ORIGINAL ARTICLE

Early Malaysian Experience on the Use of Head and Neck Localizers in the Precision Radiotherapy of Intra and Extra Cranial Sites for First 28 Cases

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Summary

Precision Radiotherapy at high doses require a fixed, referable target point. The frame system fulfills the required criteria by making the target point relocatable and fixed within a stereotactic space. Since December 2001, we have treated 28 central and peripheral nervous system lesions using either radiosurgery as a single high dose fraction or fractionated 3-dimensional conformal radiotherapy using a lower dose and a multi-leaf collimator. Various pathological lesions either benign or malignant were treated. Eighty six percent of our treated lesions showed growth restraint, preventing them from causing new symptoms with a median follow-up duration of 20.5 months. However, the true benefit from this technique would require a long-term follow-up to document the progress.

Key Words: Radiosurgery, Fractionated 3-dimensional conformal radiotherapy, Central and peripheral nervous lesions.

Introduction

The delivery of precision radiation therapy based on accurate and reproducible set ups for tumours in the cranial and extracranial sites is a new treatment modality in radiotherapy. The most important advance in this field has been the development and use of fractionated 3-dimensional conformal radiotherapy (3D-CRT) and radiosurgery. In our centre, Universiti Sains Malaysia health campus, Kelantan, the stereotactic radiotherapy and radiosurgery service was introduced in December 2001. We used various localiser frames to deliver single fraction and fractionated radiotherapy. This is our early experience with the technique.

Materials and Methods

From December 2001 till February 2003, we treated 28 cases of cranial and extracranial tumours. The frames used were Brown Roberts Wells (BRW), Gill Thomas Cosman (GTC) and Head and Neck Localiser Accessories (HNL Accessories-Radionics.Inc). Twenty one cases were treated with a single fraction or stereotactic radiosurgery and seven cases were treated with fractionated stereotactic radiotherapy using 3D-CRT. The BRW frame was used for all single fraction irradiation and re-locatable GTC frame and HNL Accessories were utilized for 3D-CRT.

Stereotactic planning was performed on Radionics X-plan 2.2. The 3D-CRT required an additional Radionics mini-Multileaf collimator (mMLC) for non-spherical target. The radiation therapy was given via Radionics X-Knife using a linear accelerator (LINAC) for 3D-CRT and a combination of Radionics cones for radiosurgery. The BRW frames were used in 21 cases. GTC frames in

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five cases and HNL Accessories in two cases. In radiosurgery, the mean cone diameter was 2.9cm, mean number of beams was 5.37 and mean total arc angle of 364.9 degrees. In 3D-CRT, the mean number of beams was 4.72 and mean equivalent square sides of 3.77cm. The radiation dose was prescribed to 80-95% isodose lines to cover the lesion. The radiation dose varied from 12 to 24 Gy for single fraction radiosurgery and up to 50 Gy in 25 fractions in five weeks (50Gy/ 25#/ five week) for 3D-CRT. All patients were followed-up every six months after the treatment. The volume of the lesions and the acute reactions to irradiation were documented for each visit. The median follow-up time for this series was 20.5 months.

Results

In this series of 28 patients, the number of men and women were equal, 14 of each gender. The age ranged from 14 to 70 years, with a mean of 41 years. Twenty five cases had been treated with either surgery or endovascular embolisation as the primary modality of treatment and followed by precision radiotherapy. Three patients were treated primarily with precision radiotherapy with the diagnoses of a meningioma, an arteriovenous malformation and an acoustic neuroma.

Ten patients had intracranial meningiomas, seven were treated with radiosurgery and three patients were treated with 3D-CRT. None of our irradiated meningioma showed an increase in tumour volume after irradiation. Six of seven meningiomas showed a decrease in the volume after radiosurgery. One meningioma patient showed a decrease in the volume and two meningioma patients remained static after receiving 3D-CRT. One patient with meningioma was lost to follow-up. Six of Acoustic neuromas patients were treated with radiosurgery, two remained static, three had a decrease in tumour volume and one lost to follow-up.

