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Ein Erfahrungs-bericht aus der Thieme Gruppe

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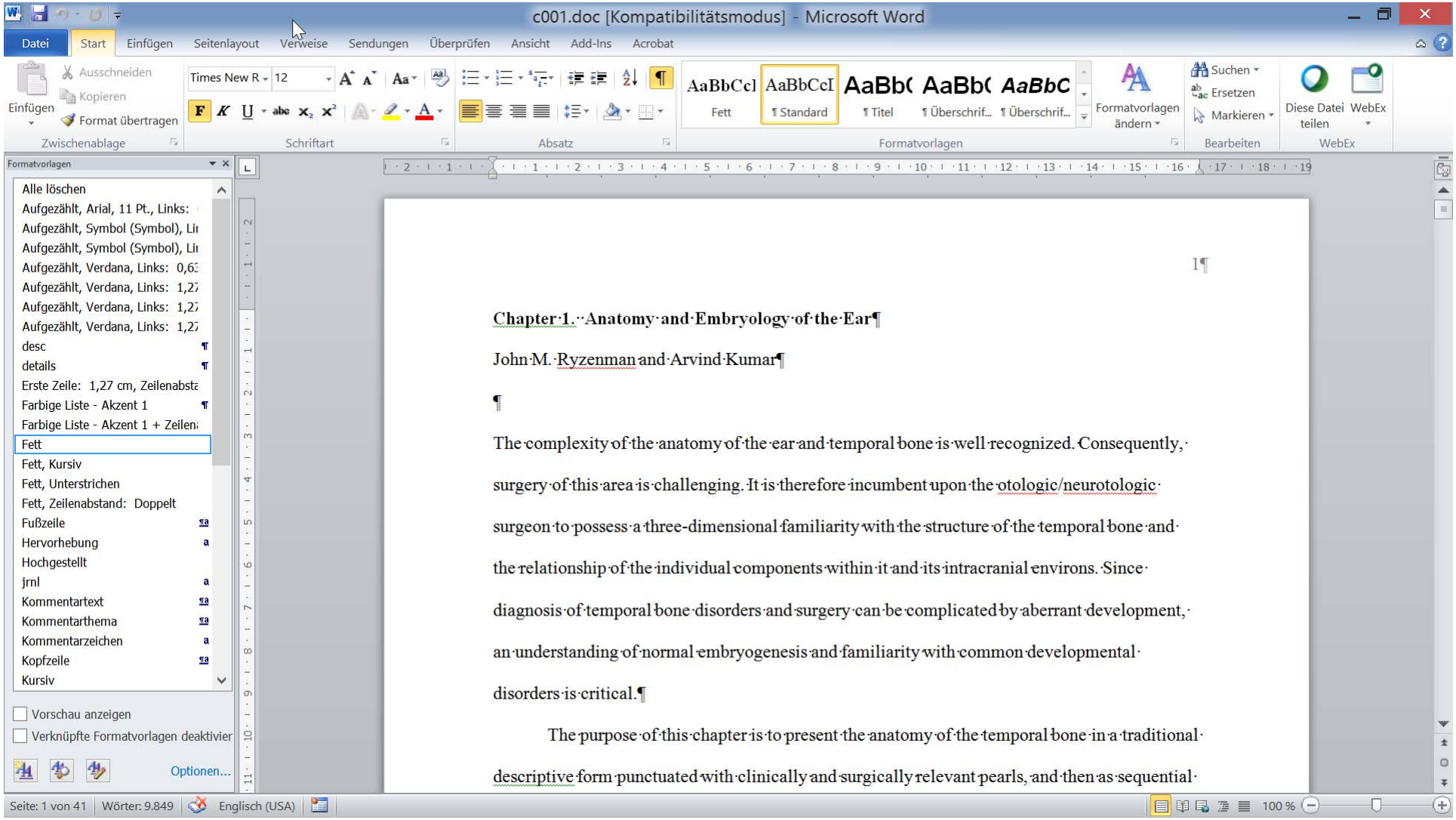
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John·M.·Ryzenman and·Arvind·Kumar¶
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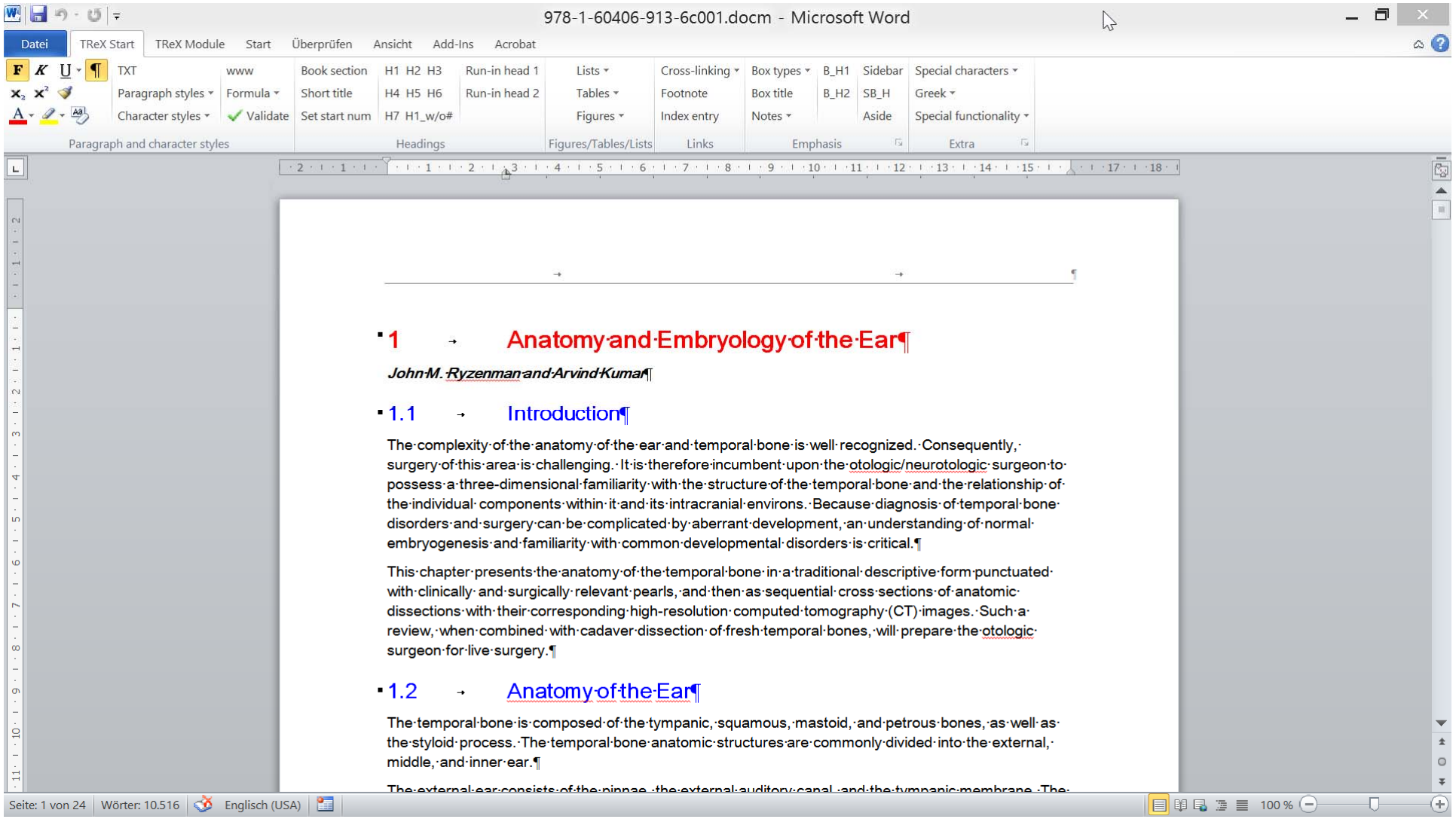
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1 Anatomy and Embryology of the Ear
John M. Ryzenman and Arvind Kumar
1.1 Introduction
The complexity of the anatomy of the ear and temporal bone is well recognized. Consequently, surgery of this area is