

Long-Term Hearing Preservation in Vestibular Schwannoma

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Objective: The aim of the present study was to evaluate the long-term hearing during “wait and scan” management of vestibular schwannomas.

Subjects: During a 33-year period, from 1976 to 2008, 1,144 patients with vestibular schwannoma were allocated to observation by the wait and scan policy, with annual magnetic resonance imaging and audiologic examination. Two complete pure-tone and speech discrimination audiograms were available for 932 patients. In 900 patients (97%), the wait and scan period was at least 1 year. In 377 patients (40%), the observation time was at least 5 years, and in 102 patients (11%), at least 10 years.

Results: At diagnosis, 491 patients (53%) presented with good hearing, that is, speech discrimination better than 70%. After a

mean of 4.7 years of observation, 59% of these patients spontaneously preserved good hearing. Of patients with 100% speech discrimination at diagnosis, 69% maintained good hearing after more than 10 years of observation. Of patients with only a small discrimination loss at diagnosis, 38% maintained good hearing.

Conclusion: Most vestibular schwannoma patients with 100% speech discrimination at diagnosis maintain good hearing even after many years of observation. **Key Words:** AAO classification—Acoustic neuroma—Conservative management—Pure-tone hearing—mWRS classification—Speech discrimination—Word Recognition Scoring classification.
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Reports of large series of patients with vestibular schwannoma have shown that a substantial proportion of these tumors do not grow after diagnosis (1–5). Thus, with the acknowledgement that the quality of life generally is poorer after surgery compared with conservative management for patients with a small tumor (6–8), a “wait and scan” policy has become a reasonable option for this group of patients. In the case of a small nongrowing tumor, this leaves preservation of good hearing as the remaining indication for surgical treatment. However, hearing preservation surgery is only meaningful if the hearing preserved is superior to the spontaneous hearing preservation during observation.

Conversely, an argument against conservative management of vestibular schwannoma is the risk of progressive hearing deterioration during the period of wait and scan, which may lead to a loss of serviceable hearing and candidacy for hearing preservation surgery (9–11). Speech discrimination at diagnosis may be a good predictor of subsequent hearing deterioration because 88% of patients with 100% speech discrimination at diagnosis maintain good hearing after a median of 4.3 years of

observation, whereas only 50% preserve good hearing in case of only a minor initial discrimination loss (12). However, the long-term spontaneous hearing preservation is unknown.

Accordingly, the aim of this study is to analyze the long-term hearing during wait and scan and to evaluate the predictive value of good speech discrimination at diagnosis.

SUBJECTS AND METHODS

In Denmark, with a population of 5.4 million people, 2,283 patients have been diagnosed with a unilateral vestibular schwannoma and registered in the national database during the 33-year period from January 1976 to December 2008.

Of the 2,283 patients, 1,144 patients were allocated to wait and scan treatment strategy with the intention to perform annual magnetic resonance imaging, as well as annual audiologic examination. The reason for observation was tumor size 20 mm or smaller (1,105 patients) or other reasons like poor medical condition, old age, or personal reasons (39 patients).

Of the 1,144 patients, at least 2 full audiograms, including pure-tone (PTA) and speech audiometry, were available for 932 patients (85%).

The observation period was terminated in 196 of the 932 patients, in most cases because of tumor growth. Thirty-two of these were irradiated, and 164 were operated. Seventy-four patients had died from non-tumor-related reasons, terminating

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TABLE 1. Length of observation time, cumulated number of patients observed, and reason for termination of the observation period

Observation time, yr	No. patients	Cumulated no. patients	Reason for termination of observation period			Still observed
			Irradiation	Operation	Death	
No data	11	932	2	2	2	5
0-1	21	921	1	13	—	7
1-2	182	900	16	57	17	92
2-3	134	718	6	37	10	81
3-4	122	584	3	29	11	79
4-5	85	462	3	8	7	67
5-6	86	377	1	6	7	72
6-7	52	291	-	6	5	41
7-8	62	239	-	1	1	60
8-9	47	177	-	3	3	41
9-10	28	130	-	1	4	23
≥10	102	102	-	1	7	94
Total	932	932	32	164	74	662

the observation period. Six hundred sixty-two patients were still observed at the end of 2008 (Table 1).

The median age at diagnosis for the 932 patients was 58.3 years, ranging from 15 to 85 years. Four hundred forty-eight of the patients were women, and 484 were men. At the time of diagnosis, the tumors were categorized as purely intrameatal in 372 patients and as intrameatal and extrameatal in 560 patients. The mean observation period was 4.7 years, with a range of 0.5 to 21 years.

