Anatomic logic of the Foramen Luschka in Neurootologic Surgery

Anatomiczna logika otworu Luschki w chirurgii neurootologicznej

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SUMMARY

The authors emphasise the key role of the state of the foramen Luschka in indication of neurootologic surgical approaches. Blockage of the foramen Luschka with a medium or big tumour may impair the CSF circulation. In such case the lateral transtemporal approaches – translabyrinthine and transtotic are the best options. In all other situations where there is no blockage of the CSF circulation in the affected pontocerebellar angle the choice of a surgical approach is determined by the state of hearing and character of disease. Surgical indications should be elective and individually considered.

Hasła indeksowe: neurootologia, otworki Luschki, osłoniok nerwu przedsionkowo-ślimakowego

Key words: neurootology, foramen Luschka, vestibular schwannoma

In the second half of last century a principal change in the diagnosis and treatment of vestibular schwannoma can be seen. It surely means a new era in solving this not an easy problem by the development of new diagnostic, visualization and microsurgical methods – the development of neurootology, that is joined mostly with the name of W. House but of course with a lot of others [1, 2, 6, 7, 10, 11, 12]. In Europe J-M. Sterkers was probably one of the first who performed transtemporal microsurgical vestibular schwannoma treatment as well as all neurootologic surgery in a complex way [13], and our neurootologic activity started thanks to his teaching.

In last 13 years we performed 250 operations on the lateral skull base, mostly for vestibular schwannomas, epidermoids, meningiomatas, complicated cholesteatomas necessitating combined otologic and neurootologic approaches, but also for glomus jugulare tumours, sections of the vestibular nerves in the cases of invalidizing vertigo, decompression and reconstruction of the facial nerve, and decompression procedures in neurovascular conflicts in the pontocerebellar (PC) angle.

Neurosurgical and neurootologic techniques have been developing very intensively thanks to a lot of surgical experience in the centers dealing with this problem as well as thanks to the development of anaesthesiology, technical and instrumentation equipment, where we must emphasise the introduction of videoendoscopy and peroperative monitoring [4, 6, 8, 9]. The postoperative results of the experienced neurosurgeons and neurootologists have been improved a great deal in all important aspects (absolute decrease of mortality, less serious morbidity, good preservation of the facial nerve function and in some cases the preservation of hearing). In many centers both specialists cooperate very well, one can learn very much from the other, and neurosurgical phylosophy influences neurootology and vice versa.

However, there are still very strong objections against lateral transtemporal approaches into the PC angle for vestibular schwannoma removal, that can be summarized into three points: 1. suboccipital approach (nowadays it is usually named retrosigmoid approach, and of course it is...the retrosigmoid minimal and minimally invasive neurootologic approach [7] is different...) gives a chance to preserve hearing, 2. in the lateral transtemporal approaches the hearing is definitely lost, 3. suboccipital surgery is the best one for controlling all structures in the posterior fossa, and the transtemporal approaches do not give a sufficient access to remove a big tumour.

If we accept this logic there will be no or aleast a minimal place for neurootologic surgery. On the other hand we have seen and observed the patients having been operated by the suboccipital way, suffering from longlasting ataxia, having slow and very prolonged convalescence after removal of big tumors, and when evaluating their postoperative MRI we could see severe changes on the cerebellar hemisphere (the retractor disease) or even the state after partial resection of the cerebellum. MRI shows also cases where the internal auditory meatus has not been opened at all and also...
residual tumours growing in such cases. When evaluating postoperative hearing we see deafness on the operated side.

