

# World Journal of *Radiology*

*World J Radiol* 2011 August 28; 3(8): 199-214





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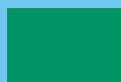
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<http://www.wjgnet.com/1949-8470/full/v3/i8/199.htm>

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**LAUNCH DATE**  
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**PUBLICATION DATE**  
August 28, 2011

**ISSN**  
ISSN 1949-8470 (online)

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## Computed tomography scans of paranasal sinuses before functional endoscopic sinus surgery

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Received: February 10, 2011 Revised: July 16, 2011

Accepted: July 23, 2011

Published online: August 28, 2011

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Cashman EC, MacMahon PJ, Smyth D. Computed tomography scans of paranasal sinuses before functional endoscopic sinus surgery. *World J Radiol* 2011; 3(8): 199-204 Available from: URL: <http://www.wjgnet.com/1949-8470/full/v3/i8/199.htm> DOI: <http://dx.doi.org/10.4329/wjr.v3.i8.199>

### Abstract

This review aims to familiarize the radiologist with the common types of sinus surgery including their indications and techniques. We also illustrate how surgeons interpret 3D sinus anatomy when evaluating computed tomography (CT) studies. Preoperative evaluation by CT is mandatory for all patients undergoing functional endoscopic sinus surgery (FESS). In the past decade in particular, CT of the paranasal sinuses has become a roadmap for FESS. The radiologist's goal is to report on five key points: the extent of sinus opacification, opacification of sinus drainage pathways, anatomical variants, critical variants, and condition of surrounding soft tissues of the neck, brain and orbits. We present a systematic approach to the use of coronal, axial, and sagittal images in CT evaluation before FESS.

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**Key words:** Computed tomography; Sinus; Functional endoscopic sinus surgery; Anatomy; Complications

**Peer reviewers:** Bunyamin Sahin, PhD, Professor, Vice President of Turkish Society for Stereology, Department of Anatomy,

### INTRODUCTION

Chronic rhinosinusitis is one of the most common chronic diseases in the United States and is now the most common indication for sinus surgery. Chronic rhinosinusitis is estimated to occur in 14% of the population, however the degree of accuracy of many reported cases of chronic rhinosinusitis is difficult to ascertain<sup>[1]</sup>. To support a clinical diagnosis of chronic rhinosinusitis, in accordance with the American Academy of Otolaryngology and Head and Neck Surgery (AAO-HNS) criteria, at least two major or one major and two minor symptoms are required (Table 1). Although the diagnosis of chronic rhinosinusitis is largely a clinical one, the final diagnosis should be confirmed by objective measures and, in 2003, the AAO-HNS amended the existing 1996 diagnostic criteria for chronic rhinosinusitis, citing confirmatory radiographic, nasal endoscopic or findings on physical examination necessary to confirm a diagnosis of chronic rhinosinusitis.

Congenital anomalies and normal anatomical variants in this region, while rare, are important as they have pathological consequences and may lead to difficulties intraoperatively. Therefore, appropriate radiological imaging with accurate interpretation of normal and aberrant

anatomy plays a vital role in the diagnosis and safe surgical management of these patients.

## BACKGROUND

Open approaches to the maxillary sinus were first described as early as the 18th century. The Caldwell-Luc procedure was described in 1893 by George Caldwell and further elucidated in France by Henri Luc in 1897. Some of the more recent advances in the movement towards functional endoscopic sinus surgery (FESS), can be attributed to Messerklinger and Stammberger in the early 1980s and 1990s, respectively<sup>[2]</sup>, with the role of computed tomography (CT) in sinus surgery expanding greatly with the advent of image-guided surgery (IGS) in recent years.

FESS confers the advantage of being minimally invasive and allows for sinus air cells and sinus ostia to be opened under direct visualization. The primary goal of FESS is to return the mucociliary drainage of the sinuses to normal function. FESS is most successful in patients who have recurrent acute or chronic infective sinusitis, with success rates as high as 98% cited<sup>[3]</sup>. Surgical failure when it occurs is usually as a result of postoperative adhesions or when the surgeon fails to address outflow tract of the frontal sinus<sup>[3]</sup>. Sinus surgery conducted in certain settings may be facilitated by IGS. Such situations could include revision surgery in the absence of recognizable anatomical landmarks, cases where disease extends into the frontal or sphenoid sinus, or disease abutting the skull base. IGS essentially permits the real-time correlation of the operative field to a preoperative imaging data set that reflects the precise location of a surgical instrument in relation to surrounding anatomical landmarks.

The classical indication for FESS is chronic rhinosinusitis but also includes nasal polyposis, antrochoanal polyps (arising from the maxillary antrum), sinus mucoceles, cerebrospinal leak closure, orbital decompression, choanal atresia repair, optic nerve decompression, control of epistaxis and dacryocystorhinostomy (Table 2). Although the most common indication for FESS is failure to respond to conservative management, intraoperative correlation with real-time CT imaging has allowed the use of FESS for a wider range of procedures, including access to skull base malignancies and trans-sphenoidal approaches to the pituitary gland. IGS is also deployed in cases where a dehiscence lamina papyracea has been noted on a preoperative scan or in cases where there is orbital pathology present.

## PATHOPHYSIOLOGY OF CHRONIC RHINOSINUSITIS

The success of FESS is based on the premise that the symptoms in chronic rhinosinusitis arise largely as a result of blockage of the ostiomeatal complex (OMC), which Mackay and Lund have described as an outflow tract for the maxillary, anterior ethmoid and frontal sinus<sup>[4]</sup>.

**Table 1 American Academy of Otolaryngology and Head and Neck Surgery criteria for chronic rhinosinusitis**

Major criteria	Minor criteria
Purulence in nasal cavity	Headache
Facial pain, pressure, congestion, fullness	Fever (all nonacute)
Nasal obstruction, blockage, discharge, purulence	Halitosis
Fever (acute rhinosinusitis only)	Fatigue
Hyposmia/anosmia	Dental pain
	Cough
	Ear pain and fullness

**Table 2 Indications for functional endoscopic sinus surgery**

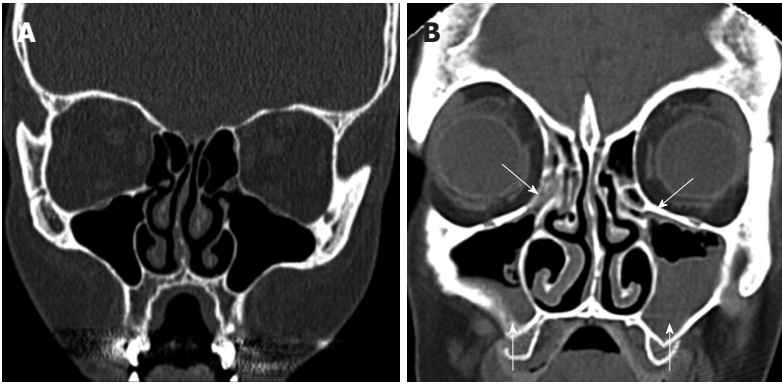
Chronic sinusitis refractory to medical treatment
Recurrent acute sinusitis
Nasal polyposis
Antrochoanal polyps
Sinus mucoceles
Excision of selected tumors
Cerebrospinal fluid leak closure
Orbital decompression (e.g. Graves ophthalmopathy)
Optic nerve decompression
Dacryocystorhinostomy
Choanal atresia repair

Radiologically, it is obstruction of the OMC by inflammation, polyposis, or more rarely, by tumor that is of key interest to the otolaryngologist. This obstruction leads to a defect in mucociliary clearance, resulting in stagnation of secretions and subsequent development of a culture medium facilitating the development of infection, and is one of the most common findings in patients with chronic rhinosinusitis (Figure 1). A recent study by Nouraei *et al*<sup>[5]</sup> has noted an obstructed OMC in 53% of patients with chronic rhinosinusitis. CT scanning is extremely useful in confirming a clinical suspicion of chronic rhinosinusitis and classically, features such as significant mucosal thickening, air-fluid levels, OMC obstruction, or polyposis are suggestive of sinogenic disease. However, many of the radiological manifestations of sinus disease are more subtle.

