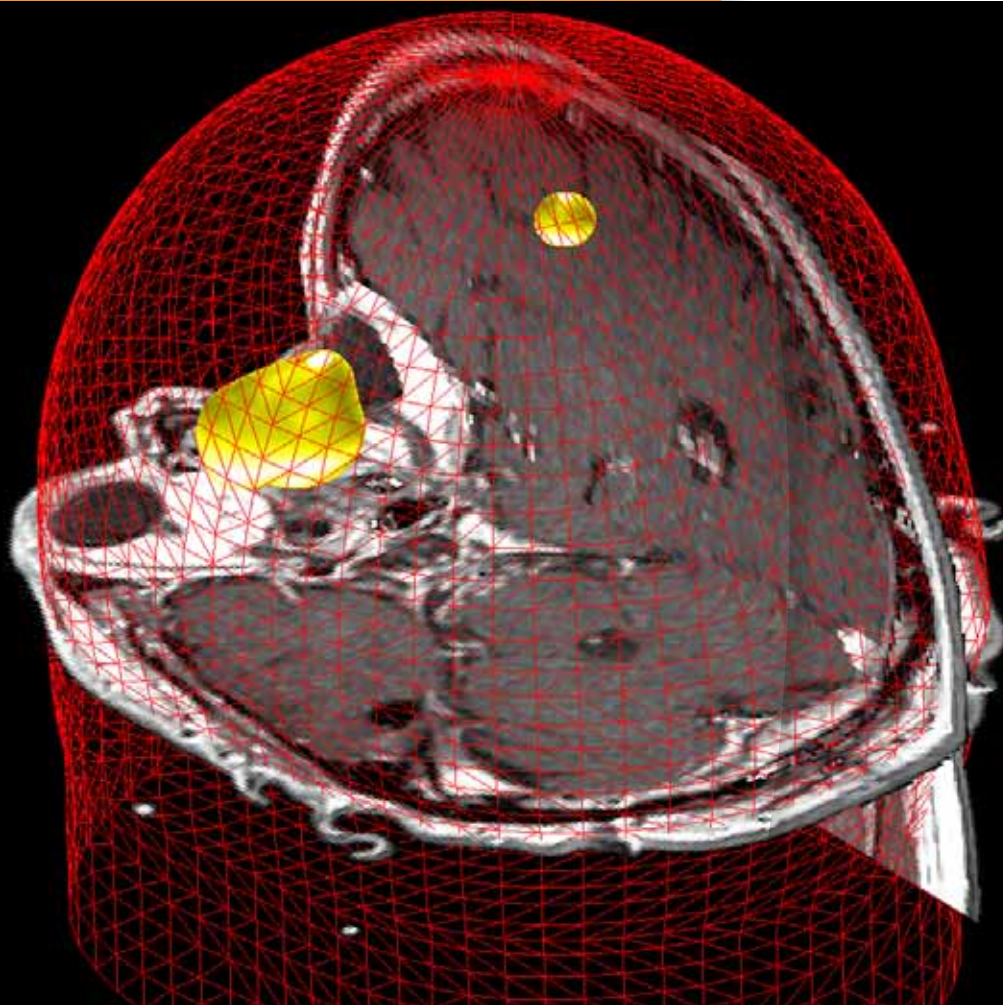


# Radiosurgery of multiple brain metastases using Leksell Gamma Knife® Perfexion™



## **Institution**

Hospital Na Homolce, Prague, Czech Republic

## **Patient 1**

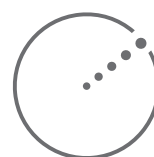
63-year-old male, diagnosis – kidney cancer, multiple brain metastases

## **Patient 2**

48-year-old male, diagnosis – lung cancer, multiple brain metastases

## **Treatment**

Repeated Leksell Gamma Knife radiosurgery



**ELEKTA**



- Neurosurgeon:** Roman Liščák, M.D., Ph.D.  
Associate professor of neurosurgery in the 3<sup>rd</sup> Faculty of Medicine, Charles University and head of the Stereotactic and Radiation Department at Na Homolce Hospital
- Radiation Oncologist:** Gabriela Šimonová, M.D., Ph.D.
- Medical Physicist:** Josef Novotný, Ph.D.

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## Radiosurgery of multiple brain metastases using Leksell Gamma Knife® Perfexion™

### Repeated Leksell Gamma Knife® Radiosurgery

Leksell Gamma Knife® Perfexion™ with its enlarged space inside the collimator helmet allows unlimited reach to all multiple brain metastases with standard attachment of the stereotactic frame (positioned low and centered on the midline of the head) in one session. In cases where new brain metastases are detected, radiosurgery can be repeated. Leksell GammaPlan® allows the import of previous treatment plans, their co-registration with current images and superimposition of old treatment plans on them. This planning feature makes it easy to identify new brain metastases unequivocally and evaluate regression of previously treated ones at a glance.

