MASTOIDECTOMY USING THE TECHNIQUE OF REAMING
THE EXTERNAL EAR CANAL – (I.C.) THE PROCEDURE’S
ENUNCIATIONS AND PRINCIPLES – ANATOMICAL AND
RADIOLOGICAL SUBSTANTIATION

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Abstract: The author presents the third article of his series, in which he explains a new and original method of performing radical mastoidectomy through reaming the external ear canal. The present paper describes this procedure’s enunciations and the anatomical and radiological data which this procedure’s principle is based on.

Keywords: middle ear, mastoidectomy, surgical technique

Cuvinte cheie: ureche medie, mastoidecție, tehnică chirurgicală

Rezumat: Autorul prezintă al treilea articol din seria în care vorbește despre un procedeu nou și original de mastoidecție radicală pe care îl numește alezarea meautului acustic extern osos. Prezentul articol se referă la enunțurile procedeului și la datele de anatomiie radiologică care întemeiază principiul acestuia.

Procedure’s enunciations

Enunciation 1.1.: The reaming of the external ear canal (circumferential enlargement using a drill or chisel) leads to concomitant opening all cavities which form the middle ear: a) Protympanum, b) Tympanic cavity, c) Aditus ad antrum; d) Antrum Mastoideum, e) Mastoid cells; f) Petrous cells.

It is interesting to note that, considering this enunciation, the surgeon can modify at will the progress of the section and the preferential opening of certain middle ear cavities according to his proposed goals and objectives. For example, if the hearing condition entails a conservative modification would not be regained even with the help of the most skilled surgeon. No man can redo what the Nature once did.

Enunciation 1.2.: the external ear canal due to its characteristics: permanently visible, direct and integral; by removing its walls, allows the direct access—both visual and instrumental - to all the cavities belonging to the middle ear. This way, as an immediate consequence of the possibility to perform a correct and complete intra-operative exploration, ensures a correct and complete intra-operative lesion’s inventory and, further on, it ensures the treatment and, even more, provides multiple ways to approach the temporal bone and the adjacent skull base.

In figure 1.A. we present a horizontal section through the left temporal bone at the level of stapes in which we tried to demonstrate the direct access – visual and instrumental – to all the cavities of the middle ear. The two arrows, which intersect each other in the large cavity that is left after the removal of the superior and posterior walls of the external ear canal, indicate how sight and straight instruments can reach the protympanum and the tympanic sinus.

Figure 1.B. presents the same section through the temporal bone as the preceding figure, but here the posterior and superior canal walls have been preserved. The arrows show that the visual and instrumental access is restricted. Practically, there are two access ways that can be used in a serial manner, in other words they cannot be used simultaneously because they represent two different ways of surgical approach.

To a certain point during the procedure it is not

The meatopecty is similar to building a supra-structure. The osseous part of the intervention can be compared with the foundation of the same building. Is it necessary to mention that a building will collapse if its foundation is not solid enough? The simplest meatopecty technique is always the most efficient one. The essential idea is that the external acoustic pore and pinna are “noli me tangere” anatomical elements, first because modifying their anatomy will not retrieve the expected results and second because their natural structural and morphological delicacy once modified would not be regained even with the help of the most skilled surgeon. No man can redo what the Nature once did.

Enunciation 1.3.: The preservation of the external ear canal confines or even makes impossible to perform a correct mastoidectomy, as it was demonstrated in previous articles. The successful draining effect of a mastoidectomy is based upon a correct performance of the osseous part of this procedure and not of the meatopecty.

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have to keep an eye on removing all bony cells, all the way to the internal surface of the temporal bone. Why we have to do it like this? Because the irreversible lesions that have to be removed, are not always visible, even under the surgical microscope.

The mass removal of the entire mastoid cellular complex, which facilitates the access to the inner surface of the temporal bone, is the only possible manoeuvre that ensures the complete removal of all irreversible lesions, even if they may be accompanied by healthy tissues.

There is not and probably will never be a way to differentiate, during the surgery, between healthy tissues and irreversible lesions, mainly because these can be intra-cellular (cytologically speaking). Even if we admit that the questioned differentiation would be possible, their preservation would still depend upon local histological subsistence conditions.

This is a delicate moment in which we have to question the statement which says that the surgical microscope can differentiate between those lesions and that they can be completely removed, especially when referring to cholesteatoma lesions.(1)

The moment has come to emphasize the genial intuition that Sir Alfred Charles Ballance had in that moment in which he masterly summarized the principle of removing the entire mastoid structure except for the inner temporal cortex.(2)

When we reach to open the aditus and posterior attic, the situation gets nuanced, meaning that we have to choose between two possible variants, not like when opening the antrum that leaves no alternatives, as seen above.

If we have a macroscopic cholesteatoma inside the aditus then, it is imperative to open the whole tympanic cavity and to perform a visual inspection inside the supratubal recess and the protympanum, inspecting also the tympanic sinus and the fossae of both windows, requiring the removal of the bridge, the posterior tympanic ring, the facial sinus and tactical disarticulation of incus. The final steps are repositioning of incus and of tympano-meatal flap.