## SURGICAL SIGNIFICANCE OF RADIOLOGICAL FINDINGS

Intraoperatively, on entering nasal cavity, the first structures encountered are the nasal septum and inferior turbinate. The septum consists of quadrangular cartilage extending to the perpendicular plate of the ethmoid bone postero-superiorly and the vomer postero-inferiorly. It is important to recognize septal deviations because these may lead to significant nasal obstruction and limit endoscopic visualization. As appropriate, patients with septal deviations noted preoperatively on CT, may be counseled regarding the need for septoplasty in conjunction with FESS (Figure 2A).





**Figure 1** Coronal computed tomography reformat of the paranasal sinuses. A: Coronal computed tomography (CT) reformat of the paranasal sinuses. Normal sinuses. No evidence of sinusitis; B: Coronal CT reformat of the paranasal sinuses in a different patient demonstrating chronic sinusitis as evidenced by osteomeatal complex disease (upper two arrows) and mucosal thickening in the maxillary sinuses (lower two arrows).

Extending along the inferior nasal wall posteriorly towards the nasopharynx is the inferior turbinate. In patients with an allergic component to their disease, the inferior turbinate may be edematous and in some cases enlarged, to the extent that the patient is likely to benefit from turbinate reduction (Figure 2B). Again, if significant inferior turbinate enlargement is noted on preoperative imaging, patients can be advised of the benefits of turbinate reduction in conjunction with their sinus surgery.

As the endoscope is advanced through the nasal cavity, the next structure encountered is the middle turbinate, which attaches superiorly to the cribriform plate. It is composed of a vertical and horizontal component; the latter is also referred to as the basal lamella, which partitions the anterior and posterior ethmoid air cells. The middle turbinate is a key landmark in FESS. It has a vertical (lying in sagittal plane running from posterior to anterior) and horizontal component (lying in coronal plane, running medial to lateral). The vertical part, referred to as the basal lamella, divides the anterior and posterior ethmoid cells (Figure 3A). Care must be taken when manipulating the middle turbinate because it attaches to the skull base at the cribriform plate and, in addition, the surgeon must be mindful of the importance of preserving the middle turbinate because it serves as an important landmark during revision surgery. A relatively common anatomical variant of sinonasal anatomy is a concha bullosa or pneumatized middle turbinate (Figure 2C). Their cited incidence varies in the literature from 15% to 45%, although they are not thought to have any significant role in the pathogenesis of chronic rhinosinusitis<sup>[6,7]</sup>.

Another rare aberration is a paradoxical middle turbinate. Convexity of the middle turbinate is usually deviated medially towards the septum. When it is paradoxically curved (convexity of bone directed laterally), the inferior end of the turbinate may obstruct and narrow the nasal cavity and middle meatus. Such structures however, have very little relevance surgically.

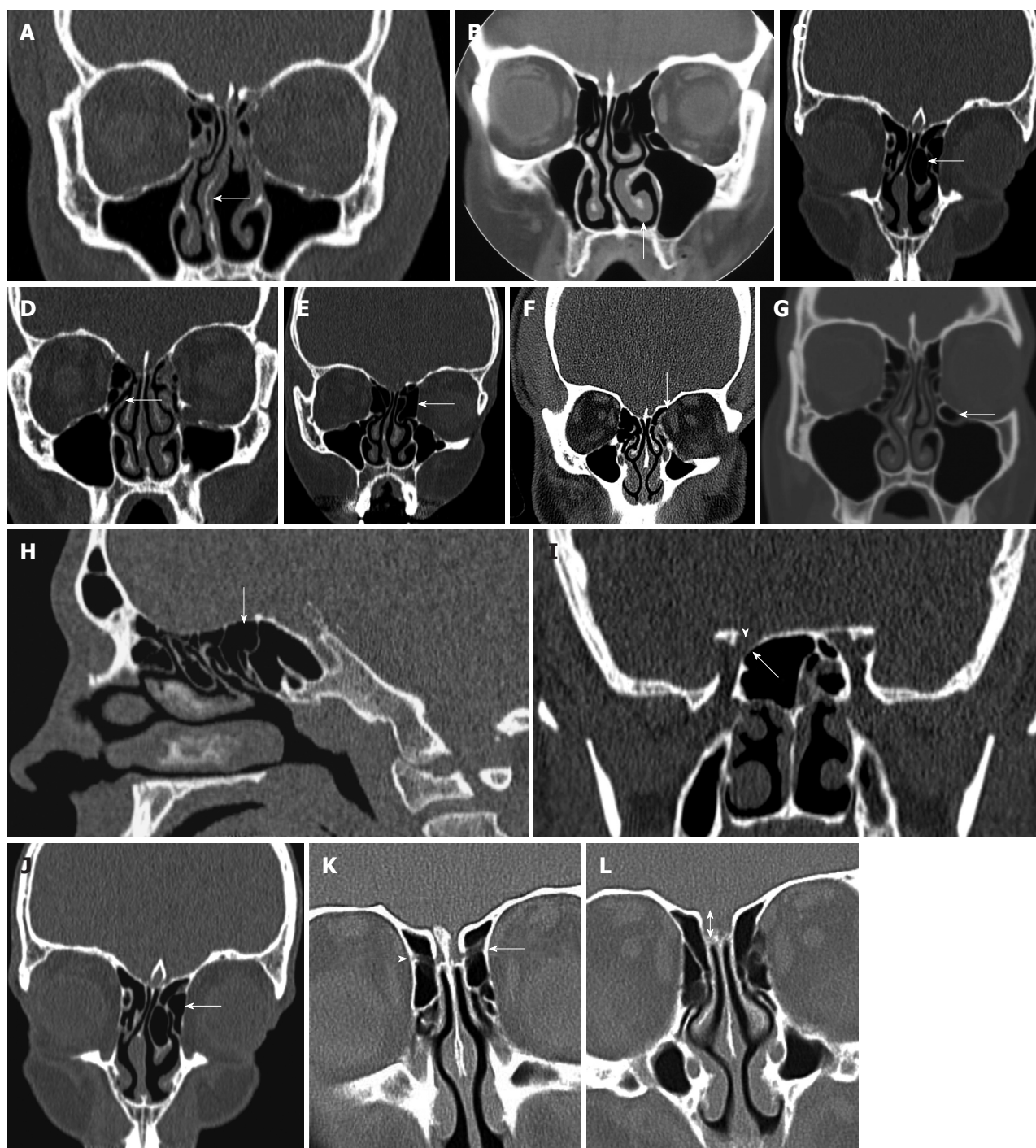
The next key landmark is the uncinate, an L-shaped bone of the lateral nasal wall, which forms the anterior border of the hiatus semilunaris, or infundibulum, which

marks the location of the OMC (Figure 2D). The natural ostium of the maxillary sinus is typically located just posterior to the uncinate process, one third of the distance along the middle turbinate, from its anterior edge. Surgically, the uncinate must be removed to gain access to the ethmoid infundibulum and maxillary sinus ostium. The free edge of the uncinate may be deviated medially, laterally, pneumatized or bent and when such deviations are lateral, they can result in narrowing of the hiatus semilunaris and infundibulum, jeopardizing their patency. A so called “atelectatic” uncinate occurs where the free edge of the uncinate approximates the orbital floor or inferior aspect of the lamina papyracea, and an uncinectomy in this setting may result in damage to orbital contents. Once the uncinate has been resected, the ostium of the maxillary sinus can be visualized and enlarged by a maxillary antrostomy. These steps, uncinectomy and maxillary antrostomies, form the basis of the FESS procedure and are essential for optimal surgical outcome.

The next structure encountered is the ethmoid bulla (Figure 2E). The relationship of the ethmoid bulla with the lamina papyracea laterally, and the floor of the anterior cranial fossa superiorly, should be clarified on preoperative CT. The ethmoid bulla is a reliable surgical landmark, because it is the largest and most constant of the anterior ethmoid cells. It is located just beyond the natural ostium of the maxillary sinus and forms the posterior border of the hiatus semilunaris. Superiorly, the bulla may extend to the ethmoid roof or alternatively, a suprabullar recess may exist above the roof of the bulla.

The ethmoid sinus is composed of anterior and posterior groups of air cells, consisting of a variable number of cells (typically 7-15). The close relationship of the orbit and the anterior skull base render these structures vulnerable intraoperatively. An important finding to note on review of imaging of the anterior ethmoid air cells is the presence of a dehiscent lamina papyracea (Figure 2F). In this anatomical variant, the orbital contents are not protected by bone along the lateral orbital margin, and are at increased risk of injury intraoperatively.

