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EDITORIAL

Avoidance of postoperative acute cerebellar swelling after pineal tumor surgery

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Broggi and colleagues present an interesting case in this issue of Acta Neurochirurgica and describe a well-known complication of pineal tumor surgery [1]. Their patient, a 56-year-old female, underwent removal of a WHO grade 3 pineal tumor via the supracerebellar infratentorial route. After an uneventful early postoperative course acute cerebellar swelling occurred that required emergency decompressive craniectomy.

Indeed, surgical removal of tumors arising within the pineal region belongs to the most challenging neurosurgical procedures [2, 6]. Due to their deep location and close anatomical relationship to the cerebellum, midbrain tectum, bilateral pulvinar and Galenic venous draining group, these tumors must be resected in the most efficient fashion without causing any harm to these important adjacent structures. Postoperative acute cerebellar swelling as described by Broggi and colleagues constitutes a serious complication that may rapidly cause the patient to develop a life-threatening condition because of the compressive effect on the brainstem. Because of severe clinical implications, occasionally even with fatal outcomes, this complication has received attention for a long time in the literature [4, 8]. Apparently, and in concordance with my own experience, the most frequent pathomechanism is a combination of venous obstruction, sometimes combined with postoperative local hemorrhage. Using a cerebellar self-retaining retractor during surgery significantly increases the risk for this complication as the retractor may cause local ischemia, produce cerebellar contusion and venous congestion, or even cause rupture of superficial bridging veins. These problems may be accentuated in the presence of obstructive hydrocephalus or a tight posterior fossa. If such postoperative cerebellar swelling occurs, the only way to efficiently treat and possibly save the patient's life is rapid decompression and/or removal of a local hematoma or hemorrhagic residual tumor in a fashion similar to what Broggi and colleagues have eloquently described in their article.

During my career I have removed a number of tumors located in the pineal region, among them pineal cysts, pineocytomas, pineoblastomas, pilocytic, fibrillary and anaplastic astrocytomas, rosette-forming glioneuronal tumors, germinomas, ependymomas, anaplastic choroid plexus papillomas, meningiomas, mature teratomas, carcinoma metastases, etc. I applied a versatile surgical technique to achieve good results as these tumors varied widely in size, extent, consistency, vascularization, adhesion to adjacent vessels, presence or absence of the dissection plane, etc. Each time I planned the microsurgical resection of such tumors, I tried to be aware of possible factors that could lead to postoperative acute cerebellar swelling, taking appropriate precautions to avoid this serious complication. At least seven issues seem important to me in this context.

1. Indication for surgery

Strictly verifying the decision to operate on a pineal region tumor helps avoid an unnecessary high-risk surgical procedure. Some low-grade gliomas must not be operated on immediately, especially if they are small and do not significantly increase in size over time. Also, most germ cell tumors do not need to be operated on as they are most sensitive to radiation. Certain metastatic tumors may also not require surgery, but instead Gamma Knife or cyberknife radiosurgery, depending on the underlying carcinoma and stage of the disease.

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2. Neuroradiological imaging

Selecting the pertinent information that should be extracted from preoperative neuroradiological imaging is one of several keys to successful pineal region surgery. Routine MR images provide us useful details about the size, extent and vascularization of the underlying tumor and, most importantly, about the degree of midbrain, thalamus and cerebellar compression. Our attention should then be focused on the position of the Galenic venous draining group and presence of an obstructive hydrocephalus that may perhaps require an initial third ventriculostomy. Among the most important veins in the region are the two internal cerebral veins, the basal vein of Rosenthal on both sides, the precentral cerebellar vein and superficial vermian vein [6]. Some of them drain directly into the vein of Galen, others into the torcular Herophili. These veins and their anatomical relationship to the underlying tumor should be clearly visualized. Equally important is looking for superficial bridging veins of the cerebellum [9]. They may sometimes be well recognizable on MRI; however, I noted that useful information about their exact location and particularly about the pattern of venous drainage could not be obtained from imaging. For this reason, it is not predictable whether sacrificing a superficial bridging vein may lead to hemorrhagic cerebellar infarction or may remain without harmful consequence. In addition to studying the veins, I paid great attention to the angle of the straight sinus [3] and tentorium. A very steep tentorium required correct positioning of the patient's head with sufficient ventral flexion. Additionally, I learned that a tight posterior fossa must be recognized and taken into account because in such a case even slight postoperative cerebellar swelling may already compress the brainstem. Last but not least, the craniocaudal tumor extension should be assessed on preoperative MRI as it plays an important role in the choice of surgical approach.

