MASTOIDECTOMY BY REAMING THE BONY EXTERNAL ACOUSTIC MEATUS PRINCIPLE OF THE TECHNIQUE

M. RĂDULESCU[1]

Prof. Dr. Dorin Hociotă" Institute of Phonoaudiology and ORL Functional Surgery

Keywords: *middle ear, mastoidectomy, surgical technique*

Abstract: *The author hereby presents the first paper of a series that provide a description of an original surgical technique for radical modified mastoidectomy, called the reaming of the external acoustic meatus. This article presents the principles, the schematic representation and the histological foundation of this new procedure.*

Cuvinte cheie: *ureche medie, mastoidectomie, tehnică chirurgicală*

Rezumat: *Autorul prezintă primul articol dintr-o serie în care realizează o descriere a unui procedeu original de mastoidectomie radicală modificată, pe care îl denumeşte alezarea meatului acustic extern osos. În prezentul articol se discută despre principiul, reprezentarea schematică şi fundamentarea histologică a procedeului.*

Within the technique we are going to present, the *bony external auditory meatus* is considered the main surgical landmark. More precisely, we refer to: 1) *the internal surface of its walls*, which are natural and constantly visible landmarks, 2) *the axis of the external auditory meatus*, which is a conventional landmark, an imaginary bent line easily represented. A careful analysis of the current surgical techniques shows that the external auditory meatus is undoubtedly, the essential landmark. Although this fact is not explicitly mentioned, it is implicitly. So, in the *Canal wall up* technique, the external meatus must be preserved intact or unchanged anatomically. In the *Canal wall down* technique, the posterior canal wall and its axis are the main landmarks that guide us in drilling the *suprameatal groove.*

The *mastoid antrum* is located at the bottom of this groove. Regarding the above-mentioned, we have a paradoxical situation: the axis of the drilling groove must be parallel to the axis of the external meatus. Otherwise, the drilling (or chiseling) direction will be wrong and will drive to at least three forbidden structures: 1). *Fallopian aqueduct* in its mastoid segment; 2). *Sigmoid sinus* in its descendent portion, especially in undeveloped mastoids (it is not about the abnormal anterior position of the sigmoid sinus, because in such a situation, its accidental interception is done even if the drilling axis is correct); 3). *Middle cranial fossa*.

The paradox is that the technique is made in such a way that the external meatus is hidden by the arm of the autostatic retractor and by the soft parts retracted for surgical exposure. One could say there is no problem to move the retractor to see the meatus, to memorize the direction of its axis and the plane of its posterior wall, to replace the retractor and to go on with drilling or chiseling. But what should you do if you feel the need to check again and again to be sure? The autostatic retractor is almost never correctly placed at the first attempt. We may add that we constantly use two retractors placed at an angle of 90 degrees one to the other. Now, let's do the arithmetic for all the manoeuvres required to examine the axis of the external meatus when it is hidden and fixed at distance against the two retractors.

Safe surgical gestures are mandatory. This precision is a subject that should not undergo any discussion. If more than 100 years, oto-surgeons managed so well, this is due to the unbeatable technique. It is true that, we cannot find any convenient, appropriate and in the same time academic answer to this statement. Instead, the maximum safety is achieved by having permanently in sight the lumen of the external ear canal, as happens when the trephination is done in the manner described here.

We consider the *bony external auditory meatus* the main surgical landmark as a consequence of the spatial position of the middle ear cavities in relation with it. This allows us to open all the middle ear cavities in a simultaneous manner if the external face of the temporal bone is sectioned after a *conical coaxial canvas* with the *external acoustic meatus*. In fact, reaming the walls of the *external auditory meatus* after this imaginary conical canvas, will lead to the simultaneous opening of the *antrum, aditus, attic* and *atrium*. It is about the process of circumferential reaming which is like drilling the cannon pipe or reaming the cylinders for internal combustion engines. The only difference between these actions and the surgical technique is the spatial geometry of the procedure. In case of cannon pipe, the reaming follows a regular cylindrical plane, while during surgery, it is done after an asymmetric conical canvas. For technological situations, the canvas is represented by the shape of the reamer itself, while during surgery the conical plane is the spatial projection in the surgeon's mind, when he uses the chisel or the small burr for creating the final surface of the section.

Principle of the technique: graphical representation

The endo-temporal spatial settlement of the external ear canal and of the middle ear cavities can be represented as a regular solid. This solid can resemble to a cylindrical vessel with double walls and hemispherical bottom, without handles. We can more easily say that it resembles to a tea cup with double walls. The hemispherical bottom of this cup corresponds to the tympanic cavity, the protympanum and the aditus. If we break the internal walls in a controlled manner, we get a simple cup

[1] Corresponding author: Marian Rădulescu, Prof. Dr. Dorin Hociotă" Institute of Phonoaudiology and ORL Functional Surgery, Str. Mihail Cioranu, Nr. 21, Sector 5, Bucureşti, e-mail: focaargintie@yahoo.com; tel: 0788414497;
Article received on 12.01.2012 and accepted for publication on 23.03.2012
ACTA MEDICA TRANSILVANICA June 2012;2(2):192-194

with one wall. In the following images, we will represent these aspects, in order to illustrate the principle scheme of the reaming procedure.

