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Review

What is the Required Frequency of MRI Scanning in the Wait and Scan Management?

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The wait and scan policy is being increasingly used as the first measure after the diagnosis of a vestibular schwannoma (VS) using magnetic resonance imaging (MRI). As part of the European Academy of Otology & Neuro-Otology (EAONO) position statement on VS, the frequency of imaging has been studied in the literature. Among 163 studies, 29 fulfilled the inclusion criteria and were scored using the Grading of Recommendations, Assessment, Development, and Evaluation system. Because tumor growth rate during the first 5 years of follow-up is predictive of further growth during the upcoming years, a protocol for wait and scan is useful for centers dealing with this condition. The EAONO proposal is that after the initial diagnosis by MRI, a first new MRI would take place after 6 months, annually for 5 years, and then every other year for 4 years, followed by a lifelong MRI follow-up every 5 years. The first early MRI is to screen for fast-growing tumors, and the lifelong follow-up with tapered intervals is to detect late repeated growth.

KEYWORDS: Wait and scan, vestibular schwannoma

MATERIALS and METHODS

As part of the Vestibular Schwannoma Project conducted by the EAONO, a comprehensive literature search was performed to examine the protocols used for the follow-up of vestibular schwannoma (VS) following the wait and scan management.

An English literature review was conducted using the PubMed database and reached as far back as the year 2000 and was updated until August 2015.

A PubMed search using the keywords "vestibular schwannoma," "acoustic neuroma," and "conservative management" alone and in combination was performed.

This query identified 163 studies between 2000 and 2015.

Search syntax

("neuroma, acoustic" [MeSH terms] OR ("neuroma" [all fields] AND "acoustic" [all fields]) OR "acoustic neuroma" [all fields] OR ("vestibular" [all fields] AND "schwannoma" [all fields]) OR "vestibular schwannoma" [all fields]) AND conservative [all fields]

Inclusion and exclusion criteria

Article titles and abstracts were screened for the following criteria:

a) clinical articles reporting original data, thus excluding reviews and case reports
b) presented data only on adults
c) series using conservative management for solitary VS
d) series with > 30 patients were included

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e) quantitative assessment of VS surveillance as one of the primary study end-points
f) mean follow-up of at least 3 years
g) studies in which the reported data included patients with neurofibromatosis type 2, and if these data could not be separately identified from the reported data for patients with VS, were excluded
h) the frequency of magnetic resonance imaging (MRI) follow-up must be mentioned in the Materials and methods section with preferably the presentation of a protocol of conservative management

The initial search yielded 163 articles, but 134 articles that did not meet one or more of these inclusion criteria were excluded. Only 29 articles of which the methodology was reviewed and scored using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system remained.

RESULTS

The question:
What is the required frequency of MRI scanning in the wait and scan management?

INTRODUCTION

A conservative treatment strategy is often proposed as a primary treatment option in the management of VS. This can be justified because the growth rate of VSs is known to be extremely variable, with most tumors remaining stable or showing only minimal growth for several years. Today, this option is widely adopted in small- or medium-sized tumors or tumors without contact with the brainstem. Because it is impossible to predict the expected behavior of an individual VS based on the information available at diagnosis (age, sex, tumor laterality, and tumor size at presentation), tumor growth rate must be established by means of radiological surveillance, and the imaging interval cannot be guided by

