Growth of Primary and Remnant Vestibular Schwannomas: A Three-Year Follow-Up Study

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■ OBJECTIVE: **Vestibular schwannomas (VSs) are benign, slowly growing tumors. The management strategy, however, remains unclear for both primary VS and remnant VS after subtotal or partial resection. In this study, we analyzed the radiographical tumor growth to elucidate factors possibly predicting growth or regrowth of their tumors.**

■ METHODS: **We retrospectively analyzed the data of 76 patients with diagnoses of VS at a single tertiary academic referral center. The primary VS group consisted of 43 patients with conservative management, and the remnant VS group included 33 patients with tumor remnant after surgery. All patients were followed up with serial magnetic resonance imaging without intervention. The primary end point in this study was significant tumor growth at the end of the 3-year follow-up period.**

■ RESULTS: **Multivariate analysis revealed that remnant VS was less likely to grow than primary VS (odds ratio: 0.27, 95% confidence interval: 0.09−0.84). Tumor volume was correlated with tumor growth; larger tumors grew more frequently than small tumors in both primary and remnant VS groups with marginal ($P = 0.05$) and definite ($P = 0.007$) significance, respectively. The receiver operating characteristic curves plotted for tumor growth identified the optimum cutoff points of tumor volumes with greater sensitivity and specificity for remnant VS than for primary VS (sensitivity: 80% vs. 59%, specificity: 87% vs. 76%, respectively).**

■ CONCLUSIONS: **Small remnant VS after surgery could be conservatively managed without additional treatment, and relatively large remnant VS should be followed up with close serial imaging or might be a possible candidate for radiosurgery during the early postoperative period.**

INTRODUCTION

Vestibular schwannomas (VS) are benign, slowly growing tumors, and recent advances in diagnostic and therapeutic technologies have introduced changes to the management strategy for this tumor. The introduction of magnetic resonance (MR) imaging has led to the diagnosis of increasing numbers of small, minimally symptomatic or even asymptomatic tumors (25, 26), and stereotactic radiosurgery (SRS) has greatly expanded the treatment options for patients with VS (15, 28). The indolent growth pattern and the possibility of long-term quiescence in most patients also allow a number of management options. Although small VS can be treated by either microsurgical excision or SRS, the need for treatment of all such tumors immediately after diagnosis is controversial (15, 30). The accuracy of MR imaging in detecting tumor growth has allowed conservative management as a further valid alternative (3).

The primary targets for surgery of large VS include preservation of facial nerve function and hearing if feasible, with complete tumor removal; however, adherent, large tumor often has been intentionally left behind to preserve neural integrity in a subset of patients. Despite the common postoperative finding of remnant tumor, the biological behavior of remnant VS has received less attention (6, 12, 20, 27, 29). The optimal management after subtotal or partial resection remains unclear, especially whether immediate staged surgery or additional SRS is necessary or not. The recurrence rates associated with remnant tumors vary widely from 5% to 55% during long-term follow-up (8, 10, 12, 14, 18, 22, 29).

In the present study we retrospectively investigated the clinical and radiographical characteristics of patients with primary and

Key words
- Natural history
- Recurrence
- Stereotactic radiosurgery
- Surgery
- Vestibular schwannoma

Abbreviations and Acronyms
MR: Magnetic resonance
QOL: Quality of life
SRS: Stereotactic radiosurgery
VS: Vestibular schwannoma

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remnant VS who underwent follow-up imaging for at least 3 years to elucidate the factors predicting growth or regrowth of their tumors.

METHODS

Patient Population

We retrospectively analyzed the data of patients with diagnoses of VS at a single tertiary academic referral center between January 1998 and December 2010. We included only patients with World Health Organization grade I schwannomas originating from the eighth cranial nerve who underwent follow-up MR imaging for 3 years or longer. Patients with a history of radiation therapy, previous surgery, neurofibromatosis type 2, or recurrent tumors were excluded. The primary end point in our study was significant growth at the end of the 3-year follow-up period. This study was approved by the institutional review board of Gunma University Graduate School of Medicine. The management profile of our patients is shown in Figure 1.