Figure no.1 represents the cup with double walls and hemispherical bottom, corresponding to the right temporal bone of an individual lying on the left lateral decubitus position. The lateral wall of the cup is opaque and of red colour. The opening of the cup is transparent and allows the visualization of the blue coloured space between the two walls. It can be observed that the two cylinders that represent the inner and the outer walls are non-coaxial. In other words, the smaller or interior cylinder is placed closer to the front side of the cup. The smaller cylinder represents the external ear canal. The opening of the cup is not horizontal but tilted from back to front, up to down and lateral to medial according to the anatomical situation.

Figure no. 1. The principle scheme of the reaming procedure

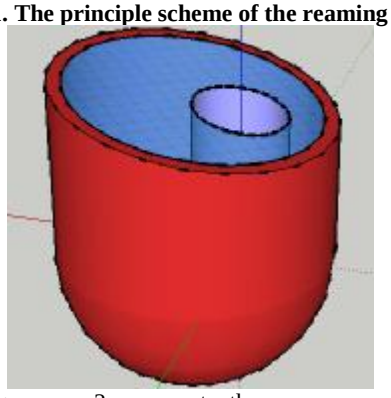
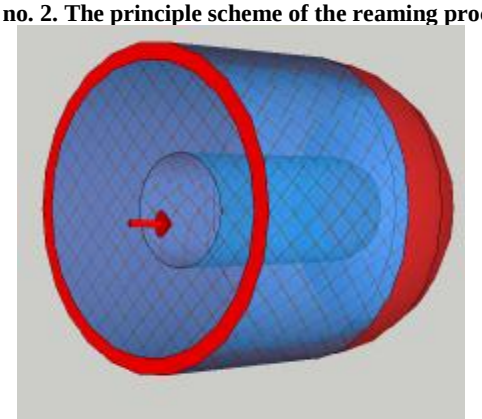


Figure no. 2 represents the same cup with double walls and hemispherical bottom, corresponding to the right ear in anatomical position. In this figure, the external walls are transparent up to the level if the hemispherical bottom which is opaque. The entire blue area represents the volume of bony tissue that will be removed during the reaming procedure. The cup is lying on lateral-inferior wall with the opening to the lateral side (toward the reader) and anterior wall toward the right side of the page. The red arrow represents the axis of the bony external ear canal.

Figure no. 2. The principle scheme of the reaming procedure

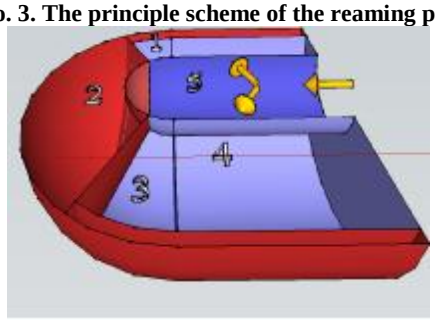


In Figure no. 3, the cup with double walls and hemispherical bottom corresponding to the right ear is cut in a horizontal section passing through the axis of the external ear canal (CT or MRI axial section). The inferior half of the section is seen from above and from behind. 1. protympanum, 2. tympanic cavity, 3. aditus, 4. mastoid antrum, 5. bony external auditory meatus.

Principle of the technique: histological background

At first sight, this technique may seem hazardous and dangerous, generating functional or even fatal complications. On the contrary, it is completely founded on topographical and descriptive anatomical data, confirmed by CT and MRI scans and by histological sections. If we compare the images of the following histological sections with the appropriate sections of the cup with double walls which is the schematic diagram of the process discussed, we find that the reaming procedure does not intercept, so it does not endanger any noble anatomical structures, therefore being a safe action. The anatomical-histological examples follow with the help of horizontal and vertical standard sections of a cadaver temporal bone of a child. Decalcified paraffin-embedded bone is sectioned into slices of 20 micron thickness. The latter are fixed on glass slides of 25/76 mm. and coloured with hematoxylin-eosin.(1,2)

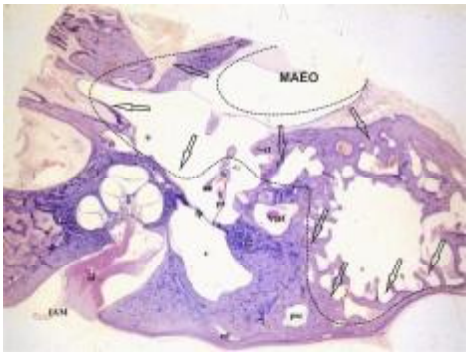
Figure no. 3. The principle scheme of the reaming procedure



The horizontal sections is performed in the standard plane of the axis of cochlear modiolus, from the superior edge of the temporal bone, in other words from top to bottom. The results of the cutting process are about 500 histological slices of 20 microns thickness which are fixed on 500 glass slides. One of ten slides is stained with hematoxylin-eosin, resulting 50 coloured slides from which 20 are chosen for the study.(1,2)