### Patient 1

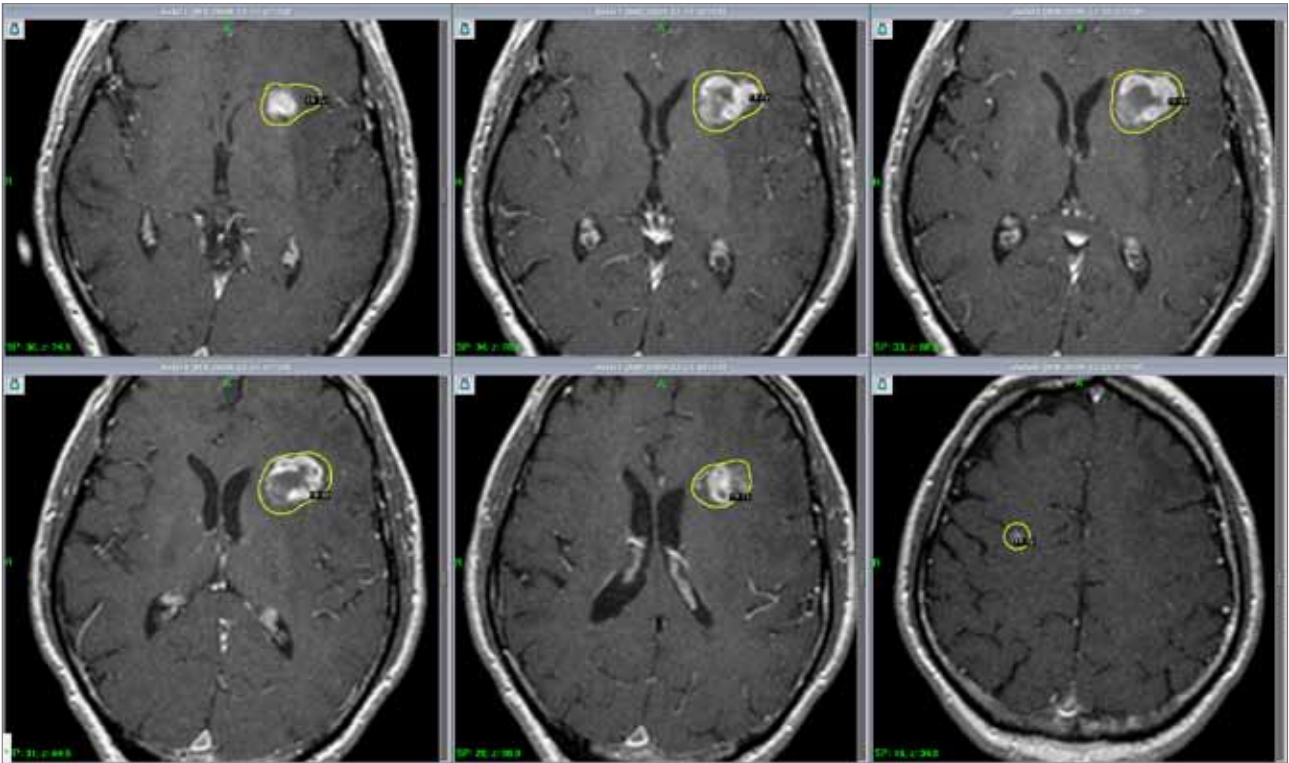
#### Diagnosis and History

This 63-year-old male underwent nephrectomy for cancer of the kidney 10 months ago. An MRI scan was performed for sudden onset of dysphasia and right sided hemi-paresis, this revealed two brain metastases with collateral edema - in the parietal lobe on the right and frontal lobe on the left. The patient was referred to neurosurgery for open surgery, but because of the presence of multiple brain lesions and suspicion of a metastasis in the lung, the less invasive treatment method was chosen. Dr. Roman Liščák, was contacted to consider Leksell Gamma Knife radiosurgery. The patient was informed about all treatment options including the effects of fractionated radiation therapy in this relatively radio-resistant cancer and the risks of general anesthesia with regards to his lung metastases from kidney cancer. The patient decided for gamma knife radiosurgery. At the time of treatment the neurological symptoms of the patient, thanks to corticotherapy, improved and the Karnofsky score was 90%.

