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Surgical treatment of acoustic neuroma: Outcomes and indications

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ABSTRACT

Aim: Surgery for acoustic neuroma has developed over the years with a gradual improvement in outcome. The goal of surgery should be cure of the disease and a low morbidity, preserving facial nerve function – and hearing, too, whenever feasible (i.e. in small tumors). The most appropriate approach must be decided case by case.

Background: Results of microsurgery remain heterogeneous, however, probably due to the different amount of experience gained at different centers.

Materials and Methods: Surgical series reported in the recent literature (2012–2015) were critically reviewed, along with some older papers with particularly representative series.

Results and conclusion: Considering patients' age, surgical morbidity of different approaches, tumor size and hearing, some principles can be identified on which to base surgical indications with a view to achieving the goals of curing the disease with a low morbidity, preserving facial nerve function and hearing, too, whenever feasible (i.e. in patients with small tumors). Different therapeutic approaches are discussed.

1. Background

Surgery for acoustic neuroma has developed over the years with a corresponding reduction in intraoperative and perioperative morbidity, and better preserved facial nerve and hearing functions.[1] The goal of surgery today is complete removal of the tumor with no further morbidity.

When investigating the outcome of surgery, the main bias is represented by the "human factor": although the surgical techniques involved in various approaches to the internal auditory canal and cerebellopontine angle (CPA) have been thoroughly described, and indications for surgery are shared and based on objective parameters, the experience gained by a surgical center strongly influences the results, adding a non-objective prognostic parameter that is not easy to judge. The results of microsurgery for acoustic neuroma vary considerably. Reviewing a selection of the most representative surgical series might help to overcome this problem and identify the "best surgical practice", and thereby contain the influence of this human experience factor on patient outcome.

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2. Materials and methods

Surgical series reported in the recent literature (2012–2015) were critically analyzed, together with several historical papers on particularly representative surgical series. Using the PubMed database, 350 papers of potential interest were identified, then screened by title, abstract and accessibility. Thirty-four articles were selected, based on the numerosity of the surgical series, the length of follow-up, the surgical experience gained by the authors (a parameter that influences the scientific value of any surgical series) and the completeness of their description and analysis of the following topics:

1. details of the surgical approaches;
2. outcome in terms of curing the disease (% of recurrences);
3. mortality rate and perioperative complications;
4. outcome in terms of facial nerve function;
5. outcome in terms of hearing preservation;
6. outcome of any salvage surgery after radiation therapy.

These parameters were reported as qualitative data, with rates and ranges of values, where available.

