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ORIGINAL ARTICLE



## Audiological outcome for hearing preservation surgery in acoustic neuroma: the need of agreement in reporting results

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### ABSTRACT

**Purpose:** Early diagnosis in acoustic neuroma (AN) has increased the prevalence of small tumors with good hearing. Otoneurological centres have increasingly aimed to preserve hearing function. The management options of small ANs range from observation to active treatments (surgery, radiotherapy). No firm agreement has been made on which is the best option for audiological function preservation. Nowadays, no definitive guidelines are present in order to suggest a standard way of evaluating and comparing the hearing quality. The lack of a universally agreed hearing classification leads to the impossibility of comparing data from different centres or different therapeutic options.

**Method:** The paper wants to show, analyzing our surgical experience in hearing preservation surgery for ANs, the different results that are demonstrable by just using different hearing classification.

**Results:** About the 13 patients considered 'in protocol' who underwent HPS, 69% are considered to have 'good' hearing after surgery using the Tokyo or Sanna classifications; with the AAO-HNS or the GR classifications the outcome of 'good' hearing preservation was 77% and in 87% with the WRS classification.

**Conclusion:** A shared hearing classification is potentially the solution in order to facilitate comparison of functional outcomes across different centres or different treatment modalities.

### KEYWORDS

Vestibular schwannoma;  
hearing preservation;  
acoustic neuroma; hearing  
classification



## Introduction

The availability of increasingly sophisticated diagnostic methods and innovative therapeutic procedures have revolutionized the management of acoustic neuroma (AN). Magnetic resonance imaging (MRI) allows early diagnosis of small tumours. The therapeutic options for small vestibular schwannomas range from observation, radiotherapy (RT) with gamma knife and stereotactic radiosurgery, and surgery. The options are balanced on a range of factors including hearing, growth of tumour, age of patient, co-morbidities, patient choice as well as institutional preference [1]. Surgical options include hearing preservation surgery (HPS) with middle cranial fossa (MCF) approach or retrosigmoid (RS) approach [2]. Translabrynthine approach would be considered in cases of tumour growth and impaired hearing, or when an early hearing restoration with cochlear implant is planned. Although still debated, the transcanal route to the internal

auditory canal (IAC) for small ANs may also represent a viable surgical option in very selected cases [3].

Simultaneously to the expectations of the patients around the functional preservation, the paradigm is that the most effective treatment needs to have the fewest side effects and that the functional outcome needs to be evaluated on a long term basis, considering the natural history of the disease and its benign nature [4]. Only level III evidence [5] is reached when trying to compare hearing outcome between the three options of treatment to define the best therapy. The long-term results seem to be in favour of surgery [6,7].

The challenge of preserving/restoring hearing in patients with small ANs is a debated issue and has to become the ambition when the diagnosis occurs before the organ function has deteriorated. Multioptional therapy is probably the answer to set a tailored management for each case of small tumour with good, or bad hearing and should be offered in

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every referral centre [6]. Despite the increase of audiological consciousness in the otoneurological field, to date, the way of assessing hearing is not universally endorsed in the scientific community, both for wait and scan and HPS patients. As well as the lack of clear guidelines, also an agreement in how to report hearing outcomes is lacking. The availability of different hearing classification systems does not allow a reliable comparison of results with other centres worldwide.

The purpose of the present study was to analyze our experience at a tertiary care referral centre on the subset of patients who underwent HPS. Moreover, it will be highlighted how the hearing outcome results affected by the use of different hearing classification systems, thus ending up with different rates of success.

## Materials and methods

The clinical documentation of patients diagnosed with small AN who were treated at the ENT Department of the University Hospital of Padua (Italy) between January 2012 and June 2016 was retrospectively evaluated. The diagnosis was obtained by contrast-enhanced MRI with high-resolution T2 and contrast-enhanced T1-weighted sequences.

## Audiological evaluation

Every patient underwent pure tone and speech audiometry at diagnoses and during follow up. Auditory brainstem response (ABR) test was performed in cases with good hearing, in order to better evaluate the eligibility for HPS. Hearing function was evaluated through the pure tone average (PTA) defined as the mean dB value between 0.5, 1, 2 and 4 kHz, as well as with the speech discrimination score (SDS), determined by the number of words correctly repeated (in per cent) at the most comfortable intensity level,

according to the masking rules. In the clinical practice, the Tokyo classification [8] was commonly adopted for stratifying the audiological status before and after treatment.

