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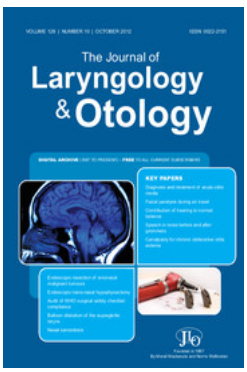

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Imaging for endoscopic sinus surgery in adults

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Abstract
Computerized tomography (CT) offers the gold standard in terms of imaging the extent of disease and the fine detailed anatomy, both pre-requisites to the safe practice of endoscopic sinus surgery. Neither plain X-rays nor magnetic resonance imaging (MRI) offer optimal information in this respect. A variety of protocols minimizing radiation dose to the lens whilst providing high quality images are presented together with a menu of anatomical features that require careful evaluation pre-operatively.

Key words: Imaging; endoscopic sinus surgery; rhinosinusitis

Introduction

For many years plain radiographs provided clinicians with the information required regarding sinonasal pathology, supplemented in selected cases by hypocycloidal tomography. The maxillary sinus was well displayed by plain sinus X-rays and was the focus of most surgical interventions in the form of wash-outs, inferior meatal antrostomies and Caldwell-Luc procedures in chronic rhinosinusitis. The resurgence of interest in the role of the natural drainage pathways of the sinuses embodied in the concept of the 'osteomeatal complex' coincided with the improved visualization afforded by endoscopy and CT that in turn resulted in the widespread development of endoscopic sinus surgery (ESS) for inflammatory sinonasal disease.

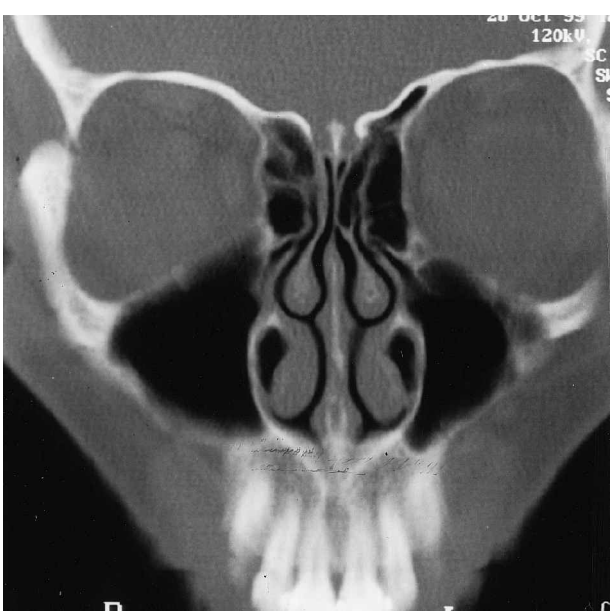

Fig. 1
Coronal CT through infundibulum showing the optimal anatomical detail.

Plain X-rays

With the widespread availability of CT, the role of plain sinus X-rays (occipito-mental, occipito-frontal, and lateral) has become less clear. Plain X-rays are inexpensive and involve exposure to less radiation than CT but, for the pre-operative evaluation for endoscopic sinus surgery, CT is essential to demonstrate the fine detailed anatomy and full extent of disease. Therefore, plain X-rays are unnecessary.

Computerized tomography (Figures 1 and 2)

The necessity for a CT scan prior to endoscopic sinus surgery is now generally accepted as the gold standard in demonstrating both extent of disease and the fine detailed anatomy. The literature contains many alternative protocols but the following have been developed over the last 16 years to provide optimum imaging with minimal radiation dosage to the eye (Table I) (Figure 3).

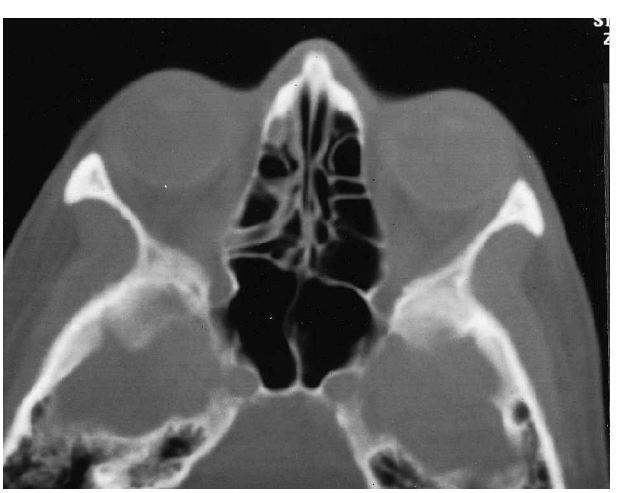

Fig. 2
Axial CT in same patient showing relationship of ethmoids and sphenoid to orbit and carotid arteries.

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TABLE I
PROTOCOLS FOR CT SCANNING IN CHRONIC RHINOSINUSITIS

	Zinreich *et al.*[1]	Charing Cross[2]	RNTNEH
Plane	Direct coronal	Direct coronal	Direct coronal
Slice thickness	4 mm	2 mm	5 mm (2.5 mm through the OMC)
Increments	3 mm	8 mm	Contiguous *i.e.* 5 mm (2.5 mm through the OMC)
Scan images	20–25	10 + 2 axial	18–20
Window	2,000 Hounsfield units	2,000 Hounsfield units	Width: 4000 Level + 350
Radiation	125 kV, 450 mAs	120 kV, 200 mAs	120 kV, 100 mAs

OMC = osteomeatal complex.

