Preface

This book was conceptualized to address the need for a pragmatic and complete overview of radiologic anatomy of the head and neck. Although some aspects of radiologic anatomy are described in extended handbooks of radiology, a step-by-step manual to aid recognition of the normal structures in the entire head and neck region has not been available before.

This book is an illustrated guide to radiologic anatomy of the head and neck as visualized on the most frequently used radiologic modalities, that is, conventional radiography, computed tomography (CT), and magnetic resonance imaging (MRI). Furthermore, radiologic features of the most commonly occurring and characteristic pathologies of the head and neck region are shown, with the aim of aiding recognition earlier in the diagnostic pathway. The differential diagnosis and possible points of interest are also discussed. For MRI, Chapter 1 provides an overview of the interpretation of findings.

For residents, knowledge of normal radiologic anatomy is a first step in recognizing pathology in this field, diagnosing diseases, and planning surgical procedures. For specialists, this book provides an opportunity to update their knowledge and refine their radiologic diagnostic skills in a time of rapidly progressing radiologic techniques.

Most radiologic books are mainly or exclusively written by radiologists. This guide has been designed from the perspective of the field of otorhinolaryngology and will be a vital diagnostic tool in clinical practice. It emphasizes the importance of the relation between clinical features and radiologic findings in the establishment of the correct diagnosis.

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The author welcomes suggestions for improving the content of this book in future editions. If you have any comments, please send an email to dunnebier@zonnet.nl.
3 Pathology of the Temporal Bone

Pathology of the External Auditory Canal

Inclusion Cholesteatoma and Atresia of the External Auditory Canal

Differential Diagnosis

- Any benign mass in the region of the external auditory canal, post-traumatic cholesteatoma of the external auditory canal, or cholesteatoma due to secondary stenosis of the external auditory canal as a result of chronic cicatriz- ing external otitis or bony stenosis due to fibrous dysplasia or exostosis in the lateral part of the external auditory canal.
- Aural atresia is often related to syndromes such as Treacher Collins, Crouzon, Nager, Goldenhar, Klippel–Feil, and Pierre Robin.

Points of Evaluation

- Expansion toward and/or destruction of the temporomandibular joint and toward the middle ear structures, abscess formation, and osteomyelitis and (intracranial) spread of infection.
- In case of aural atresia (first branchial groove anomaly), other dysmorphic features may be present too, especially in case of syndromal comorbidity.
- Particular attention needs to be paid to:
  - the appearance of the middle ear cavity and mastoid pneumatization
  - signs of ankylosis or malformation of the ossicular chain
  - presence of inner ear deformities, the round and oval windows and the vestibular aqueduct
  - aberrations in the anterior and/or lateral course of the facial nerve, which may complicate surgery.
a **CT, axial.** Expanding, round, smooth-bordered lesion (1) in the cranial part of the mastoid with partial destruction of the cortex (2). The head of the malleus is possibly dysmorphic and ankylosic (3). Note the geniculate ganglion (4) with a clearly visible greater petrosal nerve canal anteriorly. The vestibule and horizontal semicircular canal (5) are normal.

b **CT, axial.** More caudally, osseous atresia of the external auditory canal is observed with osseous occlusion (1). The mastoid is not pneumatized (2). Lateral to the atresia is an expanding mass (3), suggestive of inclusion cholesteatoma, filling the meatus. The cochlea (4) and internal auditory canal (5) show normal features.
Exostoses of the External Auditory Canal

Differential Diagnosis

- Exostoses are frequently multiple and bilateral.
- An osteoma of the external auditory canal is most often unilateral, isolated, and round in shape.
- Fibrous dysplasia has a specific appearance on computed tomography (CT) and typically is not limited to the external auditory canal (see also “Fibrous Dysplasia” [1] and [2]).
- Clinically, exostoses can be easily differentiated from soft-tissue tumors by palpation.

Points of Evaluation

- In patients with aural discharge, chronic otitis may be the result of infected epithelial stasis.
- In cases with a narrowed orifice and meatus, a meatoplasty might be considered for better aeration and cleaning options. Furthermore, CT might be reassuring, showing a normal aerated middle ear.

