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Main Article

Nerve origin of vestibular schwannoma: a prospective study

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Abstract

Objective: The origin of vestibular schwannoma has always been a matter of debate. The aim of our study was to identify the nerve origin of this tumour.

Study design: Prospective case review. This study was conducted at Gruppo Otologico, a private referral centre for neurotology and skull base surgery.

Methods: A total of 200 cases of vestibular schwannoma were included in the study. All the tumours were removed surgically utilising the translabyrinthine approach. The origin of the tumour was sought at the fundus of the internal auditory canal.

Results: A total of 200 consecutive cases was included in the study. The origin of the tumour was limited to one nerve at the fundus in 152 cases (76 per cent). Out of these cases, the tumour originated from the inferior vestibular nerve in 139 cases (91.4 per cent), from the superior vestibular nerve in nine cases (6 per cent), from the cochlear nerve in two cases (1.3 per cent) and from the facial nerve in two cases (1.3 per cent).

Conclusion: The vast majority of vestibular schwannomas originate from the inferior vestibular nerve; the incidence of involvement of this nerve increases as the tumour size increases. An origin of vestibular schwannoma from the inferior vestibular nerve can be considered as one of the explanatory factors for the poor functional outcome of the extended middle cranial fossa approach, and probably accounts also for the better hearing preservation rate reported in some series for the retrosigmoid approach.

Key words: Vestibular Schwannomas, Origin; Vestibular Nerve

Introduction

Until a few decades ago, there were a number of misconceptions regarding vestibular schwannomas. One of these was the origin of the tumour. Based on the finding that the response to the caloric stimulation test was reduced in cases of vestibular schwannoma, an assumption was made that the tumour originated from the superior vestibular nerve.[1–3] The justification for such an assumption was that the caloric test detects the function of the lateral semicircular canal, which in turn is innervated by the superior vestibular nerve. Thus, indirectly, the test would be detecting the function of the superior vestibular nerve.

In our centre, we have been surgically removing vestibular schwannomas since 1986. In 1995, we began using the superior ampullary nerve technique for identification of the facial nerve during the enlarged translabyrinthine approach.[4] Since then, we noticed that, in the vast majority of cases in which the origin of the vestibular schwannoma could still be identified, the superior division of the nerve was free and the origin of the tumour was the inferior vestibular nerve. We initiated this prospective, case review study in order to confirm our clinical impression regarding the origin of vestibular schwannoma.

Materials and methods

In our centre, a total of 960 vestibular schwannomas has been operated upon by the senior author (MS) during the period from January 1986 to 30 October 2003. In March 2003, we commenced a prospective study identifying the nerve origin of the vestibular schwannoma. Only schwannomas operated upon via the enlarged translabyrinthine approach were included in the study. This was because this approach offered the possibility of identifying the distal ends of the vestibular nerve, which are generally the parts free from tumour infiltration, thus enabling the origin of the tumour to be accurately identified. A total of 200 consecutive cases undergoing surgery from March 2003 to October 2004 were included in the study. In all cases, the diagnosis was made by magnetic resonance imaging and confirmed by histological examination.

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The data collected for analysis were: tumour size; presence or absence of widening of the internal auditory canal; and the nerves involved by the tumour. For the assessment of tumour size, the intracanalicular part of the tumour was considered to be zero and the largest extrameatal diameter was considered to represent the size. The tumours were divided into three groups according to size: 0–1 cm, 1.1–3 cm and greater than 3 cm. The internal auditory canal was considered to be widened when the difference in size between the porus of the canal involved by the tumour and the normal side was more than 2 mm at the level of the axial section crossing the tympanic segment of the facial nerve. The nerves in the fundus of the internal auditory canal were assessed for tumour involvement. The involved nerve was reported to be the origin of the tumour. If more than one nerve was involved by the tumour, the origin of the tumour was reported as unknown.

The chi-square test was used for statistical analysis, and the significance level was set at a p value of less than 0.05.

Surgical technique

Our techniques for performing the enlarged translabyrinthine approach have been described in detail elsewhere.[5–9] In this report, we will describe only those steps involving identification of the VIIth and VIIIth cranial nerves at the fundus of the internal auditory canal.

