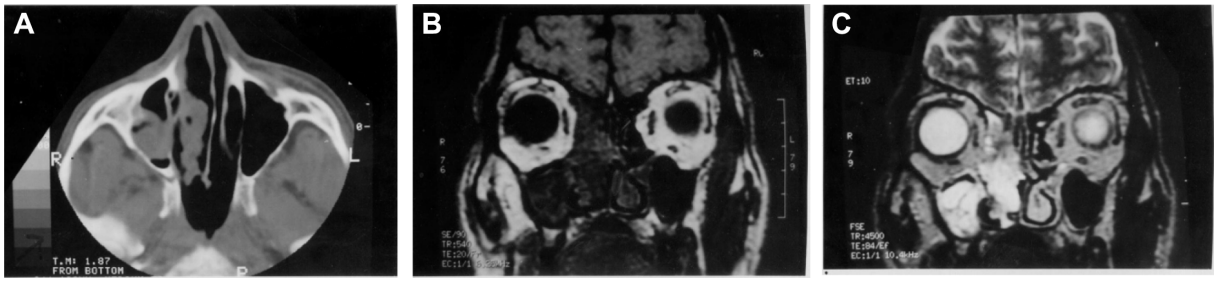

Figure 2. Inverted papilloma. (**A**) Axial CT scan shows peripheral enhanced soft tissue mass in the right nasal cavity with extension to the right maxillary sinus. Nasal septum erosion (**B**), coronal MRI T1-weighted and (**C**) Coronal MRI T2-weighted images showing mass in the right nasal cavity and right maxillary sinuses. The tumor appears hypointense in T1WI and hyperintense in T2WI.

ages were between 10 and 18 years old. On MRI, the juvenile nasopharyngeal angiofibroma appears as mass of intermediate signal on T1-weighted images and of intermediate to high signal on T2-weighted images.[9] There are usually multiple flow-void channels, which represent vascularity. All cases have marked enhancement after Gd-DTPA administration. This is in agreement with Mafee.[1]

MRI may better illustrate the extent of soft tissue abnormality than CT and is particularly helpful in detecting recurrence following surgery.[10]

Most of inverted papilloma arise from the central portion of the middle meatus, thus involving the osteomeatal complex. Contrast enhancement was heterogeneous in three out of four patients on MRI. These findings coincide with Damman et al,[11] Ojiri et al,[12] and Pasquini et al.[13]

In this work, no definite histopathologically proved tumoral calcification, but there were entrapped bones inside the tumor. This is in agreement with Som and Lidov,[14] who questioned the presence of true tumoral calcification. Differentiation of inverted papilloma from inflammatory disease may be more successful in routine cases in which the inflamed mucosa has low signal on T1-weighted images and very high on T2-weighted images. The signal intensity of inverted papilloma is never as high as that of benign inflamed mucosa or obstructed secretions. The solid enhancing pattern of inverted papilloma may distinguish it from inflamed mucosa and/or mucoceles, which have thin peripheral rims of enhancement.[15] This is in agreement with our findings. Yousem et al[16] stated that there is no signature pattern of MR signal characteristics or enhancement suggestive of a specific diagnosis of inverted papilloma. In this study, there was no characteristic signal of inverted papilloma.[16] Previous experience with MRI has shown that it is difficult to distinguish tumor, secretions, and inflamed mucosa on T1-weighted images. As T2 weighing increases, discrimination between the pathologies also increases, so that tumor can best be distinguished on T2 spin echo sequences using long echo and repetition times.[8,17] In our study, sinonasal tumors had signal intensities lower than those of associated secretions or thickened mucosa on T2-weighted images. On T1-weighted images, no signal intensity differences were seen except after the injection of Gd-DTPA. Gadolinium emphasizes the difference between inflamed or

Table 1. Histopathologic types of benign sinonasal tumors.

Type	Number	%
Angiofibroma	6	42.8%
Inverted papilloma	3	21.4%
Frontal osteoma	1	7.1%
Fibrous dysplasia	1	7.1%
Ossifying fibroma	1	7.1%
Benign epithelial cyst	1	7.1%
Dermoid	1	7.1%
Total	14	100%

Table 2. Histopathologic types of malignant sinonasal tumors.