Fig. 3.1c

c CT, axial. On a lower slice, a narrowed and ending obstructed meatus is observed (1), as well as an expansile mass (2) near the temporomandibular joint (3) without signs of destruction. The slice is taken at the level of the basal cochlear turn (4) and of the roof a high jugular bulb (5).
**Fig. 3.2a** Patient referred by his general practitioner because of abnormalities in the outer ear canal.

**a CT, axial.** Small exostoses are visualized in the roof of the external auditory canal near the annulus (1), and a larger one laterally on the floor of the meatus (2). Although some accumulation of cerumen (3) is present, hearing did not seem to be compromised, and there was no discharge. Also clearly seen are the basal cochlear turn (4), vestibule (5), and horizontal (6) and anterior (7) semicircular canals.

**Fig. 3.2b** Another patient with more extensive exostoses.

**b CT, axial.** Only a small lumen remains (1), with accumulation of cerumen or epithelium more medially (2) with a high risk of impaction and development of an inclusion cholesteatoma. Note the internal carotid artery (3), indicating the caudal orientation of this slice.
4  Radiologic Anatomy of the Skull Base

The skull base can be evaluated by computed tomography (CT), which will demonstrate the bony structures of the skull base with its foramina and fissures for vessels and cranial nerves, the temporal bone, and sinonasal cavities. Magnetic resonance imaging (MRI) will demonstrate the contents of the foramina and fissures as well as the intracranial soft tissues. CT or MRI may provide enough information individually to demonstrate and classify the pathology in this area, however, when used together these modalities can be complementary and define even better the invasion and destruction of (bony) structures of the skull base by soft-tissue masses.

Radiologic Evaluation Points of the Skull Base

Computed Tomography

- Bony outline of the outer skull.
- Bony outline of the intracranial skull base.
- Temporal bone structures: internal auditory canal, vestibular and cochlear aqueduct, apex.
- Foramina: ovale, spinosum, jugular, rotundum.
- Large vessels: carotid artery, sigmoid sinus, jugular bulb.
- Supraorbital fissure and orbital structures.
- Infratemporal fossa, sphenoidal bone, clivus.
- Clinoid processes, sella and pituitary fossa.
- Features of the pathology: expanding or invasive growth pattern.

Magnetic Resonance Imaging

- Intracranial brain structures: cerebrum, cerebellum, pons and brainstem, ventricles, dural outlines.
- Vascular structures: transverse sinus, sigmoid sinus and jugular bulb, superior petrosal sinus, carotid artery, vertebrobasilar system, anterior and posterior inferior cerebellar arteries (AICA and PICA).
- Temporal bone: fluid contents (T2-weighted MR image) of inner ear structures and internal auditory canal, appearance of the cochlear, vestibular (inferior and superior), and facial nerves.
• Other cranial nerves: olfactory region, optic nerve, supraorbital fissure, abducens and trigeminal nerves, Meckel cave.
• Intensities on T1-weighted and T2-weighted MR images, with contrast, and possible asymmetry.

Evaluation of the Skull Base on Axial CT Slices in a Craniocaudal Sequence

![Figure 4.1 CT slice.](image)

1 Temporal bone
2 Anterior semicircular canal
3 Posterior clinoid
4 Anterior clinoid
5 Dorsum sellae
6 Pituitary fossa
7 Tuberculum sellae
8 Fovea ethmoidalis (cranial nerve I in anterior cranial fossa)
9 Superior orbital fissure
Fig. 4.2  Axial CT slice.
1 Subarcuate canal and artery
2 Posterior cranial fossa
3 Middle cranial fossa
4 Posterior clinoid process
5 Anterior clinoid process
6 Superior orbital fissure (cranial nerves III, IV, VI, and a part of V)
7 Sphenoid bone
8 Crista galli
9 Fovea ethmoidalis
10 Region of the cavernous sinus and internal carotid artery