Primary VS Group

A total of 131 patients with newly diagnosed VS was identified. At our institution, factors including patient neurologic status, patient age, and tumor size strongly influence management selection. SRS rarely was performed as the initial treatment modality for VS but was mainly reserved for recurrent VS or for patients with risk factors for general anesthesia. In general, conservative management was chosen for a relatively small or medium-sized VS, or if the patients did not prefer early treatment. Consequently, 55 of 131 patients (42%) did not receive intervention at the time of initial diagnosis and were followed up by serial MR imaging. Twelve of these 55 patients were excluded because of insufficient follow-up data, mainly because these patients were followed up at a hospital near their home. Therefore, the primary VS group included 43 patients who underwent serial follow-up MR imaging for more than 3 years. The clinical follow-up period ranged from 15 to 134 months (median, 49 months). Conservative management was discontinued as the result of tumor growth and/or worsening symptoms during the follow-up period in 4 patients; 2 patients underwent surgery, and 2 patients

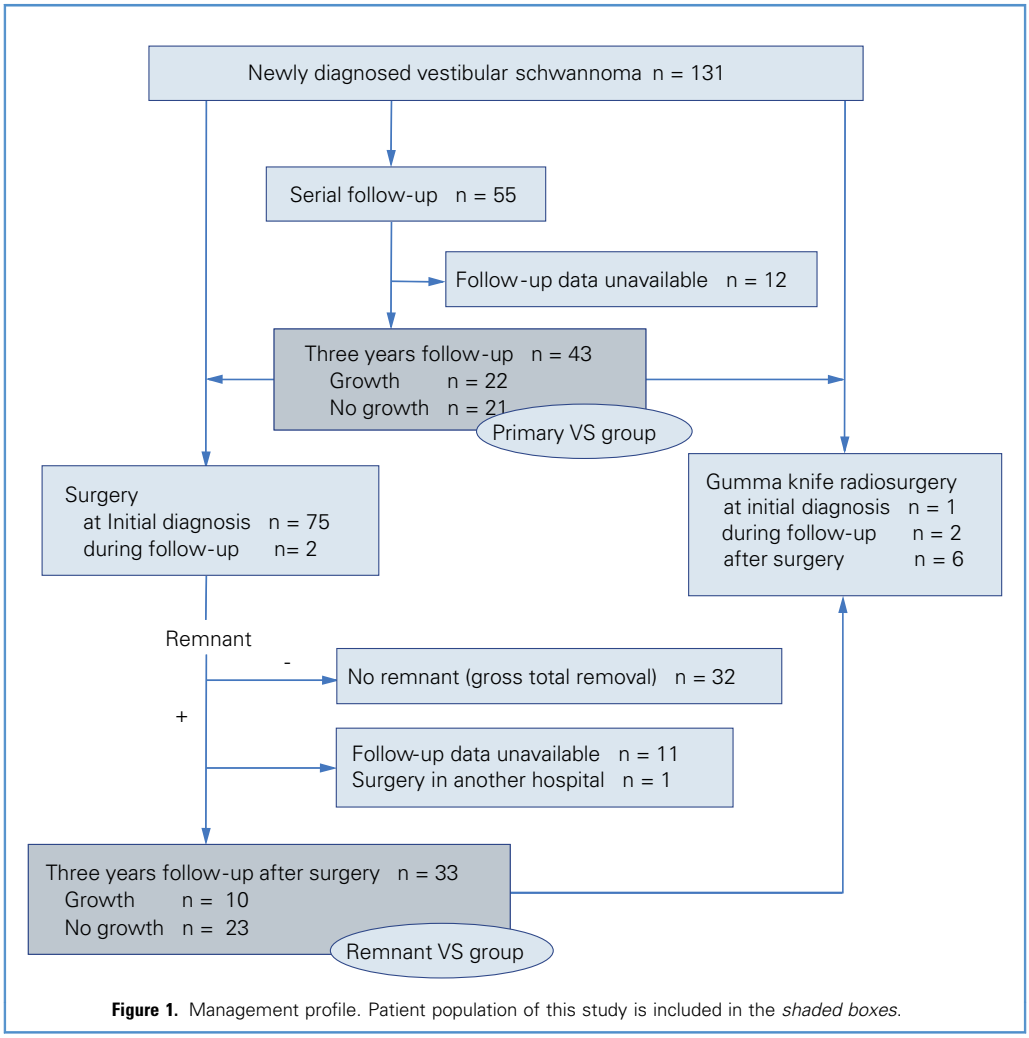

Figure 1. Management profile. Patient population of this study is included in the *shaded boxes*.