Imaging of the facial canal by means of multiplanar angulated 2-D-high-resolution CT-reconstruction

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Summary. The facial canal containing the intratemporal portion of the facial nerve is very important for the otologist and radiologist concerning fractures and other lesions of the temporal bone. Axial and/or coronal standards are sufficient for imaging of the labyrinthine and the mastoid segment of the facial canal. The sensitivity of visualization (sensitivity = number of identified structures per number of examinations) of the tympanic segment, however, is low and particularly the pyramidal segment (elbow, posterior knee) is not visualized in these standards. Based on anatomical considerations a new plain for imaging both the tympanic and mastoid segment in continuity was obtained. The pyramido-longitudinal plain is achieved by a twice angulated 2-D-reconstruction based on axial high-resolution CT-scans.

Imagerie du canal facial par reconstruction TDM en deux dimensions multiplan avec angulation à haute résolution

Résumé. Le canal facial, où chemine la partie intra-temporale du n. facial, est très important pour l’ORL et le radiologue s’intéressant aux fractures et aux autres lésions de l’os temporal. Les incidences standard axiales et/ou coronales sont suffisantes pour l’imagerie des segments labyrinthique et mastoïdien du canal facial. Cependant la sensibilité (rapport du nombre de structures identifiées au nombre d’examens) de ces incidences pour le segment tympanique est faible, en particulier le segment pyramidal (coude ou genou postérieur) n’est pas visualisé sur ces incidences standard. Sur la base de considérations anatomiques, un nouveau plan est défini pour l’imagerie simultanée des segments tympanique et mastoïdien. Le plan pyramido-longitudinal est obtenu par une reconstruction en deux dimensions angulée dans deux plans de l’espace, basée sur des examens tomodensitométriques (TDM) axiaux en haute résolution.

Key words: Facial nerve canal — Computed tomography, technique — Anatomy

The facial canal - first described by Gabriele Falopio- traverses the temporal bone in a Z-shaped course. It contains the intratemporal portion of the facial nerve, a fact that is very important for the otologist concerning fractures and lesions of the temporal bone. Therefore and because of the complicated anatomy of the temporal bone a high quality imaging of this canal is desirable. High quality images can be achieved by high resolution computed tomography. However, in standard CT-scans the facial canal is visualized only partially. Particularly the sensitivity of the tympanic segment of the facial canal is very low [2, 10, 13, 17, 21]. Therefore, the aim of this study was to gain a better imaging method of the whole facial canal, particularly of its tympanic segment.
Materials and methods

CT-scans of three cadaveric human heads and of 15 patients’ heads (with normal anatomy) were made in axial and coronal standards. Based on anatomical considerations secondary reconstructions were achieved using these axial scans to get longitudinal, i.e., parallel to the superior margin of the pyramid - scans of the temporal bone. Following decalcification with EDTA-solution the cadaveric heads were cut into 1.5 mm thick CT-according slices by means of a rotation-meat slicer. In addition anatomical preparations of slices of 1 cm thickness (cut by band saw in the same standards) were used to compare CT-scans and anatomical slices.

CT

The CT examinations were conducted, taking 1.5 mm thick axial images, using a Philips Tomoscan SR 7000 in high-resolution-mode (window center: 300 HU, window width: 1800 HU, scan time: 4 s). The scans were made adjacent to each other at 150 mA (600 mAs). The images were magnified with a zoom-factor of 1.6-1.9 in a field of view of 250 (Matrix: 512 x 512 pixels). The gantry-angulation for the axial scans was 15-20° to the orbito-meatal line. The longitudinal reconstructions were angulated 40-50° to the sagittal plane along the superior margin of the pyramid. Reference points for this reconstruction plane were the antero-lateral border of the canalis caroticus and the sulcus sinus sigmoideus. A second angulation to ventrolateral was 8-10° to the frontal plane; as angulation points the pyramidal basis and the internal acoustic meatus were used.

Decalcification [1]

The decalcifying solution was prepared as follows: 195 g EDTA (ethylene-diamintetracetic acid) were mixed with 200 ml aq.dest. heated and stirred. Then 50 ml of sodium hydroxide 40% were added. The solution was filled up to 800 ml with aq.dest and again sodium hydroxide 40 % was added drop by drop to a pH-level of 7.4. Finally aq.dest. was added up to 1000 ml. For decalcification we used formalin-fixed specimens. To achieve total decalcification we submerged the specimens for at least one month in 100 ml of EDTA-solution per gram of tissue.

Anatomy of the facial canal [3-9, 11, 12, 14-16, 18-20, 22-26]

The facial canal with approximately 3 cm total length is actually the longest osseous canal of a nerve in man. According to its Z-shaped course it is divided into three segments: a) the labyrinthine segment, b) the tympanic segment, and c) the mastoidal segment. The first two segments roughly lie in a horizontal plane and the last in a vertical plane. There is an angle between the first and the second segment as well as between the second and the third segment. The angle between the labyrinthine and the tympanic segment opens posteriorly by 70-80° and is called the “knee” or “geniculum” of the facial canal, containing the knee of the facial nerve and the geniculate ganglion. The angle between the tympanic and the mastoidal segment is wide open by 95-125° and is called the “elbow” [14], “posterior genu” [22, 26], or “pyramidal segment” [19] because this part lies beneath the pyramidal eminence that contains the stapedius muscle. The labyrinthine segment measures about 2.5-6 mm in length and about 0.8-2.5 mm in width. It runs from the upper medial part of the fundus of the internal auditory meatus to the geniculate fossa close behind the anterior wall of the petrous part of the temporal bone. The course of the labyrinthine segment is from postero-medial to antero-lateral and lies in between the cochlea (antero-medial) and the vestibule (postero-lateral). Moreover, this segment is concave on its medial side; it bends laterally around the cochlea. At its beginning it is divided from the cochlear nerve and the inferior part of the vestibular nerve by the falciform or transverse crest and from the superior branch of the vestibular nerve by a vertical crest called “Bill’s bar”-honoring William F. House [26]. At the end of this first segment the canal opens to the geniculate fossa which is approximately 3 mm in diameter. Here the canal bends sharply backwards (knee) to the tympanic segment. The tympanic segment measures about 8-12 mm in length and about 1.1-2.5 mm in width. It runs from the geniculate fossa to the pyramidal eminence. The course of this segment is from antero-medial to postero-lateral and lies in between the labyrinth (postero-medially) and the tympanic cavity (antero-laterally). Moreover, this segment is directed slightly downwards from the front to the back. In its course it runs over the cochleariform process and over the oval window. Finally it runs under and almost parallel to the anterior or ampullary crus of the lateral semicircular canal. Baxter [6] identified three sections of the tympanic segment: area geniculi, area cochleariformis, and area fenestrae ovalis. At the end of the second segment the canal bends gradually downwards (elbow) to the mastoidal segment. The mastoidal segment measures about 9-13 mm in length and about 1.3-3.7 mm in width. It runs from the pyramidal eminence to the stylomastoid foramen. The course of this segment goes from superior to inferior and sometimes a little backwards.

Decalcification [1]