LITERATURE REVIEW

Author	Year	Study design	Number	Frequency of MRI	Follow-up time months (range or SD)	% of tumors presenting no growth	% change in strategy, surgery, or radiotherapy?	GRADE Quality of evidence	GRADE Strength of recommendation
Jethanamest et al. [1]	2015	Retrospective study	94	Annual	34.8 (SD32.8)	37.8%	22.3%	Low	Weak
González-Orús Álvarez-Morujo et al. [2]	2014	Retrospective study	73	First at 6 months, then annually If growth every 6 months	35.75 (12-240)	87.7%	8.2%	Low	Weak
Fayad et al. [3]	2014	Retrospective study	114	"Serial"	57.6 (SD=43)	62%	31%	Low	Weak
Nikopoulos et al. [4]	2013	Meta-analysis	NA	Variable	NA	From 6% to 73%	NM	Moderate	Weak
Ferri et al. [5]	2013	Retrospective study	161	6 months, annually	73.2 (8-162)	64.2%	62% (37.9% surgery, 24.1% radiotherapy)	Low	Weak
Stangerup and Caye-Thomasen [6]	2012	Review of own retrospective studies	2500	Annually in the study proposal Yearly for 5 years Followed up by MRI every other year for 4 years Followed up by MRI 5 years later then stop	NM	NM	NM	Moderate	Weak
Moffat et al. [7]	2012	Prospective study	381	Every 6 months, annually for the next 3 years, every 2 years for 6 years, then every 3 years	50.4 (6-204)	67%	NM	Low	Weak
Breivik et al. [8]	2012	Prospective study	186	6 months, 1, 2 and 5 years	46 (9-115)	60%	40% (9% surgery, 31% radiotherapy)	Moderate	Weak
Kaltoft et al. [9]	2011	Retrospective study	959	6 mo, annually	61	73%	17%	Low	Weak
Hughes et al. [10]	2011	Retrospective study	59	Annually	68 (11-156)	81%	19%	Low	Weak
van de Langenberg et al. [11]	2011	Retrospective study	36	Annually	20 mo (12-67)	68%	NM	Low	Weak
Agrawal et al. [12]	2010	Retrospective study	180	Annually	32	63%	35% (surgery or radiotherapy)	Moderate	Weak
Suryanarayanan et al. [13]	2010	Retrospective study	286	Annually	43,2 (12-168)	68%	% (21% surgery, 254% radiotherapy)	Low	Weak

the baseline data. Only tumor growth rate during the first years of follow-up is predictive of further growth during the upcoming years. Protocols for wait and scan have been proposed in the literature and are based on data from the observation of the natural history of VSs in cohorts of patients usually followed up annually over a prolonged period.

EVIDENCE

The reviewed literature was studied to find an answer to how often should VS be screened for growth. This review comprised 2 meta-analyses, 4 prospective cohort studies, and 23 retrospective case series. A total of 8711 patients were included in these studies. The mean number of patients who were included for the clinical series was 215 (50-2500).

Most studies were initially designed to study the growth rate of VS and found a decreasing percentage of growing tumors along the observation time.

The wait and scan policy had to be changed into an active management in 23% of the cases (range: 7%-62%), and surgery was adopted in 14% and radiotherapy in 9% of the cases.

Although the overall quality of the previous studies is low, all point in the same direction, suggesting a significant reduction of new growing tumors during longer observation times. Following the GRADE system, 24 articles were considered to have a "low" level of evidence for being observational studies. Two meta-analyses and 3 good quality obser-

LITERATURE REVIEW (Continued)