The best responses were seen with arteriovenous malformation (AVM) of the brain. All four radiosurgically treated patients had an early good response, one was totally obliterated and the other three showed significant decrease in volume. Figures 1 and 2 showed a patient who had an AVM treated and had a good initial response.

Two patients with a recurrent pituitary adenomas were treated radiosurgically, one showed a static response and the second patient was lost to follow-up. Two patients with cervical schwannoma treated with 3D-CRT using HNL frames showed a significant decrease in tumour volume. One patient with cerebellar haemangioblastoma was treated with radiosurgery and had a static response. The two patients with brainstem glioma and a metastatic brain tumour were treated with 3D-CRT. The tumours had decreased and became static in volume respectively. One patient with supratentorial glioma was lost to follow-up after receiving radiosurgery.

Types of therapy and doses administered to different types of pathology are tabulated in table one including our early outcome data on 24 cases. All of the lesions were restrained from growing and four patients were lost to follow-up. One patient with an Acoustic neuroma required surgery for tumoral bleed nearly one year after radiosurgery.

Discussion

Meningioma, acoustic neuroma and central nervous system arteriovenous malformation were the main diseases treated with focal, conformal stereotactic technique in our institution for the last three years. The accurate targeting and conformal irradiation concept used during radiosurgery has also been utilised in fractionated radiotherapy. The frame system helps in two ways for this new method of radiation delivery; to deliver the radiation stereotactically and to make the target site relocatable after series of fractionated irradiation.

The difference in the technique from the conventional radiation, has allowed us to irradiate lesions near important anatomical areas with higher doses radiation. We irradiated lesions in the cerebellopontine angle and parasellar areas which were nearly impossible to irradiate with conventional radiotherapy without producing radiation complications at higher doses. The focus radiation resulted in a sharp fall off in the dose distribution for the lesion and adjacent normal structures. The dose of radiation used varied according to types of lesion, whether previous radiation was received, the anatomy of adjacent normal areas and the configuration or the volume of the lesions.

Generally, we used stereotactic radiosurgery technique for lesions that were less than 5cm in diameter, non diffused, had a favorable shape with sharply defined margins and also as a boost after fractionated radiotherapy. A multi-leaf collimator conformal

Table I: Diagnosis, mode of radiation administered, dose of radiation and outcome of case series.

Diagnosis	No. Of Cases	Mode of Radiation therapy				Outcome (Median follow-up time of 20.5 months)				Lost to follow up.
		Radio-Surgery (SRS) (Case No)	Dose: Ranged (mean)	Fractionated 3D-radiotherapy. (SRT) (Case No)	Dose: Ranged (fraction)	Complete response	Decreased volume	Static	Increased volume	
1. Meningioma	10	7	12-20 Gray (17)	3	45-200 cGy (25)	-	7 (6 SRS,1 SRT)	2 (SRT)	-	1
2. Acoustic Neuroma	6	6	16-24 Gray (19)	-	-	-	3 (SRS)	2 (SRS)	-	1
3. Arteriovenous malformation	4	4	16-22 Gray (18.5)	-	-	1 (SRS)	3 (SRS)	-	-	-
4. Recurrent Pituitary Adenoma	2	2	12-15 Gray (13.5)	-	-	-	-	1 (SRS)	-	1
5. Cervical Schwannoma	2	-	-	2	600 cGy (4)	-	2 (SRT)	-	-	-
6. Cerebellar Haemangio-blastoma	1	1	20 Gray	-	-	-	-	1 (SRS)	-	-
7. Brainstem Glioma	1	-	-	1	200 cGy (25)	-	1 (SRT)	-	-	-
8. Metastatic tumour	1	-	-	1	300 cGy (10)	-	-	1 (SRT)	-	-
9. Supratentorial low grade glioma	1	1	16 Gray	-	-	-	-	-	-	1

