Current Vestibular Schwannoma Management

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1. ABSTRACT

1.1 INTRODUCTION

The vestibular schwannoma (VS) is a benign slow growing tumour. It is derived from
the vestibular part of the VIII cranial nerve and could potentially grow into the
cerebellopontine angle (CPA). Clinically, it is usual presented accompanied by
unilateral hearing loss, tinnitus and dizziness, however for its diagnostic it is
necessary MRI. It occurs in around 10 cases per million habitants per year. The
current management approaches are: the conservative management (CM),
stereotactic surgery and therapy (SRS/SRT) and microsurgery. This study tries to
determine the principal patients’ features and treatment of the patients from the
RNTNE Hospital and compare its findings with a systematic review of the literature.

1.2 METHODS

A retrospective observational study was carried on with the patients of the RNTNE
hospital between 2008 and 2013. A total of 226 cases were analysed and parametric
statistics were performed. Continuous variables were compared using one way
analysis of Variance (ANOVA) and Bonferroni’s multiple comparisons. Additionally a
systematic review of the published literature was reviewed through the Medline,
PubMed and Ovid databases.

1.3 RESULTS

A total of 226 clinical records were found in the RNTNE Hospital, from which 176
had the complete information required. From these, 120 patients continued with CM,
29 underwent surgical excision, 12 to SRS/SRT, and 15 were derived to a multidisciplinary team for further evaluation. The size of tumour based on the MRI scan was on average 13.8 mm and the bigger tumour size was found in the surgical approach. The more common symptom found at the moment of diagnosis were deafness (84.74% of cases), tinnitus (68.3%) and vertigo (37.3%). After subsequent controls, in overall 38.98% of patients presented tumour growing, but there were not differences of tumour growing between the three management groups.

On the systematic review, a total of 67 papers were identified in the category of level A to C but the foremost studies found were: 2 Meta-analysis, 2 Prospective studies, 6 cross-sectional studies, 5 review articles, 9 systematic reviews, and 13 retrospective papers. These studies grouped approximately 262,000 patients.

1.4 DISCUSSION

The size of the tumour on the MRI is the main basis for management approach selection. Patients with a bigger tumours undergo usually to surgical excision, and patients with smaller tumours are derived to SRS/SRT or CM.

Patients with high degrees of facial palsy were derived directly for surgical excision, but evidence has not shown better outcomes after tumour removal. Deafness, tinnitus and vertigo are also common symptoms found in VS patients, for this reason to relieve them should be also a goal in the VS management.

In cases when the treatment decision is not straightforward (i.e.: rapid growing tumours or patients with a profounder facial or hearing symptomatology), patients should be referred to a MDT. Independently of the management approach selected, the tumour growing rate shows no differences.
1.5 CONCLUSION

There was no difference in tumour growing and symptomatology development between treatment groups. This observational retrospective study and the systematic review of literature determined that SRS/SRT and surgery are not better than observation to treat VS, for this reason a conservative therapy should be the principal approach carried on in newly diagnosed VS.
2. INTRODUCTION

The Vestibular Schwannoma tumour (VS), as its name suggests is originated from the Schwann cells located on the vestibular part of the vestibule-cochlear nerve (VIII cranial nerve). It is situated on the lateral position of the rim in the internal auditory meatus (IAM). This benign slow growing tumour has been typically related with unilateral hearing loss, tinnitus, or dizziness. For its complementary diagnosis is necessary the support of audiology tests and imaging scans habitually magnetic resonance imaging (MRI) (Hughes et al., 2011, Rutherford and King, 2005).

Epidemiologic studies historically considered that the VS incidence was around 10 cases per million of habitants per year (Tos and Thomsen, 1984). However lately incidence has increased mainly due to advances in non-invasive imaging techniques which leaded to a more accurate diagnosis. A clear example of this increase are the studies in Denmark which until the 1970s' reported an annual incidence of 5.4 per million habitants (Thomsen et al., 1977), until 1999 it ranged between 7.8 and 12.4 cases per million habitants (Tos et al., 1999), and until 2004 between 13 and 17.4 cases per million habitants (Tos et al., 2004). Strikingly the constant increase in the amount of VS cases over the last four decades showed a rare peak followed by decreased trend in recent years. This peak was apparently caused by the diagnosis on cases that were not detected with the previous diagnostic tools. At the present time hearing impairment is better managed than before and the tumour size on diagnosis has decreased over time, and the incidence apparently has remained steady at about 19 per million each year (Stangerup et al., 2010b).
In England a recent study completed between 1995 and 1999 reported an annual incidence of 14 cases of VS per million habitants (Evans et al., 2005). Compared with other epidemiologic reports, this study corrected its VS incidence values using the latest annual incidence to infer into the general population. In the same study the authors remarked the importance of past cases detection previously undiagnosed (Evans et al., 2005).

A more recent study developed in USA reported a corrected overall annual incidence of VS is 12 cases per million habitants (Babu et al., 2013). In this study it is highlighted how the noise and radiation exposure are the only environmental factors that have shown to increase the risk of VS and could contribute to the increased incidence (Babu et al., 2013).

Although most of VS cases are idiopathic, it is important to highlight its management patients with Neurofibromatosis type 2 (NF2). This is a rare pathology characterized by multiple benign tumours of the central and peripheral nervous system. Among these some ocular and skin lesions, as the presence of unilateral or bilateral VS. For its diagnosis, it is generally used the Manchester diagnostic criteria. Although these tumours are benign, the multiplicity and rapid growth features, different in each case, make this a challenging pathology to manage (Suryanarayanan et al., 2010, Evans et al., 2005).

Since the early ages of modern surgery, starting from Cushing and Dandy in 1894, almost all patients newly diagnosed of VS underwent tumour surgical excisions. This pathology has been managed exclusively by neurosurgeons but this practice has changed during the last 15 years. Nowadays multidisciplinary teams formed by neurosurgeons, otologists, and radiation oncologists manage this pathology with the
newly developed microsurgery techniques, skull base approaches, radiosurgery, and stereotactic radiotherapy. Sadly many patients especially in developing countries or in communities lacking of surgical expertise and modern technology cannot get this high standard treatments (Yu, 2013). Although great outcomes and good quality of life (QoL) has been reached with microsurgery, the earlier tumour diagnosis encouraged a comprehensive evaluation of less invasive management strategies. Therefore by 1969 stereotactic radiosurgery (SRS) was promoted by Leksell and Norén as a potential alternative surgical procedure (Kondziolka et al., 2012, Maniakas and Saliba, 2012).