## Treatment

The choice of HPS rather than the wait and scan program according to the Institutional multioptional treatment program [6] was found on the patients' audiological profile, age, anaesthesiologic risk and the personal motivation. HPS was performed via a RS approach combined with retrolabyrinthine meatotomy [9]. Inclusion criteria for HPS consisted of good hearing at diagnosis ( $\leq 30$  dB PTA,  $\geq 70\%$  SDS, ABR in class I or II) and small ANs, namely intrameatal tumours or with a less than 10 mm extrameatal extension [10].

Hearing before and after HPS was classified according to the Tokyo classification system. Moreover, other hearing classifications reported in the literature (Table 1) were retrospectively applied to the patients' cohort. Hearing results were thus classified and compared according to four other classifications, namely the classifications of American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) [11], Gardner-Robertson [12], Sanna [13], as well as with the word recognition score (WRS) proposed by Meyer et al. [14].

## Results

The clinical characteristics of the 87 patients diagnosed with a small AN were: 62 (71%) patients followed a wait and scan policy and 25 (29%) went to primary surgical treatment. Among these, 19 underwent HPS, while six patients were submitted to translabyrinthine surgical excision of the AN. Thirteen patients under observation had to stop observation

**Table 1.** Different classification systems adopted in the literature.

	Tokyo [8]		AAO-HNS [11]		Sanna [13]		GR [12]		WRS [14]
	PTA	SDS	PTA	SDS	PTA	SDS	SRT/PTA <sup>a</sup>	SDS	
A	$\leq 20$	$\geq 80$	$\leq 30$	$\geq 70$	$\leq 20$	$\geq 80$	$\leq 30$	$\geq 70$	70–100
B	21–30	79–70	31–50	69–50	21–40	79–60	31–50	69–50	50–69
C	B <sup>up</sup> 31–40	$> 70$	$> 50$	$\geq 50$	41–60	59–40	51–90	49–5	1–50
D	C <sup>up</sup> 31–40 41–60	69–60 $> 60$	Any	$< 50$	61–80	39–20	$> 90$	4–1	0
E	D <sup>up</sup> 41–60 61–80	59–50 $> 50$	–	–	81–100	$> 20$	No response	–	–
F	E <sup>up</sup> 61–80 $> 80$	49–40 $> 40$	–	–	$> 100$	20–0	–	–	–
	$> 80$	39–0							
Frequencies for PTA calculation (kHz)	0.5–1–2–4		0.5–1–2–3		0.5–1–2–4		0.5–1–2		No PTA

PTA: pure tone average (dB); SDS: speech discrimination score (%); SRT: speech reception threshold (dB); WRS: word recognition score (%).

<sup>a</sup>use the better score. If PTA/SRT and SDS do not qualify for the same class, use class appropriate for poorer of the 2 scores.

**Table 2.** Hearing preservation rates for the HPS group of patients, according to the different classification systems in use.

Hearing classification	Preoperative hearing class		Postoperative hearing class						
	A	B	Good hearing		Impaired hearing				
			A	B	C	D	E	F	
Tokyo [8]	15	4	2	53%	8	2	1	47%	5
AAO-HNS [11]	13	6	2	63%	10	1	6	37%	–
Sanna [13]	9	10	2	53%	8	3	1	47%	4
GR [12]	19	–	7	63%	5	1	0	37%	–
WRS [14]	19	–	12	68%	1	0	6	32%	–

AAO-HNS: American Academy of Otolaryngology-Head and Neck Surgery; GR: Gardner-Robertson; WRS: Word Recognition Score.

**Table 3.** Hearing preservation outcome for 'in protocol' patients.

Classification	Postoperative preserved hearing (%)	Postoperative deafness or bad hearing (%)
Tokyo [8]	9 (69)	4 (31)
AAO-HNS [11]	10 (77)	3 (23)
Sanna [13]	9 (69)	4 (31)
GR [12]	10 (77)	3 (23)
WRS [14]	11 (87)	2 (13)

AAO-HNS: American Academy of Otolaryngology-Head and Neck Surgery; GR: Gardner-Robertson; WRS: Word Recognition Score.

and shifted to surgical treatment, but no one met the inclusion criteria for HPS.

In the sample of 19 patients submitted to HPS via retrosigmoid approach and retrolabyrinthine meatotomy, 13 (68.4%) were male. The mean age at diagnoses was  $47 \pm 10.4$  years. Extrameatal tumours occurred in 10 (52.6%) patients. Six of the patients who underwent HPS were treated even though they did not meet the criteria for the 'HPS protocol'. The median PTA at diagnosis was 20 dB (range 10–39) with a 100% SDS in all patients. At a mean follow up of 20.5 months (range 2–71 months), the postoperative median PTA was 40 dB (range 18–85 dB).