#### Treatment

The treatment was performed in December 2009 using Leksell Gamma Knife® Perfexion™. The frame was attached to the head under local anesthesia and stereotactic magnetic resonance imaging detected two metastases (see figures 1a and 1b). The frontal metastasis on the left had a diameter of 26,24,22 mm, volume 6.8 cm<sup>3</sup> and a dose of 19 Gy to 50% isodose level was prescribed (11 isocenters using 16 mm and 8 mm collimators were used). The smaller metastasis on the right had a diameter of 6 mm (volume 0.17cm<sup>3</sup>) and the same dose was prescribed (single isocenter and 8 mm collimator was used to cover this metastasis). The beam on time was 35 min and the treatment was completed without interruption. The patient continued with antiedematic corticotherapy for several weeks after the radiosurgery.

(1a)



(1b)

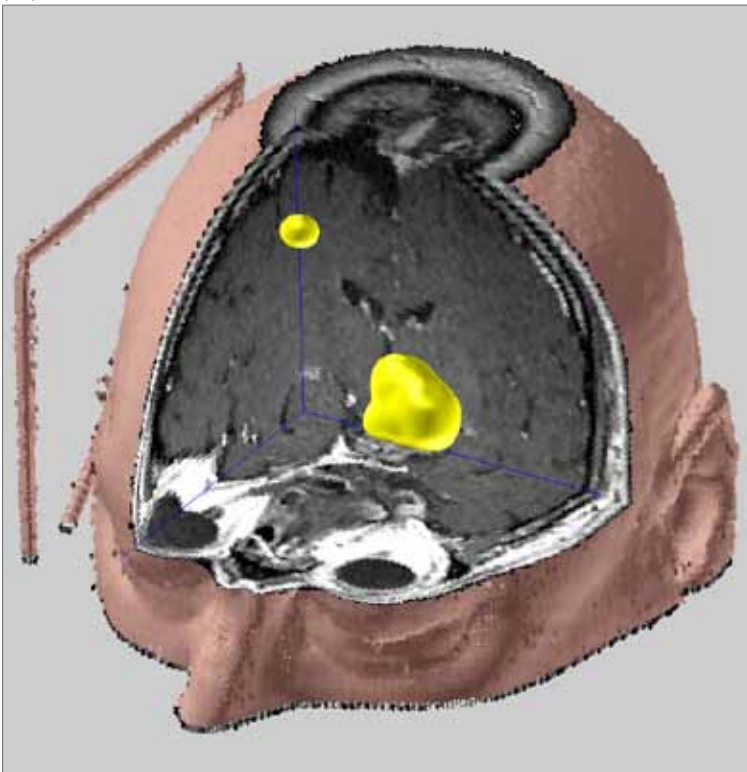
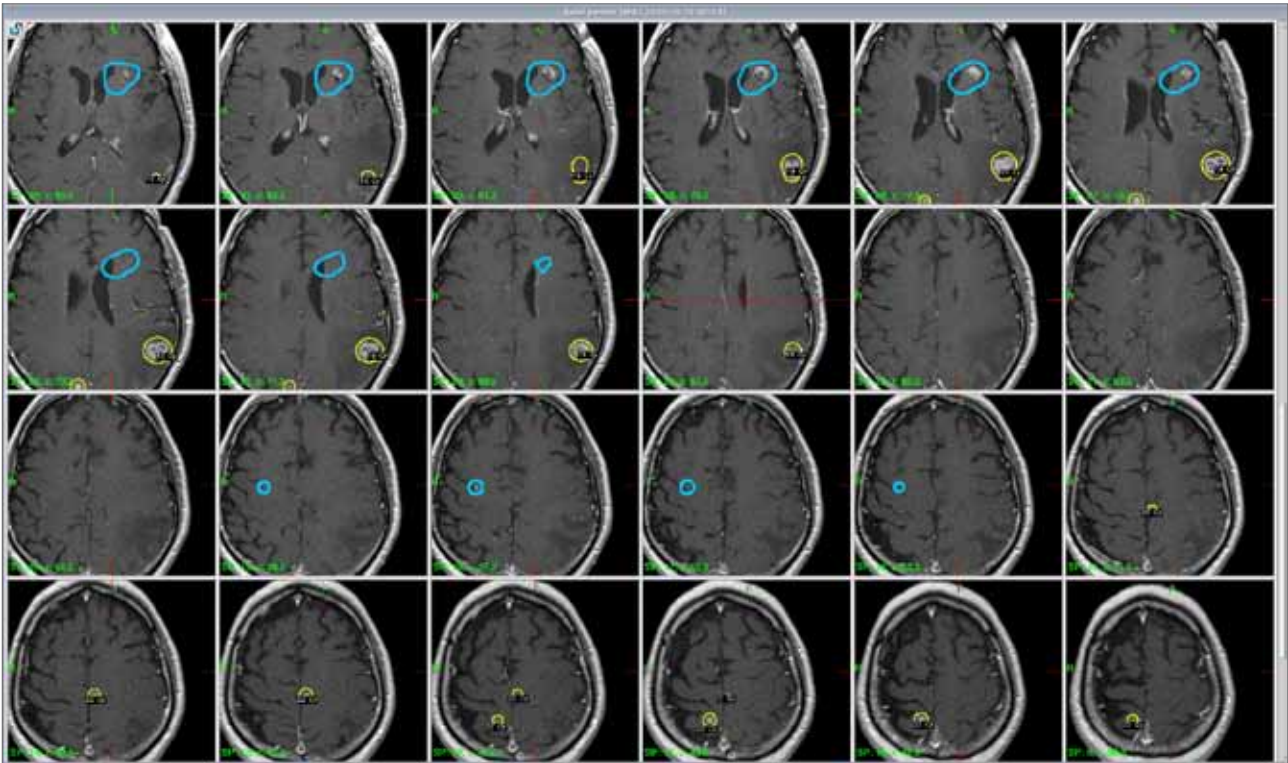