The traditional endpoints of VS management are tumour control rate, facial nerve function and hearing preservation, however vertigo, unsteadiness, tinnitus and health-related QoL should also be reported but the priority in treatment is to prevent morbidity caused by tumour growth(Patel et al., 2013, Babu et al., 2013). Decision making in the management of vestibular schwannoma remains a controversial issue in neuro-otology and skull base surgery (Husseini et al., 2013). However, it is not easy to determine why a particular treatment must be chosen in every case mainly because the lack of clinical evidence (Babu et al., 2013, Patel et al., 2013). Nevertheless, physician’s favouritism to a particular treatment has shown to significantly affect treatment choice in VS as well as in other cerebellopontine angle (CPA) tumours. In patients with NF2 the strategy is to determine when VS removal will be appropriate, because this depends of many factors including: size of tumour, rate of growth, extent of brainstem compression, hearing loss, facial function, balance, other tumours, and patient choice (Tysome et al., 2012)

An adequate treatment plan and surgical approach should be based on careful patient assessment and the tumour specific characteristic. However it is necessary
an individualized consideration and analysis of the risks to maximize the benefit to the patient (Ansari, Terry, & Cohen-Gadol, 2012). The most important predictors in VS surgery are: the final tumour size, patient age, overall health status, anatomy of the vestibule and CPA, involvement of the brainstem and facial nerve, and extent of involvement of the internal auditory meatus (Ansari, Terry, & Cohen-Gadol, 2012). VS tumours can also be sub-classified into intracanalicular and extracanalicular (Gauden et al., 2011). Other management protocols are based exclusively on the size of the tumour, thus usually the management of tumours smaller than 3 cm vary in correlation with clinical factors and the clinician’s judgment (Gauden et al., 2011). The three most popular methods to treat VS are: conservative management, surgical excision, and stereotactic radiosurgery (SRS)/stereotactic radiotherapy (SRT) (Arthurs et al., 2011).

Conservative management (CM) also called observational therapy includes long term periodically follow ups using MRI for detecting changes in tumour growth. There are some criteria suggested for its use based on the slow growth feature and the absence of symptomatology development (Arthurs et al., 2011).

Surgical excision is widely used via one of these three approaches: translabyrinthine, middle fossa, or retro-sigmoid. The surgical procedure election will dependent on specific characteristics, such as the size, location of the tumour but also the hearing status. Some complications are reported through these techniques such as: VII CN, VIII CN other neurological and vascular structures injuries which are the most common (Gurgel et al., 2012, Husseini et al., 2013). However, the conservation of facial nerve remains an important issue because of the substantial physical and psychological consequences. Surgical approaches were also chosen according to the tumour extension. The following is a scale of incidence in descending order
where the tumour is most likely adherent to: the VII Cranial nerve, brainstem, cerebellum, and trigeminal nerve (Husseini et al., 2013). Ansari et al. established that the primary goal in VS therapy is the early detection and complete removal of the tumour (Ansari et al., 2012). However if near complete removal is reached, it should be necessary the addition of radiotherapy to reach an optimal preservation of hearing and facial nerve function (Tos and Thomsen, 1984). Myrseth et al. identified in a clinical trial that in surgery selection all the patients must be advised of facial nerve dysfunction of grade 1 or 2 according to the House –Brackmann system because their probabilities could reach until the 96% (Myrseth et al., 2007).

Stereotactic radiosurgery or Stereotactic radiotherapy (SRS/SRT) were introduced by Leksell in 1969 for VS management. This became an alternative to surgical resection predominantly attractive for patients with complex medical comorbidities or increased age. This therapy offers also a little post-operatory recovery time without the need of inpatient admission. However there have been reported short term and long term complications such as: radiation toxicity which leads to facial weakness, synkinesis or balance impairment. Some other authors have mentioned risk of malignancy over the time. On the other hand, hydrocephalus may be developed in 2% of VS patients treated by Gamma knife radiotherapy, and it is recommended to be suspected as a late complication which may require ventricular shunting. SRS/SRT have a clear role in the management of neurofibromatosis type 2 in patients with bilateral VS where surgical resection is often associated with a higher risk of hearing loss and other morbidities. It seems less invasive than surgery (Husseini et al., 2013). The main disadvantage of radiation therapy is the non-removal of the tumour which keeps the growth risk and consequently the requirement of long term follow up (Husseini et al., 2013). An early diagnosis and
early SRS could lead to achieve the two goals of successful treatment: tumour control and maintenance of the existing neurological function (Gauden et al., 2011).

No significant outcomes difference has been shown yet between SRS/STR and microsurgery in the literature. This may be in part due to the lack of modern, well-designed, large-scale prospective studies. The study by Saeed et al. on 2006 states a clear necessity of a prospective audit study and creates a philosophy of a collaborative practice between the neuro-otologist (ENT sub-specialists) and the neurosurgeon (Saeed et al., 2006). This multidisciplinary team additionally should further include an otolaryngologist, neurosurgeon, neurologist, geneticist, oncologist, audiologist, radiologist, ophthalmologist, and nurse specialist (Tysome et al., 2012).

In order to determine how the management of VS is currently performed in the UK and how it is related with the state of the art practices worldwide, this study intents to compare between the current published literature and the current management of VS in the RNHT hospital.
3. METHODS

A clinical records audit (retrospective observational study) was carried on with the patients of the Royal Ear Nose and Throat Hospital. On parallel a systematic review of the literature was performed with the purpose of comparing the UK data with the published evidence worldwide.

3.1 OBJECTIVES OF THE STUDY

- To examine a cohort collected of 5 years period and determine how the management of VS has changed in terms of number of patients that underwent to each treatment group.
- To determine the patients characteristics used for treatment approach selection.
- To compare our results with the current evidence worldwide in the form of a systematic review of the literature

3.2 OBSERVATIONAL RETROSPECTIVE STUDY

The study collected the data from the patients diagnosed with VS on the last 5 years (period 2008-2013). It was determined the number of attended cases and also the type of treatment selected for each one. From the VS patients’ clinical records were collected the following variables: clinical record number, date of birth, date seen, treatment after VS diagnosis, revised treatment, date revised treatment, surgery date, surgery extent, MRI, intra-canaliculat tumour, tumour side, facial nerve
immediate grade, deafness, deafness duration, tinnitus, tinnitus duration, vertigo, vertigo duration, headache, facial, facial grade, visual symptoms, other symptoms, referral by, cranial nerves, cerebellar signs, hearing loss degree, speech audiology alteration, vestibular function, surgery complications, hospital stay, recurrence, comments. There were excluded the patients without a MRI scan prior treatment, patients without data of posterior follow-up visits, and patients without information about signs and symptoms at the time of the first visit.