Fig. 4.3  Axial CT slice.
1 Emissary vein
2 Internal auditory canal (cranial nerves VII and VIII)
3 Geniculate ganglion
4 Petrous apex
5 Foramen for the ophthalmic nerve (part of the trigeminal nerve)
6 Superior orbital fissure
7 Sphenoid sinus
8 Ethmoid sinus
9 Optic nerve (cranial nerve II)
10 Horizontal semicircular canal and vestibule
6 Radiologic Anatomy of the Nasal Cavity and Paranasal Sinuses

Conventional radiography (plain film) of the paranasal system and other parts of the skull is frequently used as a screening tool in the diagnosis of sinusitis, but has limited value for detailed evaluation due to superimposition of structures.

For more accurate preoperative evaluation and use during surgery, computed tomography (CT) is the preferred tool to visualize anatomic borders and to detect pathology in the paranasal system. Although CT does not always clearly differentiate between soft-tissue processes and secretions, it provides crucial information about disease localization and integrity of the osseous structures.

Magnetic resonance imaging (MRI) enables better discernment of the characteristics of soft-tissue disease and the relation to other anatomic structures, as well as spread to and invasion into these structures. Detailed information is provided about the intracranial compartments as well as the intraorbital structures. Examples of MRI are shown and discussed in Chapter 5.

In conventional radiography, the Caldwell view and Waters view are the most commonly used projections; these are complementary to each other.

![Fig. 6.1 Caldwell view](image.png)

1 Left frontal sinus, right side aplasia
2 Ethmoid sinus
3 Planum sphenoidale
4 Superior aspect of the petrous bone
5 Pneumatized and aerated mastoid cells
6 Foramen rotundum (infraorbital canal)
7 Zygomatic arch (better seen on Waters view)
8 Mastoid apex
9 Maxillary sinus
10 Maxilla
11 Inferior turbinate
12 Nasal septum
13 Cochlea
14 Innominate line of the greater wing of the sphenoid
15 Lamina papyracea
16 Crista galli
**Fig. 6.2 Waters view**

1. Frontal sinus
2. Frontal recess
3. Supraorbital nerve canal
4. Orbital floor
5. Maxillary sinus
6. Sphenoid sinus
7. Intersphenoidal septum

**Fig. 6.3 Waters view.** Waters view of a 7-year-old child. The frontal sinuses are not yet pneumatized. In the region of the maxillary sinus, several unerupted teeth are present, which limit the surgical procedures that can be carried out in this area.
Evaluation Points for CT of the Nasal Cavity and Paranasal Sinuses

Although most of the below-mentioned points of evaluation might also be evaluated on plain films, CT will demonstrate much more detail on bony outlines and contents. Systematic evaluation is best done in an anteroposterior sequence, starting with the coronal slices followed by a craniocaudal sequence of axial slices. In both sequences, the evaluation starts with the less complex slices. The paranasal sinuses as well as the remaining structures are systematically and bilaterally screened according to the points mentioned below. Although a clinical description will end up being longer, it is always worth looking at both sides in the evaluation, even in cases without pathology.

Frontal Sinus

- Presence, extension, and degree of pneumatization, bony outlines.
- Contents: septal structures, aeration or opacification of the sinus.
- In case of opacification: characteristics such as calcifications.
- Frontal recess: patency and opacification.

Ethmoid Sinus

- Degree of pneumatization, bony outlines.
- Opacification: diffuse, localization (anterior/posterior).
- Ethmoid roof: appearance, height, and left/right differences.
- Ethmoid bulla: morphology, degree of caudal extension.
- Lamina papyracea.

Infundibulum

- Patency, morphology of the uncinate process.
- Obstruction by a caudally extended ethmoid bulla, opacities.

Maxillary Sinus

- Degree of pneumatization, bony outlines, tooth elements, any fistulas from the maxilla.
- Morphology of the bony canal containing the infraorbital nerve.
- Presence of retention cysts and their relation to the natural ostium, degree of obstruction, opacifications and their characteristics.
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