3. Choice of surgical approach

In the majority of my cases with pineal tumors, I have chosen the supracerebellar infratentorial approach, which constitutes the most common access route to the pineal region [7]. To avoid excessive downward retraction of the superior cerebellar vermis, I used the paraculminal route either on one side or bilaterally. The cerebellum gradually descended after incising the thick arachnoid membrane around the Galenic venous draining group, offering a wide exposure of the vein of Galen and tributaries (Fig. 1). In some pineal tumors I used a combination of the supracerebellar infratentorial and occipital transtentorial approach to reach the tumor via two different trajectories. Occasionally, I have chosen a combination between the infratentorial and telovelar approach through the fourth ventricle, but only in tumors with extreme caudal extension of the lesion.

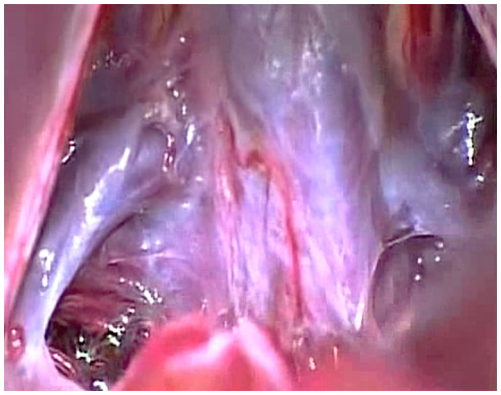

Fig. 1 Intraoperative photograph showing the Galenic venous draining group exposed via the supracerebellar, left-sided paraculminal access route. The thick arachnoid that covered this area has been sharply dissected to expose the vein of Galen and tributaries and to allow for gentle lowering of the cerebellar culmen

4. Positioning of the patient

I preferred the semisitting position because of the lack of venous congestion, easy descent of the cerebellum by gravity, and possibility of operating within a bloodless surgical field. Alternatively, I sometimes used the prone or Concorde position [5]. One must bear in mind, however, that contrary to the semisitting, these positions are less favorable in case of a highly vascularized tumor because of permanent blood accumulation within the surgical field. Also local venous congestion can be more accentuated and dangerous in the prone or Concorde position.

5. Craniotomy

I always used a suboccipital craniotomy that extended bilaterally and superiorly toward the occipital region beyond the superior margin of the transverse sinus. With bilateral exposure of the quadrangular lobulus, I selected either the left or right paraculminal route (Fig. 2), depending on the presence of bridging veins of a significant caliber that could block the access to the pineal region. A unilateral approach offers no other choice than remaining on the side of craniotomy throughout the procedure. Should a large bridging vein obstruct the access route, microsurgical maneuvers may be significantly limited; also, such large bridging veins may easily be damaged inadvertently with potentially serious consequences. The reason for extending the craniotomy superiorly was to increase the space between the tentorium and cerebellar surface. I used to suture the dura to the upper margin of the bone, concomitantly elevating the transverse sinus and tentorium, which added several millimeters of space between the tentorium and cerebellum (Fig. 2). This provided a sufficient working space between the superior cerebellar surface and tentorium, particularly in cases of a tight posterior fossa.

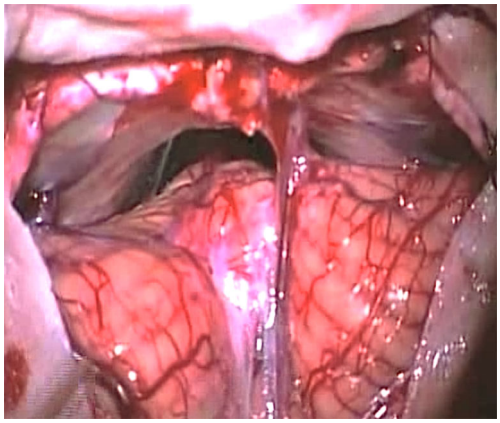

Fig. 2 An intraoperative photograph taken in a patient placed in the semisitting position. The dura mater was incised 5 mm below the transverse sinus, and the occipital sinus was ligated and divided. The superior edge of the dura was elevated and kept in place by several tenting sutures to the superior bony edge. The vermian and left lateral bridging veins have been preserved. Access to the pineal region was obtained through the quite large space between the cerebellar surface and tentorium after a slight descent of the cerebellum by gravity

6. Use of a cerebellar retractor

In the vast majority of cases, I refrained from using a cerebellar self-retaining retractor not only in the semisitting but also in the Concorde position as the cerebellum almost always descended by gravity after releasing cerebrospinal fluid. As a first step of the intradural procedure, I therefore used to open the quadrigeminal or ambient cistern and release a significant amount of CSF.

