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Case study

Leksell Gamma Knife® radiosurgery for vestibular schwannoma

Case

Vestibular schwannoma

Contributors

Giorgio Spatola, MD Phd; Lodoviga Giudice, MD; Karol Migliorati, MD; and Alberto Franzin, MD, Department of Neurosurgery;

Chiara Bassetti, Physicist, Department of Medical Physics;

Mario Bignardi, MD, Department of Radiation Oncology

Institution

Istituto Ospedaliero Fondazione Poliambulanza, Brescia, Italy

Overview

Accounting for 5% of all intracranial tumors, vestibular schwannomas are slow growing benign tumors that originate from the Schwann cells in the vestibulocochlear nerve division[1]. Leksell Gamma Knife radiosurgery is one of several treatment options for patients with vestibular schwannomas, the others being continuous observation and surgery[1,2]. Gamma Knife radiosurgery has been shown to be an effective treatment for vestibular schwannoma, providing favorable outcomes, good tumor control rates, and a high level of safety[1]. Following Gamma Knife radiosurgery, patients treated for vestibular schwannomas are reported to maintain a good long-term quality of life, very similar to the normal population[2].

In this case, a 55-year-old male patient (58 at time of treatment) presented with a three-year history of tinnitus and hypoacusia in the right ear but otherwise normal neurological status. With loss of stereo sound, he had difficulty hearing well in crowded places and could not distinguish where sounds came from in such situations.

Examination provided audiometry evidence of neurosensorial hearing loss (grade III) with medial averaged decibel loss of 68.75. Subsequent MRI investigation, with and without contrast, revealed a right-sided Koo grade 3 vestibular schwannoma (figure 1). Prior to treatment, the patient scored 95/100 on the EuroQol quality of life scale.