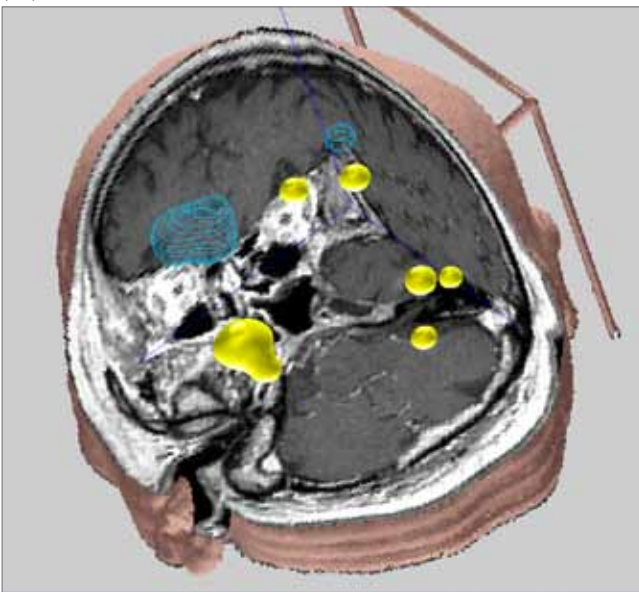
Figure 1. 63-year-old male with two brain metastases from kidney cancer, yellow line represents the dose 19 Gy to 50% isodose

Five months later the patient was hospitalized at the neurological department with an episode of generalized epileptic seizure. MRI revealed 6 new brain metastases, the two metastases treated previously had regressed (see figure 2). Besides the epileptic seizure there were no new neurological symptoms and repeated gamma knife radiosurgery was recommended and performed in May 2010. The treatment was performed on an out-patient basis. The old treatment plan was coregistered to the new stereotactic MR images (see figures 2a, 2b and 2c). The diameter of the new brain metastases varied from 3 to 16 mm and the cumulative volume of all metastases was 3.02cm<sup>3</sup>. The dose prescribed to the smallest metastases (volume 0.08cm<sup>3</sup>) was 24 Gy to the 80% isodose level and for the biggest (volume 2.2cm<sup>3</sup>) it was 19 Gy to 50% isodose level. The treatment was performed in two runs using a 90° and 110° gamma angle and the total beam on time was 61.5 min using 7 isocenters.

(2a)



(2b)



(2c)

