www.jcimcr.org

JCIMCR OPEN ACCESS Journal of Clinical Images and Medical Case Reports

ISSN 2766-7820

Case Report

Open Access, Volume 2

Radiosurgery and re-irradiation of brain metastases with cyberknife

V Popov[1,3]; V Graklanov[2,3]; A Botushanova[1,3]

[1]Department of Clinical Oncology, Medical University –Plovdiv, Bulgaria.

[2]First Department of Internal Diseases, Medical University-Plovdiv, Bulgaria.

[3]UMHAT "Sv. Georgi", Plovdiv, Bulgaria.

***Corresponding Authors: Veselin Popov**

Department of Clinical Oncology, Medical University-Plovdiv, University Hospital "Sv. Georgi" 4002 Plovdiv, Bulgaria.

Email: dr.v_popov@yahoo.com

Received: Jun 09, 2021

Accepted: Jul 16, 2021

Published: Jul 21, 2021

Archived: www.jcimcr.org

Abstract

Lung cancer is a leading cause of cancer incidence and mortality worldwide with more than 2 million newly diagnosed cases in 2018. The disease is usually diagnosed in stage 3 or 4 with extensive clinical symptoms, which is a bad prognostic factor. Around 40% of patients with brain metastases are with a primary lung cancer, which shows the importance of this pathology. The main treatment option for inoperable lesions is radiosurgery, which can be done more than once in case of progression. This gives an opportunity to deliver a high dose in low volume with a high dose gradient while maintaining healthy tissues. Re-irradiation gives a change for good quality of life for patients with a long life expectancy. This case confirms that two and even three times re-irradiation with CyberKnife is an effective and safe therapeutic option for patients with brain metastases.

Keywords: CyberKnife; radiosurgery; re-irradiation; brain metastases; lung cancer.

Introduction

Brain metastases are 4-5 times more common than primary intracranial carcinomas, occurring in 20-40% of patients with oncological diseases [1]. In most cases the primary disease is lung or breast cancer. Despite advances in systemic and local treatment, metastatic lung cancer remains an unresolved medical problem. Generally patients with brain metastases have a poor outcome with median survival for non-treated lesions around 4 months, and for treated around 8 months. Depending on the number of metastases, their dimensions and location, histology, and ECOG performance status, there are different treatment options – surgery, whole-brain radiotherapy or radiosurgery [2]. Radiosurgery and operation have similar results for overall survival and relapses, but radiosurgery is preferred option because it is non-invasive type of treatment and the risk for complications is lower. On the other hand after operation it is recommended to perform radiotherapy in area of the resection cavity so patient will need irradiation again [3,4]. Whole brain radiotherapy is used only for multiple brain metastases or if the primary disease is small cell lung cancer, because this treatment leads to many more side effects and neurological problems. Because of that there are some centers that prefer to use radiosurgery even for multiple brain metastases [5,6]. The CyberKnife system has proven to achieve all the goals of radiosurgery by delivering high, ablative radiation dose with maximal dose fall-off outside the treatment volume with a frameless sub-millimeter accuracy [7,8].

Case report

A 42 year-old male patient presented with a persistent cough and headache. Risk factors include smoking from around 20 years and dusty work environment. A thorax Computed Tomography (CT) was made with a data for a tumour formation 3,3/2,8 cm in left lung. A biopsy was made and histologically was verified adenocarcinoma, after which the formation was removed totally. A Magnetic Resonance Imaging (MRI) of head showed three brain metastases – in right parietal/frontal lobe 11,9/14,3 mm; in left temporal lobe 13/10 mm; and in right frontal lobe 43/40 mm. A frontal lobe craniotomy was made and the biggest lesion was extirpated surgically after which patient refused any other operations. The decision of the Medical Oncology Board was to treat other lesions with stereotactic radiosurgery with CyberKnife. Three fractions, 11 Gy per fractions were performed in both metastases with 2 mm margin from gross target volume (GTV) to Planning Target Volume (PTV) (Figure 1,2). Biological Effective Dose (BED) was ~ 69.3Gy with alpha/beta ratio 10.

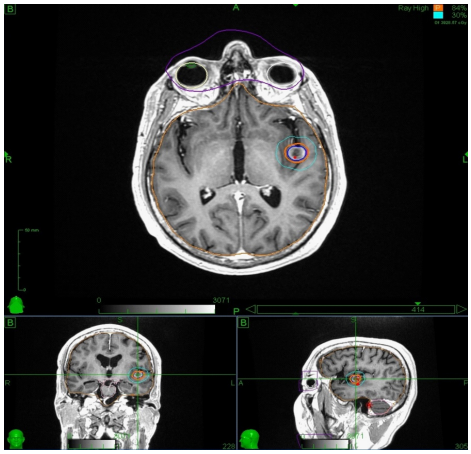


Figure 1: GTV1/ PTV1 and dose gradient.