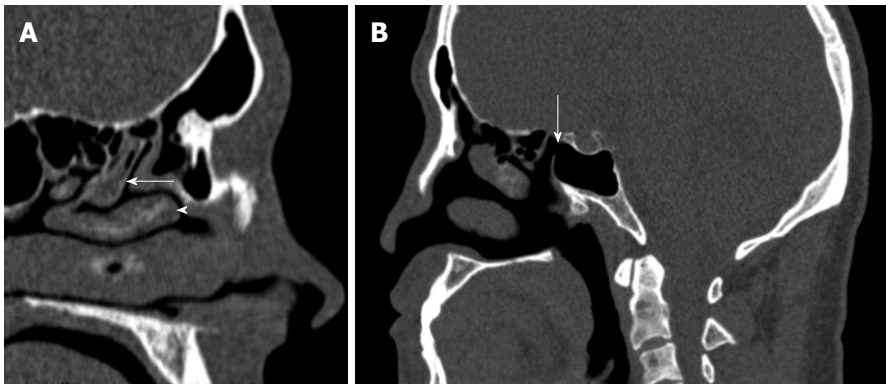
Haller cells are ethmoid cells that extend into the



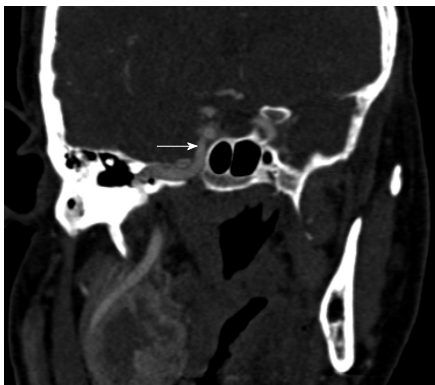
**Figure 2 Coronal computed tomography reformat.** A: The paranasal sinuses demonstrating a deviated septum to the right side (arrow); B: Mucosal thickening of the inferior turbinate on the left side (arrow); C: A pneumatized left middle turbinate (arrow); D: The uncinate process (arrow); E: The ethmoid bulla adjacent to the left orbit (arrow), note its extent to the floor of the anterior cranial fossa cranially and lamina papyracea laterally; F: A dehiscent lamina papyracea on the left side (arrow); G: An infra-orbital cell (Haller cell) (arrow); H: The posterior ethmoid cell (arrow) directly anterior to the sphenoid sinus; I: At level of sphenoid sinuses, thinning of the bony in the superolateral right sphenoid sinus adjacent to the right optic nerve (arrow head); J: The agger nasi cell (arrow) which lies inferior to the frontal recess and lateral to the middle turbinate; K: The anterior ethmoidal artery (arrow) traversing the anterior ethmoid air cells, which is susceptible to injury during functional endoscopic sinus surgery; L: A type III olfactory fossa (arrow).

floor of the orbit and are more appropriately referred to as infraorbital cells, which vary in size, but when large, can narrow the ostia of the maxillary sinus or ethmoid infundibulum (Figure 2G). Controversy surrounds the exact origin of Haller cells, as to whether they arise from the anterior or posterior ethmoid cells. Their prevalence

is thought to be in the region of 10%, although results in the literature vary widely. Haller cells are thought to be implicated as a possible etiological factor in recurrent maxillary sinusitis due to their negative influence on maxillary sinus ventilation by narrowing the infundibulum and maxillary ostium.



**Figure 3** Sagittal computed tomography reformat. A: The paranasal region demonstrating the vertical basal lamella (arrow) and horizontal components (arrowhead); B: The location of the sphenothmoidal recess (arrow) in relation to the cranial fossa.



**Figure 4** Arterial phase computed tomography oblique reformat of the region of the sphenoid sinuses demonstrates the relationship of the internal carotid artery (arrow) to the sphenoid sinus.

The posterior ethmoidal and sphenoid sinuses are accessed through the anterior ethmoidal air cells. The anatomy of the posterior ethmoid is critically important because of its variable relationship with the sphenoid sinus. Although routine FESS does not ordinarily encompass a posterior ethmoidectomy or entry to the sphenoid sinus, such steps may be indicated if significant pathology is evident on preoperative imaging. Exenteration of the posterior ethmoid results in access to the sphenoid sinus; the most posterior of the sinuses (Figure 2H). The posterior ethmoid cells may extend laterally or superiorly beyond the anterior wall of the sphenoid sinus, and therefore, the surgeon cannot assume that the sphenoid sinus is directly behind the posterior ethmoid cells. Furthermore, the sphenoid sinus is related to several important, potentially hazardous structures, including the internal carotid artery; typically the most posterior-lateral structure within the sphenoid sinus (Figure 4). Another key structure, the optic nerve, produces an anteroposterior indentation in the roof of the sphenoid, and in about 4% of patients, the overlying bone is dehiscent (Figure 2I), and thus the importance of a systematic approach to the use of coronal, axial and sagittal images for CT evaluation<sup>[7]</sup>.

The presence of an Onodi cell, a posterior ethmoid

cell extending to the sphenoid sinus, lying medially to the optic nerve, places the nerve at an increased risk of damage during sinus surgery. These cells can, in some cases, even surround the optic nerve and their reported incidence is about 5%<sup>[8]</sup>. The best orientation for identifying the Onodi cells are axial images, where the course of the optic nerve can be followed past the orbital apex and judged in relation to the posterior ethmoid and sphenoid sinuses. Identification of an Onodi cell preoperatively is paramount because its presence may contribute to an increased risk of injury, of not only the optic nerve, but additionally, the internal carotid artery. Another common anatomical variant are agger nasi cells (Figure 2J), which are located just anterior to the attachment of the middle turbinate and the frontal recess. These represent the most anterior ethmoid cells and are an important surgical landmark, and are identified in as many as 88.5% of preoperative images<sup>[9]</sup>. On coronal CT they appear inferior to the frontal recess and lateral to the middle turbinate, and on the sagittal plane they are located anterior and inferior to the frontal recess. Surgically, opening these cells usually provides an excellent view of the frontal recess. When there is extensive pneumatization of the agger nasi cells, it may displace the attachment of the middle turbinate medially and superiorly and result in anatomical narrowing of the frontal recess. The exact location of the agger nasi cells is of clinical importance in the pathogenesis of chronic rhinosinusitis, and the close relationship of these cells to the lacrimal bone may explain the presence of epiphora in select patients with sinus disease.

If they are not noted preoperatively, some anatomical variations may contribute to surgical complications along the floor of the anterior cranial fossa. The ethmoid roof is formed by the fovea ethmoidalis of the frontal bone laterally and the cribriform plate of the ethmoid bone medially, and asymmetry in its height may expose the lower side to inadvertent penetration during surgery. The anterior ethmoidal artery crosses the ethmoid sinus and enters the anterior cranial fossa before exiting and re-entering the nasal cavity *via* the cribriform plate, and this is the site where the vessel is most vulnerable to injury (Figure 2K).



Another important anatomical variation occurring along the ethmoid roof is described by the Keros classification. This measures the vertical height between the cribriform plate and fovea ethmoidalis and the depth is categorized as 1-3 mm (Keros I), 3-7 mm (Keros II) and 7-16 mm (Keros III) (Figure 2L). Clearly, as this bone is thin, an increased vertical height will result in an increased risk of intraoperative damage.

The nasopharynx or postnasal space is evaluated on preoperative CT, although this region is not routinely involved in the FESS procedure. Postnasal space imaging is most commonly indicated for the presence of nasopharyngeal lesions. Extension of nasopharyngeal tumors, especially at the skull base and deep facial planes, is well illustrated on imaging. Magnetic resonance imaging best depicts perineural spread, whereas CT is useful to detect very early skull base erosion<sup>[10]</sup>.

Finally, the sphenoid sinus may be involved in sino-genic disease. Drainage of this sinus is through the sphenoidal recess, although the position of the natural ostium of the sphenoid is highly variable<sup>[11]</sup> (Figure 3B). The intersphenoid septum, partitioning the sinus, is often deflected to one side attaching to the bony wall covering the carotid artery, which can be avulsed during surgery. The artery may bulge into the sinus in 65%-72% of patients<sup>[12]</sup>, and the thin bone separating the artery and sphenoid sinus may be absent in 4%-8% of cases<sup>[13]</sup>. Recent studies have re-emphasized the need for multiplanar reconstruction as a routine part of presurgical work-up of this complex anatomical region<sup>[14]</sup>.