In 900 patients (97%), the wait and scan period was at least 1 year. In 377 patients (40%), the observation time was at least 5 years, and in 102 patients (11%), the observation period was 10 years or longer (Table 1).

The PTA was measured as the mean sum of the hearing level (in decibels) at the frequencies 500, 1,000, 2,000, and 4,000 Hz. The speech discrimination (SD) test had been performed in quiet using word list scoring by phonemes correctly repeated at the most comfortable hearing level.

For the classification of hearing, the Word Recognition Scoring classification (WRS) and the modified Word Recognition Scoring classification (mWRS) were used (12,13), with a Class 0, SD = 100% (only in mWRS); Class I, SD = 99 to 70%; Class II, SD = 69 to 50%; Class III, SD = 49 to 1%; and Class IV, SD = 0%. Good hearing was defined as a speech discrimination score of 70% or better.

For comparative reasons, the hearing was also classified according to the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) guidelines (14) as follows: Class A, PTA less than 30 dB and SD greater than or equal to 70%; Class B, PTA less than 50 dB and SD greater than or

TABLE 2. Change in hearing according to the AAO classification from diagnosis to after observation in 932 patients with VS

The 4 hearing classes, A to D, of AAO classification	At the last evaluation				Total	
	A	B	C	D		
At diagnosis	A	91	53	11	23	178
	B	5	100	83	89	277
	C	—	6	68	89	163
	D	—	2	18	294	314
Total		96	161	180	495	932

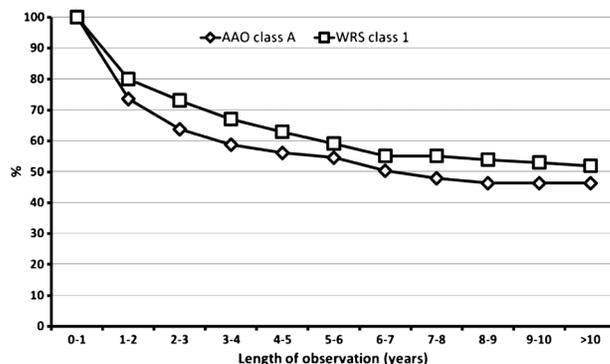


FIG. 1. Preservation of good hearing (AAO Class A or WRS Class 0/I) during observation for patients with good hearing (AAO Class A or WRS Class 0/I) at diagnosis (n = 932).

equal to 50%; Class C, PTA greater than 50 dB and SD greater than or equal to 50%; and Class D, speech discrimination score less than 50%.

RESULTS

AAO-HNS Classification

At diagnosis, 178 (19%) of the 932 patients had AAO Class A hearing on the tumor ear (Table 2). Of these, 91 (51%) maintained Class A hearing after the observation period. In 31 patients (3%), the hearing improved at least 1 AAO class during the observation period. In 348 patients (37%), the hearing deteriorated at least 1 AAO class, and in 553 patients (59%), the AAO class was unchanged from diagnosis until the last examination.

The hearing deterioration during the observation time in patients with AAO Class A hearing at diagnosis is seen in Figure 1. Twenty-six percent of the patients with Class A hearing at diagnosis had lost Class A hearing after 1 year, 45% after 5 years, and 54% after 10 years.

Word Recognition Scoring Classification

At diagnosis, 491 (53%) of the 932 patients had good hearing defined as a speech discrimination of 70% or better on the tumor ear (Table 3). Of the 491 patients, 290 (59%) maintained good hearing at the last evaluation. In 44 patients (5%), the hearing improved at least 1 Word Recognition Scoring (WRS) class during the observation. In 345 patients (37%), the hearing deteriorated

TABLE 3. Change in hearing according to the WRS classification from diagnosis to after observation in 932 patients with VS

The 4 classes, I to IV, of the WRS classification	At the last evaluation				Total	
	I	II	III	IV		
At diagnosis	I	290	73	81	47	491
	II	16	38	44	29	127
	III	7	10	91	71	179
	IV	—	3	8	124	135
Total		313	124	224	271	932

TABLE 4. Change in hearing according to the mWRS classification from diagnosis to after observation in 932 patients with VS

The 5 classes, 0-IV, of the mWRS classification	At the last evaluation					Total	
	0	I	II	III	IV		
At diagnosis	0	79	59	12	7	2	159
	I	15	137	61	74	45	332
	II	1	15	38	44	29	127
	III	—	7	10	91	71	179
	IV	—	—	3	8	124	135
Total		95	218	124	224	271	932

at least 1 WRS class, and in 543 patients (58%), the WRS class remained unchanged.