The patients were located according to their treatment approach in 4 groups: conservative approach (observational group with periodical controls), surgical treated group (excision of the tumour was carried on), SRS/SRT (patients that underwent stereotactic radiosurgery or stereotactic radiotherapy), and a group of patients that were referred to a MDT for further discussion about treatment.

Using the clinical records data was created a spreadsheet database in Microsoft® Excel and each variable was curated manually. Inaccuracies or missing data in the most important variables caused the elimination of such patients from the final database. Some bars and pie charts showed in the study were made in this same software. The statistical analysis was performed in the statistical package SPSS version 18.0, and the bar/plot charts was done in GraphPad Prism version 5.0.

Central tendency statistics were performed in all the continuous variables including mean, standard deviation and variance. The statistical analysis done considered a normal distribution of variables, therefore parametric statistics were performed.

When couples of continuous variables were compared, a student t test was performed, and to compare multiple continuous variables was used one way analysis
of variance (ANOVA). Additionally Bonferroni’s Multiple Comparison test was applied to compare between groups using Confidence Intervals of differences at 95%.

The analysis of multiple categorical variables was performed using \( \chi^2 \) between groups and Confidence Intervals at 95%. The survival morbidity Kaplan Meier curves were analysed using the Log-rank (Mantel-Cox) test. Morbidity curves were made using the period in months between the first visit from the patient to the clinic and the report of the MRI scan that showed tumour growing. Tumour growing was considered if they had more than 2 mm of tumour size with respect to a previous MRI scan, and patients with tumour regression were placed in the non-growing group.

This study was carried out after the ethics approval for an audit from the Royal Free London NHS Foundation Trust.

3.3 **SYSTEMATIC REVIEW**

An online research through PubMed, Medline and Ovid databases was performed, the terms searched through were: vestibular schwannoma treatment OR management, treatment protocols of vestibular schwannoma, radiosurgery AND vestibular schwannoma, conservative management AND vestibular schwannoma, surgery outcomes in VS. The inclusion criteria were: papers published between 2003 and 2013 (however if a particular study was cited regularly, the study was included), the papers searched were limited to English language, there were included papers that mentioned the management of VS. Additionally only the following types of publications were included in this study: Meta-analysis, systematic reviews, multicentre clinical trials, clinical trials and retrospective cohorts. A summary flowchart that includes the published literature revision was created (Fig. 1).
Figure 1. Flowchart that shows the papers reviewed in this systematic review and the exclusion criteria used. In the blue arrows are specified the number of published articles that remained on each step.

From this search the papers that fulfilled the postulated criteria were approximately included in the evidence categories A to C according to the UK National Health Service. From these, a total of 32 studies were sub selected after further revision because included patients' ethical approval, were from a high number of patients, gave information about tumour growing and relapsing. Papers on neurofibromatosis Type 2 (NF2) patients were not excluded but their particular outcomes and guidelines were managed separately.
4. RESULTS

4.1 SYSTEMATIC REVIEW OF LITERATURE

From the 67 studies originally analysed, only 32 satisfied the inclusion criteria. There were sub-selected a total of 2 Meta-analysis, 2 prospective studies, 6 cross-sectional studies, 9 systematic reviews, 6 review articles, and 14 retrospective papers. From these, approximately 262,000 patients diagnosed with VS were analysed.

The main features from the meta-analysis were:

- Smouha et al. included 21 studies and 1,345 patients. The average length of follow-up was 3.2 years. The average initial tumour size was 11.8 mm. The highest rate (57%) of patients showed no growth or tumour regression. The average growth rate was 1.9 mm/year in 793 individuals. Hearing loss occurred in 51% of 347 individuals. In 15 studies, 20% of 1,001 individuals eventually failed on CM. This meta-analysis supports the role of CM in properly selected patients on the basis that the slow tumour growth and a substantial incidence of no growth the group designed a management algorithm. However, the lack of predictive factors, the relatively short duration of follow-up, and the variability of inclusion criteria underscore the need for continued collection of long-term data (Smouha et al., 2005).

- Maniakas and Saliba meta-analysis presents strict hindrances in selecting valid studies. They discard the ones with short term follow up, incomplete information, non-uniform description of hearing loss, growth o CN lesions. However they supported that VS treatment protocols have been changed
throughout the years and nowadays represent the lowest morbidity rates in history. They also recommend the creation of a universal nomenclature including the term stereotactic radiations instead of radiosurgery (Maniakas and Saliba, 2012).

The principal characteristics from the prospective studies are:

- Sughrue et al. described functional outcomes and long-term follow up (25 years period) from a total of 204 VS patients younger than 40 years treated with microsurgery. Rates of tumour control, hearing preservation, facial nerve palsy and trigeminal neuropathy were analysed using Kaplan-Meier, as many other multivariable studies. The analysed data indicate that surgical management leads to a long-term freedom from tumour recurrence even tumoural progression of 89% after 15 years. Consistently with other publications, hearing was preserved in 68% of patients, facial nerve function was preserved in 76% of patients with smaller tumours (P<0.01). The tumour size was verified pre and post-operative stage within a month of surgery and was also a predictor of hearing loss. The description of the time of the MRI follow up was clear in this article in comparison with others. The authors conclude that surgical resection provides excellent long-term tumour control (Sughrue et al., 2010).

- Pollock et al. reported that those patients allocated in SRS group were statistically significantly older when compared patients in the surgical group. This suggest a confounder as this aged group could mean that age is a determinant for SRS/SRT management (Pollock, 2008).
From the cross-sectional studies described, three were European (two English and one from Norway) and their principal features were:

- Breivick et al. studied during a period of ten years the therapies outcome in 431 patients in Norway. The group followed their own management algorithm according to the tumour diameter and its extension into the CPA. However, both safety and effectiveness may be questioned because of the not inclusion of observational management. This study indicates that GK causes significant growth arrest without interfering negatively with hearing. (Breivik et al., 2013).