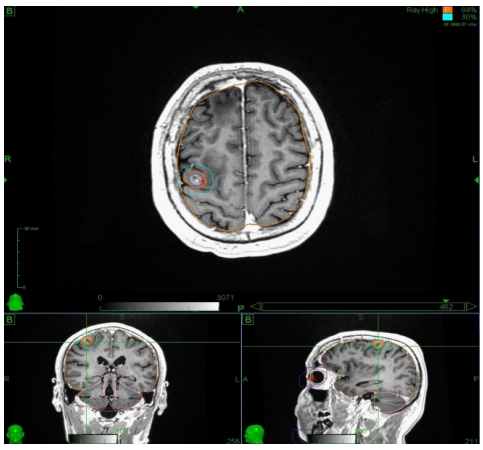
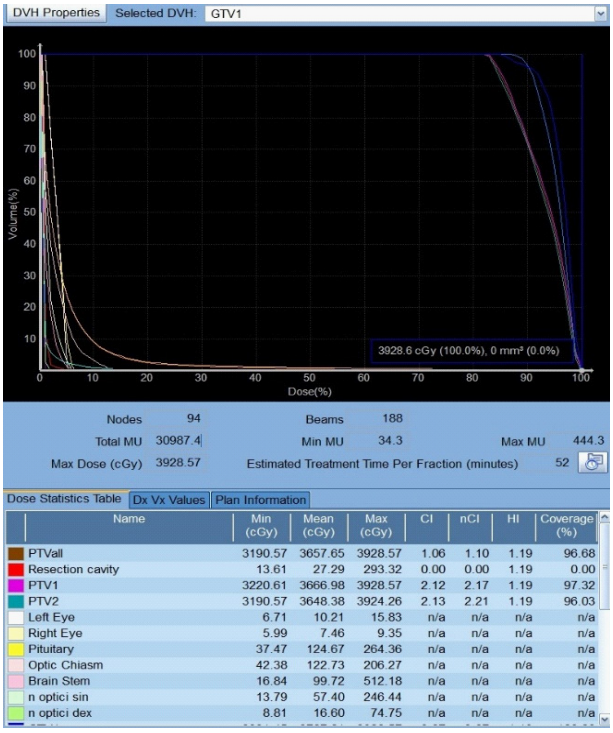


Figure 2: GTV2 / PTV2 and dose gradient.

Critical organs include eyes, lens, pituitary gland, optic chiasm, brain stem, optic nerves, cerebellum and whole brain, in all of which the dose is within acceptable limits. Estimated treatment time per fraction is 52 mins, with 188 beams and 94 nodes (Figure 3).



Name	Min (cGy)	Mean (cGy)	Max (cGy)	CI	nCI	HI	Coverage (%)
PTVall	3190.57	3657.65	3928.57	1.06	1.10	1.19	96.68
Resection cavity	13.61	27.29	293.32	0.00	0.00	1.19	0.00
PTV1	3220.61	3666.98	3928.57	2.12	2.17	1.19	97.32
PTV2	3190.57	3648.38	3924.26	2.13	2.21	1.19	96.03
Left Eye	6.71	10.21	15.83	n/a	n/a	n/a	n/a
Right Eye	5.99	7.46	9.35	n/a	n/a	n/a	n/a
Pituitary	37.47	124.67	264.36	n/a	n/a	n/a	n/a
Optic Chiasm	42.38	122.73	206.27	n/a	n/a	n/a	n/a
Brain Stem	16.84	99.72	512.18	n/a	n/a	n/a	n/a
n optici sin	13.79	57.40	246.44	n/a	n/a	n/a	n/a
n optici dex	8.81	16.60	74.75	n/a	n/a	n/a	n/a

Figure 3: Dose-volume histogram and critical organs.

PD-L1 expression was >50% and patient continued treatment with pembrolizumab. A MRI of head and CT of thorax, abdomen and pelvis were scheduled in every three months.

For a period of 9 months there was no data for a progression and patient had a good quality of life with no complaints or any side effects. On a control MRI at the 6th month lesion in right parietal/frontal lobe was decreased to 7,8/10,3 mm (before treatment was 11,9/14,3 mm), but on the 9th month there was a progression to 11/12 mm with edema. The other metastasis was under control. After calculating the residual dose (~41,7 Gy) the lesion was re-irradiated with CyberKnife again. Two fractions, 9 Gy per fraction were done, BED=34,2 Gy. Estimated treatment time per fraction was 30 mins and included 113 beams and 50 nodes. During the treatment the patients was on Dexamethasone and Mannitol because of the edema. On a control visits after that there were no complaints or side effects. Follow-up of the patient continued every 3 months with CT and MRI.