The change in hearing during the observation period is seen in Figure 1. After 1 year, 20% had lost Class I hearing. After 5 years, 41% lost good hearing, whereas 48% lost good hearing after 10 years of observation (WRS Class 0/I).

Modified Word Recognition Scoring Classification

The modified WRS (mWRS) classification subdivides the speech discrimination further because the introduced Class 0 designates patients with 0% speech discrimination loss or 100% discrimination (15). As noted, 491 patients (53%) had a speech discrimination of 70% or better on the tumor ear at diagnosis (Tables 3 and 4). Of these, 290 patients (59%) maintained good hearing at the last evaluation (Tables 3 and 4). In the subgroup of 159 patients (17%) with 100% speech discrimination at diagnosis (mWRS Class 0; Tables 4 and 5), 138 (87%) maintained good hearing at the last evaluation. In the 116 patients with a minor loss in speech discrimination at diagnosis (1-10%; Table 5), 63 (54%) maintained good hearing. In the group with a loss of speech discrimination of 21 to 30% at diagnosis, 28 (33%) of 84 patients maintained good hearing.

The change in hearing over the years in patients with mWRS Class 0 hearing at diagnosis (SD = 100%) is seen in Figure 2. After 1 year, 3% had lost Class I hearing. After 5 years, 12% had lost good hearing, and after 10 years, 31% had lost good hearing. In patients with even a minor loss of speech discrimination at diagnosis (1-10%), 18% have lost good hearing after 1 year, 60% after 5 years, and only 38% of the patients with a speech

TABLE 5. Change in subgroups of mWRS class 0/I hearing from diagnosis to after observation in the 491 patients with good hearing (mWRS class 0/I) at diagnosis

Subgroups of SD, %	Speech discrimination loss after observation						Total n
	0%	1-10%	11-20%	21-30%	>30%	≤30%	
n	n	n	n	n	n	%	n
0	79	33	22	4	21	86.8	159
1-10	9	23	21	10	53	54.3	116
11-20	3	13	27	18	71	46.2	132
21-30	3	2	13	10	56	33.3	84
Total	94	71	83	42	201	59.1	491

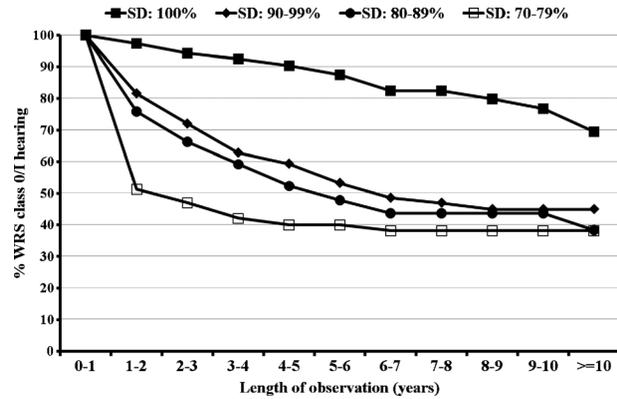


FIG. 2. Preservation of good hearing (WRS Class I) during observation related to the different SD groups at diagnosis (n = 932).

discrimination loss between 1 and 10% maintained good hearing.

Overall, the mean annual speech discrimination loss was 6.6% in patients with WRS Class 1 hearing. From Figure 3, it is seen that the discrimination loss per year is not linear but almost inversely logarithmic. The mean annual speech discrimination loss is 10.5% the first year after diagnosis, 7.6% the second, and 5.1% the fifth year of observation. Looking at the group of patients with 1 to 30% speech discrimination at diagnosis, the speech discrimination loss is 13.1% the first year after diagnosis, 8.8% the second, and 6.5% the fifth year of observation. In contrast, the annual speech discrimination loss is almost constant with 2 to 4% a year in the group of patients with 100% speech discrimination at diagnosis.