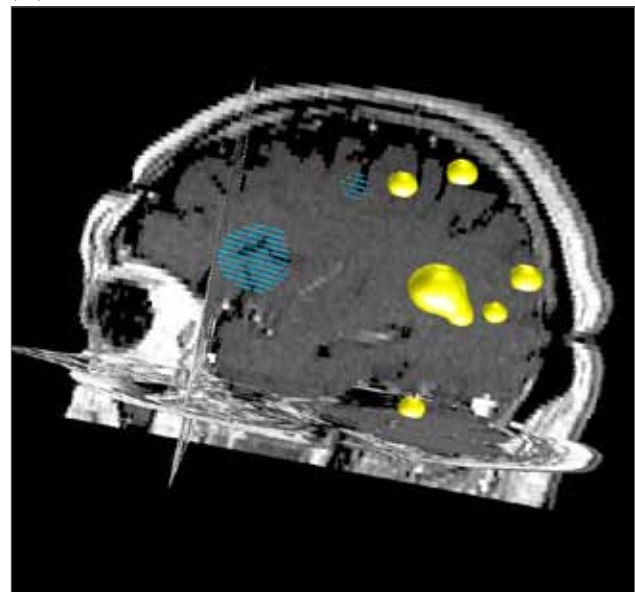
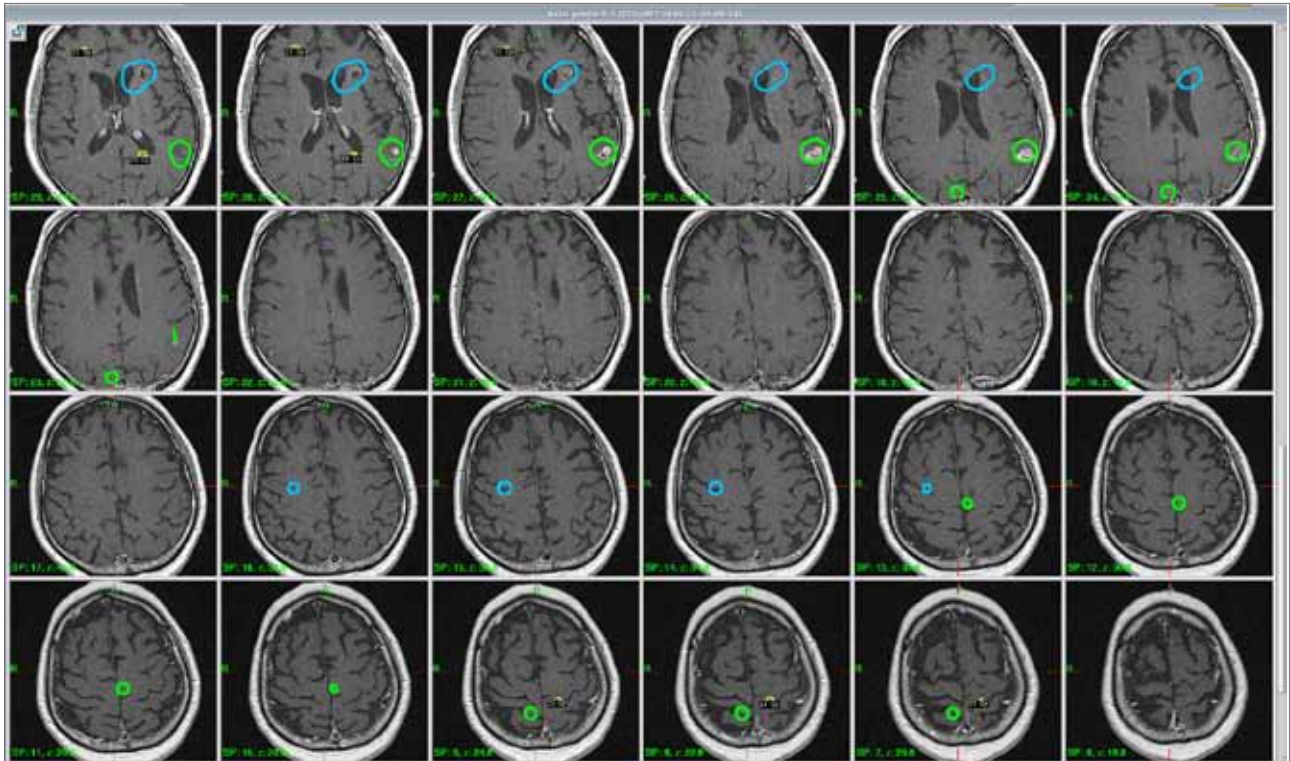


Figure 2. Five months after the first treatment new brain metastases developed and radiosurgery was repeated. The previous plan was imported and the old plan represents the blue line. It is evident, that the treated metastases had regressed. The new plan is represented by yellow line.

An MRI scan in December 2010, 12 months after the first treatment and 7 months after the second treatment, revealed another 5 new metastases. All previously treated metastases had either regressed or stabilized, none of the previously treated metastases had progressed. The patient was without neurological deficit and therefore a third treatment was indicated. Both of the previous plans were co-registered to the current images (see figures 3a and 3b). The diameter of the new metastasis ranged from 2 to 4 mm and single isocenter with 4 mm or 8 mm collimators were used to cover each metastasis, the cumulative volume was 0.16cm<sup>3</sup>. The prescribed dose was 23 Gy to 50 or 60% isodose. The treatment was completed without interruption with a beam on time of 75.3 min (5 isocenters). The patient survived 14 months after the first treatment with preserved neurological functions.