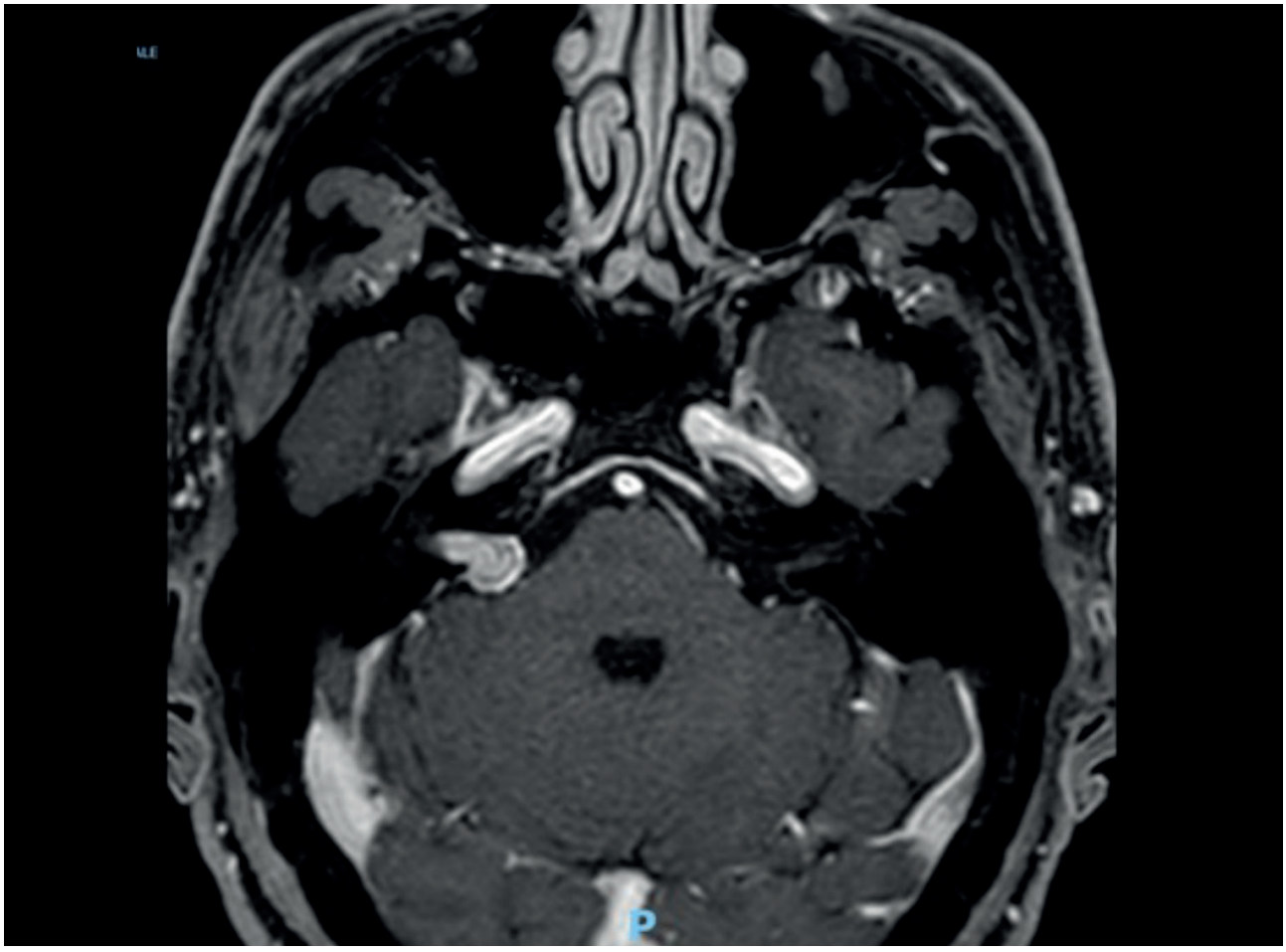

Figure 1.

MRI revealed a right-sided Koo grade 3 vestibular schwannoma

Rationale for Gamma Knife radiosurgery

Gamma Knife radiosurgery was proposed because of the hearing loss and evidence of clinical deterioration. This was deemed the best treatment option for this patient due to the size and location of the target, as well as the patient preference. The use of Gamma Knife radiosurgery avoids the risks of bleeding and infection, as well as the need for wound care, associated with surgery. The risk of facial palsy is also lower with radiosurgery compared to surgery (0.5% versus 2–3%)[3].

MRI at the time of Gamma Knife treatment demonstrated further tumor growth. In 2018, there was a distance of 2 mm between the tumor and the right cerebellar peduncle and by 2019, due to a slight increase in tumor size, it touched the right cerebellar peduncle.

Treatment protocol

The patient was immobilized using the Leksell Coordinate Frame G. Planning MRI images were obtained using FIESTA 3D sequences and 3D T_1 contrast enhanced sequences (figure 2). Planning was performed manually using Leksell GammaPlan® version 11.2. Challenges for this treatment, as for all vestibular schwannomas, included: preserving the facial nerve (cranial nerve [CN] VII); sparing the modiulus; and sparing the brainstem.

Patients treated for vestibular schwannoma using Gamma Knife radiosurgery at this center are treated using a single fraction, following ISRS guidelines[4]. Our normal approach is to avoid 16 mm shots, and to have the highest weighted shot outside the auditory canal, if possible, and as far from the CN VII as possible. No shots should be >50% outside the target and there should be no hotspots of >90% dose inside the auditory canal. Doses higher than 12 Gy to 10 mm^3 of brainstem are to be avoided, and dose to the modiolus should be less than 6 Gy.

A prescription dose of 13 Gy at 50% isodose was used. We tried to spare the modiolus, despite evidence of dysfunctional hearing on the right side. Organs at risk (OAR) doses were 10.8 Gy to 0.010 cm^3 of the brainstem and 3.6 Gy to the modiolus. The G frame was fixed with a ring at 4 cm lower than the external auditory canal. The gantry was at 90°.

Thanks to mild sedation, and a local anesthesia for fitting of the headframe, the patient tolerated the treatment extremely well and was able to return home the same day, after a three-to-four-hour period of observation.