Figure no. 4 presents the micro-photography of the horizontal standard section number 221. This section passes through the anterior crus and posterior crus of stapes, lenticular process of the long crus of the incus and Eustachian tube. On this section, we can identify almost the entire stapes: anterior crus (ac), footplate (fp), posterior crus (pc); head of stapes (h). The incudostapedial junction (->) is well visualized. The chorda tympani (ct) come to the posterior wall of the middle ear at the end of its posterior bony canal. We can see the cochlea and the vestibule (v). We can also see the non-ampullary segment of the posterior semicircular canal (psc). The endolymphatic duct (ed) is also visible. Inside the internal acoustic meatus (IAM), we can visualize the lower division of the vestibulo-cochlear nerve including the cochlear nerve and the saccular nerve. Also, the mastoid segment of facial nerve (VII f) and the facial recess can be seen.

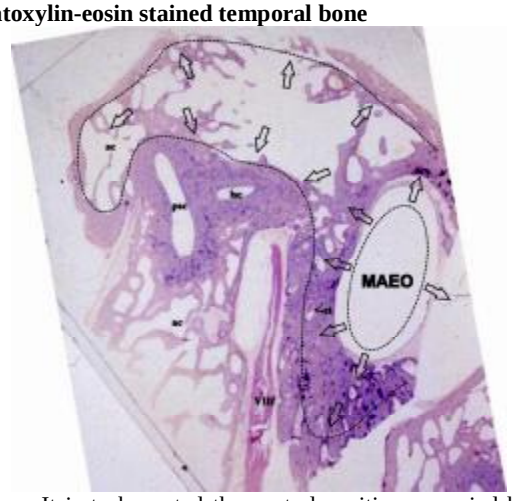
Figure no. 4. Micro-photography of the horizontal standard section number 221



We can see the central position of the lumen of the bony external auditory meatus (MAEO), which is the main surgical landmark in the technique we are presenting. The hollow arrows represent the drilling directions and the dotted line indicates the limit up to which the procedure can be done without any danger for the noble structures. It is demonstrated one more time how the enlargement of external meatus in all directions but in different degrees leads to securely and entirely removal of the bony tissue to the limit of internal cortex of the temporal bone, fulfilling the principles of radical mastoidectomy in terms of correctness and completeness.(1,2,3,4)

Figure no. 5 presents the micro-photography of the vertical standard section number 190 through the petrous part of temporal bone which is decalcified, paraffin embedded and stained with hematoxylin-eosin. This section passes through: the mastoid segment of facial nerve, the chorda tympani nerve and the posterior semicircular canal. The mastoid section of the facial nerve (VII f) is seen in its vertical direction through the temporal bone. The chorda tympani (ct) is already separated from the facial nerve and is heading obliquely up, inside its bony meatus – *iter chordae posterius,* to reach the tympanic cavity. The non-sensory part of the posterior semicircular canal (psc) is partially surrounded by aerial cells (ac), so it is the non-sensory part of the lateral semicircular canal (lsc). We note that the posterior semicircular canal is placed vertically and approximately parallel to the surface of the internal cortical plate of the posterior cranial fossa.

Figure no. 5. Micro-photography of vertical standard section number 190 through decalcified, paraffin embedded and hematoxylin-eosin stained temporal bone



It is to be noted the central position occupied by the lumen of the bony external auditory meatus (MAEO), the main surgical landmark in our procedure and its relationship with the anatomical elements described above. The ratio between the external acoustic meatus and the remaining osseous mass in the temporal bone is comparable to the ratio between two non-concentric circles, one circle inscribed into another circle. The hollow arrows represent the drilling directions and the dotted line indicates the limit up to which the procedure can be done without any danger for the noble structures.

This section is the one that demonstrates most obviously, the anatomical - histological foundation and the rightness of the reaming technique. It is proven how the enlargement of external meatus in all directions but in different degrees leads to the securely and entirely removal of the bony tissue to the limit of the internal cortex of the temporal bone. So, the requirement of correctness and completeness during the surgical step of exposure and removal of the disease is fully met.(1,2,3,4)

The next article in the series will contain the descriptive and topographic anatomical foundation of the principle of this surgical procedure. We will present several other theoretical and practical considerations regarding this technique.

This paper is supported by the Sectoral Operational Programme Human Resources Development (SOPHRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU/6/1.5/S/17.

BIBLIOGRAPHY

1. Gulya AJ, Gulya and Schuknecht's Anatomy of the Temporal Bone with Surgical Implications. Third Edition; New York: Informa Healthcare USA Inc; 2007. p. 5-22.
2. Bohne BA, Harding GW. Microscopic Anatomy of the human Temporal Bone. Dept. of Otolaryngology, Washington University School of Medicine, St. Louis, MO; 1997. oto2.wustl.edu/bbears/tb-intro.htm
3. Balance CA, Green CD. Essays on the Surgery of the Temporal Bone. London: Macmillan & Co. Ltd. 1919;1:76-93.
4. Kuster E. Die Prinzipien der radikalen Operation und Mittelohr Warzenfortsatzes. Deutsche medizinische Wochenschrift. 1989;15:254-257.