(3a)



(3b)

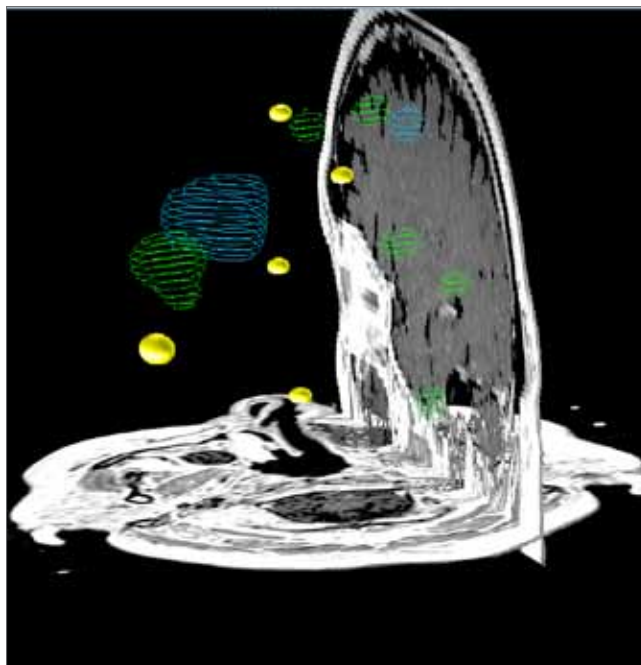


Figure 3. A third radiosurgery was indicated 12 months after the first and 7 months after the second treatment. Both previous plans were imported; the first one is represented by a blue line and the second one by a green line. It is evident, that all the treated metastases had regressed and the new metastases were treated with the plan represented by yellow line.

## Patient 2

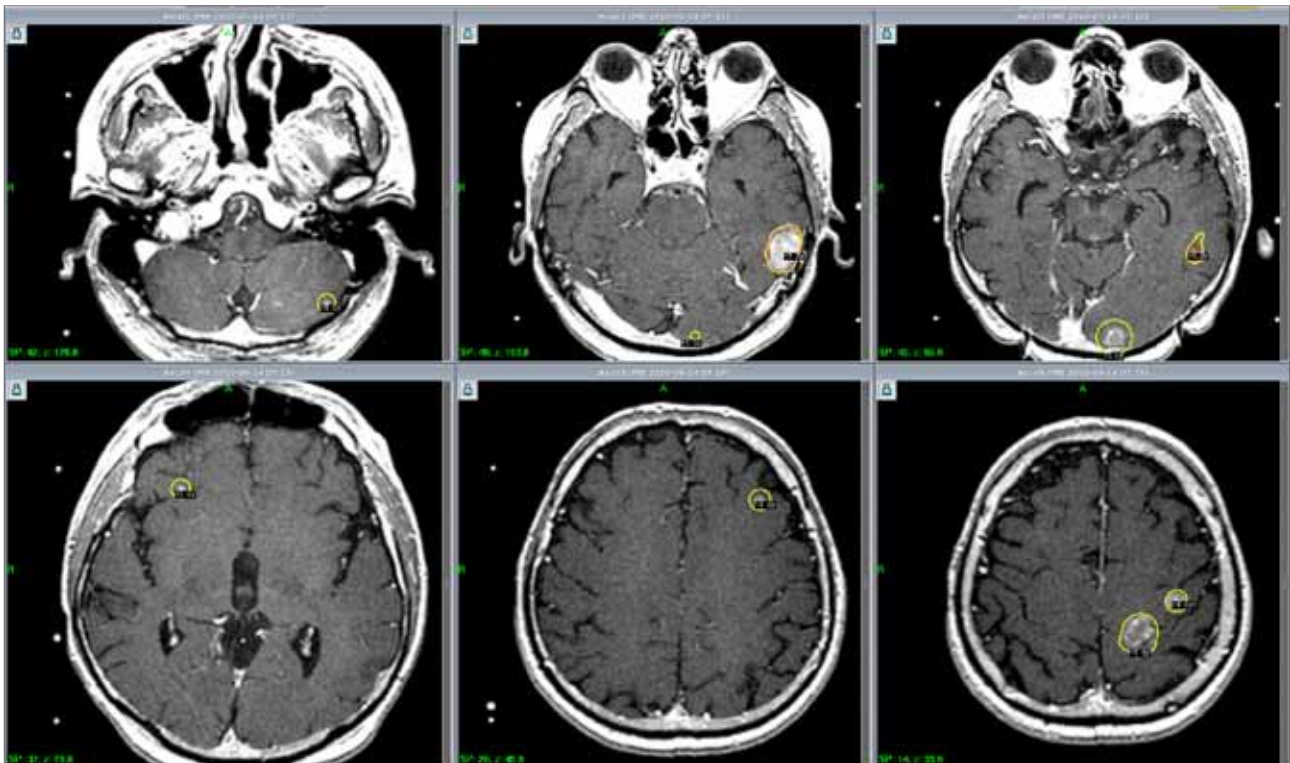
### Diagnosis and History

This 48-year-old male underwent biopsy for lung cancer followed by palliative radiotherapy to the primary lung tumor. Whole brain palliative fractionated radiotherapy for brain metastases was completed in October 2009 (36 Gy in 12 fractions). In April 2010 the patient experienced epileptic seizure and an MRI scan revealed recurrence of brain metastases. Thereafter the patient was referred to our department for Leksell Gamma Knife radiosurgery. At the time of treatment the patient complained of headaches, he was without neurological deficit and his Karnofsky score was 90%.

