MASTOIDECTOMY BY REAMING THE BONY EXTERNAL ACOUSTIC MEATUS – (I.B.) PRINCIPLE OF THE PROCEDURE – TOPOGRAPHIC AND DESCRIPTIVE ANATOMICAL BASES

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Abstract: *The author presents the second article of the series in which he explains a new and original method of performing radical mastoidectomy by surgical reaming of the external ear canal. This section details the assumptions and the data of the descriptive and topographical anatomy on which the principle of procedure is based.*

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

Rezumat: *Autorul prezintă al doilea articol din seria în care vorbeşte despre un procedeu nou şi original de mastoidectomie radicală pe care îl numeşte alezarea meatului acustic extern osos. Prezentul articol se referă la ipotezele şi datele de anatomie descriptivă şi topografică care întemeiază principiul procedeului.*

Why using the term of Reaming?

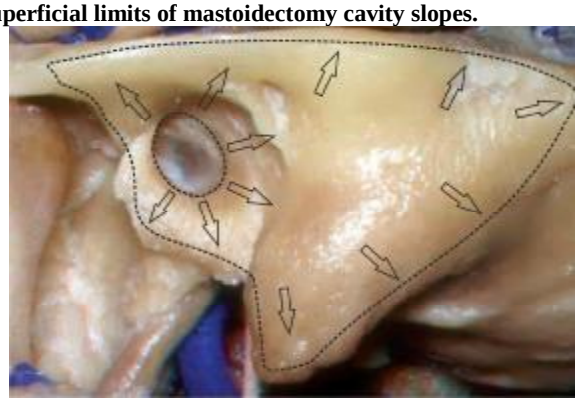
The usage of such a term like *reaming* requires some clarifications. This is a technical term that has a very precise meaning. Reaming is the process through which the internal surface of a hollow cylinder or any other hollow piece is carefully processed – *reamed*. It is also the result of this operation. It modifies the internal diameter of a cylinder from a piston engine. This refers to internal combustion engines, in particular to the recalibration of cylinder by slightly enlarging its internal diameter – *reaming*.

This term fits in the present paper only in a generic way, but it suggests pretty good our surgical action. We decided to use this term and not other to shorten as much as possible the verbal expression.

The *circumferential* enlarging of the bony external auditory meatus is performed in a differentiated way for each of its four walls. But the attribute *circumferential* is not suitable either from a spatial geometric point of view or from a mechanical one. Close to this reality (spatial geometric and mechanical) would be the term of enlargement or drilling in a conical canvas plan. Actually, we perform the drilling in the plans of a multitude of conical canvas which intersect the temporal bone. The axes of these conical plans converge in a point located in the axis of the external ear canal at approximately 6-8 mm. from the tympanic membrane (Figure no. 1). It is now clear why we chose the term of *reaming*, because of its greater power of suggestion or representation, faster and more effective than the terms expressing exactly the process but with a smaller suggestive force. Finally, the laconism of expression weighs more in favour of using the term of *reaming*.

This term is also used by other authors, for example F. Legent refers to an enlargement for tactical purposes of the external ear canal as a preliminary step when performing myringoplasty or ossiculoplasty, or as a main step during excising exostosis or osteomas. All other authors together with Ugo Fisch are using the term canalplasty for the same actions mentioned above.(1) Unlike the reaming or the canalplasty aforementioned, the technique we are talking about is not limited in drilling the meatus to widen it, but goes further in taking down some of the walls of this bony cylinder (superior and posterior wall).

Figure no. 1. Intuitive representation of the multiple conical plans that are followed during the process of reaming the external ear canal. The marginal dotted line shows the superficial limits of mastoidectomy cavity slopes.



The denomination of this procedure suffers also from the fact that it only suggests the onset of the surgical act and almost nothing about its final moment. Thus, the final target is the removal of the mastoid cells up to the internal cortical of the temporal bone, achieving the objectives of exposure and excision in accordance with Küster's principles stated in 1889 and masterfully synthesized by Sir Charles Alfred Balance in 1919.(2,3)

Founding assumptions of the principle of procedure

The first hypothesis: the preservation at all costs of anatomical integrity of the *bony external acoustic meatus* is not a prerequisite condition for conserving or improving the auditory function of the middle ear nor for wearing and functioning of a hearing aid.