Author	Year	Study design	Number	Frequency of MRI	Follow-up time months (range or SD)	% of tumors presenting no growth	% change in strategy, surgery, or radiotherapy?	GRADE Quality of evidence	GRADE Strength of recommendation
Bakkouri et al. [14]	2009	Retrospective study	325	At 1 year, then every 2 years	NM (Range 1-9 years)	76%	24% (18.4% surgery, 5% radiotherapy)	Low	Weak
Martin et al. [15]	2009	Retrospective study	276	6months, 1 year, 1 year, 2 years, 5 years lifelong	43	73%	8% surgery, 11% radiotherapy	Low	Weak
Verma et al. [16]	2009	Retrospective study	72	6m,1y, annually and subsequently every 2-3 y	121	60%	40%	Low	Weak
Ferri et al. [17]	2008	Cohort prospective study	123	6mo, 6mo, annually	57.4 (6-182)	64%	13% surgery, 7% radiotherapy, 2% lost to follow-up	Low	Weak
Nedzelski et al. [18]	2008	Retrospective study	50	Every 6 months, few years, then annually	41.7 (7-152)	51%	22% surgery, 2% radiotherapy	Low	Weak
Hajioff et al. [19]	2008	Retrospective study	72	6 months, 6 months, every 1-2 years	121 (89-271)	60%	35% 11% surgery, 19% radiotherapy	Low	Weak
Martin et al. [20]	2008	Retrospective study	167	Annually for 5 years, then every 5 years	62	65%	11% surgery, 11% radiotherapy	Low	Weak
Stangerup et al. [21]	2006	Case series prospective	552	Yearly for 5 years Every other year for 4 years MRI after 5 years Stop	42 (12-180)	76% Intrmeatal 83% Extrameatal 70%	13% surgery, 1% radiotherapy	Moderate	Weak
Battaglia et al. [22]	2006	Retrospective study	109	Annually	38 (12-156)	71%	8%	Low	Weak
Al Sanosi et al. [23]	2006	Retrospective study	205	Annually	40.8 (12-184)	66.3%	7%	Low	Weak
Yoshimoto [24]	2005	Meta-analysis	1340	NA	38	56%	18% 14 surgery, 4% radiotherapy	Moderate	Weak
Bozorg Grayeli et al. [25]	2005	Retrospective study	111	Annually	33 (6-111)	53%	16%	Low	Weak
Raut et al. [26]	2004	Case series prospective	72	6 months, annually	80(52-242)	59.3%	32%	Low	Weak
Perry et al. [27]	2001	Retrospective study	41	Annually	42 (6-108)	79%	surgery	Low	Weak
Rosenberg [28]	2000	Retrospective study	80	Annually	57,6 6-206	42%	7.5%	Low	Weak
Shin et al. [29]	2000	Retrospective study	87	Every 1-2 years	31 (4-120)	62%	12% 6% surgery, 6% radiotherapy	Low	Weak

NA: not applicable; NM: not mentioned; Y: year; MO: month; GRADE: grading of recommendations, assessment, development, and evaluation

vational studies were graded as "moderate" evidence. None of the studies achieved a grade with strength of recommendation better than weak.

CONCLUSION

The quality of evidence and strength of recommendation remains low despite the abundance of studies in this field. This may be explained by methodological issues in the clinical research of such a delicate problem as VS.

1. Nevertheless, most studies arrive at similar conclusions:
2. In order to screen for rapidly-growing tumors, one may perform a first control 6 months after the initial diagnosis.
3. Annual controls were performed for research purposes and were pursued by most authors.
4. If tumor growth occurs, this will most likely happen within the first years after diagnosis.
5. After 5 years, further growth of a tumor that remained stable for years becomes unlikely but may still occur. A lifelong surveillance is, therefore, advised but with tapered, longer intervals.
6. Too regular initial MRI controls may give a false sense of security to patients and discourage them to repeat MRI over a lifelong period. Reducing the number of follow-up scans should have a positive effect on follow-up reliability and health care expenses.
7. A protocol should be easy to use and easy to remember by the health care providers and by the patients.

Remarks

Most of the available evidence of VS growth and proposed protocols come from retrospective case series. The definition of growth varied from 1 mm to >2 mm per year. The follow-up period was quite heterogeneous and usually too short in comparison with the life expectancy of most patients with VS.