## CONCLUSION

Since the introduction of FESS in the United States in 1985, CT has been imperative in the understanding of regional anatomical variation and has been integral in the guidance of surgical procedures. Improvement in both FESS techniques and CT technology has concurrently expanded the indications for sinus surgery. Preoperative CT also can provide data for intraoperative stereotactic guidance systems, which are used to manage complex disease, and for revision surgery. Major complications in FESS, although rare, are potentially catastrophic. A detailed knowledge of normal and aberrant sinonasal anatomy is essential to the success and safety of sinus surgery. CT has very much emerged as the gold standard in preopera-

tive diagnosis and allows for accurate patient selection for FESS, and radiologists should be familiar with the FESS technique and have a systematic approach to reviewing CT scans for normal and aberrant sinus anatomy.

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S- Editor Cheng JX L- Editor Kerr C E- Editor Zheng XM

## Value of acoustic radiation force impulse elastography for the assessment of ascites syndrome

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Received: June 1, 2011 Revised: July 12, 2011

Accepted: July 19, 2011

Published online: August 28, 2011

### Abstract

**AIM:** To assess the feasibility of performing acoustic radiation force impulse (ARFI) elastography in patients with ascites and its predictive value for the cirrhotic or non-cirrhotic etiology of ascites.

**METHODS:** Our study included 153 patients with ascites, mean age  $58.8 \pm 13.1$  years. One hundred and fifteen (75.2%) patients had ascites in the context of cirrhosis, 29 (18.9%) had non-cirrhotic ascites (diagnosed by clinical, ultrasound, endoscopic and/or laparoscopic criteria) and in 9 (5.9%) cases we could not establish the etiology of ascites. We performed 10 ARFI measurements and the median value was calculated and expressed in meters/second (m/s). Among the 29 patients with non-cirrhotic ascites were included: 20 laparoscopically demonstrated peritoneal carcinomatosis with histological confirmation, 7 acute pancreatitis with ascites which later resolved, and one case each of lymphatic ascites and ascites in the context of a liver abscess. In 11 of the 20 patients with peritoneal carcinomatosis, the liver structure was homogenous in

the ultrasound examination and in 9 patients the ultrasound exam revealed liver metastases.

**RESULTS:** We could not obtain valid ARFI measurements in 5 patients (3.2%). The mean liver stiffness measurements by means of ARFI were statistically significantly higher in patients with cirrhotic ascites than in those with non-cirrhotic ascites:  $3.04 \pm 0.70$  vs  $1.45 \pm 0.59$  m/s ( $P < 0.001$ ). For a cut-off value of 1.8 m/s for predicting cirrhosis (and ascites in the context of cirrhosis), as obtained in a previous study, ARFI had 98.1% sensitivity, 86.2% specificity, 96.4% positive predictive value, 92.5% negative predictive value and 95.6% accuracy for predicting cirrhotic ascites. For a cut-off value of 1.9 m/s the accuracy was 94.9% and for a 2 m/s cut-off value it was 92.8%.

**CONCLUSION:** ARFI elastography is feasible in most patients with ascites and has a very good predictive value for the cirrhotic or non-cirrhotic etiology of ascites.

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**Key words:** Ascites; Liver stiffness; Liver cirrhosis; Acoustic radiation force impulse; Elastography

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Bota S, Sporea I, Șirli R, Popescu A, Dănilă M, Șendroi M. Value of acoustic radiation force impulse elastography for the assessment of ascites syndrome. *World J Radiol* 2011; 3(8): 205-209



## INTRODUCTION

Ascites is a fluid accumulation in the peritoneal cavity. Mild ascites is hard to notice by clinical exam, but severe ascites leads to abdominal distension. Patients with ascites generally will complain of progressive abdominal heaviness and pressure, as well as shortness of breath due to mechanical impingement on the diaphragm. The International Club of Ascites classified ascites as follows: grade 1 (mild, visible only on ultrasound); grade 2 (detectable with flank bulging and shifting dullness); and grade 3 (directly visible, confirmed with fluid thrill)<sup>[1]</sup>.

The peritoneal fluid can be transudate or exudate. The serum-ascites albumin gradient (SAAG) is probably the best method to differentiate transudate and exudate ascites<sup>[2]</sup>. A high SAAG ( $> 1.1$  g/dL) is suggestive of a portal hypertensive cause of ascites. A low gradient ( $< 1.1$  g/dL) indicates that the cause of ascites was not portal hypertension.

The causes of ascites with high SAAG (transudate) are: liver cirrhosis, heart failure, hepatic venous occlusion (Budd-Chiari syndrome or veno-occlusive disease), constrictive pericarditis, Kwashiorkor syndrome<sup>[3]</sup>. Causes of ascites with low SAAG (exudate) are: cancer (primary peritoneal carcinomatosis and metastasis), tuberculosis, pancreatitis, serositis, nephrotic syndrome or protein losing enteropathy<sup>[3]</sup>. Other causes of ascites are: Meigs syndrome, vasculitis, hypothyroidism, peritoneum mesothelioma<sup>[3]</sup>.

Acoustic radiation force impulse (ARFI) elastography is a new method used for the assessment of liver fibrosis, thyroid gland nodules, breast nodules, liver and kidney tumors<sup>[4-10]</sup>. The principle of ultrasound elastography is that compression of the examined tissue induces a smaller strain in hard tissues than in soft ones. The ultrasound probe automatically produces an acoustic "push" pulse that generates shear-waves which propagate into the tissue. Their speed, measured in meters/second (m/s), is displayed on the screen. The propagation speed increases with fibrosis severity. Using image-based localization and a proprietary implementation of ARFI technology, shear wave speed may be quantified in a precise anatomical region, focused on a region of interest, with a predefined size provided by the system. Measurement value and depth are also reported and the results of the elasticity are in m/s<sup>[11-13]</sup>.

## MATERIALS AND METHODS

We included in our study 153 consecutive patients, mean age  $58.8 \pm 13.1$  years, 61 women and 92 men. In each patient we measured the liver stiffness (LS) by means of ARFI in the right liver lobe, 1 cm below the liver capsule, by intercostal approach, with the patient laying in left

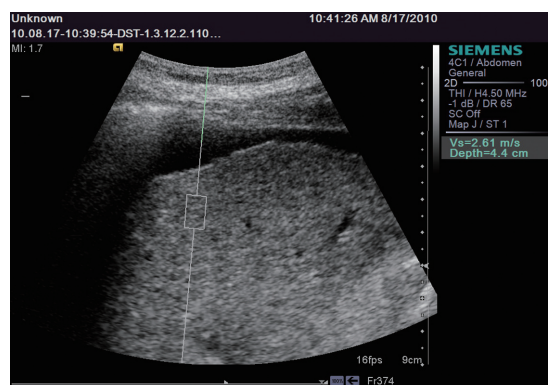


Figure 1 Acoustic radiation force impulse measurement.

lateral decubitus (Figure 1). ARFI measurements were performed with a Siemens Acuson S2000<sup>TM</sup> ultrasound system. In each patient, 10 valid ARFI measurements were performed and the median values were calculated, the results being expressed in meters/second (m/s). The investigator performed ARFI measurements blinded to the patient's clinical and biochemical data.

Our study included 115 patients (75.2%) with ascites caused by liver cirrhosis (diagnosed by clinical, ultrasound, endoscopic and/or laparoscopic criteria), 29 patients (18.9%) with non-cirrhotic ascites (20 laparoscopically demonstrated peritoneal carcinomatosis with histological confirmation, 7 acute pancreatitis with ascites which later resolved and one case each of lymphatic ascites and ascites in the context of a liver abscess) and 9 patients (5.9%) in whom we could not establish the etiology of ascites (the patients refused the laparoscopy). All the patients signed the informed consent and the study was approved ethically by the Emergency County Hospital Timisoara.

Data obtained from our patients were collected in a Microsoft Excel file, the statistical analysis being performed using the MedCalc program and WINK Statistical Data Analysis Research Software. ARFI measurements were numeric variables, so the mean values and standard deviation were calculated. The 2-way ANOVA test and *t* test were used to compare mean ARFI values of LS.

## RESULTS

The characteristics of the patients are presented in Table 1. In 11 of the 20 patients with peritoneal carcinomatosis, the liver structure was homogenous in the ultrasound examination and in 9 patients the ultrasound exam revealed liver metastases.