To enable identification of the nerves at the fundus of the internal auditory canal in the enlarged translabyrinthine approach, we utilised the superior ampullary nerve technique. The bone overlying the posterior aspect of the internal auditory canal was gradually thinned and removed, exposing 270° of the circumference of the canal from the porus medially to the fundus laterally. At the fundus, the horizontal crest was identified and the bone superior and inferior to it removed, leaving only the dura covering the superior and inferior vestibular nerves. The superior ampullary nerve, which is the continuation of the superior vestibular nerve to the lateral semicircular canal, was identified in its canal by drilling the bone lying between the distal end of the superior vestibular nerve and the medial wall of the ampulla of the lateral semicircular canal.

With its tip directed inferiorly, a small hook was used to dislodge the superior ampullary nerve from its canal. This step was safe for the facial nerve, because at this point Bill's bar lies anterior to the hook, forming a barrier between the nerve and the sharp tip of the hook. In addition, this location was important because it allowed us to identify the nerve at a location free of tumour infiltration, and thus to identify the tumour origin.

The dura covering the posterior surface of the internal auditory canal was then cut open using a pair of fine scissors, and the superior ampullary nerve was dissected medially. In cases in which the tumour originated from or involved the superior vestibular nerve, the dissection of the superior ampullary nerve ended in swollen tumour tissue near the fundus. However, in the majority of cases, the superior vestibular nerve was free of tumour and the medial dissection of the superior ampullary nerve allowed identification of the superior vestibular nerve, which could also be dissected from the tumour surface. The involvement of the inferior vestibular nerve by the tumour was assessed, and a hook was used to dissect it free from the fundus of the internal auditory canal. At this stage, both the cochlear and facial nerves were exposed and their involvement by the tumour could be assessed.

Results and analysis

A total of 200 consecutive cases were included in our prospective study. All of the tumours were removed surgically utilising the enlarged translabyrinthine approach. In 152 cases (76 per cent), the tumour involved only one nerve at the fundus (Table I). Out of these cases, the tumour originated from the inferior vestibular nerve in 139 cases (91.4 per cent), from the superior vestibular nerve in nine cases (6 per cent), from the cochlear nerve in two cases (1.3 per cent) and from the facial nerve in two cases (1.3 per cent) (Table II). In 48 cases (24 per cent), more than one nerve was found to be involved by the tumour at the fundus, and these cases were thus reported as being of unknown origin. An interesting finding in cases of unidentified origin was that, in all 48 cases, the tumour involved the inferior vestibular nerve; superior vestibular nerve involvement was present in 32 cases and cochlear nerve involvement in only 16 cases.

The internal auditory canal was normal in 125 cases (62.5 per cent) and widened in 75 cases (37.5 per cent). The origin of the tumour was unknown in 42 per cent of the cases with widened internal

TABLE I

VESTIBULAR SCHWANNOMA NERVE ORIGIN*

Origin	Cases	
	n	%
Identified, single nerve	152	76
Unidentified, >1 nerve	48	24
Total	200	100

*200 consecutive cases, enlarged translabyrinthine approach.

TABLE II

VESTIBULAR SCHWANNOMA NERVE ORIGIN IN 152 CASES WITH IDENTIFIED ORIGIN

Nerve origin	Cases	
	n	%
Inferior vestibular nerve	139	91.4
Superior vestibular nerve	9	6
Facial nerve	2	1.3
Cochlear nerve	2	1.3
Total	152	100

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auditory canal, but in only 16 per cent of cases with a normal internal auditory canal. The chi-square test showed a significant decrease in the possibility of identifying the origin of the tumour if the internal auditory canal was widened ($p < 0.0001$). The size of tumours ranged from intracanalicular to 5 cm, with an average of 1.5 cm. When we attempted to correlate the possibility of identifying tumour origin with tumour size, we found that tumours of up to 1 cm were of unknown origin in 18 per cent of cases. Tumours sized 1.1–3 cm were of unknown origin in 27 per cent of cases. Tumours larger than 3 cm were of unknown origin in 40 per cent of cases (Table III). The chi-square test showed a significant decrease in the possibility of identifying tumour origin as the tumour size increased ($p = 0.0024$). Considering these two factors together (i.e. tumour size and internal auditory canal widening), the result was as expected. There was a greater chance of widening of the internal auditory canal as the tumour size increased ($p < 0.0001$).