challenging. It is therefore incumbent upon the otologic/neurotologic surgeon to possess a three-dimensional familiarity with the structure of the temporal bone and the relationship of the individual components within it and its intracranial environs. Because diagnosis of temporal bone disorders and surgery can be complicated by aberrant development, an understanding of normal embryogenesis and familiarity with common developmental disorders is critical.
This chapter presents the anatomy of the temporal bone in a traditional descriptive form punctuated with clinically and surgically relevant pearls, and then as sequential cross sections of anatomic dissections with their corresponding high-resolution computed tomography (CT) images. Such a review, when combined with cadaver dissection of fresh temporal bones, will prepare the otologic surgeon for live surgery.
1.2 Anatomy of the Ear
The temporal bone is composed of the tympanic, squamous, mastoid, and petrous bones, as well as the styloid process. The temporal bone anatomic structures are commonly divided into the external, middle, and inner ear.
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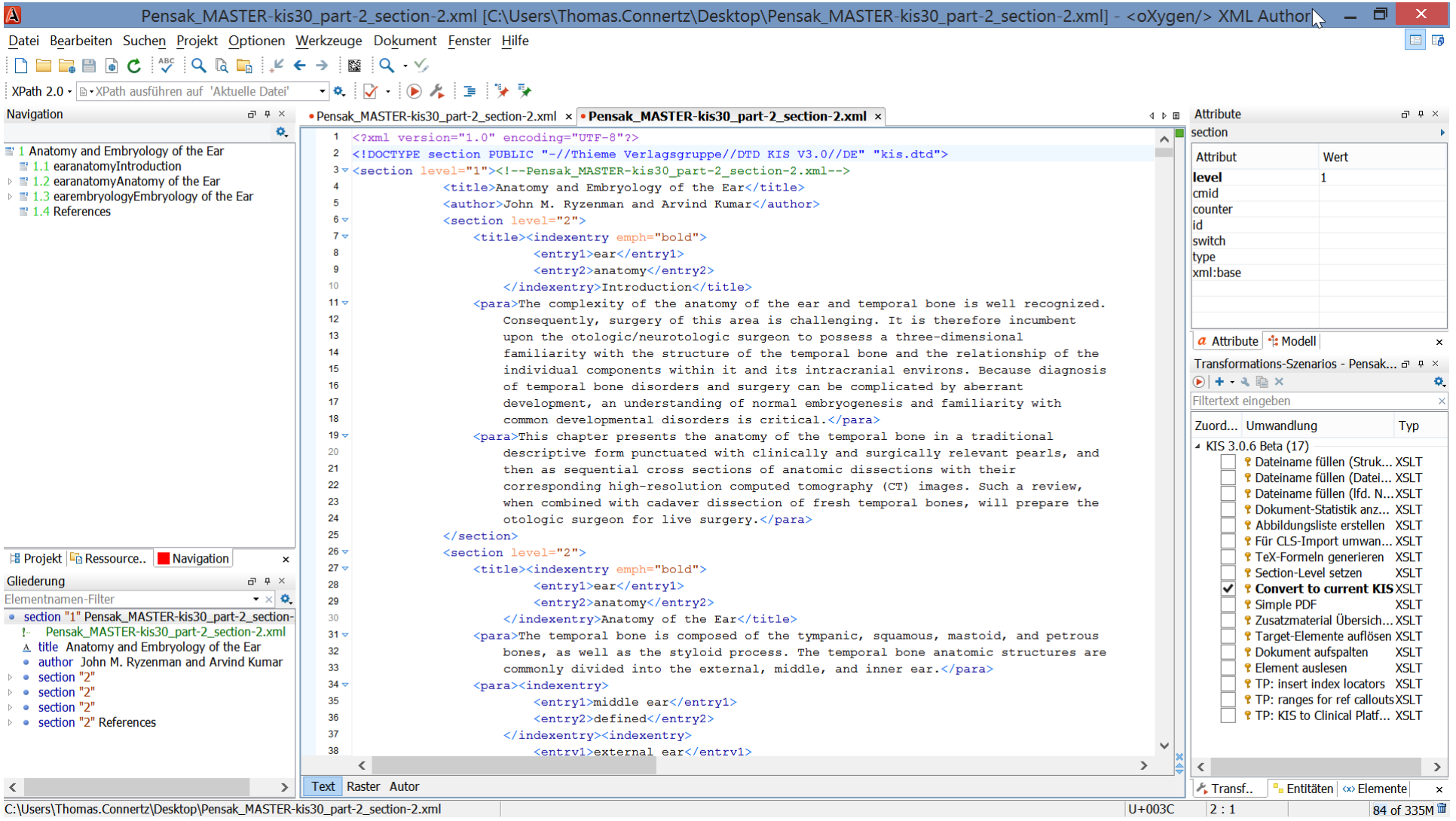
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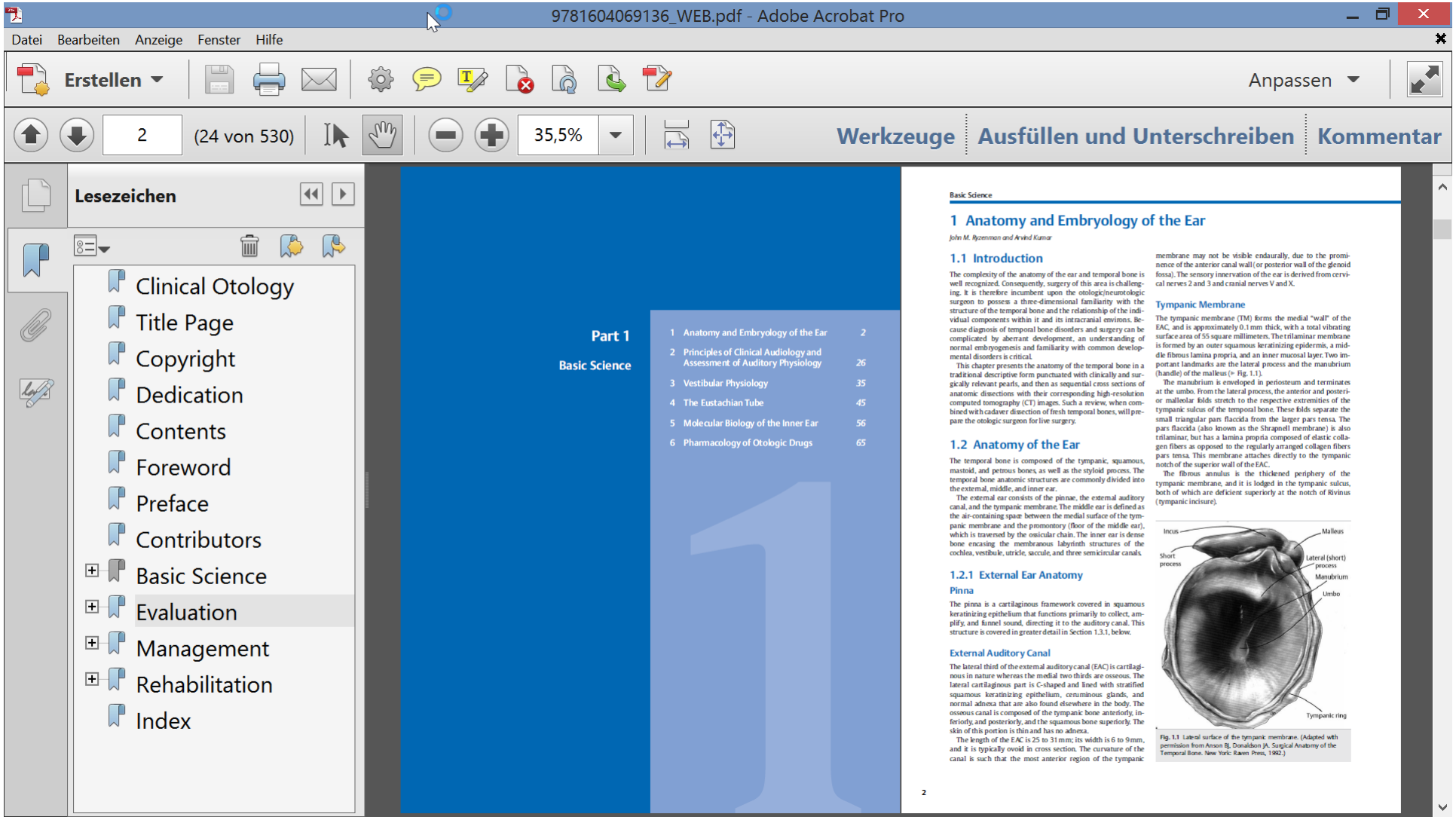
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Basic Science
1 Anatomy and Embryology of the Ear
John M. Ryzenman and Arvind Kumar
1.1 Introduction
1.2 Anatomy of the Ear
1.2.1 External Ear Anatomy
Pinna
External Auditory Canal
Tympanic Membrane
Incus
Malleus
Short process
Lateral (short) process
Manubrium
Umbo
Tympanic ring
Fig. 1.1 Lateral surface of the tympanic membrane. (Adapted with permission from Anson BJ, Donaldson JA. Surgical Anatomy of the Temporal Bone. New York: Raven Press, 1992.)
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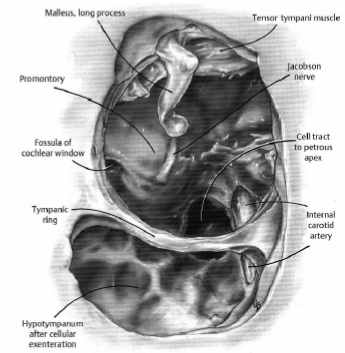

