Elekta

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETO LIGONINĖ
KAUNO KLINIKOS

Customer Perspective

Adaptive Gamma Knife radiosurgery in the treatment of large brain metastases

Gamma Knife Center

The Lithuanian University of Health Sciences Hospital, Kauno Klinikos

The Lithuanian University of Health Sciences Hospital, Kauno Klinikos, is the largest and one of the most prominent hospitals in Lithuania, dedicated to providing high quality healthcare to patients from all over the country and abroad.

The hospital's Gamma Knife Center is the first and only such facility in the Baltic states and has been providing stereotactic radiosurgery (SRS) services since 2019. The majority of the center's Gamma Knife patients come from Lithuania, but they have also seen patients from Ukraine and Latvia. The center treats around 400–450 patients per year for a wide range of indications, including malignant tumors (50%), benign tumors (28%), functional disorders (20%), ocular cases 1%, vascular pathology 1%.

Andrius Radziunas

Neurosurgeon,
Head of Functional Neurosurgery and the Gamma Knife Center

Location

Kaunas, Lithuania

Adaptive Gamma Knife radiosurgery

> "Thanks to the good patient outcomes we have experienced following volume adaptive radiosurgery, we are now receiving more referrals for Gamma Knife radiosurgery to treat large brain metastases."

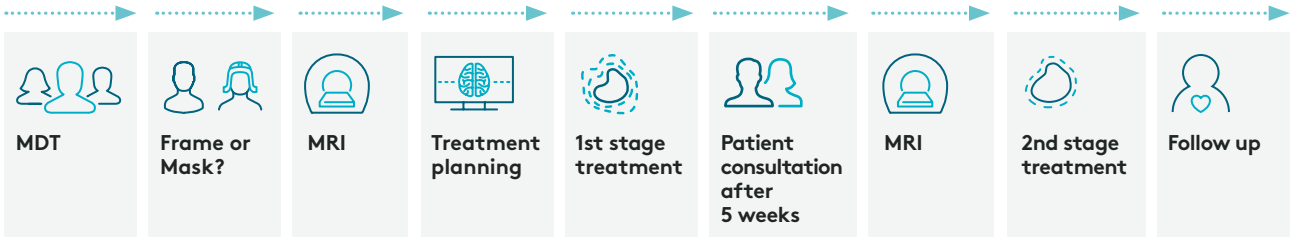
Since 2020, the Kauno Klinikos Gamma Knife Center has been using a volume adaptive SRS approach for the treatment of large brain metastases, or metastases in eloquent areas of the brain.

Open surgery is not always feasible to remove large brain metastases (>8–10 cc), due to the location or number of metastases present[1]. Radiation treatment modalities, such as SRS, are often considered for inoperable metastases. However, large tumors are challenging to treat using single fraction SRS due to difficulties in safely delivering sufficient dose to the target while sparing healthy brain tissue[2]. For such lesions, evidence suggests that hypofractionated or volume adaptive SRS may offer an alternative effective treatment option[1-5], demonstrating higher rates of local tumor control and reduced rates of neurotoxicity compared to single fraction SRS[2].

The principle of volume adaptive SRS is to divide the total prescription dose into two or more smaller fractions, with the delivery of each fraction separated by a number of days or weeks[1-5]. Not only does this enable healthy tissue to recover between doses[2], but it also allows the treatment plan to be adapted before each stage of the treatment to account for any changes to the tumor volume, such as shrinkage, which has been reported between hypofractionated Gamma Knife treatment sessions[2,3,5]. This volume adaptive SRS approach ensures accurate dose delivery to the tumor while minimizing the dose burden to surrounding brain tissue and critical structures. As a result, it is well tolerated with minimal adverse side effects[4].

"It is well known that single fraction radiosurgery for large brain lesions may lead to severe neurotoxicity, especially in eloquent regions of the brain, due to volumetric and regional constraints," comments Dr Andrius Radziunas, neurosurgeon at Kauno Klinikos. "In the past, there was little to offer such patients as an alternative. If open surgery wasn't feasible, they were referred for whole brain radiation therapy."

