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.

LITERATURE REVIEW

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Study design</th>
<th>Number</th>
<th>Frequency of MRI</th>
<th>Follow-up time months (range or SD)</th>
<th>% of tumors presenting no growth</th>
<th>% change in strategy, surgery, or radiotherapy?</th>
<th>GRADE Quality of evidence</th>
<th>GRADE Strength of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jethanamest et al. [1]</td>
<td>2015</td>
<td>Retrospective study</td>
<td>94</td>
<td>Annual</td>
<td>34.8 (SD32.8)</td>
<td>37.8%</td>
<td>22.3%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>González-Orús et al. [2]</td>
<td>2014</td>
<td>Retrospective study</td>
<td>73</td>
<td>First at 6 months, then annually</td>
<td>35.7 (12-240)</td>
<td>87.7%</td>
<td>8.2%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Álvarez-Morujo et al. [2]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fayad et al. [3]</td>
<td>2014</td>
<td>Retrospective study</td>
<td>114</td>
<td>“Serial”</td>
<td>57.6 (SD=43)</td>
<td>62%</td>
<td>31%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Nikopoulos et al. [4]</td>
<td>2013</td>
<td>Meta-analysis</td>
<td>NA</td>
<td>Variable</td>
<td>NA</td>
<td>From 6% to 73%</td>
<td></td>
<td>NM</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ferri et al. [5]</td>
<td>2013</td>
<td>Retrospective study</td>
<td>161</td>
<td>6 months, annually</td>
<td>73.2 (8-162)</td>
<td>64.2%</td>
<td>62% (37.9% surgery, 24.1% radiotherapy)</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Stangerup and Caye-Thomasen [6]</td>
<td>2012</td>
<td>Review of own retrospective studies</td>
<td>2500</td>
<td>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</td>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Moffat et al. [7]</td>
<td>2012</td>
<td>Prospective study</td>
<td>381</td>
<td>Every 6 months, annually for the next 3 years, every 2 years for 6 years, then every 3 years</td>
<td>50.4 (6-204)</td>
<td>67%</td>
<td></td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Breivik et al. [8]</td>
<td>2012</td>
<td>Prospective study</td>
<td>186</td>
<td>6 months, 1, 2 and 5 years</td>
<td>46 (9-115)</td>
<td>60%</td>
<td>40% (9% surgery, 31% radiotherapy)</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Kaltoft et al. [9]</td>
<td>2011</td>
<td>Retrospective study</td>
<td>959</td>
<td>6 mo, annually</td>
<td>61</td>
<td>73%</td>
<td>17%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Hughes et al. [10]</td>
<td>2011</td>
<td>Retrospective study</td>
<td>59</td>
<td>Annually</td>
<td>68 (11-156)</td>
<td>81%</td>
<td>19%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>van de Langenberg et al. [11]</td>
<td>2011</td>
<td>Retrospective study</td>
<td>36</td>
<td>Annually</td>
<td>20 mo (12-67)</td>
<td>68%</td>
<td></td>
<td>NM</td>
<td>Low</td>
</tr>
<tr>
<td>Agrawal et al. [12]</td>
<td>2010</td>
<td>Retrospective study</td>
<td>180</td>
<td>Annually</td>
<td>32</td>
<td>63%</td>
<td>35% (surgery or radiotherapy)</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Suryanarayanan et al. [13]</td>
<td>2010</td>
<td>Retrospective study</td>
<td>286</td>
<td>Annually</td>
<td>43,2 (12-168)</td>
<td>68%</td>
<td>% (21% surgery, 254% radiotherapy)</td>
<td>Low</td>
<td>Weak</td>
</tr>
</tbody>
</table>

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...
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).