- Saeed et al. analysed 336 responses from 542 ENT surgeons (62%) via post survey. The study reports that the majority of ENT consultants referred their VS patients to another surgeon for management. Of these: 242 (80.9%) referred their patients to another ENT surgeon; 29 (9.7%) to a neurosurgeon; 28 (9.4%) to a combined clinic run by an ENT surgeon and a neurosurgeon. Only seven specialists chose their surgical approach only based on the size of the tumour. Eight preferred the retro-sigmoid approach and 6 the translabyrinthine via. The group conclude that the care of VS patients requires a multidisciplinary team with access to the full range of the specialist support services. Therefore, the group have create the necessity of a prospective audit amongst surgeons that would clarify whether the surgical outcomes of those with a small caseload fall below the acceptable standard (Saeed et al., 2006).

On the systematic reviews found the most important characteristics were:

- Ansari et al. described the complications by type of surgical approach. This was a complete breakdown regarding the outcomes of the commonest
surgical approaches and their complications. It was based on 35 studies in total including 5064 patients who had undergone VS surgery. They conclude that the middle cranial fossa approach seems safest for hearing preservation in smaller tumours. The retro-sigmoid approach seems to be the most versatile corridor for facial nerve preservation but it is associated with a high incidence in CSF leakage. The translabyrinthine approach may be useful for patients with large tumours associated with poor preoperative hearing (Ansari et al., 2012).

- Quesnel and McKenna stated that VS management have evolved and introduction of imaging techniques have helped in the diagnosis and the observational approach. The microsurgical techniques are aimed for hearing preservation, and SRS is important in long term control management. The article itself focus in the best management for intracanalicular tumours (Quesnel and McKenna, 2011).

- Wolbers et al. pointed out that microsurgery and radiosurgery are equally effective for VS treatment. However, again as many other articles quoted, SR and RCT (double-blinded) are considered the gold standard evidence. That’s the reason why they based their investigation on four studies which showed trustworthy association between interventions and outcomes because no biases were identified.

The main results obtained from the retrospective studies were:

- Hasewaga et al. established long-term (10 years) study regarding the safety and efficacy of SRS in 440 patients using multi-varied statistical analysis. This is the largest SRS trial and has longest follow-up data. Authors recommend SRS/SRT to young patients, however it is still debatable if is safer and
effective. On the other hand, the indication of surgery on compression over the brainstem cases was arguable. On its results the group referred that the most important factor causing treatment failure was the fourth ventricle deviation previously registered on MRI, because even slight tumour expansion can cause severe gait disturbance requiring craniotomy (Hasegawa et al., 2013).

- Babu et al. described the disparities of VS management. A total of 6225 patients were followed up during five years. Elder patients were associated with an increased likelihood of CM. However, no significant difference was found in tumour observation neither the variable ethnic background (Caucasians versus other races), nor gender. The authors mentioned that “although various studies have demonstrated improved outcomes with the use of SRT for small to medium-sized VS, the surgery is still the most common approach” (Babu et al., 2013).

To summarize the main findings of the systematic review of literature, it has been developed a table showing a group of the top 11 high quality papers. The selection was performed according to the level of evidence and the number of participants on each study (Table 1).
<table>
<thead>
<tr>
<th>Year and Setting</th>
<th>Design</th>
<th>No. of Participants</th>
<th>Treatment Groups</th>
<th>Follow up</th>
<th>Conclusions</th>
<th>Comments</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 Manchester UK</td>
<td>Cross sectional Posted Questionnaire survey 336 replies from British Association of Otorhinolaryngologists, Head and Neck surgery</td>
<td>767</td>
<td>386 underwent microsurgery, 318 observational management, and 63 radiotherapy</td>
<td>N/A</td>
<td>More prospective studies needed</td>
<td>Supports the philosophy of collaborative practice.</td>
<td>(Saeed et al., 2006)</td>
</tr>
<tr>
<td>2011 Boston USA</td>
<td>Systematic Review</td>
<td>N/A</td>
<td>18 studies including systematic reviews, Prospective studies.</td>
<td>N/A</td>
<td>Various factors involved in the decision making of best treatment</td>
<td>Investigation of the best management of Intracanalicular VS.</td>
<td>(Quesnel and McKenna, 2011)</td>
</tr>
<tr>
<td>2013 North Carolina USA</td>
<td>Retrospective study 6225 Database from Five years</td>
<td>N/A</td>
<td>Multivariate Logistic regression Between all groups of variables</td>
<td>N/A</td>
<td>Initial tumour size and its growth are primary determinants for treatment and VS predictors.</td>
<td>Racial disparities found. More investigations before elucidate disparities in treatment.</td>
<td>(Babu et al., 2013)</td>
</tr>
<tr>
<td>Year</td>
<td>Location</td>
<td>Study Design</td>
<td>No.</td>
<td>Follow-up</td>
<td>Incidental VS groups underwent 3 known surgeries</td>
<td>Conclusion</td>
<td>Reference</td>
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<tr>
<td>2012</td>
<td>New Jersey, USA</td>
<td>Observational review of current literature</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Early MRI is essential for maintaining conservative management. Individualized approach.</td>
<td>(Schmidt et al., 2012)</td>
</tr>
<tr>
<td>2012</td>
<td>Chiety, Italy</td>
<td>Retrospective review of patients who require salvage surgery</td>
<td>25000</td>
<td>6 months</td>
<td>N/A</td>
<td>Still debatable outcomes. Surveillance management of at least 12 months before treatment of small tumours. Encouraging recommendation to other specialist to publish results after failed SRT.</td>
<td>(Hussein et al., 2013)</td>
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<tr>
<td>2013</td>
<td>Rotterdam, Netherlands</td>
<td>Systematic research of control intervention studies</td>
<td>N/A</td>
<td>N/A</td>
<td>4 trustworthy criteria studies</td>
<td>Radiotherapy is a good practice in solitary VS &gt; 30 mm Small sized population is in concordance with most of the references.</td>
<td>(Wolbers et al., 2013)</td>
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<tr>
<td>Year</td>
<td>Location</td>
<td>Study Type</td>
<td>Sample Size</td>
<td>Follow-up</td>
<td>Findings</td>
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<tr>
<td>2013</td>
<td>South Florida, USA</td>
<td>Closed answered questionnaires</td>
<td>2372</td>
<td>N/A</td>
<td>Microsurgery still should be the chosen management</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Comparison between three groups of therapies</td>
<td>2372 From 10 years database</td>
<td>N/A</td>
<td>Use of radiosurgery increase among new diagnosis (Patel et al., 2013)</td>
<td></td>
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<tr>
<td>2005</td>
<td>New York, USA</td>
<td>Retrospective</td>
<td>21 studies 1345 patients</td>
<td>3.2 years</td>
<td>Supports conservative management in selected patients</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
<td>Lack of predictive factors. Proposed algorithm based on tumour size. (Smouha et al., 2005)</td>
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<tr>
<td>2012</td>
<td>Pittsburg Pensilvany, USA</td>
<td>Systematic Review</td>
<td>Various cohort studies for each of three management types</td>
<td>N/A</td>
<td>Less consistent outcomes in SRS, no difference with surgical group, wait and scan policy only for specific population.</td>
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<td></td>
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<td></td>
<td>N/A</td>
<td></td>
<td>Decision flowchart For VS management (Kondzio Ika et al., 2012)</td>
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<tr>
<td>Year</td>
<td>Location</td>
<td>Study Type</td>
<td>Number of Participants</td>
<td>Treatment</td>
<td>Follow-Up</td>
<td>Outcome</td>
<td>Hindrances</td>
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<td>2012</td>
<td>Montreal Quebec Canada</td>
<td>Meta-analysis</td>
<td>14 studies SRT only</td>
<td>Scale of tumor size, hearing preservation</td>
<td>N/A</td>
<td>Compare data from 3 types management in &gt;5 years follow up, SRS better long term tumor control than CM</td>
<td>Hindrances for include articles; short term follow up, incomplete report of information, non-uniform description of Hearing loss, growth o CN lesions.</td>
</tr>
<tr>
<td>2012</td>
<td>Minnesota USA</td>
<td>Retrospective Cohort study</td>
<td>350</td>
<td>Gross total resection, subtotal, near total</td>
<td>6 months</td>
<td>Post-operative MRI 6 months for prevent regrowth that normally occur early.</td>
<td>Recurrence diagnostic is challenging when non-specific imaging enhancing in surgical field</td>
</tr>
</tbody>
</table>
4.2 Retrospective Observational Study