Fig. 1.6 The tympanic membrane has been excised, with the tympanic ring left intact. Bone has been removed inferior to the tympanic ring, demonstrating the extent of the hypotympanic pneumatization and the proximity of the vertical petrous carotid artery. (Adapted with permission from Anson BJ, Donaldson JA. Surgical Anatomy of the Temporal Bone. New York: Raven Press, 1992.)

lenticular process is particularly susceptible to osteitic resorption associated with medially retracted tympanic membranes.

The stapes is the most medial and smallest of the ossicles, composed of a head (capitulum), anterior and posterior crura, and the footplate. The footplate is encircled by the annular ligament, which serves as a "joint," sealing the footplate (like an O-ring around a piston) in the oval window. Ossification of this ligament occurs in otosclerosis. The stapedius tendon stretches anteriorly from the pyramidal eminence to attach to the superior aspect of the posterior crus, just inferior to the capitulum.

1.2.3 Eustachian Tube and Temporal Bone Pneumatization

The degree of pneumatization of the temporal bone is variable and may serve as a predictor of eustachian tube function. Five main tracts of pneumatization are recognized: the posterosuperior cell tract (running at the juncture of the posterior and middle fossa plates of the temporal bone), the posteromedial cell tract (paralleling and running inferior to the posterosuperior tract), the subarcuate tract (running through the arch of the superior semicircular canal), the perilabyrinthine tracts (running superior and inferior to the bony labyrinth), and the peritubal tract (surrounding the eustachian tube).

The eustachian tube itself is singularly significant in the maintenance of normal middle ear function and hearing. It consists of a fibrocartilaginous segment located anteromedially and an osseous segment located posterolaterally (▷ Fig. 1.7). The junction of these segments, the isthmus, is the narrowest portion of the eustachian tube. The total length of this tube averages 35 mm.

The fibrocartilaginous eustachian tube (▷ Fig. 1.8) has a shepherd's crook cross section, with a larger medial and a smaller lateral lamella. The inferior margin of the medial lamella has a groove for the levator palatini muscle, whereas the tensor veli palatini muscle attaches to the tip of the lateral lamella. Active opening of the upper half of the type, which ventilates the tympanic cavity, is accomplished by contraction of the tensor veli palatini muscle.[3] The mucociliary clearance function is located in the lower half of the type, which has an abundance of mucociliary cells. The lateral fat pad (of Ostmann) contributes to the resting closure of the tube and helps protect the tympanic cavity.[3] Loss of this fat pad is thought to be related to patulous eustachian tube syndrome.

1.2.4 Inner Ear Anatomy

Bony Labyrinth

The bony labyrinth serves as a protective covering for the membranous structures of the inner ear, and comprises the vestibule, the semicircular canals, and the cochlea. The bone is trilaminar, with an inner (endosteal) layer, an outer (periosteal) layer, and a middle mixed layer of intrachondral and endochondral bone, characterized by globuli interossei or islands of cartilage. Both the middle and endosteal layers demonstrate poor reparative capacities, and thus fractures of the labyrinth tend to heal only by the formation of fibrous tissue, with some bony repair by the periosteal layer.

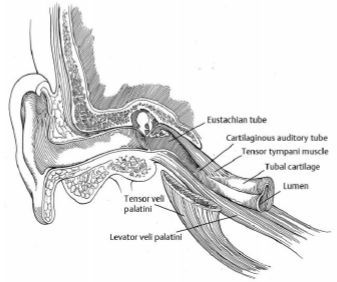

Fig. 1.7 The eustachian tube and its associated muscles. (Adapted with permission from Bluestone CD, Stool CE, eds. Pediatric Otolaryngology. Philadelphia: WB Saunders, 1990:320.)