**LITERATURE REVIEW (Continued)**

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Study design</th>
<th>Number</th>
<th>Frequency of MRI</th>
<th>Follow-up % of tumors</th>
<th>% change in strategy, surgery, or radiotherapy?</th>
<th>GRADE Quality of evidence</th>
<th>GRADE Strength of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakkouri et al. [14]</td>
<td>2009</td>
<td>Retrospective study</td>
<td>325</td>
<td>At 1 year, then every 2 years</td>
<td>76%</td>
<td>24% (18.4% surgery, 5% radiotherapy)</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Martin et al. [15]</td>
<td>2009</td>
<td>Retrospective study</td>
<td>276</td>
<td>6 months, 1 year, 1 year, 2 years</td>
<td>73%</td>
<td>8% surgery, 11% radiotherapy</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Verma et al. [16]</td>
<td>2009</td>
<td>Retrospective study</td>
<td>72</td>
<td>6 months, 1y annually and subsequently every 2-3 y</td>
<td>60%</td>
<td>40%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Ferri et al. [17]</td>
<td>2008</td>
<td>Cohort prospective study</td>
<td>123</td>
<td>6 months, 6mo, annually</td>
<td>64%</td>
<td>13% surgery, 7% radiotherapy, 2% lost to follow-up</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Nedzelski et al. [18]</td>
<td>2008</td>
<td>Retrospective study</td>
<td>50</td>
<td>Every 6 months, few years, then annually</td>
<td>51%</td>
<td>22% surgery, 2% radiotherapy</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Hajioff et al. [19]</td>
<td>2008</td>
<td>Retrospective study</td>
<td>72</td>
<td>6 months, 6 months, every 1-2 years</td>
<td>60%</td>
<td>35% 11% surgery, 19% radiotherapy</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Martin et al. [20]</td>
<td>2008</td>
<td>Retrospective study</td>
<td>167</td>
<td>Annually for 5 years, then every 5 years</td>
<td>65%</td>
<td>11% surgery, 11% radiotherapy</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Stangerup et al. [21]</td>
<td>2006</td>
<td>Case series prospective</td>
<td>552</td>
<td>Yearly for 5 years for other year for 4 years MRI after 5 years Stop</td>
<td>62%</td>
<td>42% Intrmeatal 83% Extrameatal 70%</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Battaglia et al. [22]</td>
<td>2006</td>
<td>Retrospective study</td>
<td>109</td>
<td>Annually</td>
<td>71%</td>
<td>8%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Al Sanosi et al. [23]</td>
<td>2006</td>
<td>Retrospective study</td>
<td>205</td>
<td>Annually</td>
<td>66.3%</td>
<td>7%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Yoshimoto [24]</td>
<td>2005</td>
<td>Meta-analysis</td>
<td>1340</td>
<td>NA</td>
<td>56%</td>
<td>18% 14 surgery, 4% radiotherapy</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Bozorg Grayeli et al.</td>
<td>2005</td>
<td>Retrospective study</td>
<td>111</td>
<td>Annually</td>
<td>53%</td>
<td>16%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Raut et al. [26]</td>
<td>2004</td>
<td>Case series prospective</td>
<td>72</td>
<td>6 months, annually</td>
<td>59.3%</td>
<td>32%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Perry et al. [27]</td>
<td>2001</td>
<td>Retrospective study</td>
<td>41</td>
<td>Annually</td>
<td>79%</td>
<td>surgery</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Rosenberg [28]</td>
<td>2000</td>
<td>Retrospective study</td>
<td>80</td>
<td>Annually</td>
<td>42%</td>
<td>7.5%</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Shin et al. [29]</td>
<td>2000</td>
<td>Retrospective study</td>
<td>87</td>
<td>Every 1-2 years</td>
<td>62%</td>
<td>12% 6% surgery, 6% radiotherapy</td>
<td>Low</td>
<td>Weak</td>
</tr>
</tbody>
</table>

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:
   - Then, MRI every first 6 months after the initial diagnosis.
2. In order to screen for rapidly-growing tumors, one may perform a 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 Arístegui and Jacques Magnan for their great effort as well as to all the other active members of the group.

Miguel Arístegui, 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
23. Al Sanosi A, Fagan PA, Biggs ND. Conservative management of acoustic neuroma. Skull Base 2006; 16: 95-100. [CrossRef]