A total of 226 clinical records were found with the diagnosis of VS, from which 176 had complete information required to be included in the present study and were further analysed. After the diagnosis the first managing approach determined that 120 patients continued with a conservative treatment (observation and controls), 29 were directly derived for surgical excision of the tumour, 12 to stereotactic radiosurgery or stereotactic radiotherapy (SRS/SRT), and 15 were derived to a Multidisciplinary team for further evaluation (Fig. 2). From this last group, 3 patients were surgically treated and 2 SRS/SRT, the rest 10 patients have not been treated yet as their MDT meeting have not been done until July 2013.

![Pie Chart](image)

*Figure 2. Pie Chart that shows the main 4 treatment approaches percentages found in the total studied population.*
From the patients that underwent surgery, 17 (53.12%) reported to have a total excision of tumour and 15 (46.88%) reported a subtotal/near-total tumour removal. The main surgical approach used was the retrosigmoidal with 20 cases (72%), followed by the translabyrinthine in 2 cases (7%), there were not reported middle fosa interventions but 6 patients have no information on their clinical records about the surgical approach used. The average stay time after surgery was 8.45 days and 23 (71.9%) of patients had a lumbar drain for 48 hours. Post-surgery 2 patients reported a delayed facial palsy, 1 patient a cranial haematoma and 1 a moderate hearing loss.

The average age of patients was 55.14 years, on the conservative group 56.99 years, the surgically treated 59.84 years, the SRS/SRT group 46.78 years and the group of patients referred to a MDT was 56.95 years. There were not statistically significant differences on age between groups ($P > 0.05$).

The tumour location was on the right side on 75 patients (42%), on the left on 91 (52%), on both sides on 5 patients (3%), and it was not specified on 6 patients (3%) (Fig. 3). Only 24 patients had an intra-canalaricular tumour in total which represents the 13.6%. From these, 23 belonged to the conservative treatment group (19.1% of cases on this group), and 1 in the surgically treated group (3.4% of cases on this group).
The size of tumour based on the MRI scan was on average 13.8 mm. On the conservative approach group it was 11.2 mm (SD=8.22), on the surgical approach 24.16 mm (SD=11.88), on the SRS/SRT 14.41 mm (SD=4.98) and in the referred to MDT 16.73 mm (SD=6.66) (Fig. 4). Analysis of variance between the groups showed statistically differences ($P < 0.001$), which after the Bonferroni's Multiple Comparison Test showed is mainly produced by the contrast between the conservative and the surgical group ($P < 0.001$ with a diff IC 95% of 17.58 to 7.608), and the SRS/SRT group versus the surgical managed group ($P < 0.01$ with a diff IC 95% of 17.41 to 1.376).
The more common symptom found at the moment of diagnosis was deafness which was found in 84.74% of cases (150 cases). On the conservative group 104 patients (85.9%) had a degree of hearing loss at the moment of diagnosis, 23 cases (82.1%) on the surgically treated, 9 (75%) on the SRS/SRT group and 13 cases (86.6%) on the group of patients referred to a MDT. There was not statistical difference between groups ($P > 0.05$). An 8.4% of patients didn’t have information about deafness on their clinical records (Fig. 5). The duration of deafness on average until treatment was 25.9 months with a maximum of 120 months.
The hearing loss level on average was 60.13 db (SD=29.68). On the conservative group the mean hearing loss was 56.64 db (SD=31.74), in the surgical treated group was 61.04 db (SD=29.79), in the SRS/SRT group was 61.55 db (SD=28.95) and in the group referred to a MDT was 61.31 db (SD=28.25) (Fig. 6).
Figure 6. Plot Chart that shows the db measures of each patient prior treatment grouped in the 4 treatment groups.

The second most common symptom at the time of diagnosis was tinnitus, it was found in a 68.36% of patients (121 cases). The conservative group had 80 patients (66.11%) with tinnitus, 17 patients (60.71%) on the surgically treated, 11 (91.6%) on the SRS/SRT group and 13 cases (86.6%) on the group of patients referred to a MDT. There was not statistical difference between groups ($P > 0.05$). A 9.6% of patients didn’t have information about hearing loss on their clinical records (Fig. 7). The duration of this symptom on average was 23.6 months with a maximum of 120 months.
Vertigo was the 3rd most common symptom and was found in 37.3% of patients (66 cases). The conservative group had 45 cases of vertigo (37.1%), the surgically treated 28 (42.8%), the SRS/SRT group 3 cases (25%) and the group of patients referred to a MDT 7 (46.6%). On average vertigo was present on 17.5 months with a maximum of 84 months. Altered cerebellar signs were encountered in 109 patients (61.6%), the most common cerebellar sign was an Unterberger positive sign on 76 patients (42.9%), 30 patients (16.9%) presented unsteadiness, and 21 (11.8%) had a Romberg’s positive sign. On the patients with Unterberger sign 46 patients had alteration to the left and 29 to the right, whilst in the Romberg’s positive sign 9 patients have alteration to the right and 2 to the left.