The adaptive approach workflow



Pre-treatment

MDT

At Kauno Klinikos, every patient with an intracranial lesion is discussed by the brain tumor multidisciplinary team (MDT) in order to determine the most suitable treatment approach for each individual case.

Consent

Then, on sharing the appropriate information and options with the patient and their family, the final decision to proceed is theirs. If it is decided to proceed with volume adaptive Gamma Knife radiosurgery, the first treatment session is scheduled within two weeks.

First treatment session

Mask or frame?

If the first treatment session is expected to last less than 1 hour, then mask-based delivery is offered. Otherwise, frame-based immobilization is used.

Imaging

On the day of treatment, the patient is admitted to the neurosurgery department and a pre-treatment MRI scan with double gadolinium enhancement is obtained.

Treatment planning

The treatment plan is prepared by the neurosurgeon and a medical physicist. Usually, 15Gy/50% isodose is prescribed for all lesions.

Treatment

After final plan approval, the patient is transferred to the Gamma Knife unit for treatment delivery. Following treatment, the patient returns to the ward and is discharged after several hours.

Second treatment session

Patient assessment

Five weeks later, the patient is again admitted to the neurosurgery department for complete patient condition evaluation, and clinical information is recorded.

Imaging, planning and treatment

The steps described for the first treatment session are repeated. Following brain MRI, the treatment plan is adapted to the new target volume, with 100% coverage of the 15Gy/50% isodose line.

Advantages of an adaptive approach

"The most significant advantage of using an adaptive Gamma Knife radiosurgery approach when treating very large lesions is reduced radiation to healthy brain, but still with an excellent therapeutic response," says Dr Radziunas. "Moreover, we noted that radioresistant metastases from skin melanoma or renal cell cancer respond well to a classical single-treatment approach for smaller lesions."

> "Using this approach allows us to treat more patients who might otherwise have very limited options."

"It means radiosurgery can be offered to challenging cases when open surgery is too complicated or risky. For example, we recently treated a young 32-year-old woman with breast ductal carcinoma who had a very large metastasis in the thalamus, without neurological deficit.

Following a difficult discussion with the patient and other doctors, it was decided to avoid open surgery and use a volume adaptive Gamma Knife radiosurgery approach. Five weeks after her first treatment, when she returned for the second treatment, there was already a 70% tumor volume reduction with no adverse reactions. Such an example illustrates well how this approach has expanded the patient base at our Gamma Knife center."

"We have also noted that the volume adaptive approach is suitable for large metastases with significant surrounding brain edema," he adds.

> "Such patients need fewer steroids after treatment or can even avoid them completely."

Case Study

A 46-year-old female patient with a two-year history of infiltrative ductal breast carcinoma treatment presented with headache and gait disturbance. Brain MRI revealed two metastases in the left and right cerebellum (figure 1). The left cerebellum metastasis was removed surgically with post-operative, hypofractionated radiosurgery to the cavity one week after open surgery. Due to the large volume of the right cerebellum metastasis, it was treated using volume adaptive Gamma Knife radiosurgery.

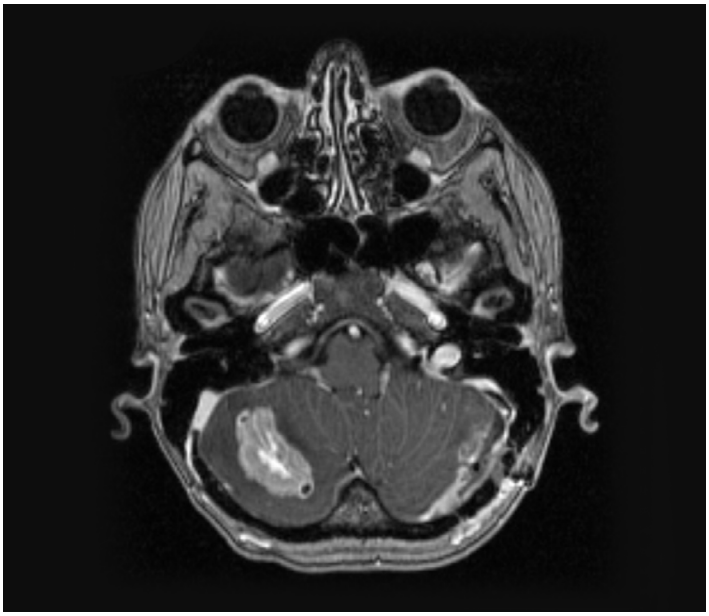


Figure 1.
Due to the large volume of the right cerebellum metastasis, it was treated using volume adaptive Gamma Knife radiosurgery.