Type	Number	%
Squamous cell carcinoma	5	31.25%
Undifferentiated carcinoma	3	18.75%
Lymphoepithelioma	2	12.5%
Non-Hodgkin lymphoma	2	12.5%
Adenoid cystic carcinoma	1	6.25%
Low grade chondrosarcoma	1	6.25%
Adenocarcinoma	1	6.25%
Rhabdomyosarcoma	1	6.25%
Total	16	100%

Table 3. Comparison between CT and MRI in evaluation of sinonasal neoplasms.

	C T is better	C T = MR	MR is better
Detectability	–	30	–
Margin	–	–	30
Extent	–	–	30
Origin	–	27	3

Notes: CT is better: mean CT is better than MRI in detection of the tumor, its margin, extent, and origin. CT = MR: mean CT is Equal to MRI in in detection of the tumor, its margin, extent, and origin. MR is better: mean MRI is better than CT in detection of the tumor, its margin, extent, and origin.

edematous sinus mucosa and fluid or tumor, which is a valuable feature of the technique both for postoperative follow-up assessment of possible tumor recurrence and for monitoring the results of radiotherapy or chemotherapy.[18] In our study, T1-Gd-DTPA images added valuable information to T1-weighted images regarding tumor margin and extent as well as the differentiation between tumor and inflammatory sinonasal changes.

All sinonasal tumors in our series were equally detectable on both CT and MRI because of their encroachment on the sinonasal air spaces. To our knowledge, no difference between CT and MRI was reported in the literature regarding detectability of sinonasal tumors.

Squamous cell carcinomas are the most common malignancies of the nasal cavity and paranasal sinuses. They presented in 63% of cases in the study that done by Chow et al.[19] In our study, squamous cell carcinoma was present in 5 cases (31.25%) of malignant sinonasal tumors.

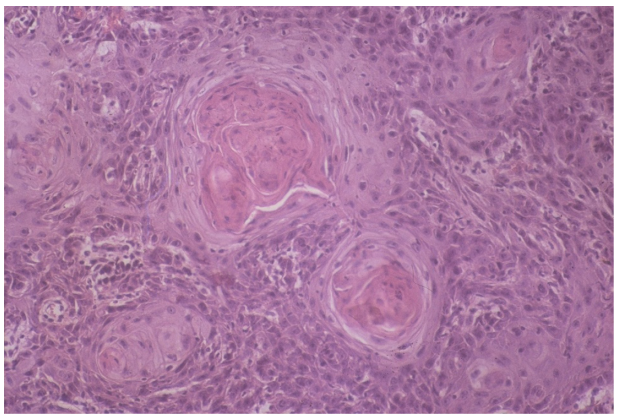

Figure 3. The microscopic picture of squamous cell carcinoma.

Undifferentiated carcinoma in our study was mainly at the ethmoid sinuses and the upper nasal cavity. Phillips et al[20] showed that undifferentiated neoplasm of the nasal cavity and paranasal sinuses are relatively common. These arise within the ethmoid sinuses and superior nasal cavity.[20]

In our study, there were two cases of non-Hodgkin's lymphoma affecting maxillary sinus and nasal cavity. Mafee[1] stated that lymphomas arising in the nose and paranasal sinuses are of the non-Hodgkin's type.

Yousem found that sarcomas of sinonasal cavities are rare and chondrosarcoma is the most common in young adults, while rhabdomyosarcoma is the most common soft tissue sarcoma in children. These findings are in accordance with our findings.

Sinonasal neoplasm can extend intracranially across the anterior skull base. In this case, the tumor surface is usually flat with broad base. The most effective barrier to tumor spread is the periostium and dura. Therefore, although MRI cannot detect focal bony erosion of sinonasal walls, it is more reliable than CT as it demonstrates the periostium and dura.[21] In our series, 9 out of 30 cases (30%) had destruction of the skull base and extension intracranially elevating the dura and brain with no parenchymal invasion.