This hypothesis is in an antagonistic contradiction with the two basic principles of the *New School of Tympanoplasty* founded in 1963 by *William Fouts Hou*se (*1923–*) and *James L. Sheehy (1918–2006)*:

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1) first of all, after mastoidectomy there should not be any open cavity
2) secondly, the anatomical relations between tympanic membrane, external ear canal and tympanic cavity should be as normal as possible.(4)

It can be seen that these two precepts mentioned above blatantly violate all the principles stated by the classics of surgery for middle ear suppurative diseases, principles that have proved their validity for more than eight decades of practice (until 1963), allowing the control of the disease evolution and the treatment of otic suppurations in the safest mode:

1. wide *exposure* of the lesions;
2. *excision* of the lesions to the deepest spaces;
3. large *exteriorization* of the lesions.(3)

The result of those mentioned above is that the first hypothesis strictly complies with the principles of the classic mastoid surgery stated in 1889, which have passed the test of time – 122 years of practice followed by success in safely management of the chronic inflammatory–infectious diseases of the middle ear.

Second hypothesis: except for the anterior wall, the preservation of the other three walls (superior, posterior, inferior) of the *bony external auditory canal* gives rise to difficulties during trephination technique and during approach of certain middle ear regions, making other regions impossible to reach and having all the negative consequences that follow.

In order to remove all the endotemporal air cell complex (in accordance with the criteria of correctness and completeness) in a way that does not jeopardize the safety of the inner ear and facial nerve, an appropriate surgical approach is imperative and the preservation of the bony external ear canal serves only to impede an already limited access.

The contemporary technology cannot fill in any way a restricted surgical access. The incompleteness of mastoidectomy technique is clinical translated by the consequence of residual lesions: persistent post-operative othorea, in other words, failure of the draining purpose of the surgery.

The considerable rates of failure mentioned in the literature have induced the belief that for open cavities othorea is an intrinsic condition and have led to the development of closed techniques to avoid this disadvantage. Unfortunately and unexpectedly they have failed to emphasize the need for correctness and completeness of surgical technique in a radical modified mastoidectomy as *Sir Ballace* masterfully synthesized in 1919. Nowadays this synthesis appears to be not longer known: we have met otosurgeons apparently surprised by the extent of resection as shown on post operative CT or MRI scans (without mentioning their confession about sense of being lost when watching the surgical steps all the way to the internal cortical surface of the temporal bone).

The third hypothesis: there are some non surgical regions of the endotemporal space occupied by the pneumatic cellular complex of the middle ear (these regions could only be approached by sacrificing the internal ear and the facial nerve) and therefore there are inflammatory non surgical lesions that can alter the outcome of cleaning by a rate that is proportional with the share of each non surgical region inside the temporal bone.

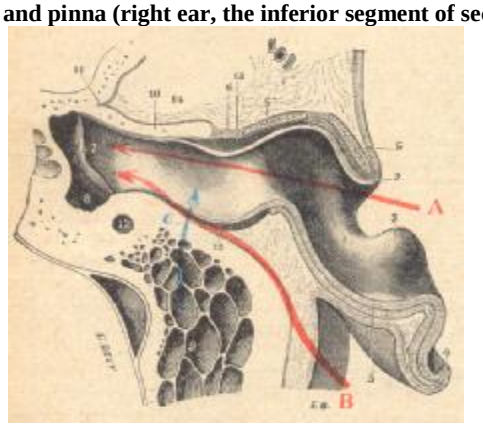
We can state that the last hypothesis is secondary to its previous because is a completion and a thorough exposure of it.

Topographic and descriptive anatomical substantiation of the principle of this procedure

This procedure is not as it may seem at first sight, risky and potentially dangerous, generator of life threatening complications or functional impairments. On the contrary, this procedure is completely justified on topographic and descriptive anatomical data. If we analyze the anatomical section images on frozen subjects and compare them with the corresponding sections of the double walled cup which represents the principle scheme of this procedure, we find that the trephination conducted this way does not intersect, so does not threaten any of the noble anatomical structures, therefore is performed in an absolute safety for the anatomical structures of vital significance.