Fig. 1.8 (a) Vertical section through the fibrocartilaginous (C) eustachian tube of an adult, illustrating the medial lamella (ML), the lateral lamella (LL), and their relation to the lumen (L). (b) Line drawing of a fibrocartilaginous (C) eustachian tube, illustrating the hypothesized functional areas. Tensor veli palatini muscle (TVPM) contraction causes lateral movement (*thick arrows*) of the lateral lamella (LL) with respect to the medial lamella (ML) from its resting position (*solid outline*) to its new position (*dashed line*). The elastin in the hinge portion mediates a return to resting position (*thin arrows*). R, roof; F, floor; OF, lateral fat pad of Ostmann.

Vestibule

The vestibule is an approximately 4-mm central chamber of the bony labyrinth, and it is dominated by depressions housing the utricle (the elliptical recess), the saccule (the spherical recess), and the basal end of the cochlear duct (the cochlear recess). The cribrose areas are perforations through which the nerve bundles gain access to the inner ear. The endolymphatic duct, housed within the bony vestibular aqueduct, originates at the posteroinferior aspect of the vestibule.

Cochlea

The cochlea is a 32-mm bony spiral that spirals 2½ turns about its central axis, the modiolus, to a total height of 5 mm. The base of the cochlea abuts the fundus of the internal auditory canal (IAC), and is perforated (the cribrose area) by its cochlear nerve fibers. The osseous spiral lamina also winds about the modiolus, partially subdividing the cochlear canal into the scala tympani and the scala vestibuli. The interscalar septum separates the cochlear turns (▷ Fig. 1.9).

Semicircular Canals

There are three semicircular canals: lateral (horizontal), posterior (posterior vertical), and superior (anterior vertical). These canals are orthogonally oriented to one another, measure 1 mm in diameter (expanding to 2 mm at the ampullae), and describe a 240-degree arc. Each of the three ampullae opens into the vestibule, as does the nonampullated end of the lateral canal. The nonampullated ends of the posterior and superior canals

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The manubrium is enveloped in periosteum and terminates at the umbo. From the lateral process, the anterior and posterior malleolar folds stretch to the respective extremities of the tympanic sulcus of the temporal bone. These folds separate the small triangular pars flaccida from the larger pars tensa. The pars flaccida (also known as the Shrapnell membrane) is also trilaminar, but has a lamina propria composed of elastic collagen fibers as opposed to the regularly arranged collagen fibers pars tensa. This membrane attaches directly to the tympanic notch of the superior wall of the EAC.

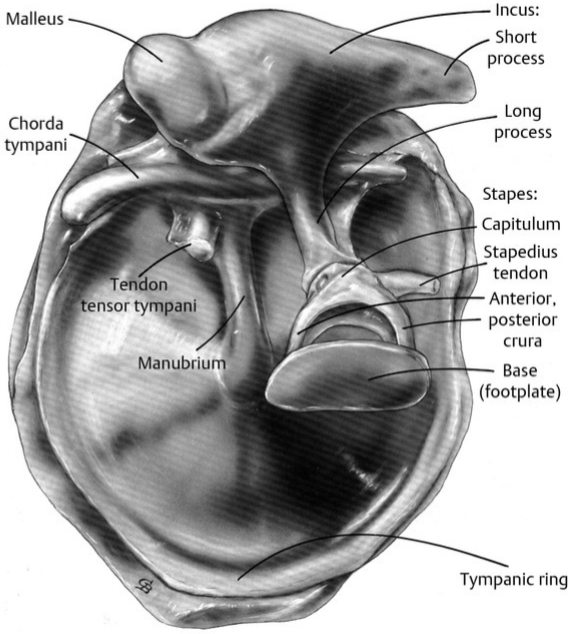
The fibrous annulus is the thickened periphery of the tympanic membrane, and it is lodged in the tympanic sulcus, both of which are deficient superiorly at the notch of Rivinus (tympanic incisure).