If we find other macroscopic lesions, they should be completely removed, the opening and removal of bony tissues being dictated by the lesion’s amplitude and, in the end, by the visual access to the apparently healthy tissues that are preserved.

Hearing preservation is the main purpose of all these cautions, especially when it is considered socially satisfactory by the patient before surgery.

Those cautions are also useful when the bone conduction curve is placed above 30 dB HL which can signify a total recovery or a substantial benefit for the future placement of a hearing aid.

What means the safety of lesion treatment? The answer lies inside the previous paragraph, in which we reminded the necessity of total and massive removal of the mastoid pneumatic cellular system and the genial intuition of Sir Alfred Charles Ballance.

Resuming, we are 65% certain that we have treated all the lesions when we have removed all mastoid cells all the way to the inner cortex of the temporal bone, without opening the aditus and its adjacent cells. If we open these cavities, the safety reaches 75%.

In figure 2.A we render in a schematic way the opening and removal of all mastoid cells, reaching the inner surface of the temporal bone which is left as a smooth plate. Figure 2.B highlights through contrast the facts revealed by the preceding figure, especially that the cavity’s walls remain uneven as long as the internal cortex of the temporal bone has not yet been reached following the removal of the mastoid cells.

This is the right moment to elucidate the problem of
removing all mastoid cells that are afflicted or suffer irreversible lesions. In the previous part of this paper, we underlined the fact that these lesions are not always visible, not even when using the surgical microscope. We emphasize that removing all the afflicted cells is equivalent with the removal of all mastoid aerial cells, because this is the only way to be certain that all damaged cells have been removed. The essential aspect in this process is to completely remove all mastoid cells, afflicted or healthy. This has to be done because we are missing a way to distinguish between them during surgery. We need to perform a valid distinction and not just rely upon an opinion, no matter how endorsed it is. We are speaking about a real, theoretical and practical distinction.

Figure 2.A. Correct and complete removal of the pneumatic cell system all the way through the internal cortex of the temporal bone.

Figure 2.B. Incorrect and incomplete removal of the pneumatic cell system all the way through the internal cortex of the temporal bone.

To resume, the essential principle of mastoidectomy consists in the complete removal of the pneumatic cells. There is a "but" or a conditioning of this manoeuvre, to all pneumatic cells that are surgically approachable.

Which are the cells considered un-approachable or non surgical? This is a question that can be easily answered at. Those are the cells that are placed around the otic capsule, the tympanic cavity, the protympanum and the cells located inside the petrous apex. Those cells are approachable but only in the prejudice of hearing, equilibrium and facial nerve.

It is important to always keep alive in our mind the idea that this principle was enlightened through the research of many generations of otologists, beginning with Schwarze who has foreseen the necessity of opening all cells from the mastoid apex and its total or subtotal resection. His followers Grueing, Waithing, Stacke, Citelli, Trautmann, Ramadier, Portman and others, who described the cellular groups of the mastoid bone such as zygomatic cells, superficial antral cells, sino-dural cells and all the other cellular groups, and underlined the necessity of their removal to ensure a favourable evolution and a complete cure.

Enunciation 1.3: the reaming of the external ear canal is an eclectic surgical procedure that takes over the satisfactory elements from all other known procedures, it cuts out the unsatisfactory features and, in the same time, it introduces new, original elements.

The reaming of external ear canal procedure is applied exclusively when performing an open mastoidectomy or semi-open mastoidectomy preserving the posterior tympanic ring. This affirmation might be redundant since we have stated from the beginning that the present procedure follows the classic principles of radical mastoidectomy mentioned in 1889 by Ernst Küster, but at this point in our paper it is considered to be necessary for our reader’s exact mind representation of the technique.

We underline that the reaming technique is extremely flexible allowing the preservation of the atical wall and of the tympanic ring in variable proportion, imposed by the lesional balance established during surgery and by pre-operative functional balance, in order to perform any conservatory or even reconstructive intervention without making rebate from the principle of all cell removal in favour of preserving the hearing function. With the risk of being redundant again we emphasize that this flexibility oscillates between two very close limits when we intend a conservative or re-constructive intervention, meaning the preservation of scutum just as much as not to impede the exploration of the posterior attic and supratubal recess and the removal of the tympanic ring as much as possible to allow a partial inspection of the tympanic sinus.

Enunciation 2.1.: the trephination using the external ear canal reaming process is performed under direct and extended visual access to the entire middle ear: a) protympanum; b) tympanic cavity; c) aditus; d) antrum; e) mastoid cells; f) petrous cells.

This utterance has the purpose to emphasize that “en bloc” removal of all pneumatic cells healthy or afflicted as far as the internal cortex of temporal bone is a manoeuvre that is being performed under direct visual control in a comfortable manner provided by the use of straight instruments or, in other words, instruments that have infinite degrees of liberty and infinite maneuverability under direct visual control. In the end we have infinite technical alternatives to accomplish as much as possible the completeness and correctness criteria of a radical modified mastoidectomy.