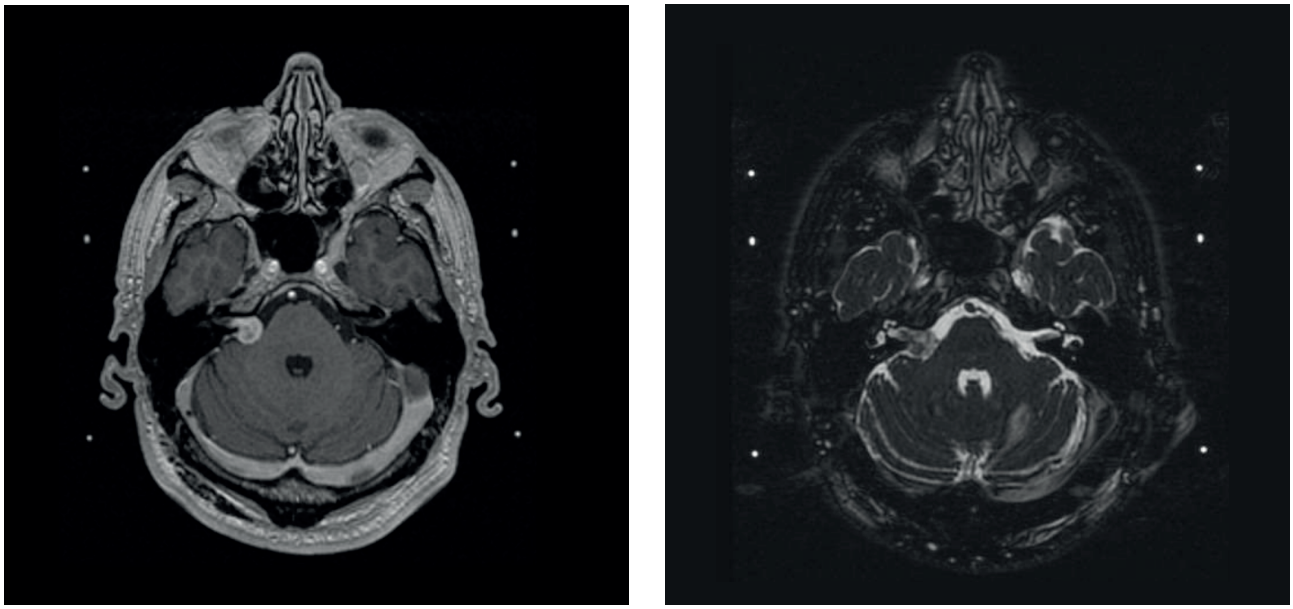

Figure 2.

MRI planning images. Left: 3D T1 axial image with contrast. Right: FIESTA axial image.

Results

At four years and three months after Gamma Knife radiosurgery, the patient is neurologically unchanged with no CN VII deficit. The patient's tinnitus has improved and hearing loss remains unchanged (grade III; 70 decibel loss on average).

Good tumor growth control was achieved for this patient with Gamma Knife radiosurgery. Tumor volume reduced from 1.008 cm^3 prior to treatment in 2018 to 0.272 cm^3 in 2023, four years and three months post-treatment (figure 3). Following treatment, the patient now scores 98/100 on the EuroQol quality of life scale. He continues to use his mobile phone on the right side, but whether this is due to osseous transmission or minimal hearing preservation on the right side is unclear.