3. Results

1. The surgical approaches used in microsurgery for acoustic neuroma can be summarized as: translabyrinthine,[2,3] enlarged translabyrinthine[4,5] with the possibility of its transapical extension,[5] retrosigmoid,[6] retrosigmoid with retrolabyrinthine meatotomy,[7] presigmoid retrolabyrinthine (an old approach that was recently adapted for use with the endoscopy-assisted technique),[8,9] and the middle cranial fossa approach.[10–12] All these approaches involve microsurgical methods, craniotomy or craniectomy, access being first extradural then intradural (translabyrinthine, middle cranial fossa), or intradural with cerebellar retraction (retrosigmoid).
2. Cure of disease – The criterion for establishing surgical success was complete tumor resection with no long-term recurrences. In recent times, few authors have been using planned near-total or subtotal resections.[13,14] Subtotal removal is sometimes preferred in selected elderly patients to improve postoperative facial nerve results and reduce the duration of the surgical procedure. After near-total or subtotal surgery, the reported regrowth rates are 21–22%, requiring further treatment in 2–10% of cases. When gross total resections are performed, the recurrence rate has ranged from 2.4%[17] to 3%.[15,16] The rate of residual-recurrent tumor after complete resection via the translabyrinthine approach is practically nil,[4,13,14] while after hearing preservation surgery[18,19] it is reportedly in the range of 0.5–2%.
3. The reported operative mortality rate is less than 0.5%[6,20,21] using the retrosigmoid approach for small tumors. The rate was higher (0.8%) in smaller series and older reports.[22] Translabyrinthine surgery for any size of tumor reportedly carries an intraoperative mortality rate ranging from 0% to 2%,[6,23,24] and the rate was 0% using the middle cranial fossa approach.[10,11] Perioperative–postoperative complications can be classified as minor and major. Springborg et al.[23] reported a 1% postoperative mortality after surgery for large-giant tumors due to major complications (postoperative hematomas, pulmonary embolism, basilar artery thrombosis) occurring in patients over the median age of 65 years. In one of the most representative series of patients treated with translabyrinthine surgery,[25] perioperative–postoperative complications included subdural hematoma (0.4%), cerebellopontine angle hematoma (0.6%), cerebellar edema (0.28%), brainstem hematoma (0.14%), transient aphasia (0.14%), and lower cranial nerve dysfunction (0.14%). The cases of CSF leakage ranged from 14%[23] to 2.8%.[25] Complications reported after using the suboccipital approach included major neurological complications, with 0.1% of tetraparesis, 1% of hemiparesis, and 5.5% of caudal cranial nerve palsy.[26] Other complications occurring with the retrosigmoid approach were hematomas in the CPA (in 2.2% of cases), cerebrospinal fluid fistulas (9.2%), hydrocephalus (2.3%), bacterial meningitis (1.2%), and need for wound revisions (1.1%).[26] The outcome of hearing preservation surgery in terms of postoperative complications differed in the various series considered. There were reports of postoperative facial nerve dysfunction (House-Brackmann Grade III or higher) in 7.2%, CSF leak in 10.3%, postoperative headache in 17.3%, and major neurological complications (arterial and venous strokes, seizures, and persistent cerebellar dysfunction) in 1.8%.[24] Postoperative complications in Mazzoni's series involved 1 cerebellum infarction regressed to normal clinical function (0.8%) and CSF leak (2%) which required revision surgery.[21]
4. Long-term facial nerve outcome depended on the size of the tumor. The dissection technique and the surgeon's experience were uncontrollable variables influencing the outcome, but as concerns the objective tumor size parameter: for small tumors (<1.5 cm in the CPA), a good facial nerve outcome, i.e. House-Brackmann (HB) grades I and II, was achieved in 94–96% of cases (and grade III in the remainder)[20,27,28]; for tumors from 1.5 to 2.5 cm in size, HB grades I and II were achieved in 83% of cases; when the tumor was between 2.5 and 3.5 cm in size, the proportion dropped to 70%; and it was 50% for tumors in the CPA over 3.5 cm in size. Considering tumors of any size, the reported rate of anatomical facial nerve preservation was 95.8%, but only 65% of them retained a good function (HB grades I or II), 29.4% an intermediate function (HB grade III), and 5.6% an unsatisfactory function (HB grades IV–VI). These outcomes related directly to the preoperative size of the tumor, HB grades IV–VI coinciding with up to 21.8% of cases of tumor larger than 4 cm.[28]
5. The outcome of hearing preservation surgery depended on preoperative hearing function and tumor size. A good postoperative hearing function was preserved in the series reporting the best outcomes, with rates of 74.1%,[29] 87%,[20] and 88%.[30] These rates were achieved for small tumors (1 cm in the CPA) in patients with good preoperative hearing. After using the middle cranial fossa approach, the reported rate of good postoperative hearing function ranged from 51% to 55%,[31,32] and the results in terms of facial nerve function were slightly worse than after

retrosigmoid/translabyrinthine surgery for the same size of tumor.[5,20,21]

6. There is little information in the literature on salvage surgery after radiotherapy.[33–35] Authors generally agree that it is more difficult to dissect tumor from the plane of the brainstem and cerebellum, or from the facial nerve. Complete resections were achieved in 70–86% of cases, and dissection difficulties were reported in 93.3% of these cases. Anatomical facial nerve preservation was achieved in 93.3%, but the nerve's function deteriorated in 73.3% of these cases.[35]

4. Discussion

Surgical outcomes are difficult to compare because the surgeon's experience is an uncontrollable parameter, different techniques and skills are involved, and the indications for surgery can vary considerably. The relevant data are therefore always heterogeneous, but some objective parameters can be analyzed with a view to suggesting a reliable rationale for surgery.

