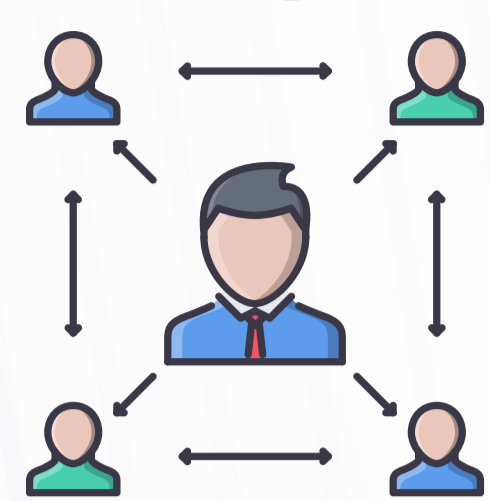


# Staged Frameless Gamma Knife Radiosurgery For Large Brain Metastasis



Heng Siew Ping<sup>1</sup>, Shahira Nabila<sup>1</sup>, Ida Suzanah<sup>1</sup>, Yong Jie See<sup>1</sup>, Ong Saw Huey<sup>1</sup>, Low Seng Hooi<sup>1</sup>, Muruga Kumar<sup>1</sup>, Ravi S Krishnapillai<sup>1</sup>, Syed Abdullah Al-Haddad<sup>1</sup>, Lee Foo Chiang<sup>1</sup>, Wong Fung Chu<sup>1</sup>, Tho Lye Mun<sup>1</sup>  
<sup>1</sup>Sunway Medical Centre, Radiotherapy Department, Selangor, Malaysia

## INTRODUCTION

Treating large brain metastases with radiosurgery has been a challenging task compared with smaller metastases, mainly due to the need of reducing the toxicity risk to the adjacent tissues and improving the local tumour control at the same time. Cleveland Clinic, which pioneering in two-stage Gamma Knife (GK) Stereotactic Radiosurgery (SRS) has reported a dramatic improvement of the local control rate when doses were divided into two fractions in about a month apart, while minimising the adverse radiation effects (Angelov L et al., 2017) [1].

## PURPOSE

The purpose of this study was to evaluate the treatment results of using 2-3 staged gamma knife stereotactic radiosurgery (GKS) in treating large brain metastasis of more than 2 cm.

## METHOD

8 patients with the brain tumour of more than 2cm were retrospectively analysed, with a total of 12 lesions treated. The primary tumours were in the breast (4 patients), lung cancer (2 patients), cervix (1 patient) and sarcoma (1 patient). The median age was 48 years (range 29–67 years). Patients were treated using Leksell Gamma Knife Icon, with 5 of them were staged in 3 fractions of total dose of 30 Gy and 2-staged of total 24Gy were prescribed for the remaining 3 patients at 50-64% of maximum dose. Interfraction interval of 2 to 3 weeks were recorded for both 2- and 3-stages. T1-weighted with Gadolinium-enhanced double contrast and T2- weighted images were used for the tumour delineation and treatment planning process.