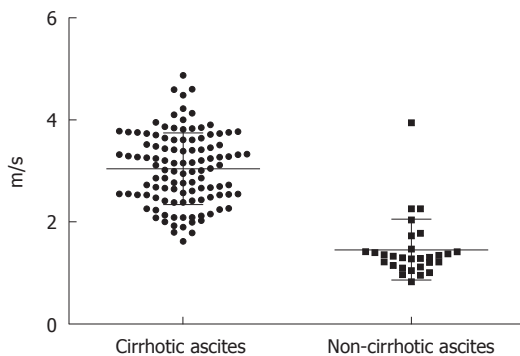
Of the 115 cirrhotic patients, 85 (73.9%) had esophageal varices, 23 (20%) had a history of variceal bleeding, 21 (18.2%) had hepatocellular carcinoma.

In 5 of the patients, we could not obtain valid measurements (3.2%) and in the other cases ARFI measurements ranged between 0.83 and 4.87 m/s. Our statistical analysis was made on 139 patients with valid ARFI measurements and proven cause of ascites.

**Table 1** Characteristics of the patients

Parameter	All patients	Cirrhotic patients	Non-cirrhotic patients
Mean age (yr)	58.8 ± 13.1	58.6 ± 12.1	57.4 ± 15.3
Sex, n (%)			
Female	61 (39.8)	50 (43.5)	7 (24.1)
Male	92 (60.2)	65 (56.5)	22 (75.9)
Classification of ascites, n (%)			
Grade 1	70 (45.7)	53 (46.1)	14 (48.3)
Grade 2	50 (32.7)	36 (31.3)	10 (34.4)
Grade 3	33 (21.5)	26 (22.6)	5 (17.3)
Mean ARFI values (range, m/s)	1.60 ± 0.66 (0.83-4.87)	3.04 ± 0.70 (1.62-4.87)	1.45 ± 0.59 (0.83-3.94)
Mean AST (U/L) (normal value = 5-34 U/L)	83.5 ± 72.8	95.1 ± 76.2	47.2 ± 43.4
Mean ALT (U/L) (normal value = 10-35 U/L)	47.7 ± 37.1	49.3 ± 33.5	47.1 ± 50
Mean total bilirubin (mg/dL) (normal value = 0.2-1 mg/dL)	3.25 ± 3.78	3.29 ± 2.80	3.41 ± 6.55
Mean total protein (g/dL) (normal value = 5.6-8 g/dL)	6.2 ± 1.2	6.5 ± 1.1	6 ± 1.2
Mean albumin (g/dL) (normal value = 3.5-5 g/dL)	3.02 ± 0.67	2.95 ± 0.66	3.38 ± 0.68
Mean prothrombin index time (%) (normal value > 75%)	70.1 ± 14.4	65.7 ± 16	86.3 ± 15.9
Mean cholinesterase value (U/L) (normal value = 4500-8000 U/L)	3252.9 ± 1743.1	2810.2 ± 1414.3	5220.3 ± 1977.2

AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; ARFI: Acoustic radiation force impulse.

**Figure 2** Distribution of liver stiffness values in patients with cirrhotic and non-cirrhotic ascites.

The mean LS measurements by means of ARFI were statistically significantly higher in patients with cirrhotic ascites than in those with non-cirrhotic ascites:  $3.04 \pm 0.70$  m/s *vs*  $1.45 \pm 0.59$  m/s ( $P < 0.001$ ) (Figure 2).

For a cut-off value of 1.8 m/s for predicting cirrhosis (and ascites in the context of liver cirrhosis), which is a figure resulting from our previous studies<sup>[8,9]</sup>, ARFI had very good predictive value for the cirrhotic etiology of the ascites (Table 2). If the cut-off value was set at 1.9 and 2 m/s, the predictive value was also very good (Table 2).

## DISCUSSION

Standard ultrasonography can be a useful tool for the etiological diagnosis of ascites syndrome. For instance, the surface of the liver is irregular in liver cirrhosis and regular in most other causes of ascites. In cirrhosis we can also find an enlarged spleen, a large portal vein, a thickened wall of the gallbladder with bowel loops freely floating within the ascitic fluid. If the peritoneal fluid is an exudate we can find small amorphous echoes within the fluid (“debris”), loculated fluid, matted bowel loops, hepatic metastases<sup>[14,15]</sup>. However, the differentiation

**Table 2** Predictive value of acoustic radiation force impulse elastography for the cirrhotic etiology of ascites (%)

Cut-off	Se	Sp	PPV	NPV	Accuracy
1.8 m/s	98.1	86.2	96.4	92.5	95.6
1.9 m/s	97.2	86.2	96.2	89.2	94.9
2 m/s	94.5	86.2	96.2	80.6	92.8

Se: Sensitivity; Sp: Specificity; PPV: Positive predictive value; NPV: Negative predictive value.

between benign and malignant ascites by means of ultrasound is frequently difficult or impossible.

ARFI elastography is a new method used for the assessment of LS. Unlike transient elastography (TE) (FibroScan, EchoSens-Paris, France), this new technique can additionally be performed in patients with ascites.

In our present study, we found statistically significant differences between LS measurements by means of ARFI in patients with cirrhotic ascites *vs* those with non-cirrhotic ascites ( $3.04 \pm 0.70$  m/s *vs*  $1.45 \pm 0.59$  m/s) ( $P < 0.001$ ). Although the patient groups were unbalanced, our results were confident enough to discriminate between the cirrhotic or non-cirrhotic etiology of ascites. For an LS cut-off value of 1.8 m/s, ARFI elastography had 95.6% accuracy for predicting the cirrhotic etiology of ascites (2 patients with cirrhotic ascites and 4 patients with non-cirrhotic ascites were incorrectly classified), for a cut-off value of 1.9 m/s, the accuracy was 94.9% (3 patients with cirrhotic ascites and 4 patients with non-cirrhotic ascites were incorrectly classified), and for a cut-off value of 2 m/s, it was 92.8% (6 patients with cirrhotic ascites and 4 patients with non-cirrhotic ascites were incorrectly classified). Thus, from our data it follows that the best ARFI cut-off for prediction of cirrhosis (and ascites in the context of the liver cirrhosis) is 1.8 m/s.

Of the 4 patients with non-cirrhotic ascites incorrectly classified for a 1.8 m/s cutoff value, in 2 cases ARFI

was difficult to determine (10 valid ARFI measurements and more than 7 invalid measurements) and in one case after we performed contrast enhanced ultrasonography we discovered multiple metastases (so ARFI was performed in the liver masses).

Regarding the 2 patients with cirrhotic ascites incorrectly classified for a 1.8 m/s cut-off value, in one case ARFI was difficult to determine (10 valid ARFI measurements and more than 7 invalid measurements).

Several studies have demonstrated the value of ARFI elastography for the prediction of liver cirrhosis and for the study of the liver in healthy subjects.

In a previous study performed by our group<sup>[9]</sup>, in which we included 114 subjects (38 healthy volunteers, 76 patients with chronic hepatopathies in whom liver biopsy (LB) was performed, and 23 with clinical, ultrasonographic and/or endoscopic signs of cirrhosis) investigated by means of ARFI, a direct, strong, linear correlation (Spearman rho = 0.675) was found between ARFI measurements and fibrosis ( $P < 0.0001$ ). The predictive value of ARFI for the presence of cirrhosis was also excellent; for a cut-off value of 1.8 m/s (for measurements made 1-2 cm under the capsule) the area under the receiver operating characteristic curve (AUROC) was 0.92.

In another study published in 2010 by our group<sup>[8]</sup>, which included 71 patients with chronic viral hepatopathies, all with LB, the cut-off value of ARFI measurement for the diagnosis of cirrhosis was 1.8 m/s [AUROC 0.868, with 100% sensitivity (Se), 77% specificity (Sp), 58% positive predictive value (PPV) and 100% negative predictive value (NPV)].

In a study performed by Lupşor *et al*<sup>[7]</sup>, 112 patients with chronic HCV hepatitis were evaluated by means of LB (the stage of fibrosis was assessed according to the Metavir scoring system), ARFI and TE (FibroScan). For a cut-off value of  $> 2$  m/s for the prediction of cirrhosis, ARFI had 80% Se, 95.4% Sp, 90.3% PPV and 90% NPV (AUROC = 0.93). Also, in the study of Fierbinteanu-Braticevici *et al*<sup>[16]</sup> which evaluated 79 patients with chronic HCV hepatitis who underwent LB and ARFI, this new elastographic method had very good sensitivity and specificity for prediction of cirrhosis (for a cut-off value  $> 1.94$  m/s ARFI had 100% Se, 98% Sp, 95% PPV and 100% NPV).

