Radiosurgery for Intracranial Meningiomas, Chilean Gamma Knife Experience

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Abstract

Introduction: Intracranial meningiomas (IM) represent the most prevalent primary central nervous system (CNS) tumors in adults, with an incidence rate ranging from 8.58 to 9.15 cases per 100,000 individuals. Small and medium-sized IM treatment standard options encompass radical surgery; however, this may not always be feasible due to surgical risks and patient preferences. In contrast, SRS stands out as an effective tool for managing tumor growth and alleviating symptoms. This holds particular significance in countries with long surgical waitlists, providing a cost-effective and low complication alternative.

Method: This is a retrospective, single-center study involving 201 consecutive patients managed with GKRS for IM from 2011 to 2023. In the other Clínica Dávila Gamma Center in Chile. other series of patients were also included from 2014 to 2023. All data were collected in a prospective registry from the clinical patients records and then analyzed retrospectively. From this consecutive cohort, only 43 patients were selected for further analyses that had macroscopic tumors on baseline MRI, and additional post-SRS follow-up MRI with volumetric calculation. In the procedure room and under local anesthesia, patients underwent placement of a Leksell stereotactic frame. Stereotactic brain CT scanning was then obtained and fused in the Leksell Gamma Plan. with the preoperative, thin slice (1 mm) axial, and coronal pre- and post-contrast administration brain MRI for treatment planning. The radiosurgical plan was formulated by the treating neurosurgeon in conjunction with a medical physicist. All patients were treated in an ambulatory setting with single-session SRS using the Leksell Gamma Knife 4C (Elekta Instruments AB) in Centro Gamma knife and the Leksell Gamma Knife perfection in Clínica Dávila . A medial marginal dose of 12.8 Gy (range from 12 to 15 Gy) was delivered in a single session with a median prescription isodose line of 48.3% (range from 35 to 60%) Routine clinical and radiologic follow-up was obtained at approximately 6-month intervals following GKRS. Tumor volumes were calculated on T1 post-contrast MRI sequences. Tumor stability (i.e., tumor control) was defined according to the RANO criteria. Statistical analyses were performed with GraphPad Prism 9 and IBM SPSS statistics. For all statistical tests, a p-value of <0.05 was considered as statistically significant. Change in meningioma volume at last brain MRI was compared to the pre-GKRS MRI before SRS. A total of 70% were skull base meningioma, and 30% were non-skull base meningioma. Only one patient from the non-skull base IM presented transient edema as a complication of SRS (2.3%).

Results: Our results showed that there is a statistically significant tumor volume reduction in the skull base IM group (mean initial volume: 5.32 cm3/last follow-up volume: 4.34 cm3). This tendency was not evident in the non-skull base group (mean initial volume: 5.78 cm3/last follow-up volume: 5.36 cm3). Also, at the volumetric follow-up, all the patients at least achieved a stable disease according to RANO, as shown in Figure B. The mean tumor volume change at 24 months post SRS was −10,6 and −23,9% for non-SB and SB meningiomas, respectively.

Discussion: Our small series shows similar results to the literature (as shown in this review). To our knowledge, this is the first Chilean report of IM patients' outcomes with GK SRS. All the patients were managed in an ambulatory setting. In our series, there was a low incidence of SRS-related compilations. The long-term outcomes were satisfactory because all the samples achieved at least a stable disease stage. This means that the radiosurgical procedure could achieve tumor control. Interestingly, the skull base group showed a

statistically significant tumor volume reduction, as well as other reported series. Of the collected cases, the most common IM treated with GK SRS was skull base IM. Among these, more than 50% were tentorial, cerebellopontine angle, and petroclival meningiomas. The posterior fossa tumors are located in a critical region considering the presence of the brainstem, and in close relation with cranial nerves and vertebrobasilar circulation. Moreover, IM surgery is associated with more complications which may explain why SRS is preferred for skull base compared to non-skull base IM. From an economic perspective, several reports have revealed that SRS treatment is less expensive than microsurgery. The Dutch study of Tan et al. demonstrated that initial treatment cost is about five times higher for microsurgery ($12,288 euros) compared to SRS ($1547 euros for LINAC radiosurgery and $2412 euros for GK radiosurgery). For this reason, our attention is directed toward SRS as an economically viable treatment option within the domain of public health and neurosurgery. By prioritizing SRS, we aim to adopt a therapeutic approach that not only proves effective in addressing health issues but also demonstrates cost-effectiveness on a larger scale and well-being of individuals

Conclusions: In conclusion, primary SRS emerges as a safe and valuable therapeutic option for addressing small to medium-sized symptomatic intracranial meningiomas. It boasts a high degree of tumor control while maintaining low complication rates and ensuring favorable long-term functional outcomes. It is indicated in tumors classified as WHO grade I IM that cannot be resected without important morbidity and mortality, in patients that are poor surgical candidates or by patient preferences with delayed and low radiotoxicity. Also, SRS can be used as adjuvant therapy in gross total and subtotal resection as well as recurrent small IM. There are several limitations of this study, first, it is a retrospective case series of two-center experience. Also, there is a low consecutive follow-up of patients that diminished our sample size of collected cases. Furthermore, as an ambulatory therapy from epidemiological point of view, it has a place in resolving the surgical waiting list that is long, especially in countries with less neurosurgical facilities with a safe and low toxicity technique.

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