## RESULTS AND DISCUSSION

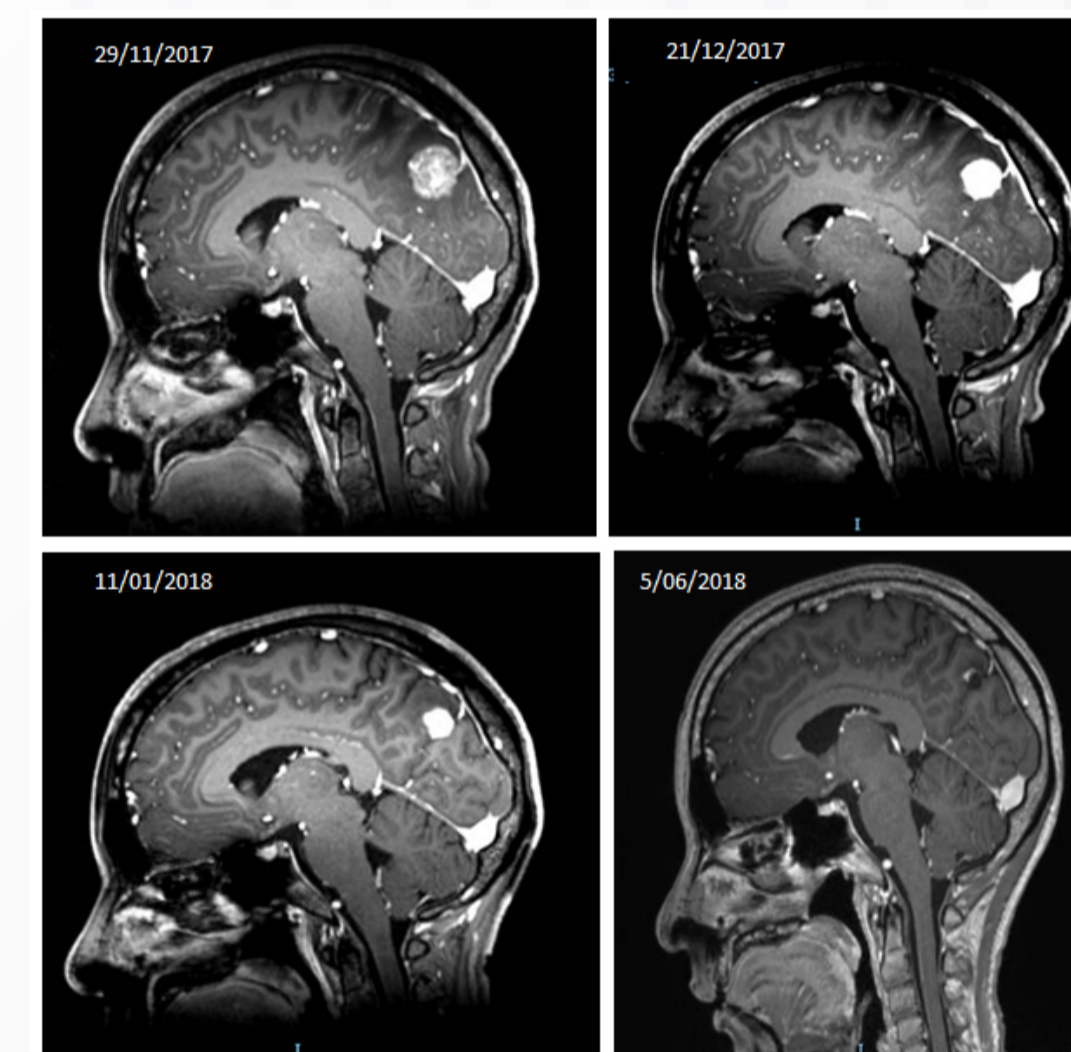
**Table 1** Table reporting the mean volume reduction for 2-and 3-staged GK SRS before and after the treatment for 8 patients with the total number of 12 lesions.

Fraction	Mean Tumour Volume (cm <sup>3</sup> )			
	1st Treatment	2nd Treatment	3rd Treatment	Total Tumour Reduction
3	10.05	7.31	5.32	4.73
2	5.93	4.51	-	1.42

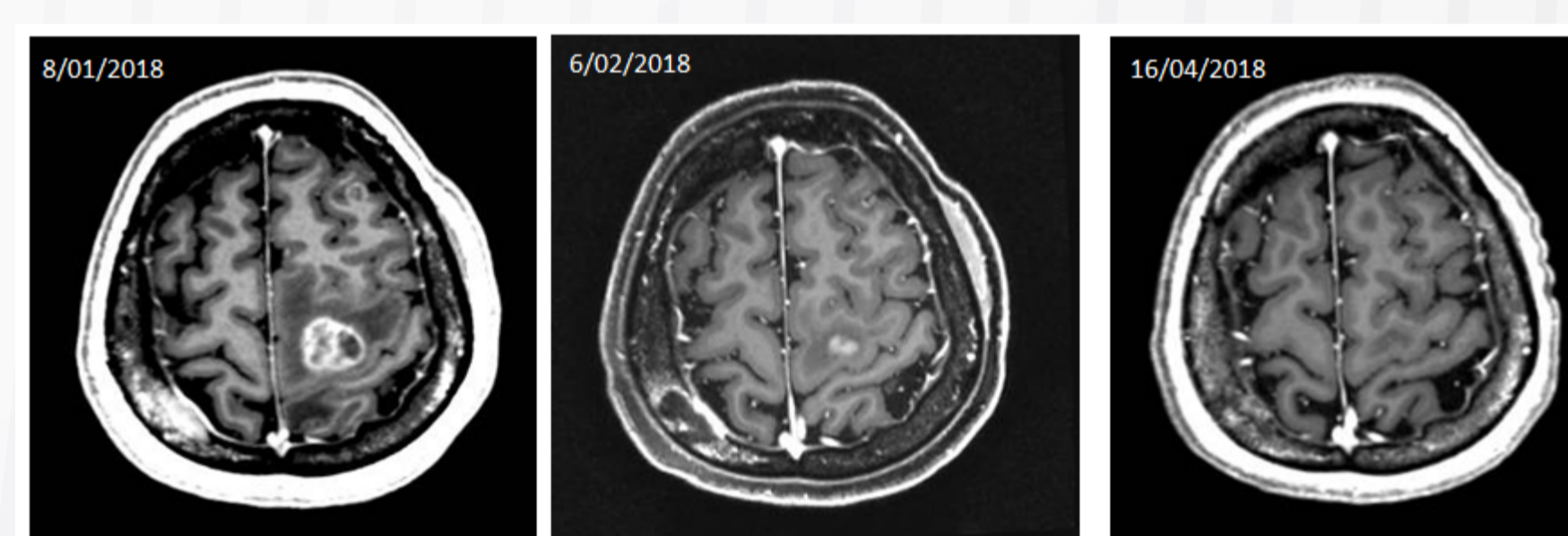
**Table 2** Table reporting the tumour volume differences for 2-and 3-staged GK SRS for 8 patients with the total number of 12 lesions.