In figure no. 2A, we present a horizontal section of the external acoustic meatus and pinna (right ear, the inferior segment of section). 1. conchal cavity that is continued internally with the cavity of external acoustic meatus; we can observe how the latter describes, in its lateral segment, a curve with anterior concavity and then describes, in its internal part, another curve with posterior concavity; 2. tragus; 3. antitragus; 4. helix; 5. cartilage of pinna; 5'. cartilage of external acoustic meatus; 6. fibrous segment of meatus; 7. tympanic membrane; 8. eardrum box; 9. mastoid cells; 10. posterior wall of glenoid cavity; 11. Glaserian fissure; 12. vertical segment of Fallopian aqueduct; 13. ceruminous glands layer of the meatus; 14. glenoid cavity.

Figure no. 2A. Horizontal section of external acoustic meatus and pinna (right ear, the inferior segment of section).



Arrow C (blue) shows the pathway followed sometimes by mastoid infection to invade the external acoustic meatus. Arrow A (red) indicates the natural route to access the tympanic membrane and the eardrum box. Arrow B (red) indicates the artificial surgical pathway of retroauricular approach by taking off the membranous meatus to access the same structures mentioned at arrow A.(5).

Figure no. 2B. The principle scheme of the procedure of reaming the bony external acoustic meatus.

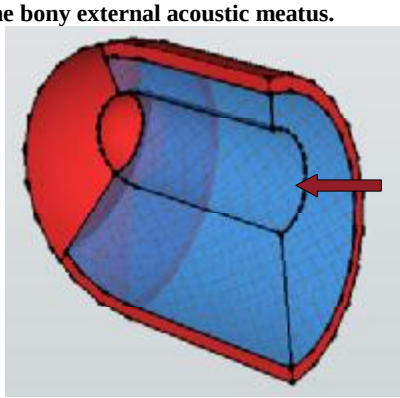


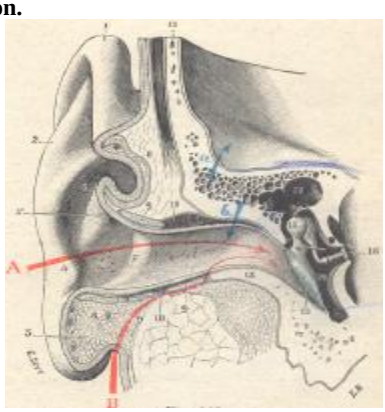
Figure no. 2B presents the principle scheme of reaming the bony external acoustic meatus. The double walled cup is represented corresponding to the right ear. The cup is sectioned in a plan that corresponds to a horizontal section of

head which passes through the axis of external acoustic meatus, or axial CT/MRI section plan. The figure shows the lower segment of this section viewed from upper (posterior) and lateral. So, the right ear is seen from above and lateral.

On the two figures (2A and 2B), it is clear enough how the differentiated reaming of anterior and posterior walls of the bony meatus leads to the opening of the middle ear cavities without jeopardizing the noble anatomical structures. Furthermore, we can see how the process of reaming continues in full safety for the anatomical structures with vital or functional significance, all the way to the internal cortical surface of the temporal bone. In other words, we act in safe conditions from the beginning and right up to the correct completion of the mastoidectomy, without the risk of intraoperative accidents or incidents, that could cause life threatening or functional impairment (e.g. hearing, balance, mimics, taste, tearing).

In figure no. 3A, we present a frontal section of the external, middle and inner ear (partially represented) that passes in front of the oval window; right ear, posterior segment of the section. 1. helix; 1. crus of helix; 2. antehelix; 3. triangular fossa; 4. antitragus; 5. sectioned lobule; 6. concha; 7. entrance to the external ear canal; 8. section through the cartilage of the pinna; 9. section through the external acoustic meatus cartilage; 10. section through the layer of ceruminous glands; 11. section through the squamous part of temporal bone; 12. section of the bony external ear canal; 13. tympanic membrane; 14. tympanic cavity; 15. ossicular chain; 16. plate of stapes in oval window; 17. attic; *a* and *b*, ways followed by the infection of mastoid cells from the superior wall of the bony external acoustic meatus, to invade the endocranial space on the one hand and the meatal soft tissues on the other hand. *A* – natural way to approach the tympanic membrane and eardrum box; *B* – artificial way to approach the tympanic membrane and eardrum box passing between the parotid gland and the inferior wall of the external acoustic meatus.(5)

Figure no. 3A. Frontal section of the external ear that passes in front of the oval window; it is right ear, posterior segment of the section.