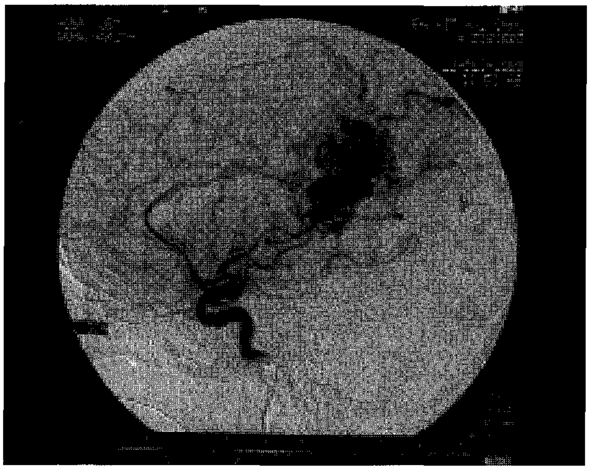

Fig 1: A dominant hemispheric left parietal AVM supplied by multiple arterial feeders from left middle cerebral artery. This AVM was graded as Spetzler Martin grade 3 and was treated with radiosurgery.

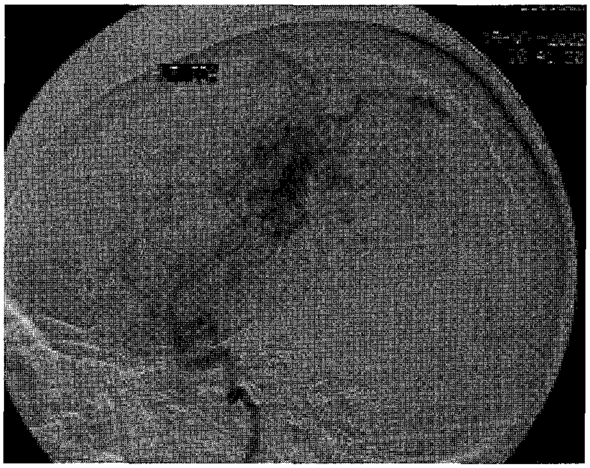

Fig 2: The repeated digital substration angiography of the brain six months after the treatment showed smaller AVM nidal size and appeared less compact. (similar patient as in Figure 1)

radiation therapy was utilized in cases of large, non-spherical or diffused lesion. The radiobiological effects of single-fraction irradiation or radiosurgery have revolutionized cerebral and spinal irradiation by improving significantly the effects on benign lesions[1]. Therefore 21 of our benign cases were treated with this technique. Malignant lesions tend to get treated with fractionated conformal type of radiation in our unit, because of the character of the lesions themselves, being either multiple, more diffused or larger lesions.

Our series, demonstrated a good response rate for most lesions, particularly cerebral arteriovenous malformations (AVMs) treated with radiosurgery. It is broadly accepted that about 80-90% of AVMs undergo thrombo-obliteration after single fraction radiosurgery. The efficacy depends on the radiation dose given to the nidus and periphery of the lesion[2]. The AVM that showed a complete response in our series had 20 Gy dose to the periphery.

This early series of precision radiotherapy however noted a patient with vestibular schwannoma received radiosurgery suffered from tumoural haemorrhage. The haemorrhage may be due to a sudden tumoural swelling or necrosis occurred in response to irradiation. Tumoural expansion or necrosis after radiosurgery were documented recently by Okunuga *et al*[3] who described tumour volume changes on serial imagings for vestibular schwannoma after irradiation therapy and by Hasegawa *et al*[4] who described three patterns of tumoural expansion after radiosurgery in patients harboring vestibular schwannoma; central necrosis, solid expansion and cyst formation.

Conclusion

A framed based precision radiotherapy was useful in the treatment of small volume lesion situated in the brain and head and neck regions. However a long-term and closed follow-up were essential to evaluate the radiation related morbidity.

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