

Transient Volume Changes After Radio Surgical Management of Vestibular Schwannomas (VS)

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Abbreviations: VS: Vestibular Schwannoma; RT: Radiation Therapy; SRS: Stereotactic Radiosurgery; HFSRT: Hypofractionated Stereotactic Radiotherapy; SBRT: Stereotactic Body Radiation Therapy; CNS: Central Nervous System; IGRT: Image Guided Radiation Therapy; IMRT: Intensity Modulated Radiation Therapy; ART: Adaptive Radiation Therapy; BART: Breathing Adapted Radiation Therapy

ABSTRACT

Vestibular schwannoma (VS), also referred to as acoustic neuroma or acoustic neurinoma comprises a benign intracranial tumor of the internal auricular canal or the cerebellopontine angle which arises from the Schwann cells of the vestibulocochlear nerve. Observation with periodical imaging may be a viable option in selected patients given the typically slow growth rate of VS and availability of advanced neuroimaging techniques allowing for precise monitorization of the growth behavior. Nevertheless, management may be warranted for progressive symptomatic presentation or growing tumors with potential to cause severe consequences. Main modalities for VS management include surgery and radiation therapy (RT) with relatively newer adoption of Stereotactic Radiosurgery (SRS) and Hypofractionated Stereotactic Radiotherapy (HFSRT). In the context of VS radiosurgery, while earlier studies reported lower rates of transient swelling, recent evidence suggests that a considerable proportion of patients receiving radiosurgery for VS may suffer from transient swelling with potential to translate into a temporary clinical deterioration which underscores importance of its consideration as a distinct entity. There is need for further studies addressing transient swelling after VS radiosurgery and related clinical implications. Herein, we address transient volume changes after radio surgical management of VS in light of the literature.

Keywords: Vestibular Schwannoma; Transient Swelling; Stereotactic Radiosurgery; Hypo fractionated Stereotactic Radiation Therapy

Introduction

Vestibular schwannoma (VS), also referred to as acoustic neuroma or acoustic neurinoma comprises a benign intracranial tumor of the internal auricular canal or the cerebellopontine angle which arises from the Schwann cells of the vestibulocochlear nerve, with an increasing incidence thanks to advances in neuroimaging and aging of the population [1]. These benign tumors typically follow an indolent disease course with a slow growth rate, however, compression or occlusion of brainstem, cerebellum and critical neurovascular structures by the tumor may manifest with a plethora of symptoms including unilateral sensorineural hearing loss, tinnitus, dizziness, gait disturbances, facial and trigeminal nerve neuropathies, facial dysesthesia or spasm, vertigo, and hydrocephalus which may lead to profound deterioration of quality

of life in some patients. Observation with periodical imaging may be a viable option in selected patients given the typically slow growth rate of VS and availability of advanced neuroimaging techniques allowing for precise monitorization of the growth behavior [2-5]. Nevertheless, management may be warranted for progressive symptomatic presentation or growing tumors with potential to cause severe consequences. Main modalities for VS management include surgery and radiation therapy (RT) with relatively newer adoption of Stereotactic Radiosurgery (SRS) and Hypofractionated Stereotactic Radiotherapy (HFSRT). These therapies may be used for upfront management or for salvage treatment as an individualized approach. Herein, we address transient volume changes after radio surgical management of VS in light of the literature.

Literature Review Regarding Transient Volume Changes after Radio Surgical Management of VS

While observation may serve as an option for selected VS lesions, increased risk of tumor growth with impaired hearing and deteriorated quality of life may be important considerations for some patients [6-8]. Surgery has been the traditional modality of management for VS which may be utilized for upfront, recurrent or salvage settings [9-11]. Considering the unfavorable toxicity profile associated with complete surgical resection, utility of less extensive surgery with or without subsequent irradiation has been addressed in several trials [12-17]. Despite improvement in surgical techniques over the years, concerns remain regarding quality of life impairment in the postsurgical period for some patients with VS [18-20]. Within this context, radiosurgery as a noninvasive modality has been suggested for VS management to be utilized for several treatment settings including upfront, complementary, or salvage therapy [21-23]. Indeed, since its inception by the Swedish neurosurgeon Lars Leksell, radio surgical applications including SRS, HFSRT, and Stereotactic Body Radiation Therapy (SBRT) have been utilized for focused and precise irradiation of several central nervous system (CNS) disorders as well as tumors throughout the human body with promising treatment results [21-57].

For VS, there is a growing body of literature with high level evidence supporting the utility of SRS and HFSRT as safe and effective treatment modalities for management [21-23, 58-61]. Several comparative studies suggested improved hearing and facial preservation rates along with better quality of life parameters with utilization of radiosurgery [62-64]. Nevertheless, response to radiosurgery in terms of tumor size may be variable particularly in the postintervention period as addressed in several studies [1,65-75]. Transient volume changes during the postradiosurgical period have been referred to as transient expansion, tumor pseudoprogression, and transient tumor enlargement which may occur due to radiation induced swelling with several mechanisms. This may be regarded as a temporary but serious adverse effect which may lead to a temporary worsening of present cranial neuropathies. The unfavorable consequences of transient swelling may be more pronounced in the setting of larger VS, which underscores the need for vigilance in decision making for management of larger VS with meticulous patient selection after thorough consideration of predicted adverse effects of therapeutic modalities.