A study published by Goertz *et al*<sup>[10]</sup> included 57 patients with chronic viral hepatitis B and C who underwent ARFI and consecutive LB. The results were compared to the histological stage of fibrosis (F). ARFI values were significantly correlated with the histological stage of fibrosis ( $P < 0.001$ ). The AUROC curve for the accuracy of ARFI imaging was 87% for prediction of cirrhosis ( $F = 4$ ).

A study published by Haque *et al*<sup>[17]</sup> included 22 patients with chronic hepatopathies, in whom LB and ARFI were performed in the same session. ARFI values were compared with both Batts-Ludwing score (F0 to F4) and modified Ishak score (F0 to F4). For the prediction of liver cirrhosis, the AUROC was 0.85 for both Ishak and Batts-Ludwing scores.

In a study published by Piscaglia *et al*<sup>[18]</sup>, these authors included 133 patients with chronic liver disease evaluated by means of ARFI elastography and TE. In 70 patients they performed LB. The diagnostic accuracy for cirrhosis was first assessed in the 90 patients submitted to TE with  $> 13$  kPa (47% of patients) as diagnostic for cirrhosis values. The best cut-off for cirrhosis with ARFI was then tested in the 70 patients with biopsy (cirrhosis in 38% of patients). The AUROC of ARFI for the diagnosis of cirrhosis (reference TE) was 0.941 with 1.75 m/s as the best cut-off (Se 93.0%; Sp 85.1%). ARFI demonstrated good performance also in patients with bioptic diagnosis of cirrhosis (AUROC 0.908, Se 81.5%, Sp 88.4%).

In all the studies presented above, the cirrhotic patients did not have ascites.

Regarding the evaluation of LS in healthy subjects, Gallotti *et al*<sup>[19]</sup> measured the stiffness of various abdominal organs by ARFI elastography in 35 healthy subjects, obtaining for the liver a mean value of 1.59 m/s. Goertz *et al*<sup>[10]</sup> obtained a mean LS value of 1.09 m/s in a group of subjects without liver pathology. Popescu *et al*<sup>[20]</sup> evaluated by means of ARFI elastography 82 subjects without known liver pathology. The mean value of ARFI measurements in normal individuals was  $1.15 \pm 0.21$  m/s.

The results of our study support the conclusion that in the investigation of an ascites syndrome, the first investigation that should be performed after abdominal ultrasound should be ARFI elastography. Regarding the limitations of this study, ARFI is not a very good method for the evaluation of LS in cases of multiple metastases, in cases when performing ARFI in liver masses (when the liver structure is homogeneous in standard ultrasonography) or in cases with a success rate  $< 60\%$  (success rate = the ratio of the number of successful acquisitions over the total number of acquisitions).

ARFI elastography is feasible in most patients with ascites (96.8%) and it has a very good predictive value for the cirrhotic or non-cirrhotic etiology of ascites.

## COMMENTS

### Background

Ascites syndrome is a quite common discovery in abdominal ultrasonography and several methods are used to establish the cause of ascites.

### Innovations and breakthroughs

Acoustic radiation force impulse (ARFI) elastography is a new method, based on ultrasound, used for the evaluation of liver stiffness. The advantage of this elastographic method compared to transient elastography, is that it can be used in the presence of ascites. In our study, ARFI was determinable in 96.8% of the patients with ascites. ARFI had a very good accuracy (95.6% for a 1.8 m/s cut-off value) for the prediction of cirrhotic or non-cirrhotic etiology of the ascites.

### Applications

This study supports the conclusion that in the investigation of an ascites syndrome, the first investigation that should be performed after abdominal ultrasound should be ARFI elastography.

### Peer review

This is an interesting cross-sectional study evaluating liver stiffness by ARFI in subjects with ascites. The authors noticed higher values in subjects with cirrhosis, which is biological plausible. Additionally authors presented some cut-off points which could be used for the diagnosis of cirrhosis in subjects with ascites. This study is clearly presented and is well written; however, some revisions are needed to improve the manuscript.

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S- Editor Cheng JX L- Editor Logan S E- Editor Zheng XM



## Poul Erik Andersen's radiological work on osteochondrodysplasias and interventional radiology

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Received: October 20, 2010 Revised: April 11, 2011

Accepted: April 18, 2011

Published online: August 28, 2011



Figure 1 Poul Erik Andersen, MD, PhD, EBIR, Professor, Department of Radiology, Cardiovascular Section, Odense University Hospital, Sdr. Boulevard, DK-5000 Odense C, Denmark.

### Abstract

Poul Erik Andersen is a Professor and Interventional Radiologist at the University of Southern Denmark, Odense and Odense University Hospital, Denmark. His innovative and expertise is primarily in vascular interventions where he has introduced and developed many procedures at Odense University Hospital. His significant experience and extensive scientific work has led to many posts in the Danish Society of Interventional Radiology, the European Society of Radiology and the Cardiovascular and Interventional Radiological Society of Europe, where he is a fellow and has passed the European Board of Interventional Radiology - The European qualification in Interventional Radiology.

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**Key words:** Biography; Clinical competence; Education; Interventional; Radiology

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Andersen PE. Poul Erik Andersen's radiological work on os-

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### INTRODUCTION AND EDUCATIONAL EXPERIENCE

Dr. Poul Erik Andersen (Figure 1) is a Professor of Radiology at the University of Southern Denmark, Odense. He received his Medical degree from the University of Southern Denmark, Odense in 1974, and passed the Educational Council for Foreign Medical Graduates, Philadelphia, Penn., USA exam in 1975. He was certified as a Specialist in Radiology in 1982. Since 1983, Dr. Andersen has been Chief Radiologist/Consultant of the Department of Radiology, Cardiovascular Section at Odense University Hospital.

### ACADEMIC ACHIEVEMENTS

#### Cardiopulmonary diseases

Poul Erik Andersen's scientific research was primarily on cardiopulmonary diseases<sup>[1-22]</sup> including left ventricular





Figure 2 Different embolization materials.

function examinations in ischemic heart diseases, before and after coronary bypass surgery and coronary angioplasty (PCI) and in cardiomyopathy<sup>[4-6,9,12-16]</sup>. He and his group demonstrated that revascularization of the myocardium improved left ventricular function.

### Osteochondrodysplasias

Subsequently, his research was on the epidemiological and radiological findings in congenital osteochondrodysplasias<sup>[23-45]</sup> where he was the first to describe heterogeneity and to define two radiological subtypes of autosomal dominant osteopetrosis<sup>[32,33]</sup>. These two radiological subtypes were later shown to correlate with two biochemical and genetically well defined subtypes<sup>[35,43]</sup>. Furthermore, he demonstrated that osteochondrodysplasias have a higher prevalence in the population than previously supposed, and that the incidence of chondrodysplasia (achondroplasia) was less seldom than generally recognized. These findings resulted in his Ph.D. degree in 1987 from the University of Southern Denmark, Odense with the thesis: "Generalized Osteochondrodysplasias and other Syndromes with Characteristic Bone Manifestations in the County of Fyn, Denmark. A Clinical, Radiological, and Epidemiological Investigation"<sup>[30,39,42]</sup>.

### Interventional vascular radiology, embolizations

In recent years, Poul Erik Andersen's research has been focussed on interventional vascular radiology, especially

embolizations<sup>[44-62]</sup>. He and his group formed a Danish National Centre for patients with hereditary haemorrhagic telangiectasia (HHT) (Mb. Osler) in which treatment of pulmonary arteriovenous malformations (PAVM) by embolization was introduced in 1996<sup>[44,45]</sup> and plays a central role in the treatment of these patients<sup>[44-47,50,54,56,58,62]</sup>. He has introduced several different embolization techniques for the embolization of PAVM, such as detachable silicone balloons, coils, microcoils, detachable coils, and vascular plugs (Figure 2). The group has also performed epidemiologic studies on HHT<sup>[44,45,48]</sup>, and recently at least three genetic subtypes of HHT have been demonstrated<sup>[52]</sup>. Poul Erik Andersen and his interventional group are also leading the treatment of uterine fibroids in Denmark using uterine artery embolization, which was introduced in 1999<sup>[48]</sup>. Furthermore, they perform many other embolization procedures for conditions such as gastrointestinal bleeding, bleeding in trauma patients, haemoptysis, and in many tumour types.