We have got the greatest experience with translabyrinthine approach in the tumours of all sizes and recently also with minimal retrosigmoid approach in small and carefully selected tumours suitable for hearing preservation. We are discussing the removal of vestibular schwannomas, which is our most frequent neurootologic diagnosis. Postoperative convalescence of our patients is very rapid also after removal of big tumours. On postoperative MRI we have no image of the retractor disease. Naturally all our patients after translabyrinthine tumour removal are also deaf on the operated side. We have got little experience with preservation of hearing – only 4 patients having had a very small tumor which did not influence the CSF circulation in the pontocerebellar cistern, and we preserved normal hearing in two of them (5). We do not discuss the facial nerve function here, but the logic of anatomy is clear – translabyrinthine approach is absolutely the best one for the facial nerve identification in its all extent. And our results prove it, too [3, 4].

If the protagonists of suboccipital surgery, that it is the best one itself, are right, there will be no sense for elective approach in vestibular schwannomas. We are convinced of the necessity of the elective approach and the reason for it is done by the anatomy where the foramen Luschka plays a key role.

In this paper we concentrate on the two surgical techniques, trying to emphasize the importance of the foramen Luschka and demonstrate its significance in election of both approaches: lateral – translabyrinthine and posterior – retrosigmoid for vestibular schwannoma and other neurootologic problems treatment, too.

When cognizating of the foramen Luschka we must mention that the cerebrospinal fluid (CSF) fills the brain ventricles, central canal of the spinal cord and all subarachnoid space. The CSF is produced by the ependymal cells of the choroid plexuses in the brain ventricles, from the ventricles it flows through one median posterior foramen (Magendie) and two lateral foramina of the fourth ventricle (Luschka) into the subarachnoid space and finally it is resorbed in the masses of arachnoid granulations located in the superior sagittal sinus. Blockage of the foramina of the fourth ventricle can result in accumulation of the CSF in the ventricles, it means increased intracranial pressure, i.e. internal hydrocephalus. The overpressure in the ventricles damages the brain tissue. The overpressure in the ventricles diminishes the effect of modern anaesthesiologic techniques (hyperventilation up to pCO2 = 25 mmHg) and their positive influence on the brain tissue in shrinking of the cerebellum, that is the precondition for a good and not traumatic access into the pontocerebellar cistern fully occupied with a big tumour. Increased infratentorial tension is so caused by a combination of two mechanisms: 1. a big space occupying lesion itself and 2. internal hydrocephalus caused by the blockage of the foramen Luschka with the space occupying lesion in the pontocerebellar cistern.

Fig. 1 shows a big tumour in the PC angle directly blocking the foramen Luschka on the right side and indirectly blocking two other foramina Magendie and the contralateral Luschka by their compression by the brain tissue, that results in big intraventricular overpressure. When performig suboccipital or retrosigmoid craniotomy (SOC on the fig. 1) and opening the dura mater, the cerebellum will be pushed into the craniotomy and it needs to be retracted medially in the situation of enormous intracranial pressure. Only after cerebellar retraction it is possible to touch the tumour. Compressing of the cerebellum increases subtentorial overpressure even more up to the moment of letting the CSF to leak from the PC cistern, but the cistern is fully filled with the tumour. So the tumour volume must be reduced – the tumour must be debulked to have the condition of CSF appearing in the PC cistern. The debulking of the tumour is done under the conditions of naturally increased intracranial pressure and surgically increased intracranial pressure by the compressing of the cerebellum with the retractor.

On the other hand when performing translabyrinthine craniotomy and opening the dura mater of the posterior fossa of the temporal bone in a sufficient extent, i.e. from the internal auditory meatus up to the sigmoid sinus, the tumour enters into the transtemporal craniotomy, and it is the first moment of decrease of the pressure in the posterior fossa, because the tumour is pushed into the temporal bone space very similarly as the cerebellum is pushed into the retrosi-
So in translabyrinthine approach the increased intracranial pressure pushes the tumour directly towards the surgeon making it possible to do extensive debulking of the tumour without touching the brain tissue (fig. 2).