Facial palsy was encountered in 21 patients (11.9%), from which according to House-Brackman stages 10 patients (47.6% from the patients with palsy) had a degree 1 of palsy, 6 (28.5%) degree 2, 3 (14.3%) degree 3 and 2 (9.5%) degree 6. Strikingly, most of the cases of facial palsy was find in patients that were managed by a surgical approach with 15 cases (71.4%). There were only 6 cases (28.6%)}
found in the conservative group and 4 of them were degree 1, and the 2 extra cases of facial palsy were referred to the MDT. Statistically more patients with palsy went for a surgical management than to the other management groups ($P < 0.01$).

Other symptoms as headache were declared only by 8 patients (4.5%), visual impairments on 3 patients (1.7%), speech discrimination alterations on 4 patients (2.2%), and chorda symptoms in 1 patient (0.5%).

Most of the patients were referred from an ENT specialist with 142 cases (80.2%), followed by a GP with 15 cases (8.5%), 7 (4%) from an AVM specialist, 4 (2%) from a Neurologist and 3 from an Audiologist (1.7%).

After sub sequential controls, in overall 69 patients (38.98%) presented tumour growing. From this on the conservative group 52 patients (59% of the patients on this group), 11 (61%) on the surgically treated, 6 (50%) in the SRS/SRT, and 7 (50%) on the MDT referred patients. There was not statistical difference neither on tumour progression on the analysis of the variance between all the groups nor on the Bonferroni’s Multiple Comparison Test on the paired groups ($P > 0.05$) (Fig. 8). Tumour growing in 28 patients determined a different management approach. On the conservative group, 17 patients were relocated to other treatments (10 to surgical excision of the tumour and 7 to SRS/SRT. This happened after an average of 8.16 months although many patients had a non-growing period of more than 2 years. On the surgical originally treated group, 5 patients had to be re-operated in on average 10.8 months. On the SRS/SRT group of patients only 1 was reported to have again a radiotherapy session.
Figure 8. Bar Chart that shows the number of patients that reported tumour growing in the MRI grouped by treatment group.

On overall there are not statistically differences of tumour growing rates between the management groups, and there were not statistical differences (Log-rank Mantel-Cox Test $P=0.135$) when compare the time when the tumour growing occurred. It was found that the patients that were on the conservative treatment did not have a faster tumour growth noticed in the MRI compared with the surgically treated or the SRS/SRT groups (Fig. 9).
Figure 9. Kaplan Meier survival curves showing the time when a growing tumour event was reported in every treatment group. Log Rank Test statistics showed no significant differences.

Additionally some patients developed other comorbidities that were reported in further controls. A total of 4 patients developed other malignancies (non-VS), 2 patients developed Diabetes Mellitus type II, and 1 patient developed contralateral otosclerosis.

A total of 8 patients with VF had additionally NF2 as subjacent disease. From these, 3 were directly managed by surgical excision of the tumour, 3 were placed on observation and 2 were referred to a MDT for further decision. Half of the NF2 patients had a tumour regrowth and 1 reported optic nerve and V CN lesions. These patients symptoms were mostly tinnitus (6 cases), deafness (4 cases), vertigo (4 cases), facial palsy (2 cases), and 1 case of headache.
5. DISCUSSION

5.1 SYSTEMATIC REVIEW

Despite being considered a slow growing tumour, the VS behaviour and progression depends by its inherent phenotype and genotype. For this reason, the management of patients with VS depends principally of the tumour characteristics at the time of diagnosis and the range of symptoms derived from it. The standard methods to manage VS keep being the observational management, the surgical excision, and the stereotactic radiosurgery (SRS)/stereotactic radiotherapy (SRT) approaches (Arthurs et al., 2011).

5.1.1 Observational Therapy

Silverstein and Nedzelski on the 80s were the first describing the conservative management (CM) of VS, also known as “wait and scan” or “observational” therapy which is targeted to small and slow growing tumours (Silverstein et al., 1985, Nedzelski et al., 1986). It involves serial monitoring by MRI and audiogram from the time of diagnosis. At the present time the wide availability of imaging scans principally MRI, have led to an easier diagnosis and a more reliable follow up. The use of MRI sensibility of tumour recognition has improved the detection of smaller and on earliest stages tumours (Hughes et al., 2011).

The study conducted by Suryanarayanan et al. established a good foundation of the role of conservative management. This group supports the philosophy of firstly preserve hearing by maintaining the integrity of the VIII CN cranial nerve, and also the facial nerve function. Two-thirds of the total VS patients did not shown any growth in this study, and was regarded as a safe approach in VS management.
(Suryanarayanan et al., 2010). On other study Stangerup et al. found that a limited number of small sized tumours grew within the first 5 years, and this was the reason that led to an increase of observation policies for VS patients (Stangerup et al., 2010a). The rates of tumour growth during conservative management is variable in actual evidence, however, it varies according to the length of the follow up period analysis. The monitoring period with MRI (magnetic resonance imaging) for one year was recommended before of treating small non-cystic VS tumours (Husseini et al., 2013). The presence of incidental VS presence qualifies for conservative management at it diagnosis. Followed imaging combined and posterior tumour and symptoms amelioration is crucial to ensure long-term good results (Schmidt et al., 2012).

5.1.2 SRS/SRT

In 1951, Leksell described the non-invasive alternative therapy to surgery based on stereotactic radiation that in small tumoural areas produces necrosis in the central core (Leksell, 1951), but it was not until 1969 when the first VS case was treated with gamma knife (GK). Two main radiation treatments: stereotactic radiation and stereotactic radiotherapy were by the time developed. The former involves a large single dose of radiation towards the tumour, performed with a GK or a linear accelerator (LINAC), whereas the latter involves fractionated doses of radiation, known as fractionated stereotactic radiotherapy. Currently, the term radiosurgery is widely used to refer to a stereotactic radiation treatment using GK and LINAC. Although, “radiosurgery” has been part of the nomenclature for long ago, the treatment itself is wrongfully qualified as a form of “surgery” or manual procedure (Maniakas and Saliba, 2012).
Even SRS/SRT is one is a popular strategy among surgeons nowadays (Patel et al., 2013), it is not easily accessible for all patients because of its lack of availability worldwide (Murphy and Suh, 2011, Maniakas and Saliba, 2012). In spite of the large amount of studies concerning treatment outcomes, papers comparing treatment methods are no better than class 3 or class 2 evidence showing better results for GK than for surgery (facial nerve function, complications, and hearing preservation). Surgery and SRS/SRT could reach a cure rate of 90–98% and patients should play an important role in the treatment selection (Myrseth et al., 2007).