Embolization may be life saving in acute cases such as those with haemoptysis<sup>[55]</sup>, gastrointestinal bleeding<sup>[60,61]</sup> and bleeding due to trauma. These embolization treatments are minimally-invasive techniques which, to a great extent, have substituted the corresponding conventional surgical procedures, and include the treatment of PAVM, as well as many cases of uterine fibroids, gastrointestinal bleeding, and the treatment of haemoptysis and patients with bleeding due to trauma.

### **Interventional radiology, angioplastics: Should this be angioplasty?**

Within the field of Interventional Vascular Radiology, Dr. Andersen has been innovative and has introduced the use of percutaneous transluminal angioplastics in peripheral arteries at the Odense University Hospital in 1984, renal angioplastics in 1985<sup>[51,57]</sup>, in coronary arteries (PTCA, PCI) in 1986, and peripheral vascular stents in 1991. He also introduced the first coronary stents in Denmark in 1992, the first carotid angioplastic in Denmark in 1993<sup>[21]</sup>, and the first carotid stent implantation in Scandinavia in 1996. In addition, angioplastics in renal arteries in patients with renovascular hypertension is now the treatment of choice. He has refined these embolization techniques, including the use of microcatheters and has introduced many new embolization materials.

Dr. Andersen has published more than one hundred research papers in peer reviewed journals and book chapters, and is the author of a radiological textbook (Chest Radiology) and editor of another radiological textbook (Musculoskeletal Radiology). Dr. Andersen has presented more than one hundred papers and lectures at several Postgraduate Courses and at the Danish, Nordic, European, and World Congresses. He has been an invited speaker and has chaired and moderated at several international meetings, including the European Congresses of Radiology (ECR) in Vienna and the Annual Meetings and Postgraduate Courses of the Cardiovascular and Interventional Radiological Society of Europe (CIRSE). He is a member of the abstract reviewer group in both ECR and CIRSE and a member of the faculty for CIRSE. He was the local Meeting Chairman of CIRSE in Copenhagen in 2008 and a member of the Executive Committee and Scientific Programme Planning Committee for CIRSE.

He is a subcommittee member and has assisted in the preparation of the educational programme, abstract review and grading in the topics: "Cardiac" and "Interventional Radiology" at several European Congresses of Radiology and is Chairman of the Interventional Radiology Subcommittee 2011.

He has been a peer reviewer for several scientific journals including Danish Medical Journal (Ugeskr. Laeger), *Acta Orthopaedica Scandinavica*, *American Journal of Medical Genetics*, *Acta Radiologica*, *European Respiratory Journal*, *European Radiology*, *European Journal of Vascular and Endovascular Surgery*, *CardioVascular & Interventional Radiology*, *European Journal of Cancer*, *Lung*, *Thorax*, and *World Journal of Radiology* as well as research grant committees.

As a leading radiologist, Dr. Andersen has received numerous awards from the Danish Society of Radiology, the Danish Heart Association, the James Polack's Foundation, the Disabled Foundation, and Poul Lundbeck's Foundation.

Dr. Andersen has been a lecturer at the University of Southern Denmark, Odense in Anatomy and Radiology since 1979 and since 1985 has held the position of Associate Professor at the Institute of Radiology, University

of Southern Denmark, Odense and from 2011 Professor of Radiology, University of Southern Denmark, Odense.

Since 1994, he has been a member and since 2000 a Fellow of CIRSE, and has passed the European Board of Interventional Radiology - The European qualification in Interventional Radiology.

He is a member of the Danish Society of Radiology and Danish Society of Interventional Radiology, and Chairman of the Danish Society of Interventional Radiology from 2002 - 2006. He has arranged and led several postgraduate courses and scientific meetings in the Danish Society of Interventional Radiology and has held in all nine uterine fibroid embolization (UFE) Workshops at Odense University Hospital for Radiologists from Denmark, Sweden, Finland, Italy, and Holland and has given simulator training as a Proctor on UFE at the CIRSE meeting in 2010. He has had many positions in the Danish Society of Radiology and has for many years been Chairman of the Educational Committee for Radiologists. **Since 2010, Dr. Andersen has been Co-Editor of *World Journal of Radiology*.**

## **CONCLUSION**

Interventional radiology (IR) techniques are patient-friendly minimally-invasive procedures which in many cases can substitute for the corresponding surgical treatments. Patients treated with IR generally have a shorter hospital stay and recovery than patients treated with the corresponding surgical procedures. IR involves very selective treatments with few complications. IR is now a UEMS recognized and fast growing radiological subspecialty with great research potential.

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S- Editor Cheng JX L- Editor Webster JR E- Editor Zheng XM

## Acknowledgments to reviewers of *World Journal of Radiology*

Many reviewers have contributed their expertise and time to the peer review, a critical process to ensure the quality of *World Journal of Radiology*. The editors and authors of the articles submitted to the journal are grateful to the following reviewers for evaluating the articles (including those published in this issue and those rejected for this issue) during the last editing time period.

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## Events Calendar 2011

January 23-27 Radiology at Snowbird San Diego, Mexico	March 20-25 Abdominal Radiology Course 2011 Carlsbad, CA, United States	the Art: A Collaborative Course for Radiologists and Sports Medicine Specialists New York, NY, United States	September 22-25 European Society of Neuroradiology (ESNR) XXXV Congress and 19th Advanced Course Antwerp, Belgium
January 24-28 Neuro/ENT at the Beach Palm Beach, FL, United States	March 26-31 2011 SIR Annual Meeting Chicago, IL, United States	May 24-26 Russian Congress of Radiology Moscow, Russia	October 12-14 International Conference Vipimage 2011 - Computational Vision and Medical Image Processing Algarve, Portugal
February 28-29 MIAD 2011 - 2nd International Workshop on Medical Image Analysis and Description for Diagnosis System Rome, Italy	March 28-April 1 University of Utah Neuroradiology 2nd Intensive Interactive Brain & Spine Imaging Conference Salt Lake City, UT, United States	May 28-31 International Congress of Pediatric Radiology (IPR) London, United Kingdom	October 15-16 Essentials of Emergency and Trauma Radiology Ottawa, Canada
February 5-6 Washington Neuroradiology Review Arlington, VA, United States	April 3-8 1st Annual Ottawa Radiology Resident Review Ottawa, Canada	June 4-8 58th Annual Meeting of the Society of Nuclear Medicine San Antonio, TX, United States	October 23-29 2011 IEEE NSS - 2011 IEEE Nuclear Science Symposium and Medical Imaging Conference Valencia, Spain
February 12-17 MI11 - SPIE Medical Imaging 2011 Lake Buena Vista, FL, United States	April 3-8 43rd International Diagnostic Course Davos on Diagnostic Imaging and Interventional Techniques Davos, Switzerland	June 6-8 UKRC 2011 - UK Radiological Congress Manchester, United Kingdom	October 25-28 NYU Radiology in Scottsdale - Fall Radiology Symposium in Scottsdale Scottsdale, AZ, United States
February 17-18 2nd National Conference Diagnostic and Interventional Radiology 2011 London, United Kingdom	April 6-9 Image-Based Neurodiagnosis: Intensive Clinical and Radiologic Review, CAQ Preparation Cincinnati, OH, United States	June 8-11 CIRA 2011 - Canadian Interventional Radiology Association Meeting Montreal, QC, Canada	October 28-30 Fourth National Congress of Professionals of Radiological Techniques Florianópolis, Brazil
February 17-18 VII National Neuroradiology Course Lleida, Spain	April 28-May 1 74th Annual Scientific Meeting of the Canadian Association of Radiologists CAR Montreal, Canada	June 9-10 8th ESGAR Liver Imaging Workshop Dublin, Ireland	October 28-30 Multi-Modality Gynecological & Obstetric Imaging Ottawa, Canada
February 18 Radiology in child protection Nottingham, United Kingdom	May 5-8 EMBL Conference-Sixth International Congress on Electron Tomography Heidelberg, Germany	June 17-19 ASCI 2011 - 5th Congress of Asian Society of Cardiovascular Imaging Hong Kong, China	November 3-4 9th ESGAR Liver Imaging Workshop Taormina, Italy
February 19-22 COMPREHENSIVE REVIEW OF MUSCULOSKELETAL MRI Lake Buena Vista, FL, United States	May 10-13 27th Iranian Congress of Radiology Tehran, Iran	June 22-25 CARS 2011 - Computer Assisted Radiology and Surgery - 25th International Congress and Exhibition Berlin, Germany	November 15-19 EANM 2011 - Annual Congress of the European Association of Nuclear Medicine Birmingham, United Kingdom
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March 3-7 European Congress of Radiology Meeting ECR 2011 Vienna, Austria	May 21-24 European Society of Gastrointestinal and Abdominal Radiology 2011 Annual Meeting Venice, Italy	August 1-5 NYU Clinical Imaging Symposium in Santa Fe Santa Fe, NM, United States	November 26-28 8th Asia Oceanian Congress of Neuro-Radiology Bangkok, Thailand
March 6-9 World Congress Thoracic Imaging - IV Bonita Springs, FL, United States	May 23-25 Sports Medicine Imaging State of		