Som[2] found that CT is less reliable in identifying the internal carotid artery in instances of cavernous sinus invasion due to inability to distinguish the enhancing artery from an enhancing tumor mass. On MRI, visualization of the artery is by means of signal void characteristics flowing blood within the vessel. Encasement and invasion of the carotid artery are readily identified on MRI.[2] In our study, on MRI, the signal void of internal carotid arteries enabled us to visualize the enhancing tumor surrounding them in two cases, while CT failed to evaluate the encasement and invasion of the internal carotid artery.

The relationship between the CT scan findings and the histopatholgy examination was strong. Though false positivity was noted more in the ethmoid sinuses, significant impact on tumor staging was noted with false positivity also present the nasopharynx. Also, false positivity was noted with orbital wall/content extensions, resulting in unnecessary exenterations of the orbit. However, false negativity was noted more often in the soft palate, indicating the need of using MRI for delineation of tumor extension.[22] These results

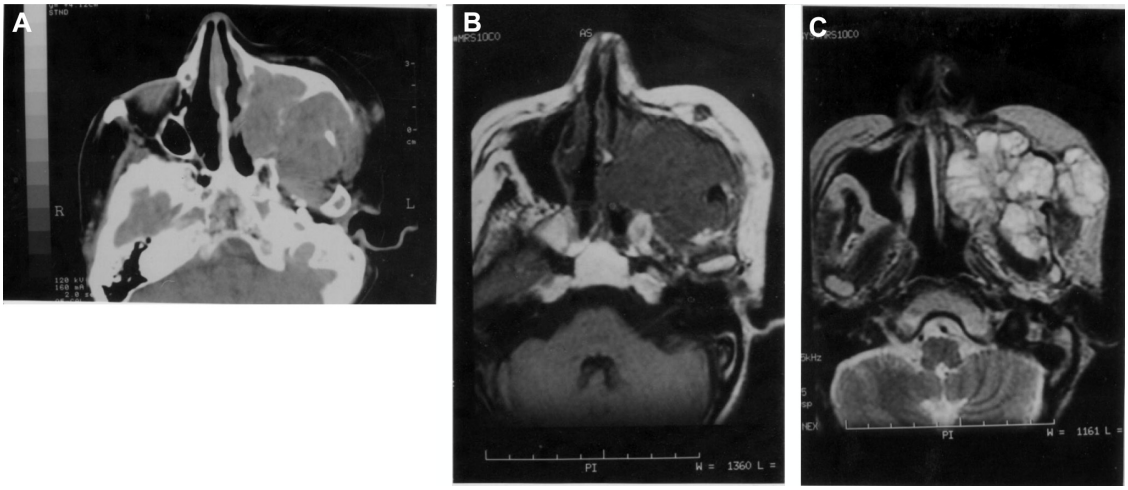

Figure 4. Squamous cell carcinoma. (**A**) Axial CT scan showing opacification of left nasal cavity and left maxillary sinus, we can't differentiate tumor mass from retaned sinus secretion. (**B**) T1-weighted axial MR scans in a patient with Squamous cell carcinoma of the nasal cavity and right maxillary sinus. Difficulty is encountered in differentiating tumor from retained secretions. (**C**) T2-weighted axial MR scan allow differentiation of tumor, which has a lower signal intensity, from retained secretions, which has a higher signal intensity.

agree with our data regarding the accuracy of MRI in detecting extension of the neoplasm at sinonasal area.

Conclusion

In conclusion, CT is essential for planning surgery and providing an operative road map for subsequent functional endoscopic sinus surgery. MRI, with its superior soft tissue contrast, is superior to CT in pretreatment evaluation of primary malignant tumors of sinonasal cavities and is the imaging modality of choice in these cases.

Author Contributions

Diagnosed the cases: MAG, MSH. Made radiological diagnoses of the cases: AME. Made pathological diagnoses of the cases: HMT. Clinically evaluated the cases: AA. Conceived and designed the experiments: AME. Analyzed the data: MSH. Jointly developed the structure and arguments for the paper: AA. Made critical revisions and approved final version: MAG. All authors reviewed and approved of the final manuscript.

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Competing Interests

Author(s) disclose no potential conflicts of interest.

Disclosures and Ethics

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