Studies on SRS/SRT have showed lower mortality rates compared with surgery but at long term SRS/SRT have not probed a better facial function, better hearing preservation and better quality of life (Quesnel and McKenna, 2011). Ansari et al. state that subtotal resection may be a reasonable strategy, especially if facial nerve integrity is at risk. They reported a low rate of regrowth of residual tumour and the effectiveness of radiosurgery for controlling small tumours and facial nerve function preservation (Ansari et al., 2012).

In a recent study by Wolbers et al. established that radiosurgery is the best practice for patients with a solitary vestibular schwannoma up to 30 mm in cisternae extension(Wolbers et al., 2013).

Microsurgical removal after failed SRT shows satisfactory outcomes and acceptable percentages of morbidity. However the functionality of cranial nerves especially the VII CN, tends to worsen after another intervention. This is the main reason why excision of the residual tumour or relapses and radiotherapy are the most challenging techniques with worse outcomes (Gerganov et al., 2012, Murphy and Suh, 2011).
Interestingly, Husseini et al. investigated how radiotherapy failure is underestimated by the evidence, and shows how specialists with experience in salvage surgery describe the surgical outcomes and difficulties in treating VS after failed radiotherapy. The patients that received SRT prior to surgical intervention had a worse post-operative function of the VII CN mainly due to a difficult tumour dissection (Friedman et al., 2005). Complete surgical resection of VS is more difficult after radiotherapy with relatively poor facial nerve outcomes and almost impossible hearing preservation. Patients who receive SRT should be aware of its potential complications and risk of failure, especially young patients and NF2 cases (Husseini et al., 2013).

The age, size of the tumour, presence of cystic components and the lack of tumour growth evidence have led to SRT abuse. For this reason should exist defined this therapy should not be indicated on tumours larger than 30mm. This is due to the fact that such large tumours need a higher radiation dose and to avoid compressive symptoms caused by tumour inflammation (Husseini et al., 2013, Friedman et al., 2005). Pollock et al. described three types of VS enlargement after radiation surgery:

- Type 1: tumour regression to the initial size or even less.
- Type 2: tumour growth remains stable after an initial enlargement on an asymptomatic patient.
- Type 3: tumour that continued to enlarge plus the presence of compressive symptoms and needs for further intervention. (Pollock, 2008)

Tumour expansion after SRS/SRT is rarely associated with a failed procedure, if this happens, the patients should undergo imaging surveillance, and surgical treatment
should be reserved only for cases with clear progressive tumour enlargement (Husseini et al., 2013).

Sughrue et al. consider that younger patients’ treatment is far more complex due the differences between therapies outcomes over time. This study describes serious issues when comes to the management in young patients who will still be on working age if the tumour recurs or progresses in 25 years. They also reported many concerns around the fact that the early exposure to radiation delivered during RST or SRS treatments could cause secondary malignancies over the rest time that these patients are expected to live (Myrseth et al., 2007), however it was found that secondary malignancies were not more prevalent even on 15 years follow-up (Sughrue et al., 2010). Therefore, this has led to propose the use of SRS/SRT as the principal treatment for VS in young patients. Furthermore, the study showed data regarding large tumours management for which SRS/SRT was not a reasonable option. Ideally in large tumours the aim would be to recognize that the tumour has been reduced to an appropriate radiosurgery target (Sughrue et al., 2010).

Breivik et al. compared the clinical course of extra-canalicual VS either treated conservatively or by SRS. The GK therapy produced tumour arrest and hearing preservation (Breivik et al., 2013, Murphy and Suh, 2011). On its results the group referred that the most important factor causing treatment failure was, the fourth ventricle deviation, previously registered on MRI, because even slight tumour expansion can cause severe gait disturbance requiring craniotomy (Hasegawa et al., 2013).

In NF2 patients a complete tumour resection should be recommended principally via a translabyrinthine approach. This surgical technique could maximize the tumour
access resulting in total resection and reduction in rates of relapses. In these patients the surgical approach is preferred over the radiotherapy (Tysome et al., 2012). However incomplete excision of VS often results in tumour recurrence. Strikingly a vast amount of patients managed conservatively with an annual MRI surveillance show absence on tumour growing, and therefore this approach is recommended first (Tysome et al., 2012).

### 5.1.3 Surgical approach

Unexpectedly, surgical management of VS can be performed until the 75% in small-sized tumours. However microsurgery decreased from 92.7% to 53.4% as initial treatment choice, while the use of radiotherapy increased from 5% to 24.2% and observation policy increased to 22.4. This study found that observational therapy is selected in small-sized tumours and RSR for medium-sized tumours (Patel et al., 2013).

The microsurgery approach is divided on: translabyrinthine, middle fossa, and retro-sigmoid, being no significant difference in terms of mortality between the three surgical approaches (Ansari et al., 2012).

Lately, in small tumours the middle fossa approach is gaining popularity whilst the translabyrinthine procedure has decreased possibly due to the better hearing preservation with the first one (Patel et al., 2013, Youssef et al., 2013). However middle cranial fossa approach is associated with a higher risk of headache and CSF leak complications, and as it places the facial nerve between the surgeon and the tumour, turning it unsafe. On contrast in large tumours it has been observed an increase of translabyrinthine procedures (Patel et al., 2013, Youssef et al., 2013). The retro-sigmoid approach is well known to neurosurgeons and allows a panoramic
visualization of the CPA. This via provide a limited visualization of the fundus of the Internal auditory Canal (IAC), which by the time will perhaps need an excision to remove the entire tumour (Youssef et al., 2013).

It is debatable the use of total excision whilst performing a subtotal resection could be a better approach for facial nerve preservation (Tonn et al., 2000). A satisfactory outcome was defined as House-Brackmann Grade III or higher, being in this study the retro-sigmoid approach associated with significantly less facial nerve dysfunction (Ansari et al., 2012). Hahn et al. determined that pre-operative tumour size is an important factor for outcome prediction. Less incidence of remnant tumours after a total tumour excision was reported, and most of them disappeared spontaneously probably due to devascularisation (Hahn et al., 2013). According to Husseini et al. to perform a complete tumour resection is the gold standard therapy to prevent a second salvage surgery. They recommend a subtotal or near total tumoural resection only in cases of elderly patients or cases with cystic tumours (Husseini et al., 2013).