DISCUSSION

The main goal in the treatment of patients with vestibular schwannoma is to maintain or improve the quality of life. In case of a large tumor, surgery is generally

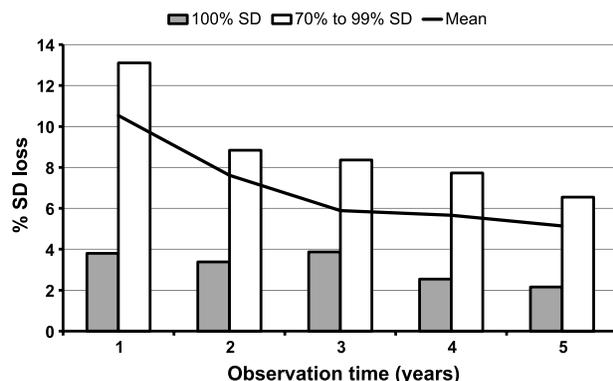


FIG. 3. Annual speech discrimination loss during the first 5 years of observation in the group with 100% SD at diagnosis, the group with 70 to 99% SD at diagnosis, and the mean annual speech discrimination loss for all patients with speech discrimination of 70% or better.

advised. If the patient has a growing tumor, treatment in the form of radiotherapy or surgery is advised. If the patient has a small nongrowing tumor, the symptoms are usually minor, in many cases, only a discrete sensorineural hearing loss on the affected ear. If the aim of an active treatment in these cases is to preserve the hearing, the treatment results should be superior to the spontaneous outcome. The hearing preservation after surgery is usually reported as the results after 1 year and reported to vary between 24 and 83% (16–20). The hearing preservation results after radiotherapy is reported to vary between 33 and 79% (6,21–23). In our study, 73% of patients with AAO-HNS Class A hearing at diagnosis preserved good hearing after 1 year of observation. According to the WRS classification, 87% of patients with WRS Class I hearing at diagnosis maintained good hearing. The spontaneous outcome is additionally emphasized using the mWRS classification, in which 99% of ears with Class 0 hearing at diagnosis preserve good hearing after 1 year.

In a study from House Ear Clinic from 2003 (24), the long-term hearing preservation after surgery was evaluated over a 5-year period in 38 patients. Of these 38 patients, 23 (61%) had AAO-HNS Class A-B hearing after surgery. Over the subsequent 5-year period, 30% lost Class A-B hearing. In the present study, 55% had Class A hearing after 5 years. With the WRS classification, 61% had Class I hearing after 5 years. For patients with 100% speech discrimination at diagnosis, 91% of patients preserved good hearing after 5 years of observation.

In the literature, to our knowledge, there have been no reports of the hearing preservation after 10 years or more after hearing preservation surgery or radiotherapy. In the present study, 95 patients had been observed for 10 years or more. According to the AAO classification, 46% maintained good hearing after 10 years or more compared with 45% using the WRS classification and 75% of patients with 100% speech discrimination at diagnosis.

The great variability in the success rate of hearing preservation after surgery may be explained by difficulties in comparing data due to variable definitions of good or serviceable hearing and different reporting of the size of the operated tumor. Some surgeons include the intrameatal part of the tumor in size measurement, whereas others measure the extrameatal part only according to the consensus on reporting tumor size (25). Most authors agree that the chance of hearing preservation is significantly reduced for tumors with an extrameatal diameter of more than 15 mm (25), whereas others have good results of hearing preservation in large tumors (58% in T3 tumors and 29% in T4 tumors) (26). Hearing preservation surgery may be performed by the middle fossa approach or by the retrosigmoidal approach. Comparing the 2 approaches, it seems that the results are better by the middle fossa approach in small and intrameatal tumors (27).

In patients undergoing radiotherapy, the great variability in the reported hearing preservation may be explained

by differences in radiation doses, preoperative hearing, tumor size, and length of follow-up.

The main clinical implication of the present study is that the results indicates that it may be possible to identify patients who have a good chance of maintaining good long-term hearing by focusing the speech discrimination at the time of diagnosis. Thus, a small nongrowing tumor with 100% discrimination should be allocated to wait and scan because it is highly likely that the patient will preserve good long-term hearing spontaneously and thus have an outcome superior to radiotherapy and hearing preservation surgery. When the discussion is on growth, it can be argued that unless patients are born with the tumor, all tumors have grown to the size as revealed at the diagnostic magnetic resonance imaging. The same argument can be applied when discussing if not all the patients with a VS had 100% speech discrimination until some time before diagnosis, just like in tumor behavior where some tumors have stopped growing before diagnosis and then diagnosed because of the progressive hearing deterioration. The same reason could be the case with the hearing, especially the speech discrimination.

CONCLUSION

Patients with 100% speech discrimination at diagnosis have a 75% chance of maintaining good hearing even after 10 years of observation or longer.

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