Position of EAONO

- Distinguishing individual patients whose tumors will grow and pose a threat to them from those whose tumors will likely remain stable or even regress is central to the current management of patients with VS.
- Since most lesions do not grow, a wait and scan strategy seems justified in several patients.
- Evidence of tumor growth has become the defining criterion for intervention, especially for small- and medium-sized tumors.
- When to discharge a patient from a regime of interval scanning remains uncertain, some evidence indicates that most tumor growth occurs in the first 5 years after identification. However, this is not always the case because cases with late growth after prolonged tumor quiescence have been reported.
- Clinicians should seek to instigate national tumor registries in their countries and common data set to facilitate international cooperation.
- For the present, the EAONO proposes a protocol mainly based on the Danish experience. Only one additional 6 months repeat MRI after the initial diagnosis could be added to find for fast-growing tumors and a five yearly repeat MRI in the long run.
- Initial diagnosis by MRI
- First MRI 6 months later
- Yearly MRI for 5 years
- Then, MRI every other year for 4 years
- Then, MRI every 5 years, lifelong

Peer-review: Externally peer-reviewed.

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Editor's Note:

The EAONO Project on guidelines of Otology and Neurotology was initiated by Franco Trabalzini and the Working Groups began working in 2011. Since then a considerable work has been issued to produce the first Consensus Documents.

The working Group on Vestibular Schwannoma have esteemed members from dedicated centers all over Europe. I wish to express my thanks to the working group leaders Miguel Aristegui and Jacques Magnan for their great effort as well as to all the other active members of the group.

Miguel Aristegui, Shakeel Saeed, Simon Lloyd, Per-Caye Thomasen and Jacques Magnan's comments for this "Consensus Document" have been very much appreciated.

This study is very much respected by the Editorial of the Journal in this regard.

Prof. Dr. O. Nuri Ozgirgin
Editor in Chief

REFERENCES

1. Jethanamest D, Rivera AM, Ji H, Chokkalingam V, Telischi FF, Angeli SI. Conservative management of vestibular schwannoma: Predictors of growth and hearing. Laryngoscope 2015; 125: 2163-8. [CrossRef]
2. González-Orús Álvarez-Morujo RJ, Alvarez-Palacios I, Martin-Oviedo C, Scola-Yurrita B, Arístegui-Ruiz MÁ. Conservative management of vestibular schwannoma. Acta Otorrinolaringol Esp 2014; 65: 275-82. [CrossRef]
3. Fayad JN, Semaan MT, Lin J, Berliner KI, Brackmann DE. Conservative management of vestibular schwannoma: expectations based on the length of the observation period. Otol Neurotol 2014; 35: 1258-65. [CrossRef]
4. Nikolopoulos TP, Fortnum H, O'Donoghue G, Baguley D. Acoustic neuroma growth: a systematic review of the evidence. Otol Neurotol 2013; 31: 478-85. [CrossRef]
5. Ferri GG, Pirodda A, Ceroni AR, Fioravanti A, Calbucci F, Modugno GC. Management of growing vestibular schwannomas. Eur Arch Otorhinolaryngol 2013; 270: 2013-9. [CrossRef]
6. Stangerup SE, Caye-Thomasen P. Epidemiology and natural history of vestibular schwannomas. Otolaryngol Clin North Am 2012; 45: 257-68. [CrossRef]
7. Moffat DA, Kasbekar A, Axon PR, et al. Growth characteristics of vestibular schwannomas. Otol Neurotol 2012; 33: 1053-8. [CrossRef]
8. Breivik CN, Varughese JK, Wentzel-Larsen T, Vassbotn F, Lund-Johansen M. Conservative management of vestibular schwannoma--a prospective