The main challenges in this case were the large volume of the metastasis and peritumoral brain edema in the posterior fossa due to compression to the brain stem and fourth ventricle. Single fraction radiosurgery would result in an increased dose to healthy brain tissue, potentially causing further peritumoral edema, obstruction to CSF flow, and a worsening of the patient's condition.

Adaptive Gamma Knife radiosurgery was delivered in two fractions, each delivering 15 Gy to the 50% isodose line five weeks apart. This led to a decrease in metastasis volume of 55.8% at the second stage, with reduced risk of brain edema. The plan was adapted to the reduced tumor volume before delivery of the second fraction. By six months post second treatment, the metastasis was no longer evident by MRI. Patient symptoms diminished and no recurrence was observed in one year of MRI control (figure 2, table 1).

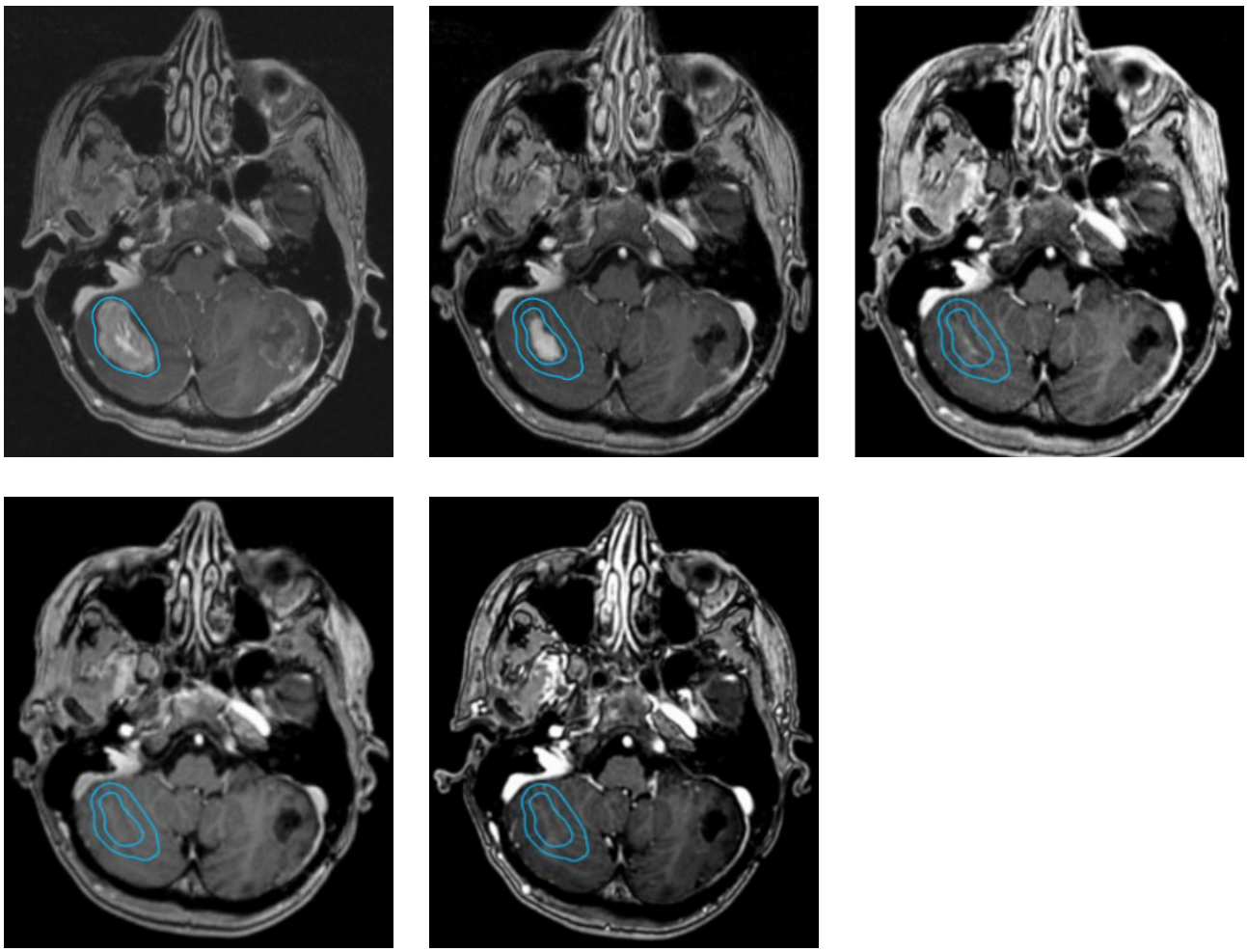


Figure 2.

MRI scans showing right cerebellum metastasis at (from left to right) first fraction, second fraction, three month follow up, 6 follow up and 12 month follow up.

	Stage 1 SRS	Stage 2 SRS	3 month follow up	6 month follow up	12 month follow up
Tumor volume (CC)	8.085	3.572	0.1	0	0
Decrease in tumor volume (%)	0	55.8	97.2	100	100

Table 1.

Reduction of right cerebellum metastasis during, and up to 12 months after, volume adaptive Gamma Knife radiosurgery.

A valuable treatment option

Adaptive Gamma Knife radiosurgery has become an important treatment option for the management of large inoperable brain metastases at the Kauno Klinikos Gamma Knife Center.

"The adaptive approach has allowed us to increase our patient base, and to improve functional outcomes for difficult-to-manage patients since they can avoid open surgery with its many possible complications," comments Dr Radziunas.