### Treatment

The patient was from a distant part of the Czech Republic and he was admitted to Na Homolce Hospital a day before the treatment. The treatment was performed at the beginning of May 2010 and the head frame attached under local anesthesia. The MRI scan revealed 7 brain metastases scattered throughout both brain hemispheres, above and below the tentorium (see figures 4a and 4b). The diameter of the largest metastasis was 19x26x20 mm and the smallest was 4 mm, the cumulative volume was 9.6cm<sup>3</sup>. The prescribed dose was reduced to 15 Gy because of the previous radiotherapy to the whole brain. The marginal isodose ranged from 44-70% across the different metastases. Between 1 and 9 isocenters were used to treat each metastasis with a total of 19 isocenters employed to treat all 7 metastases. The beam on time was 67.7 min and the treatment was completed without interruption.

(4a)



(4b)

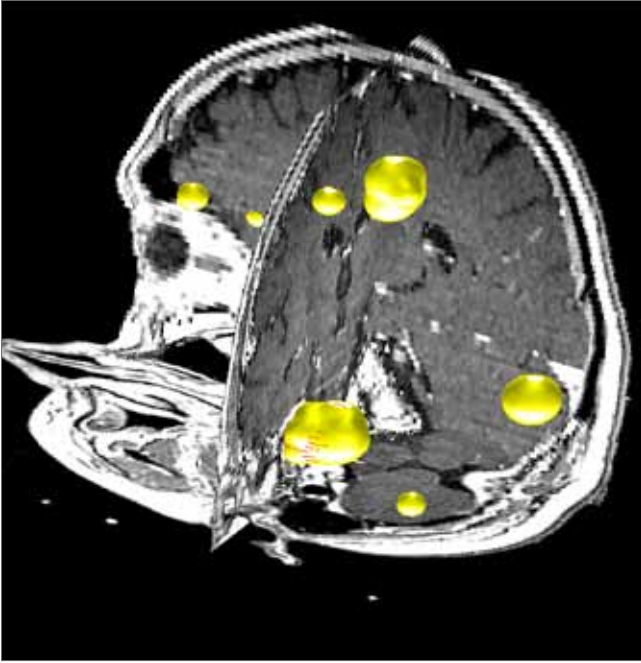
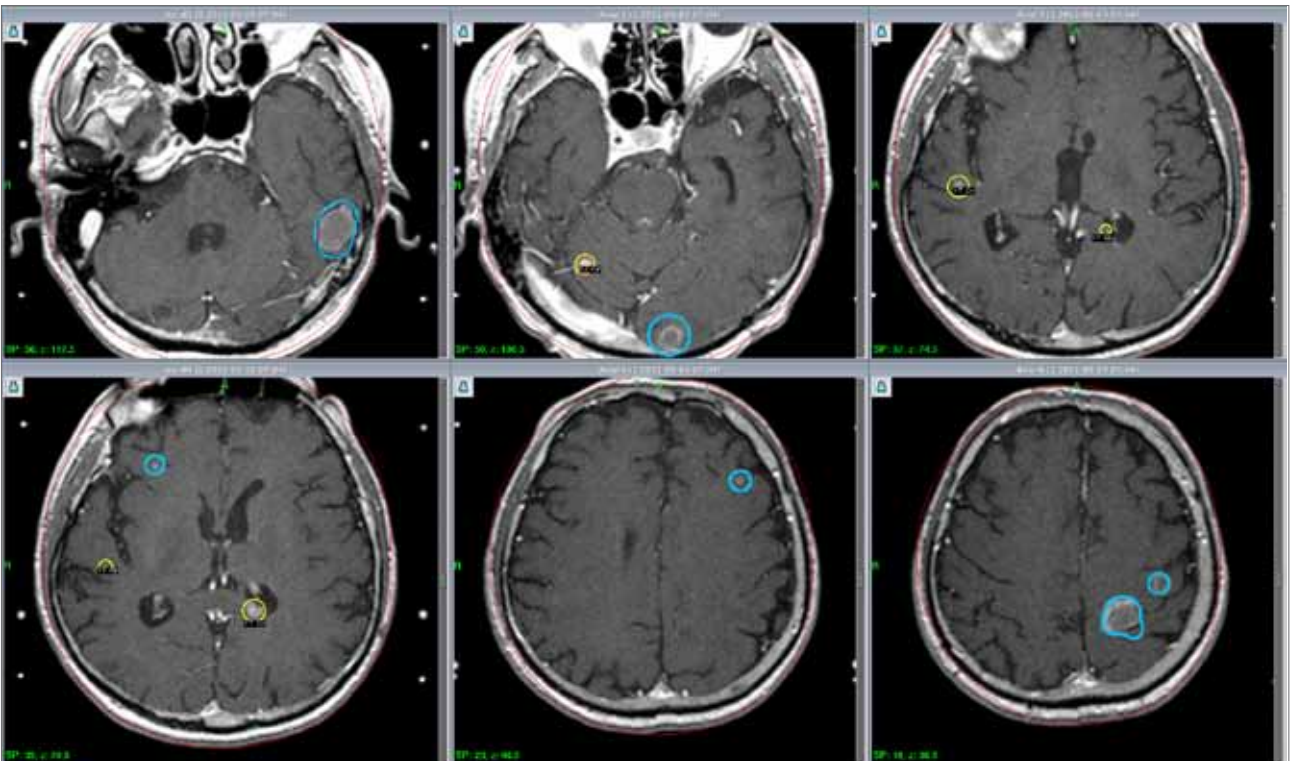