In the next 20 months (29 months from the first radiosurgery) imaging studies showed a stable disease. One week before next scheduled control visit patient complained from a persistent headache and sleep problems. MRI showed a small progression in size of both metastases with around 2-3 mm each. Patient refused operation again. After calculating the residual dose and explained the possible side effects to the patient, he agreed to re-irradiate lesions to the maximum possible dose. Prescribed dose to the lesion in right parietal/frontal lobe was 2x5 Gy, and for the lesion in left temporal lobe was 2x9 Gy. GTV to PTV margin was 2mm. Estimated treatment plan per fraction was 43min, with 152 beams and 105 nodes. PTV1/2 coverage was over 98% and dose in all critical organs was in tolerance. Two weeks after that there was an improvement in the patient condition.

On a control MRI 36 months after the first radiosurgery there

is no data for radiation necrosis or any other side effect. Patient is with stable disease and has no complaints and a good quality of life.

Discussion

Multiple prognostic indices for brain metastases patients have been developed and are currently in use, but the ideal index has not been defined yet and further research into alternative approaches is needed. Some results indicate that the factor adenocarcinoma histology could add to the prognostic value of specialized future indices [9]. Multiple distant metastases, small cell lung cancer histology, comorbidities and ECOG performance status more than 1 are bad prognostic factors for these patients. The median expected overall survival for patient with brain metastases from small cell lung cancer treated with radiosurgery is 3 months actuarial 6-month and 12-month rates of 25% and 3.6%, respectively [10]. Re-irradiation gives a change for patients with longer life expectancy for a local tumour control. Radiosurgery can be used to treat a new brain lesion or to re-irradiate already treated one, if needed. In terms of compliance with CyberKnife radiosurgery, the majority of patients did not develop any acute side effects. Re-irradiation is a feasible and effective option for pre-irradiated, recurrent brain lesions to obtain clinical benefit without excessive acute toxicity [11]. Re-irradiation of brain tumours is increasingly considered as our understanding of brain tolerance to radiation evolves and developments in radiation technology and imaging make highly accurate targeting of recurrent tumours possible. With developments in systemic therapy, further exploration of the role of re-irradiation on its own or in combination with novel agents is needed [12].

Conclusion

Robotic stereotactic radiosurgery with CyberKnife is widespread radiotherapy method around the world with proven clinical results. The ability to administer a high dose in a small volume with a high dose gradient protects the healthy tissues and minimized the side effects. This gives a change for re-irradiation if needed.

Disclosure: The authors have declared no conflict of interest.

References

1. Kaul D, Angeldis A, Budach V, Ghadjar P, Kufeld M, et al. Prognostic indices in stereotactic radiotherapy of brain metastases of non-small cell lung carcinoma. Radiation Oncology. 2015; 10: 244.
2. Bradley KA, Mehta MP. Management of brain metastases. Semin Oncol. 2004; 31: 693–701.
3. Soltys S, Adler J, Lipani J, et al. Stereotactic radiosurgery of the postoperative resection cavity for brain metastases. International Journal of Radiation Oncology, Biology, Physics. 2008; 70: 187-193.
4. Madawala P, Jin R, Rock J. Radiosurgery alone or postoperative radiosurgery for 1–3 brain metastases. Int J Radiat Oncol Biol Phys. 2008; 72: 201–202.
5. Bhatnagar A, Flickinger J, Kondziolka D, Lunsford L. Stereotactic radiosurgery for four or more intracranial metastases. International Journal of Radiation Oncology, Biology, Physics 2006; 64: 898-903.
6. Yamamoto M, Swrizawa T, Shuto T. Stereotactic radiosurgery for patients with multiple brain metastases (JLGK0901): A multi-institutional prospective observational study. Lancet Oncol. 2014; 15: 387–395.
7. Cuauhtemoc de la Pena, Guajardo J, Gonzalez M et al. CyberKnife stereotactic radiosurgery in brain metastases: A report from Latin America with literature review. Reports of practical oncology & radiotherapy 2018; 23: 161-167.
8. Popov V. Brain metastases from non-small cell lung carcinoma – CyberKnife re-irradiation after Gamma Knife radiosurgery. Folia Medica. 2020; 62: 856-860.
9. Kaul D, Angelidis A, Budach V, et al. Prognostic indices in stereotactic radiotherapy of brain metastases of non-small cell lung cancer. Radiation oncology. 2015; 10: 244.
10. Olson A, Wegner R, Rwigema J et al. Clinical outcomes of reirradiation of brain metastases from small cell lung cancer with CybeKnife stereotactic radiosurgery. Journal of cancer research and therapeutics 2012; 8: 411-416.
11. Greto D, Livi L, Bonomo P, et al. Cyberknife stereotactic radiosurgery for the re-irradiation of brain lesions: A single-centre experience. Radiologia medica 2014; 119: 721-726.
12. Gains J, Short R. Brain Tumours. In: Nieder C, Langendijk J (Eds). Re-Irradiation: New Frontiers. 2011; 85-94.