Moreover, it is important to highlight that there is a lack of reliable studies regarding long term outcomes after surgical therapies in patients younger than 40 years old (Sughrue et al., 2010)

Patients with NF2 that have undergone surgery for VS excision have higher than usual re-growing rates, therefore the importance of long-term and more periodic follow-up (Myrseth et al., 2007, Kimmel et al., 2013).

After surgery a typical MRI control shows the presence of a central hypo-intensity in the 93% of cases. Multi-septal cyst formation is also common after SRT due to a secondary necrosis and protein leak. This reaction remains active till one year or 18
months, when the chronic inflammation relieved and is replaced by glial formation. The scarring left by the tumour to the adjacent nerves plus the direct toxic, effect of the radiation, elucidates the delayed neuropathies and the demyelination of the nerves (Quesnel and McKenna, 2011, Husseini et al., 2013).

5.1.4 Quality of life (QOL)

Quality of life in these patients has to be taken into account at the time of management selection. The development of progressive neurological compressive symptoms is an important impact factor over patient’s QoL (Schmidt et al., 2012).

As there is not a validated disease-specific questionnaire for VS, the Glasgow Benefit Inventory (GBI) is used (Myrseth et al., 2007). A study using this questionnaire found a slightly better QoL outcome using SRS/SRT (Myrseth et al., 2007), but others found no differences (Quesnel and McKenna, 2011, Brooker et al., 2010). On the other hand, patients who underwent microsurgery reported significantly more deterioration in general well-being compared with SRS/SRT radiation group (Brooker et al., 2010). Interestingly there was no difference of QoL when comparing before, during and after treatment on patients under conservative management (Myrseth et al., 2007).

5.2 Current retrospective observational review

On the clinical records audit performed most of the patients underwent to a conservative therapy and much less patients were derived directly for tumour excision or SRS/SRT approaches. A minority of patients had a deferred management decision as were derived to multidisciplinary team for further analysis, which the team judgement were relocated to the surgical or SRS/SRT groups, this approach as stated before is one of the main recommendations (Saeed et al., 2006).
The patients that underwent surgery mostly had a retrosigmoidal approach which is concordant with the international recommendations (Ansari et al., 2012), however only half of cases had a complete tumour excision whilst the rest had a subtotal tumour removal. This high prevalence of incomplete tumour removal can later determine a higher amount of regrown tumours which some authors consider a fail in the surgical approach that could lead to re-intervention (Husseini et al., 2013), however a suboptimal removal can still lead to tumour remnant necrosis (Hahn et al., 2013).

Few patients developed expected side effects after surgery as facial palsy and haematomas which were under the expected rates but because of the low amount of surgically treated patients, it was not possible to perform statistics to determine differences in outcomes and adverse effects of each surgical approach.

The age of patients as expected for this disease was between the 50s or 60s, and was not different between treatment groups (which excludes age for treatment selection). Most of patients with an intra-canalicual tumour were located in the observational management group, which is concordant with Quesnel and McKenna’s large systematic review specific for these type of patients (Quesnel and McKenna, 2011).

The main reason why the patients were derived to a specific management approach, on particular to the surgical approach, was the size of the tumour on the MRI. Hence the patients with a bigger tumour on the MRI were derived directly to the surgical approach and the ones with smaller tumours went to SRS/SRT or to the conservative management groups. This outcome in the present study agrees with the largest published studies (Wolbers et al., 2013, Youssef et al., 2013).
Additionally the patients that suffered facial palsy pre-treatment went also mostly to the surgical treatment, especially the ones with higher degrees of palsy according to the House-Brackman scale. This finding suggest that neural compression was also taken account on the management approach decision and is consistent with published studies (Schmidt et al., 2012).

Other symptoms or signs as hearing loss, vertigo and age were not dissimilar between groups and therefore not influential in the management choice. Deafness was the most common symptom encountered but there were not differences on hearing loss level between treatment groups. Tinnitus and vertigo were also very common symptoms encountered but as deafness it was not encountered more in one of the groups. All these symptoms are on concordance with previous reports on VS patients (Babu et al., 2013).

Tumour growing came across in half of patients on total, also independently of the type of management the patients underwent which is slightly higher with the previous reported data (Hughes et al., 2011). Most of patients had a very slow growing rate that didn’t determine a change in the management approach, therefore less than one sixth of patients on the conservative group had to be operated or receive SRS/SR. The main outcome from this retrospective observational analysis suggests that SRS/SRT and surgery are not better than observation to treat VS, these results support even more the thesis that observational approach is the best practice on VS management (Suryanarayanan et al., 2010).
6. CONCLUSIONS

Many studies have been published regarding the optimal management of VS, however the selection of the idoneus treatment method is still debatable. Although a randomized control trial (RCT) should be developed to clarify this issue, it is not possible due to ethical issues. This have caused that does not exist yet a global consensus for VS management and that the most common reason for treatment decision be tumour size and growth.

Observational management, SRS/SRT and surgical excision are the available alternatives in the treatment of VS so far, and a multi-disciplinary team should decide the ideal management approach for each patient regarding the symptomatology, progression rate and tumour characteristics.

The published studies do not show a clear evidence in favour a specific management over the others, however the conservative management has shown lately stronger results in its favour. Therefore, in small and stable growing tumours this approach should be the firstly elected including periodical MRI scans.

There is no need for every VS to be treated invasively. SRS/SRT or surgery should be indicated only on fast growing tumours when the treatment is expected to be less harmful than the pathology per se. Between the surgical management techniques, the retrosigmoidal approach should be considered first because its low facial nerve side effects. In contrast the translabyrinthine approach should be reserved only for bid size tumours.
In the current observational study on the RNTNE Hospital it was established that the patients assigned to a treatment type principally by the tumour size at the time of diagnosis. Patients with small tumour were placed on observational therapy and periodic MRI scans were performed. The patients with bigger tumours were considered for SRS/SRT or surgical approaches.

In cases when the treatment decision is not straightforward (i.e.: rapid growing tumours or patients with a profounder facial or hearing symptomatology), they should be referred to a MDT group.

There was not difference in tumour growing and symptomatology development between treatment groups. This determines that SRS/SRT and surgery are not better than observation to treat VS, for this reason a conservative therapy should be the principal approach carried on in newly diagnosed VS.
7. References


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