Figure 4. 48-year-old male with 7 recurrent metastases from lung cancer after previous whole brain fractionated radiotherapy. The yellow line represents the dose 15 Gy, the marginal isodose varies in different metastases between 44-70%.

Seven months later the patient had a control MRI scan which revealed 3 new brain metastases. The patient was suffering from increasing right hemiparesis and repeated epileptic seizure. However, after corticoids his clinical status improved, the patient was fully self-sufficient and repeated Leksell Gamma Knife radiosurgery was recommended in January 2011. The old treatment plan was co-registered to the new stereotactic MRI images (see figures 5a and 5b). The diameter of the new brain metastases ranged from 6-7 mm the cumulative volume was 0.55cm<sup>3</sup> and the prescribed dose was 17 Gy delivered to 52-66% isodose level. All metastases were treated using a single isocenter and 8 mm collimator. The beam on time was 29.8 min. and the treatment was completed without interruption. This patient continues to be followed and now has a Karnofsky score of 70%.

(5a)



(5c)

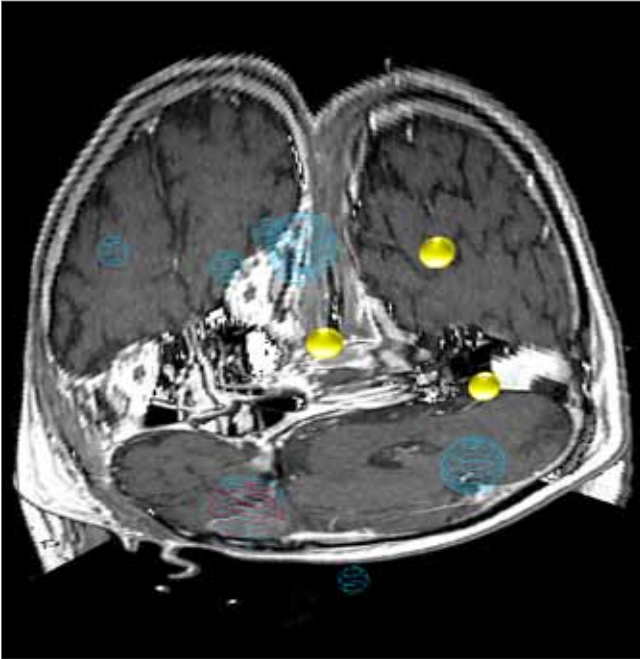


Figure 5. Seven months after the first radiosurgery 3 new metastases were diagnosed and the treatment was repeated. The old plan was imported, which is represented by the blue line. All treated metastases have regressed or are stable. The new plan is represented by the yellow color and because of the small diameters of the metastases a dose of 17 Gy was prescribed this time.

## Conclusion

Leksell Gamma Knife Perfexion enabled all of the multiple brain metastases to be treated without any restrictions, facilitating single session treatment regardless of the number and the locations of the lesions in the brain. Where the patient was receiving a repeat treatment co-registration of the old plans allowed unequivocal identification of new brain metastases. Radiosurgery of multiple brain metastases was an effective treatment without the increased risk of morbidity often seen in repeated treatments. However, collateral edema of metastases required frequent antiedematic corticotherapy. Leksell Gamma Knife treatment can be indicated as the primary treatment of multiple brain metastases and repeated if necessary, or it can be combined with the whole brain fractionated radiotherapy.

Since 1992 the Department of Stereotactic and Radiation Neurosurgery at Na Homolce Hospital has performed more than 11,500 Leksell Gamma Knife radiosurgeries. Brain metastases are one of the most common diagnoses referred for Leksell Gamma Knife treatment and so far more than 2,700 of such patients were treated in our department using Leksell Gamma Knife.

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