Cure of the disease and complete resection are the goals of surgical treatment for acoustic neuroma nowadays. What happens in cases of residual disease is not clear. Subtotal or partial resections may be preferred for large tumors strongly attached to the brainstem, or in elderly patients, or when preserving a good facial nerve function is the primary goal of surgery. A growing residual neuroma might be amenable to radiotherapy.

Cure of the disease should be associated with no further morbidity. The surgery-related death and severe complication rates are now lower than 0.5% in experienced hands. This means that properly-performed surgery can be considered a low-morbidity treatment, with very few major or minor complications. Small and medium-sized tumors do not differ in terms of the associated major complications, but the same cannot be said of the outcome on the facial nerve. Patients with tumors less than 1 cm in size in the CPA have a more than 96% rate of normal or near-normal facial nerve function (HB grades I and II) after surgery, while in tumors up to 1.5 cm in the CPA the rate of facial nerve preservation is 83% (I and II).[27] This rate drops to 70% in tumors over 2.5 cm, and to 50% in ones over 3.5 cm. While intraoperative monitoring and the development of new surgical tools have contributed to improving surgical outcomes over time, functional outcomes are really only slightly better nowadays than they were 20 years ago.[11,27] Observation alone may be the best option for tumors up to 1.5 cm in size. If they grow, they can undergo low-morbidity surgery providing this is done promptly, before the tumor reaches the critical size of 1.5 cm.[23,27] This maximizes the likelihood of preserving a good facial nerve function, as emerges from the reported outcomes of the surgical series analyzed.

These days, such an early surgical strategy for small tumors in patients with good preoperative hearing makes hearing preservation surgery feasible as opposed to observation. Patients should be informed of the pros and cons of the two options. Hearing preservation rates are very good in some series[20,29,30] with intraoperative-perioperative morbidity rates of less than 0.5%. Cerebellar retraction is the event with the greatest influence on the surgical risk, and should be avoided. Appropriate preoperative patient positioning and intraoperative general anesthesia should enable spontaneous retraction.

Although the choice is influenced by surgeons' preferences, the retrosigmoid approach is recommended in surgery for acoustic neuroma whenever hearing preservation surgery is an option,[21] or for tumors of any size irrespective of hearing function.[26] In cases where the goal is not to preserve hearing, translabyrinthine surgery would enable the safe removal of the tumor with fewer risks and an equally good or even better outcome for the facial nerve.[28]

Translabyrinthine surgery may be performed by drilling circumferentially around the internal auditory canal (transapical approach) to enlarge the surgical corridor to the anterior CPA.[5] Surgery should follow clear indications and be tailored to each case, considering the tumor's size and growth rate, and the patient's hearing function, age and willingness to receive treatment.

Large tumors are challenging and the risk of major complications exceeds 1%, but the surgical principle of "removing bone to spare the brain", which lies behind the transpetrous approaches to the CPA, has considerably lowered the related mortality and morbidity rates. The broad access achievable by drilling the petrous bone and skull base[5] assures an adequate exposure of the surgical field without any need for further brain retraction, making this surgical procedure safer and with a low risk of major complications.

5. Conclusion

Only homogeneous results should be compared when analyzing what might be the best option for a given case, but all surgical series suffer from a marked heterogeneity of results.

Considering the patient's age, the morbidity of the different surgical approaches, tumor size and hearing function, some principles emerge[21] to support surgical decision-making. For small tumors that are not growing, a 'wait and see', scanning policy is advisable, switching to active treatment in the event of evidence of tumor growth. If hearing is still preserved, then hearing preservation surgery using the retrosigmoid approach and retrolabyrinthine meatotomy is a safe option that achieves good results. When hearing function has been lost or is severely impaired, there is no way to restore it and translabyrinthine surgery provides an extradural corridor to the internal auditory canal, enabling cerebellar retraction to be avoided and assuring a good exposure of the cerebellopontine angle. The retrosigmoid approach is feasible in these conditions, too, and the choice is often dictated by the surgeon's preferences. The goal of surgery should be cure of the disease and a low morbidity, preserving facial nerve function – and hearing, too, whenever feasible (i.e. in small tumors). The most appropriate approach must be decided case by case.

Conflict of interest

None declared.

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