Stage	Dose (Gy)	Tumour Staging Volume (cm <sup>3</sup> )			Tumour Volume Reduction (cm <sup>3</sup> )			Response
		1st Treatment	2nd Treatment	3rd Treatment	After 1st Treatment	After 2nd Treatment	Total Reduction	
3	10	16.23	7.71	4.68	8.52	3.03	11.55	Complete
		8.10	3.81	1.73	4.29	2.08	6.37	Partial
		8.07	5.45	3.04	2.62	2.41	5.03	Partial
		4.59	2.92	1.13	1.67	1.79	3.46	Partial
		5.28	3.88	2.07	1.40	1.81	3.21	Partial
		2.60	1.41	0.57	1.20	0.84	2.03	Partial
		2.71	2.55	1.23	0.16	1.32	1.48	Progressive
		29.75	24.96	19.79	4.79	5.17	9.97	Partial
2	12	13.12	13.14	13.67	-0.02	-0.53	-0.53	Complete
		4.90	2.76	-	2.14	-	2.14	Partial
		9.40	7.80	-	1.60	-	1.60	Partial
		3.48	2.96	-	0.52	-	0.52	Partial

**Figure 1:** Complete response after 3-staged gamma knife radiosurgery, with 3 weeks interval.



**Figure 2:** Complete response after 2-staged gamma knife radiosurgery, with 3 weeks interval.



The mean tumour volume before 3 staged therapy was 10.05cm<sup>3</sup> and at the 3rd fraction was 5.32cm<sup>3</sup> (mean reduction of 4.73cm<sup>3</sup>); the mean tumour volume before 2 staged therapy was 5.93cm<sup>3</sup> and at the 2nd fraction was 4.51 cm<sup>3</sup> (mean reduction of 1.42cm<sup>3</sup>), as demonstrated in Table 1 . Decreased in tumour volume were observed for patient with lung cancer, cervical cancer and breast cancer, as demonstrated in Table 2. The previously enhancing lesions have resolved and greatly reduced in size. The overall reduction in volume of metastasis nodules was also reported, with 30-50% diameter reduction. Only sarcoma primary tumour patient indicated the progression of the tumour after the radiosurgery treatment, as sarcoma is histologically considered as a radioresistant tumour.

## CONCLUSION

At the 2-6 months follow up (mean 2.3month), non-small cell lung, cervix and breast cancer patients presented with radiological complete and partial response , improved symptoms and no radiation-induced adverse effects were observed.

Our experience has shown staged Gamma Knife SRS treatment for large brain metastases allows interval reduction in treated volume with each subsequent fraction and improved local rate of control with the minimal invasiveness.

## REFERENCE

[1] Impact of 2-staged stereotactic radiosurgery for treatment of brain metastases  $\geq 2$  cm. Angelov<sup>L1,2</sup>, Mohammadi AM<sup>1,2</sup>, Bennett EE<sup>2</sup>, Abbassy M<sup>3</sup>, Elson P<sup>4</sup>, Chao ST<sup>1,5</sup>, Montgomery JS<sup>1</sup>, Habboub G<sup>2</sup>, Vogelbaum MA<sup>1,2</sup>, Suh JH<sup>1,5</sup>, Murphy ES<sup>1,5</sup>, Ahluwalia MS<sup>1</sup>, Nagel SJ<sup>2</sup>, Barnett GH<sup>1,2</sup>. J Neurosurg. 2018 Aug;129(2):366-382. doi: 10.3171/2017.3.JNS162532. Epub 2017 Sep 22.