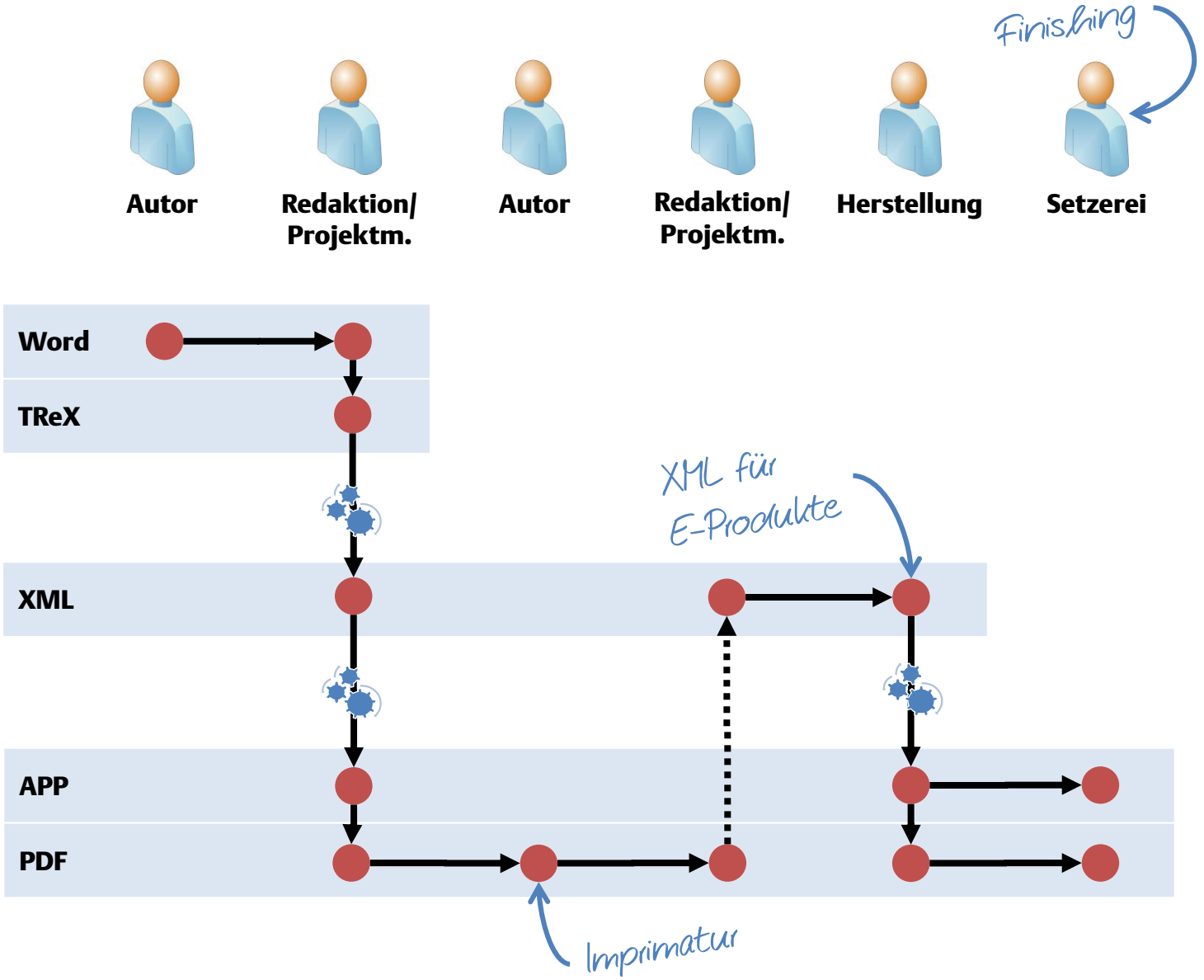
1.2.2 Middle Ear Anatomy

The middle ear is a sagittally oriented cleft that is pneumatized by the eustachian tube, traversed by the ossicular chain (described in detail below), and lined by cuboidal epithelial mucosa and goblet cells. The middle ear space is also traditionally further partitioned.

Mesotympanum

The mesotympanum represents the bulk of the middle ear space and is bounded by an imaginary line circumferentially from the tympanic sulcus (or most medial edge of the auditory canal) to the floor of the middle ear. Superiorly the compartment is limited by a horizontal plane drawn from the scutum to the tympanic segment of the facial nerve (fallopian) canal. This space has lateral, medial, and posterior "walls," and is bordered by three spaces: the protympanum (anteriorly), the epitympanum (superiorly), and the hypotympanum (inferiorly). Within the mesotympanum are found the manubrium, the long process of the incus, the stapes, and the chorda tympani nerve (▸ Fig. 1.2).

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