Avoiding management of large VS lesions with upfront radiosurgery may be a judicious approach given the considerable rates of transient swelling and the risk of exacerbating the consequences of already present mass effect due to large tumor volume. In a study by Oyama et al. assessing early changes in volume of acoustic neurinomas after radiosurgery, lesion volumes had a tendency for growing slightly at 6 months following

radiosurgery and then to shrink to approximately identical volumes at 9 months[65]. Nagano et al. prospectively evaluated volumetric changes in VS after SRS [66]. A total of 100 consecutive patients with unilateral VS were included and mean observation period was 65 months [66]. Lesion volumes increased by 23% at 3 months, and 27% at 6 months, then shrinking to initial size over a mean period of 1 year [66]. Maximum volumetric increase was less than 10% in 26 patients, in the range of 10% to 30% in 23 patients, in the range of 30% to 50% in 22 patients, in the range of 50% to 100% in 16 patients, and more than 100% in 13 patients which was found to be in association with cranial nerve dysfunction [66].

Meijer et al. defined the term "transient swelling" as a tumor volume shrinkage to a volume smaller than the pretreatment volume preceded by a tumor volume enlargement [67]. They identified 45 patients receiving radiosurgery with a mean follow up duration of 50 months [67]. At the last follow up neuroimaging with MRI, calculated volumes were smaller in 37 (82.2%) out of the 45 assessed patients [67]. Out of these 37 lesions, 11 lesions (29.7%) demonstrated transient swelling prior to shrinkage [67]. The authors emphasized the importance of optimal scheduling of follow up MRI for avoiding unnecessary interventions [67]. In the study by Aoyama et al. assessing symptomatic outcomes with regard to tumor expansion following fractionated stereotactic RT of VS, postirradiation tumor expansion was observed in 21% of patients which was associated with an elevated risk of serviceable hearing loss, worsening of facial and trigeminal nerve functionality [68]. In the study by Hathout et al., rate of transient volume increase with a median time to tumor enlargement of 5.5 months in VS lesions was 25% following RT which was found to be in association with elevated rates of facial and trigeminal neuropathies [69].

In the study by Hayhurst and Zadeh assessing tumor pseudoprogression after radiosurgery for VS, rate of pseudoprogression was found to be 23% with the onset of enlargement at 6 months and regression typically by 2 years, without an association between transient tumor growth and clinical worsening [70]. In this context, the authors suggested that pseudoprogression should be expected and not considered as treatment failure [70].

In the study by Mohammed et al. evaluating pseudoprogression of VS lesions following fractionated stereotactic RT, neuroimaging with MRI revealed pseudoprogression in one third of patients occurring within 3 years of the postirradiation period before regression [71]. The authors emphasized the importance of repeated imaging and vigilant clinical follow up to exclude pseudoprogression so as to avoid unnecessary therapeutic interventions [71]. In a study by Mindermann and Schlegel addressing discrimination between tumor growth and transient expansion of VS after radiosurgery, the authors suggested that time could serve as a good parameter to distinguish between tumor growth from transient expansion of VS after radiosurgery [72].

The authors reported that transient expansion of VS frequently occurs at 6 to 18 months after radiosurgery whereas tumor growth seems to develop approximately at 3-4 years [72]. In a comprehensive analysis of MRI volumetric changes following HFSRT for benign intracranial neoplasms, Fega et al. reported that transient volume expansion was a frequent finding after HFSRT of VS which was in association with temporary adverse effects [73]. The authors reported an overall 15% discordance rate regarding the neuroradiologist interpretation and volumetric MRI measurements, which underscores importance of incorporating volumetric measurements as part of detailed assessments to aid in decision making [73]. In a study by Yardımcı et al. assessing volumetric and morphological changes in VS after radiosurgery, transient swelling was observed in 18 patients (46%) out of the total 39 patients, with the transient swelling rate being significantly higher in cystic VS lesions as compared to solid VS lesions [74]. In a study by Langenhuizen et al. regarding prediction of transient tumor enlargement by use of MRI tumor texture following radiosurgery of VS, it has been suggested that MRI tumor texture could provide data for prediction of transient tumor enlargement [75]. The authors emphasized that the proposed predictive model could allow for individualized treatment selection for VS to improve overall therapeutic outcomes [75].

Conclusion and Future Perspectives

There have been unprecedented breakthroughs in the discipline of radiation oncology in the millennium era leading to significant paradigm shifts with increased adoption of contemporary RT technologies including Image Guided Radiation Therapy (IGRT), Intensity Modulated Radiation Therapy (IMRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation Therapy (BART) as well as radio surgical applications such as SRS, SBRT, and HFSRT [76-84]. In the context of VS radiosurgery, while earlier studies reported lower rates of transient swelling, recent evidence suggests that a considerable proportion of patients receiving radiosurgery for VS may suffer from transient swelling with potential to translate into a temporary clinical deterioration which underscores importance of its consideration as a distinct entity. There is need for further studies addressing transient swelling after VS radiosurgery and related clinical implications.

Conflicts of Interest

There are no conflicts of interest and no acknowledgements.

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