7. Surgical technique

Only in rare instances did I coagulate a superficial bridging cerebellar vein of small caliber if it was significantly obstructing the access to the pineal region. Conversely, I used to preserve large lateral bridging veins and tried to enhance their wall by wrapping the venous surface at the entry point into the tentorium with gel foam fixed with fibrin glue (Fig. 3a and b). Working in the deep pineal region even in young children required the use of very long microsurgical instruments (bipolar and tumor forceps, microscissors, suction tubes, dissectors, etc.). As the operating microscope was mainly focused on the pineal region, the superficial cerebellar veins remained out of focus during tumor removal. To avoid damaging these veins, I paid great attention to briefly focusing the microscope on these veins while inserting the surgical instruments into the deep surgical field. This maneuver was facilitated by the continuous use of a microscope equipped with a mouth switch that permitted moving the microscope while both hands were holding the instruments within the surgical field (the suction tube in my left and the bipolar forceps, etc., in my right hand).

If the tumor had encased part of or the entire Galenic venous draining group, I began with tumor volume reduction in the central or lower tumor region to avoid an initial conflict with these veins. Once the tumor volume had been reduced in size, I continued with identifying the deep-seated veins and gently dissecting them away from the tumor. In each single case I considered it crucial to avoid any mechanical damage to the tributaries of the vein of Galen. Only in very few cases did I prefer leaving a minimal portion of the tumor behind that I could not readily separate from these veins. In the vast majority of cases, however, I was able to remove the tumor completely or nearly completely, thus also eliminating or minimizing the risk of bleeding from the residual tumor.

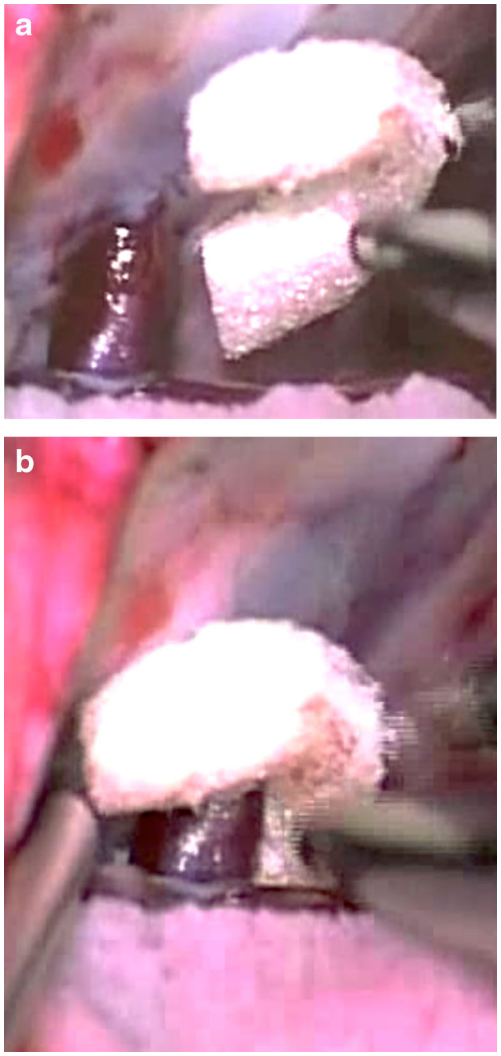

Fig. 3 Intraoperative photographs showing a superficial cerebellar bridging vein of large caliber that penetrates the tentorium (**a**). This vein was considered a major draining vein of the cerebellar hemisphere since there were no other drainers on the same side. For this reason, preserving the vein was given the highest priority. Before starting with the exposure of the pineal region tumor, a U-shaped piece of gel foam was used to enforce the venous wall at the entry point into the tentorium (**b**). Subsequently, this region was covered with fibrin glue

With their case report, Broggi and colleagues have focused our attention once again on the possibility of postoperative

acute cerebellar swelling after pineal tumor surgery. The authors must be commended for the successful management of their difficult case as well as for their detailed discussion of the pathogenetic mechanism and management of such a dreaded postoperative complication.

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