According to the Tokyo classification, preoperative classes A or B were registered in the 100% of the patients. The same preoperative hearing class was maintained in the 53% of cases. Table 2 provides the pre- and postoperative hearing results of the 19 HPS patients in the present series stratified according to the available hearing classification systems in use.

A further analysis focused on the 13 cases belonging to the HPS in-protocol group is presented in Table 3. HPS success rates range between 87% and 69%.

## Discussion

The importance of having easily comparable data cannot be understated. This represents the only way of comparing outcomes and, subsequently, the best treatment option.

Provided that hearing preservation is the current goal of therapies in small AN [15], comparison of outcome is still far to be reliable among the different options. The methods to measure hearing differ in the classifications and the result of 'good hearing' has not the same meaning in all the systems.

The retrospective analysis of our series showed clearly how the same patient with postoperative hearing preserved can belong to a different class depending on the hearing classification system that was used.

Specifically, of the 13 patients considered 'in protocol' who underwent HPS, 69% are considered to have 'good' hearing after surgery using the Tokyo or Sanna classifications; with the AAO-HNS or the GR classifications the outcome of 'good' hearing preservation was 77% and in 87% with the WRS classification.

This clearly evidences how it is not possible to compare hearing outcome when the results are calculated with different methods and grouped with different classifications. Only when a shared, representative classification is set, the hearing function will be comparable among the different options.

At the moment, no conclusion can be achieved when the 'good' result is so heterogeneous, and the rates of 'successful' hearing preservation are misleading. The different experiences in hearing preservation, be it obtained with surgery, radiotherapy or observation coming from various skull base centres will be incomparable [16].

At present, the rates of successful hearing preservation are not comparable, since the methods to

measure and evaluate hearing are heterogeneous. The lack of homogeneity and long-term results make it impossible to define which is the best option to preserve hearing in small AN [16]. Surgery seems to have better outcome at long term, but only level III of evidence is achieved [5].

Each classification has some strengths and weaknesses, we consider the Tokyo's, the AAO-HNS' and the Sanna classifications (Table 2) to be more representative.

The differences are

- The number of classes used. On the one hand, the Tokyo [8] and the Sanna [13] classifications have six classes, whereas the AAO-HNS [11] classification only 4.
- The Tokyo classification allows an upgrade of class if the SDS is better than the PTA. This is valid from C class to E, resulting in creating 4 'upgrade' classes, B<sup>up</sup>, C<sup>up</sup>, D<sup>up</sup> and E<sup>up</sup>. This shows that a great importance, although not exclusive, is given to the speech discrimination score.
- The PTA, according to the Tokyo and the Sanna classifications is the average threshold at the 0.5, 1, 2 and 4 kHz frequencies; the AAO-HNS utilizes the 3 kHz instead of 4 kHz.

When comparing to other classifications, the differences increase. The WRS classification proposed by Myer et al [14] does not take into consideration the PTA but only the monosyllable word recognition score, grouping into four classes. The Gardner–Robertson scale [12] uses the better score between the PTA (as average of 0.5, 1 and 2 kHz frequencies) and the SRT (speech recognition threshold) in addition to the SDS and divides the results in five classes.

A standard hearing classification should be agreed in order to compare the functional outcomes of the various treatments. The use of a homogeneous method to evaluate hearing is also useful in selecting the good candidates to address to HPS or to observation.

In our experience, the Tokyo classification seems to be more complete and precise than the others. Its wide range of classes and, within certain limits, the role which is given to speech discrimination score makes it at present the most representative of hearing function. Nevertheless, more effort is to be made to find out and apply methods to explore the 'good' hearing, both in the diagnostic and post-treatment phase, which is more representative of the everyday listening conditions.

## Conclusions

In small ANs, our experience supports HPS performed via a RS and retrolabyrinthine meatotomy approach as the best option for hearing preservation when specific criteria are preoperatively present ( $\leq 1$  cm size,  $\leq 30$  dB PTA,  $\geq 70\%$  SDS and class I–II ABR). Provided that only long-term results will set the superiority of a therapeutic option over another one, a homogeneous method of measurement and classification of hearing is warranted. Only with homogeneously expressed data the hearing outcome can be evaluated, discussed, and compared, to find out which is the best treatment for small AN.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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