The direct coronals are a pre-requisite to virtually all protocols even with the advent of the fast spiral scanners which have considerably improved the quality of reconstructed images, both axial and sagittal. Generally reconstructions are reserved for those patients who cannot adequately extend their neck. Axial scans optimally demonstrate the relationship of the posterior ethmoids and sphenoid to the optic nerve and carotid artery but may not be required in every case, particularly were disease is limited to the anterior sinus system. The amount of radiation exposure differs depending on the protocol, machine, kV and milliamperes-second (mAs) setting of the scanner[3] ranging from a mean lens dose of 70.3 mGy at 475 mAs and 17.6 mGy at 210 mAs to 4.7 mGy at 30 mAs. Stammberger[4] estimated the lens dose from coronal CT to be 12–90 mGy whereas that described by Rowe-Jones *et al.*[2] renders a means lens dose of 9.81 mGy (S.D. ± 5.62). These are all well below the doses regarded as relevant to cataract formation where a threshold of 0.5 to 2 Gy is thought to be significant.[5]

It is generally agreed that the primary role of the CT is to provide information on the anatomy and extent of pathology in chronic rhinosinusitis. A period of medical therapy is recommended prior to performing the scan and some radiologists have advocated the use of a topical vasoconstrictor immediately before scanning[6] although this is not employed in our own practice.

A number of important anatomical landmarks may be examined on the CT scan (Table II) which are of particular importance in the avoidance of complications e.g. an absent uncinate process in association with a hypoplastic antrum, or asymmetry of the cribriform niche. Common variations in anatomy may also be demonstrated, the incidence of which varies from series to series (Table III).[1,7–11]

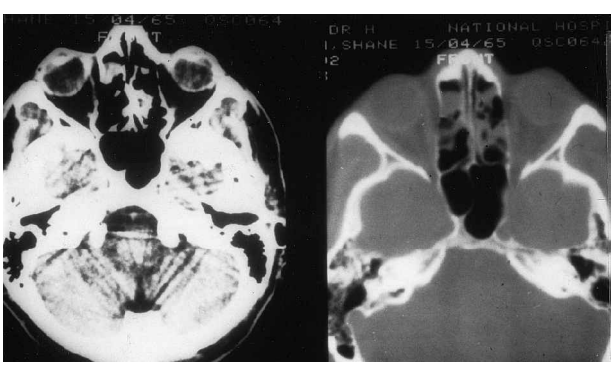

FIG. 3
Axial images of identical section taken: (a) on narrow window widths and (b) on wide window widths showing difference in information on anatomy and pathology using a sub-optimal and optimal protocol, respectively.

The overall extent and pattern of sinus involvement may be readily assessed on CT and estimation of disease extent is possible using a number of staging and scoring systems[12–18] of which the Lund and Mackay system has been used for nearly a decade. However, it is well established that the correlation of extent of disease with symptoms is poor.[19,20] It is also clear that there is no correlation between the various anatomical variants and extent of disease[8,21] which has led to a re-examination of their importance in the development of chronic rhinosinusitis. It is also worth noting that a number of studies have shown a significant degree of incidental changes in 'normal' controls probably related to recent viral upper respiratory tract infections.[22–24]

Magnetic resonance imaging

There is an increasing tendency to request magnetic resonance imaging (MRI) in preference to CT which may be led by the neurologists who obtain MRI in cases of facial pain but this fails to offer optimum information for surgery. Not only is bone shown as a signal void but inflammatory change is potentially over-diagnosed.[25] Sinonasal mucosa has an excellent blood supply and as a consequence readily gives a high signal. In addition the nasal cycle may affect the ethmoid sinuses.[1] The study of Leopold *et al.*[26] has shown that whilst the majority of patients with acute maxillary sinusitis are symptomatically better within a week, following antibiotic therapy, the sinus mucosa continues to give high signal suggestive of inflammation in up to 50 per cent of scans at eight weeks. Whilst the sensitivity and specificity of MRI is of great value in differentiating neoplastic disease from other

TABLE II
ANATOMICAL FEATURES TO BE EVALUATED ON CT SCAN

Frontal and anterior ethmoid sinuses
- Pneumatization of bulla
- Frontonasal recess – configuration e.g. suprabullar cell encroaching on frontonasal recess
- Lamina papyracea – dehiscence
- Roof – height and angle on each side
  - lateral lamella of cribiform niche
  - dehiscence
  - angle of crista galli
  - position of anterior ethmoidal artery
- Frontal sinus – size, shape, septa (intersinus and lateral)

Maxillary sinus – size and shape
- Width of infundibulum
- Uncinate process
- Infra-orbital ethmoidal (Haller) cells
- Nasolacrimal duct

Posterior ethmoids
- Pneumatization with respect to sphenoid e.g. spheno-ethmoidal (Onodi) cells and relation to optic nerve

Sphenoid sinus
- Optic nerve
- Carotid artery

TABLE III
INCIDENCE OF ANATOMICAL VARIANTS ON CT FOR CHRONIC RHINOSINUSITIS[1,7–11]

	%
Concha bullosa	17–30
Everted uncinate process	5–21
Pardoxical middle turbinates	3–26
Haller (Infra-orbital) cells	4–15
Agger nasi pneumatization	14–42
Onodi (spheno-ethmoidal) cells	5–12

tissue, this degree of discrimination is not normally required in chronic rhinosinusitis.

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