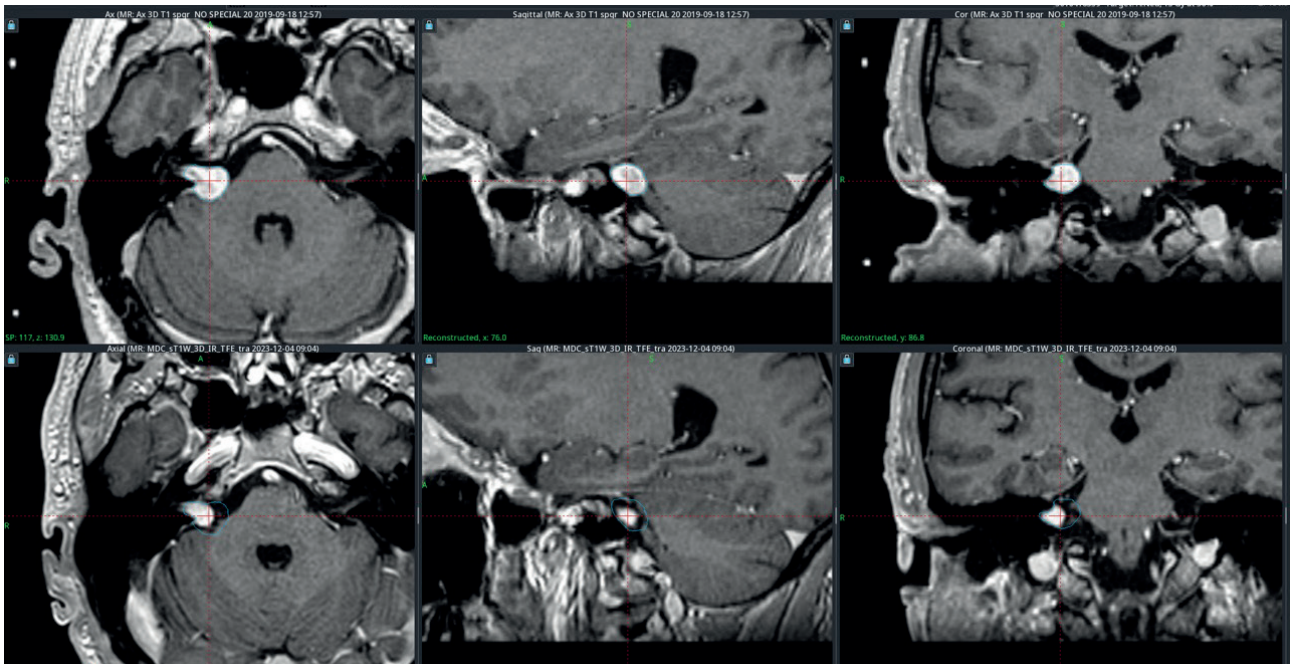

Figure 2.

MRI of the right-sided vestibular schwannoma demonstrates a reduction in size following Gamma Knife radiosurgery: from 1.008 cm^3 in 2018 (pretreatment – top) to 0.272 cm^3 in 2023 (post-treatment – bottom).

Conclusions

Gamma Knife radiosurgery is a noninvasive treatment that demonstrates at least as good tumor control and hearing preservation compared to microsurgery, but with reduced treatment-related adverse effects[4].

Gamma Knife radiosurgery proved to be a good option for this patient, controlling tumor growth (in fact reducing tumor size) with no deterioration of symptoms. The excellent conformation of dose to the tumor that was achieved with Gamma Knife enabled preservation of the facial nerve. The patient was very happy with the outcome.

This case demonstrates that Gamma Knife radiosurgery, performed at the correct time (i.e. the vestibular schwannoma is not too large and not causing significant compression on the brainstem), can achieve excellent results without complications. The principles of Gamma Knife radiosurgery, with excellent dose conformity and fall off, help to avoid dose to organs at risk, while frame fixation ensures that the treatment is stereotactically precise. In addition, the anatomical knowledge and microsurgical expertise of the neurosurgeon helps to ensure preservation of the CN VII, even when the nerve is not perfectly recognizable on the MRI, thus avoiding facial palsy.

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Elekta AB
Box 7593
SE-103 93
Stockholm, Sweden
T +46 8 587 254 00

Turkey, India, Middle East, Africa
T +90 216 4743500

North America
T +1 770 300 9725

Latin America, South America
T +55 11 5054 4550

Asia Pacific
T +65 6221 2322

Japan
T +81 3 6722 3808

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T +86 10 5669 2800

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