cohort study: treatment, symptoms, and quality of life. Neurosurgery 2012; 70: 1072-80. [CrossRef]
9. Kaltoft M, Stangerup SE, Caye-Thomasen P. Facial nerve function after vestibular schwannoma surgery following failed conservative management. Neurosurgery 2012; 70: 278-82. [CrossRef]
10. Hughes M, Skilbeck C, Saeed S, Bradford R. Expectant management of vestibular schwannoma: a retrospective multivariate analysis of tumor growth and outcome. Skull Base 2011; 21: 295-302. [CrossRef]
11. van de Langenberg R, de Bondt BJ, Nelemans PJ, et al. Follow-up assessment of vestibular schwannomas: volume quantification versus two-dimensional measurements. Neuroradiology 2009; 51: 517-24. [CrossRef]
12. Agrawal Y, Clark JH, Limb CJ, Niparko JK, Francis HW. Predictors of vestibular schwannoma growth and clinical implications. Otol Neurotol 2010; 31: 807-12. [CrossRef]
13. Suryanarayanan R, Ramsden RT, Saeed SR, Aggarwal R, King AT, Rutherford SA, et al. Vestibular schwannoma: role of conservative management. J Laryngol Otol 2010; 124: 251-7. [CrossRef]
14. Bakkouri WE, Kania RE, Guichard JP, Lot G, Herman P, Hut PT. Conservative management of 386 cases of unilateral vestibular schwannoma: tumor growth and consequences for treatment. J Neurosurg 2009; 110: 662-9. [CrossRef]
15. Martin TP, Senthil L, Chavda SV, Walsh R, Irving RM. A protocol for the conservative management of vestibular schwannomas. Otol Neurotol 2009; 30: 381-5. [CrossRef]
16. Verma S, Anthony R, Tsai V, Taplin M, Rutka J. Evaluation of cost effectiveness for conservative and active management strategies for acoustic neuroma. Clin Otolaryngol 2009; 34: 438-46. [CrossRef]
17. Ferri GG, Modugno GC, Pirodda Aet al. Conservative management of vestibular schwannomas: an effective strategy. Laryngoscope 2008; 118: 951-7. [CrossRef]
18. Nedzelski JM, Schessel DA, Pfleiderer A, Kassel EE, Rowed DW. Conservative management of acoustic neuromas. 1992. Neurosurg Clin N Am 2008; 19: 207-16. [CrossRef]
19. Hajioff D, Raut VV, Walsh RM, Bath AP, Bance ML, Guha A, et al. Conservative management of vestibular schwannomas: third review of a 10-year prospective study. Clin Otolaryngol 2008; 33: 255-9. [CrossRef]
20. Martin TP, Tzifa K, Kowalski C, Holder RL, Walsh R, Irving RM. Conservative versus primary surgical treatment of acoustic neuromas: a comparison of rates of facial nerve and hearing preservation. Clin Otolaryngol 2008; 33: 228-35. [CrossRef]
21. Stangerup SE, Caye-Thomasen P, Tos M, Thomsen J. The natural history of vestibular schwannoma. Otol Neurotol 2006; 27: 547-52. [CrossRef]
22. Battaglia A, Mastrodimos B, Cueva R. Comparison of growth patterns of acoustic neuromas with and without radiosurgery. Otol Neurotol 2006; 27: 705-12. [CrossRef]
23. Al Sanosi A, Fagan PA, Biggs ND. Conservative management of acoustic neuroma. Skull Base 2006; 16: 95-100. [CrossRef]
24. Yoshimoto Y. Systematic review of the natural history of vestibular schwannoma. J Neurosurg 2005; 103: 59-63. [CrossRef]
25. Bozorg Grayeli A, Kalamarides M, Ferrary E, Bouccara D, El Gharem H, Rey A, et al. Conservative management versus surgery for small vestibular schwannomas. Acta Otolaryngol 2005; 125: 1063-8. [CrossRef]
26. Raut VV, Walsh RM, Bath AP, Bance ML, Guha A, Tator CH, et al. Conservative management of vestibular schwannomas - second review of a prospective longitudinal study. Clin Otolaryngol Allied Sci 2004; 29: 505-14. [CrossRef]
27. Perry BP, Gantz BJ, Rubinstein JT. Acoustic neuromas in the elderly. Otol Neurotol 2001; 22: 389-91. [CrossRef]
28. Rosenberg SI. Natural history of acoustic neuromas. Laryngoscope 2000; 110: 497-508. [CrossRef]
29. Shin YJ, Fraysse B, Cognard C, Gafsi I, Charlet JP, Berges C, et al. Effectiveness of conservative management of acoustic neuromas. Am J Otol 2000; 21: 857-62.