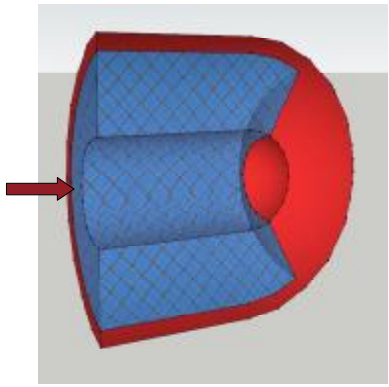


In this figure we can clearly notice how the reaming process involves in a differentiated manner the inferior wall of the meatus which is much thinner than the superior wall. Here, once the reaming process is started, all the endotemporal cavities are to be removed reaching the internal cortical surface of the temporal bone that corresponds to the middle cranial fossa. The properly reaming does not threaten in any way any of the important anatomical parts.

In figure no. 3B we present the principle scheme of the reaming process of the external ear canal. The double walled cup is represented corresponding to the right ear. The cup is sectioned in a plan that corresponds to a frontal section of the head passing through the axis of the external acoustic meatus or coronal CT / MRI section plan.

The posterior segment of this section is seen from anterior and medial. The purpose of this figure is to suggest how the reaming will be done and which will be its final result. The blue hatched area marks the volume of the temporal bony tissue that will be removed by drilling (preferably) or chiselling.

Figure no. 3B. Principle scheme of the process of reaming the bony external acoustic meatus.



In figure no. 4A, I present the relation of the membranous portion of the external acoustic meatus as seen on a sagital section of the head, made at 1 cm. medial to the external ear canal entrance (frozen subject, right side, internal segment of the section). 1. external acoustic meatus, with 1' and 1" representing its fibrocartilage; 2. internal segment of mandibular condyle; 3. articular meniscus; 4. and 4' upper and lower meniscus synovial; 5. internal maxillary artery; 6. parotid gland; 7. external pterygoid muscle; 8. mastoid process; 8'. mastoid cells; 9. temporalis muscle; 10. scuamous portion of the temporal bone; 11. zygomatic arch; 12. temporal lobe; 13. cerebral meninges.(5)

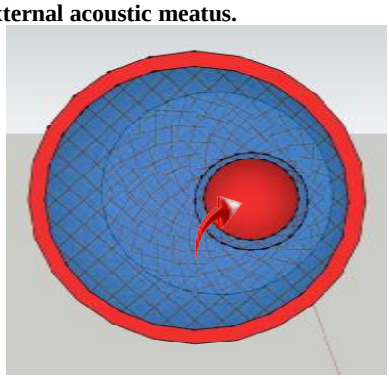
Figure no. 4A. Membranous part of the external acoustic meatus and its relation as seen on a sagital section of the head made at 1 cm. medial to the external ear canal entrance (frozen subject, right side, internal segment of the section).

Figure no. 4B presents the principle scheme of reaming the bony external ear canal. It shows the cup corresponding to the right ear placed in a lying down position (anatomical position).

Practically, the cup representing the right ear is seen from above. In other words, the patient is lying down on the left side therefore the right ear is positioned upwards.

The blue area represents the area of the bony tissue that will be removed or milled beginning from inside the meatus (meatal reaming or widening).

Figure no. 4B. Principle scheme of the process of reaming the bony external acoustic meatus.



On these last two images, it becomes clearly enough how the differentiated reaming or the enlargement of the external bony meatus, upmost at the level of posterior and superior walls, to open the axial cavities of the middle ear and from here, further up to the internal cortical surface of the middle and posterior cranial fossa (in close vicinity to the brain and cerebellum), can be performed in maximal security conditions for these vital organs.

All the examples presented so far are good enough to substantiate the statement that reaming is very safe in terms of anatomical risks and is not a phantasmagorical or dangerous procedure, as it might seem at a first sight, even if well-intentioned.

In the next paper, I will present the anatomo-radiological foundation of this procedure together with other related data.

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