Sufficient reduction of the tumour volume by intracapsular debulking means further reduction of the pressure in the posterior fossa, and it also means that the foramen Luschka on the contralateral side is becoming gradually deblocked and liberated (ipsilateral foramen Luschka is usually still blocked with the tumour capsule), and the conditions of the CSF circulation in all subtentorial space are now much improved. In this moment in translabyrinthine surgery we can enter with a microraspatorium into the PC cistern just in front of and inferior to the tumour capsule, as can be seen on fig. 2 and 3, and tear the arachnoid. In such a way we enables the CSF to leak from the contralateral foramen Luschka, i.e. from all ventricular system. This is the crucial moment in this surgery, because the intracranial pressure is not only normalized, but also reduced – the cerebellum starts to be shrunked and gradual developing of the tumour capsule by its pushing towards the tumour center and its removing by pieces can start. Always when possible we try to avoid touching the brain tissue – by working on the tumour capsule (coagulating, cutting the coagulated vessels going into the tumour, freeing the capsules from the nerves, respecting the arachnoid/tumour dissection layer, etc.). In the big tumours firm adhesions of the capsule and the brainstem may be encountered. They are freed at the end of the procedure and they usually occur in the region of the pontocerebellar portion of the facial nerve and of course the foramen Luschka. The removing of last piece of the capsule means complete liberation of the ipsilateral foramen Luschka and normalization of the CSF circulation, that is controlled endoscopically at the end of surgery (fig. 4).

Situation in removing small tumours (fig. 5, 6) when the CSF circulation is not impaired by the foramen Luschka blockage is different. In such cases minimal retrosigmoid craniotomy of 2 cm diameter is sufficient. Good anaesthetic technique, protection of the cerebellum with the dural patches, quick opening of the PC cistern just in the region of the foramen Luschka let the CSF to leak from the brain ventricules, and the cerebellum shrinks. Using a big cottonoid instead of a retractor, to be put between the pyramid just posterior to the mixed nerves and the cerebellum, makes a good

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**Fig. 2.** Translabyrinthine approach – right side. The tumour after debulking occupies all translabyrinthine craniotomy. m – internal auditory meatus, c – tumour capsule, 7– facial nerve, dpf – dura mater of posterior fossa; Two cottonoids are placed: one superior (left), one inferior (right) to the tumour, the arrow shows the place, where the microraspatorium will enter the PC cistern for evacuation of the CSF.

**Fig. 3.** Big tumour – right side. Translabyrinthine way is limited with two arrows. The dotted arrow shows the place anteriorly, where the PC cistern arachnoid will be teared and the CSF evacuated.

**Fig. 4.** Translabyrinthine endoscopy of the left PC angle after removal of menigioma – 3.5 cm. ce – cerebellum, pch – chorioid plexus, Lu – foramen Luschka, 8 – n. cochleovestibularis, 7 – n. facialis, 9 – n. glossopharyngeus, 10 – n. vagus, 11 – n. accessorius; Four arrows depict the foramen Luschka.
space for work. Such an approach is minimally invasive and is suitable also for performing vestibular nerve section, decompression of the nerves in neurovascular conflicts (5). These small tumours can be removed also by middle fossa approach, and if they are bigger by enlarged middle fossa approach.

Conclusion

When considering vestibular schwannoma removal, the anatomic and physiologic logic of the CSF circulation where the foramen Luschka is a crucial structure determines our surgical indications:

1. In all tumours over 2 cm translabyrinthine approach is preferred,
2. In all smaller tumour than 2 cm tumours, if there is no serviceable hearing, translabyrinthine approach is preferred,
3. In smaller tumours fulfilling the criteria for hearing preservation surgery minimal retrosigmoid approach is preferred,
4. In intrameatal tumours fulfilling criteria for hearing preservation surgery also middle fossa approach is the method of choice.

Definite indication of surgery is decided by the patient himself after our detailed explanation of all surgical options and our experience with the individual approaches.

Anatomy and physiology of the CSF production, circulation and resorption is an axiom. Tumour in the pontocerebellar angle may impair the CSF circulation a great deal. Neurootologic techniques accept this reality and the surgeon who knows them can choose the most suitable one individually for a patient.

REFERENCES