Discussion

Early attempts to identify the origin of vestibular schwannoma either used indirect evidence (such as canal paresis) or were confounded by the large size of the tumours encountered (making surgical identification of tumour origin more difficult). Looking at the literature, we note a change in the reported origin of vestibular schwannoma over time. In early papers, the most commonly reported origin was the superior vestibular nerve, with a rate of 90 per cent.[1] In 1978, Ylikoski *et al.*[10] reported a rate of 80 per cent from the superior vestibular nerve and 20 per cent from the inferior vestibular nerve, for tumours of identified origin. In 1986, Clemis *et al.*[11] reported that only 50 per cent of the tumours they studied originated from the superior vestibular nerve. In 2001, Komatsuzaki and Tsunoda reported a retrospective study[12] which found an incidence of origin of 84.8 per cent for the inferior vestibular nerve and of only 8.9 per cent for the superior vestibular nerve. To the best of our knowledge, the current report represents the first prospective study with the aim of identifying the origin of vestibular schwannoma.

In our study, 91.4 per cent of the tumours originated from the inferior vestibular nerve. This is the highest reported rate in the literature. The increase in the reported rate of inferior vestibular nerve origin of vestibular schwannoma is unlikely to be explained on the basis of evolution or changing pathogenesis of vestibular schwannoma. In our opinion, the main reason for this change is the improvement in both diagnostic and surgical techniques over time. Before the introduction of magnetic resonance imaging, the diagnosis of vestibular schwannoma depended, at least in part, on changes in the internal auditory canal diameter, as judged by tomography and later by computed tomography. The result was late diagnosis of tumours, which by this stage had grown quite large. Analysis of our results showed that both of these factors – large tumour size and widened internal auditory canal – were associated with a high rate of unknown origin of vestibular schwannoma, supporting our explanation for the observed changes in the reported incidence of tumour origin over time.

TABLE III

THE PERCENTAGE OF IDENTIFICATION OF TUMOR ORIGIN AS RELATED TO TUMOR SIZE IN THE 200 CASES*

Origin (%)	Size (cm)		
	0–1	1.1–3	>3
Identified, single nerve	82	73	60
Unidentified, >1 nerve	18	27	40
Total	100	100	100

*200 cases.

- **This study analysed the nerve of origin of vestibular schwannoma, in a prospective series of 200 surgical cases**
- **The majority of tumours originated from the inferior vestibular nerve. The likelihood of origin from the inferior vestibular nerve increased with tumour size**
- **An origin of vestibular schwannoma from the inferior vestibular nerve may explain the poor functional outcome for the extended middle cranial fossa surgical approach, and also the higher hearing preservation rate for the retrosigmoid approach, reported by some authors**

Apart from the obvious scientific importance of correcting this misconception, our findings are important in explaining the poor hearing results obtained when using the middle cranial fossa surgical approach, compared with the retrosigmoid approach.[13] The vast majority of vestibular schwannomas originate from the inferior vestibular nerve; therefore, when using the middle cranial fossa approach, more surgical manipulation is needed near the cochlear nerve and the labyrinthine artery, in order to remove the tumour. Such manoeuvres are performed at a deeper and narrower plane, exposing these delicate structures to a higher risk of surgical injury. However, when using the retrosigmoid approach, a tumour originating from the inferior vestibular nerve will shield the anteriorly lying cochlear nerve, thus reducing the surgical trauma and accounting, at least partially, for the higher hearing preservation rates for the retrosigmoid approach. Poor facial nerve function following middle cranial fossa approach surgery, compared with that following enlarged translabyrinthine approach surgery,[13,14] can also be explained on the basis of tumour origin. However, when using the enlarged translabyrinthine approach, the facial nerve stays anterior to the tumour, away from the surgeon and surgical

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manipulation; therefore, a vestibular schwannoma originating from the inferior vestibular nerve would push the facial nerve onto its superior surface, placing it between the surgeon and the tumour and resulting in increased risk of facial nerve injury – thus explaining the difference in facial nerve functional outcomes. Unfortunately, in our series, the cases undergoing middle cranial fossa approach surgery were too few to draw any statistically significant results regarding facial nerve functional outcome in relation to tumour origin.

Another interesting finding of our study was the fact that as the tumour size increased, the possibility of tumour involvement of more than one nerve increased. In all the cases with large tumors involving more than one nerve, the inferior vestibular nerve was involved by the tumour. This means that as the tumour size increased, the incidence of involvement of the inferior vestibular nerve also increased. If we consider the previous discussion to be true, the findings of this study further support our policy of limiting use of the middle cranial fossa approach to tumours smaller than 0.5 cm, in order to optimise the functional outcome of vestibular schwannoma surgery, in terms of hearing and facial nerve function.

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