Enunciation 2.2.: The reaming of external ear canal process ensures direct and extended access: 1) to all lesions for their correct and complete treatment and for reconstructive procedures using grafts or implants; 2) to the petrous segment of the temporal bone and to the adjacent internal skull base.

This is a natural addition to the previous enunciation. Until reaching the subject of reconstruction procedures we have to emphasize once more the fact that the reaming procedure facilitates the assessment of inflammatory-infectious lesions beyond the internal cortex of the temporal bone. The entire surgical approachable surface of the internal cortex is revealed in routine or in special conditions (when the natural lesions have completely or partially destroyed the internal ear or the facial nerve canal), so that we can safely perform an exploration of the extradural space and remove any encountered lesion.

When mastoidectomy represents only a preliminary step in the approach of other regions of the temporal bone or the internal or external skull-base, we can fully use this offer of direct and large, instrumental and optic access made available through the technique of reaming the external ear canal.

Anatomical and radiological substantiation of the procedure’s principle

In figure 3.A. we present a coronal CT section (in a frontal plane) of the right temporal bone (it is the contralateral ear of a patient suffering from bilateral inflammatory disease
with left reacutization that will undergo mastoidectomy following the described process (we have chosen the right temporal bone for its correspondence with the comparative images that are drawn for the right side) passing through both internal and external bone canals, the posterior pole of the oval fossa, the ampullary region of the superior and lateral semicircular canal, the hook-like segment of the cochlear duct or the vestibular ramp of the bony labyrinth. The continuous line placed laterally follows the outline of the external ear canal and marks the spot where the reaming process should begin. The continuous line placed internally indicates the internal limit as far as the reaming should go. This image clarifies the exposure extent and the amplitude of mastoid tissue removal. The internal limit of mastoid cell complete removal is clearly distinguishable – internal cortex of the temporal bone. The white hollow arrows show the direction of conic planes that are followed during the reaming process or the enlargement of the external ear canal. The image shows that the reaming process is a technique that belongs to the osseous step of the mastoidectomy. The figure demonstrates that the drilling technique is a direct one and therefore, it is easier and more efficient and most of all, it provides safety guarantees for the anatomical and functional integrity of multiple noble structures within the temporal bone. We emphasize that “direct” means that the technique is performed under permanent and complete visual control of the surgical field extended to all the cavities of the middle ear.

Figure 3.A. Coronal CT section that passes through internal and external bone canals

![Coronal CT section](image1)

Figure 3.B. Axial CT section (in horizontal plane) of a right side temporal bone

![Axial CT section](image2)

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Figure 3.B. presents an axial CT section (in horizontal plane) of a right side temporal bone that goes through external and internal ear canal, ductus singularis, vestibule, posterior semicircular canal. The continuous line that has been placed laterally follows the border of the external ear canal and marks the place where the reaming process will begin (it is the contralateral ear of a patient suffering from bilateral inflammatory disease with left reacutization that will undergo mastoidectomy following the described process) (we have chosen the right temporal bone for its correspondence with the comparative images that are drawn for the right side). The internal continuous line indicates the internal limit of the reaming. The image clarifies the extent of exposure and of bony tissue removal. It is clearly distinguishable the internal limit of bony cells removal – the internal surface of the temporal bone. The white hollow arrows show the direction of conic planes that are followed during the reaming process or the enlargement of the external ear canal. The image shows that the reaming process is a technique that belongs to the osseous step of the mastoidectomy. The figure demonstrates that the drilling technique is a direct one and therefore, it is easier and more efficient and most of all, it provides safety guarantees for the anatomical and functional integrity of multiple noble structures within the temporal bone. We emphasize that “direct” means that the technique is performed under permanent and complete visual control of the surgical field extended to all the cavities of the middle ear.

Figure 4. Coronal CT section of the left temporal bone

In figure 4 we present a coronal CT section of the left temporal bone that passes through the axis of both internal and external bone canals that has been performed at 3 and a half years after surgery. The patient underwent first rank radical modified mastoidectomy using the external ear canal reaming technique. The first surgical intervention has been a simple mastoidectomy (antrotomy) performed about 20 years before, when the patient was 2 years old. This section passes through the sub-vestibular ramp that corresponds to the promontory, ampulla of the superior semicircular canal, the loop of the lateral semicircular canal, oval window. There are clearly distinguishable the superior and inferior limits of bony tissue removal. In the superior area, the internal cortex has not been reached as requested by the completeness principle of the procedure enounced by Sir Alfred Charles Balance.(2)
impression that the internal cortex has been reached, therefore the drilling process was not continued till the real internal cortical surface). (2)

The series of CT scan images performed before and after surgery previously presented, demonstrates that the drilling technique is direct therefore, easier and more efficient and, most of all, it provides safety guarantees for the anatomical and functional integrity of multiple noble structures within the temporal bone.

Figure no. 5. Axial CT section of the left side temporal bone performed at 3 and a half years after surgery

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REFERENCES