"Going forward, we need more data about the long-term efficacy of this approach for different brain metastasis histologies," he adds. "We know that breast cancer metastases respond well, even to smaller dose irradiation, and so 12-13 Gy at the first session might be considered for lesions >30 cc, with higher doses at the second treatment. Radiological and immunogenetic data analysis with radiogenomics would help to better differentiate patients who are most likely to respond to the volume adaptive approach."

References

1. Adaptive hypofractionated gamma knife radiosurgery in the acute management of large thymic carcinoma brain metastases. Surg Neurol Int. 2017; 8: 95. Sinclair G, Martin H, Fagerlund M, Samadi A, Benmakhlouf H, Doodo E.
2. Two-staged stereotactic radiosurgery for the treatment of large brain metastases: Single institution experience and review of literature. Jour. of Radiosurgery and SBRT. 2020; 7: 105-114. Ginalis EE, Cui T, Weiner J, Nie K and Danish S.
3. Adaptive hypofractionated gamma knife radiosurgery for a large brainstem metasta¬sis. Surg Neurol Int. 2016; 7: S130-8. Sinclair G, Bartek J Jr, Martin H, Barsoum P, Dodoo E. doi:10.4103/2152-7806.176138.
4. Dose-staged Gamma Knife radiosurgery for meningiomas: A retrospective study in a single center. Front. Neurol. 2022; 13: 893480. Gong X, Ding J, Knisely JPS, Wang E, Pan L, Wang B, Zhang N, Wu H, Dai J, Yu T and Tang X. doi:10.3389/fneur.2022.893480.
5. Impact of 2-staged stereotactic radiosurgery for treatment of brain metastases ≥ 2 cm. J Neurosurg. 2018 Aug;129(2):366-382.Angelov L, Mohammadi AM, Bennett EE, Abbassy M, Elson P, Chao ST, Montgomery JS, Habboub G, Vogelbaum MA, Suh JH, Murphy ES, Ahluwalia MS, Nagel SJ, Barnett GH. doi: 10.3171/2017.3.JNS162532.

Elekta

We don’t just build technology, **we build hope.**

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

China
T +86 10 5669 2800

For further information please contact your local Elekta office.
Details can be found at **elekta.com/offices**

elekta.com **/elekta**

@elekta **/company/elekta**

elekta.com

LLFNX230421 © 2023 The Elekta Group. All rights reserved.