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### GENERAL INFORMATION

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The role of academic journals is to exhibit the scientific levels of a country, a university, a center, a department, and even a scientist, and build an important bridge for communication between scientists and the public. As we all know, the significance of the publication of scientific articles lies not only in disseminating and communicating innovative scientific achievements and academic views, as well as promoting the application of scientific achievements, but also in formally recognizing the "priority" and "copyright" of innovative achievements published, as well as evaluating research performance and academic levels. So, to realize these desired attributes of *WJR* and create a well-recognized journal, the following four types of personal benefits should be maximized. The maximization of personal benefits refers to the pursuit of the maximum personal benefits in a well-considered optimal manner without violation of the laws, ethical rules and the benefits of others. (1) Maximization of the benefits of editorial board members: The primary task of editorial board members is to give a peer review of an unpublished scientific article via online office system to evaluate its innovativeness, scientific and practical values and determine whether it should be published or not. During peer review, editorial board members can also obtain cutting-edge information in that field at first hand. As leaders in their field, they have priority to be invited to write articles and publish commentary articles. We will put peer reviewers' names and affiliations along with the article they reviewed in the journal to acknowledge their contribution; (2) Maximization of the benefits of authors: Since *WJR* is an open-access journal, readers around the world can immediately download and read, free of charge, high-quality, peer-reviewed articles from *WJR* official website, thereby realizing the goals and significance of the communication between authors and peers as well as public reading; (3) Maximization of the benefits of readers: Readers can read or use, free of charge, high-quality peer-reviewed articles without any limits, and cite the arguments, viewpoints, concepts, theories, methods, results, conclusion or facts and data of pertinent literature so as to validate the innovativeness, scientific and practical values of their own research achievements, thus ensuring that their articles have novel arguments or viewpoints, solid evidence and correct conclusion; and (4) Maximization of the benefits of employees: It is an iron law that a first-class journal is unable to exist without first-class editors, and only first-class editors can create a first-class academic journal. We insist on strengthening our team cultivation and construction so that every employee, in an open, fair and transparent environment, could contribute their wisdom to edit and publish high-quality ar-

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#### Name of journal

*World Journal of Radiology*

#### ISSN

ISSN 1949-8470 (online)

#### Indexed and Abstracted in

PubMed Central, PubMed, Digital Object Identifier, and Directory of Open Access Journals.

#### Published by

Baishideng Publishing Group Co., Limited.

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### Format

#### Journals

*English journal article (list all authors and include the PMID where applicable)*

- 1 **Jung EM**, Clevert DA, Schreyer AG, Schmitt S, Rennert J, Kubale R, Feuerbach S, Jung F. Evaluation of quantitative contrast harmonic imaging to assess malignancy of liver tumors: A prospective controlled two-center study. *World J Gastroenterol* 2007; **13**: 6356-6364 [PMID: 18081224 DOI: 10.3748/wjg.13.6356]

*Chinese journal article (list all authors and include the PMID where applicable)*

- 2 **Lin GZ**, Wang XZ, Wang P, Lin J, Yang FD. Immunologic effect of Jianpi Yishen decoction in treatment of Pixu-diarhoea. *Shijie Huaren Xiaohua Zazhi* 1999; **7**: 285-287

*In press*

- 3 **Tian D**, Araki H, Stahl E, Bergelson J, Kreitman M. Signature of balancing selection in Arabidopsis. *Proc Natl Acad Sci USA* 2006; In press

*Organization as author*

- 4 **Diabetes Prevention Program Research Group**. Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. *Hypertension* 2002; **40**: 679-686 [PMID: 12411462 PMCID:2516377 DOI:10.1161/01.HYP.0000035706.28494.09]

*Both personal authors and an organization as author*

- 5 **Vallancien G**, Emberton M, Harving N, van Moorselaar RJ; Alf-One Study Group. Sexual dysfunction in 1, 274 European men suffering from lower urinary tract symptoms. *J Urol* 2003; **169**: 2257-2261 [PMID: 12771764 DOI:10.1097/01.ju.0000067940.76090.73]

*No author given*

- 6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

*Volume with supplement*

- 7 **Geraud G**, Spierings EL, Keywood C. Tolerability and safety of frovatriptan with short- and long-term use for treatment of migraine and in comparison with sumatriptan. *Headache* 2002; **42** Suppl 2: S93-99 [PMID: 12028325 DOI:10.1046/j.1526-4610.42.s2.7.x]

*Issue with no volume*

- 8 **Banit DM**, Kaufer H, Hartford JM. Intraoperative frozen section analysis in revision total joint arthroplasty. *Clin Orthop Relat Res* 2002; **(401)**: 230-238 [PMID: 12151900 DOI:10.1097/00003086-200208000-00026]

*No volume or issue*

- 9 Outreach: Bringing HIV-positive individuals into care. *HRS-A Careaction* 2002; 1-6 [PMID: 12154804]

### Books

*Personal author(s)*

- 10 **Sherlock S**, Dooley J. Diseases of the liver and biliary system. 9th ed. Oxford: Blackwell Sci Pub, 1993: 258-296

*Chapter in a book (list all authors)*

- 11 **Lam SK**. Academic investigator's perspectives of medical treatment for peptic ulcer. In: Swabb EA, Azabo S. Ulcer disease: investigation and basis for therapy. New York: Marcel Dekker, 1991: 431-450

*Author(s) and editor(s)*

- 12 **Breedlove GK**, Schorffheide AM. Adolescent pregnancy. 2nd ed. Wicczorek RR, editor. White Plains (NY): March of Dimes Education Services, 2001: 20-34

*Conference proceedings*

- 13 **Harnden P**, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ cell tumours Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer, 2002: 30-56

*Conference paper*

- 14 **Christensen S**, Oppacher F. An analysis of Koza's computational effort statistic for genetic programming. In: Foster JA, Lutton E, Miller J, Ryan C, Tettamanzi AG, editors. Genetic programming. EuroGP 2002: Proceedings of the 5th European Conference on Genetic Programming; 2002 Apr 3-5; Kinsdale, Ireland. Berlin: Springer, 2002: 182-191

**Electronic journal** (list all authors)

- 15 Morse SS. Factors in the emergence of infectious diseases. *Emerg Infect Dis* serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: <http://www.cdc.gov/ncidod/eid/index.htm>

**Patent** (list all authors)

- 16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

### Statistical data

Write as mean  $\pm$  SD or mean  $\pm$  SE.

### Statistical expression

Express *t* test as *t* (in italics), *F* test as *F* (in italics), chi square test as  $\chi^2$  (in Greek), related coefficient as *r* (in italics), degree of freedom as *v* (in Greek), sample number as *n* (in italics), and probability as *P* (in italics).

### Units

Use SI units. For example: body mass, *m* (B) = 78 kg; blood pressure, *p* (B) = 16.2/12.3 kPa; incubation time, *t* (incubation) = 96 h; blood glucose concentration, *c* (glucose) 6.4  $\pm$  2.1 mmol/L; blood CEA mass concentration, *p* (CEA) = 8.6 24.5  $\mu$ g/L; CO<sub>2</sub> volume fraction, 50 mL/L CO<sub>2</sub>, not 5% CO<sub>2</sub>; likewise for 40 g/L formaldehyde, not 10% formalin; and mass fraction, 8 ng/g, etc. Arabic numerals such as 23, 243, 641 should be read 23 243 641.

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### Italics

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Biology: *H. pylori*, *E. coli*, etc.

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