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Clinical cases in SRS Radiotherapy, Albania

Lulzime Daci
Radiotherapy Department
Hospital Trust
3-Bodø,Norway
lulzime.daci@nordlandssykehuset.no

Prof.Partizan Malkaj
Faculty of Mathematics Engineering and Physics Engineering
Tirana, Albania
malkaj_p@hotmail.com

Artur Xhumari
Unit, Service of Neurosurgery, UHC "Mother Tereza", Tirana, ALBANIA
artur.xhumari@gmail.com

Ledio Bregu
Unit, Service of Neurosurgery, UHC "Mother Tereza", Tirana, ALBANIA
lediobregu@hotmail.com

***Abstract*—In this work evaluation of ten clinical cases SRS plans were discussed with the aim to investigate the role of stereotactic surgey as a new techniques implemented for the first time in Albania in December 2014.**
Dose volume histograms were used for physical and evaluation. The discussion of the results will be mainly focused on three aspects: the planning parameters, and the analysis of the dosimetric data for the PTV and healthy tissues. The main planning
parameters are the number of beams for the LINAC. Various parameters were considered for the quantitative analysis of PTV dosimetric data

Keywords—SRS, dose distribution, Treatment planing

I. Introduction

The target minimum dose is a critical clinical parameter. One of the main planning objectives is to irradiate all the cells within the PTV with the prescription dose. If the minimum dose is lower than this dose, than some cells are receiving a dose potentially not associated with cell lethality. But these considerations cannot be separated from the analysis of other PTV parameters: target coverage and conformity index. Final treatment plans are a compromise of balancing the competing risks of missing a part of the PTV against the larger risks for radiation-induced adverse effects, especially when treating benign lesions. The aim is to have a Target coverage and conformity index inside as near the RTOG recommended values as possible, but also we aim to have a coverage of >95% . These goals were achieved for most of the plans . In general, dose planning the PITV is less than 2.5. The coverage is highly dependent on the target location, because sparing of neighboring critical structures, e.g. optic nerves or brainstem, may necessitate lower target coverage.

II. Treatment Planning

In radiosurgery there is a steep dose fall off near the target boundary, with dose gradients of up to 30% per mm, which, depending on the tumor volume, may represent a tiny proportion of the total PTV volume. Therefore, the analysis of target minimum dose should always be performed in combination with the analysis of DVHs.
Common planning objectives were defined as used in clinical practice, and are the following:

- Enclose the entire target volume as closely as possible with the same prescription dose. Planning isodose of 90%
- Minimise the dose to surrounding normal tissue, considering the given threshold dose limits for organs at risk.

Table.I summarizes the prescribed dose to the PTVs and Table.II gives a list of the organs at risk (OAR) with the respective maximum tolerance dose. The given threshold dose limits for OARs considered in this study are the same as used in clinical practice.
None of the patients has had previous radiotherapy treatments.

TABLE I. Perscribed dose to PTV at 90% of isodose

Diagnosis	Prescribed Dose
MAV	16 Gy
Clivus Chordoma	15 Gy
Pituitary adenoma	14 Gy
Sinus Meningioma	14 Gy
Sphenoid orbital meningioma	14 Gy
Vestibular Schwannoma	13 Gy

TABLE II. Maximum Tolerance for OAR

OAR	Tolerance Dose
Optical nerves and chiasm	8 Gy
Trigeminus	14 Gy
Hippocampus	12 Gy
Temporal lobes	As low as possible
Facialis	As low as possible
Brain Stem	13 Gy
Brain	14 Gy
Eminentia mediana	8 Gy

All treatment plans were generated experienced medical physicists, and all the structures were reviewed, by radiation oncologist, neurologist and in special cases by neuro-radiologist.

III. EVALUATION

Plan assessments based on physical dose distributions were carried out qualitatively by visual inspection and quantitatively by calculation of DVHs for both PTV and OARs. For each patient and for each organ, a set of physical parameters was computed from the DVHs to assess the general characteristics of each technique: minimum, mean, and maximum dose. To evaluate the quality of the plans, target coverage TVR, conformity index PITV were used.

A. Plan Parameters

Common planning objectives were defined in the clinical practice. The number of isocentres does not go further than 3 and the number of arc beams used ranged from 3 to 8. Using the BEV field, the beam direction (gantry and table angles) is the means to control and minimize the dose to OARs. Of course the number of beams used can play a role too.

The case summary are presented here give a description of target diagnosis, localization and PTV volume. Prescribed dose, number of isocentres and number beam arcs and volumes for the volumes are summarized. Axial, coronal and sagittal views at PTV center are given they show an overview of the 14Gy and 8Gy, isodose distributions in orange and green color.

Age sex	Pathology	Previous treatment	Vol. (cc)	Dose (Gy)	No. isocenter	Arcs	Cones (mm)	Energy (MeV)	Vol % covered
49/F	AVM	-	1.53	16	1	6	22.5	7	90
38/M	AVM	Partial endovascular embolisation	0.48	16	1	5	17.5 15	7	91
57/M	Vestibular schwanoma	Total surgical removal	1	13	1	3	22.5	7	98
46/F	Spheno-orbit-meningioma	Partial surgical removal	2.1	14	1	5	25	7	95
56/F	Cavernous sinus meningoma	Partial surgical removal	1.48	14	2	8	15 12.5	7	96
46/M	Clival cordoma	Partial surgical removal	1.59	15	1	4	22.5	7	90
51/F	Pituitary adenoma	Partial surgical removal	1.18	14	1	4	22.5	7	98.5
61/F	Pituitary adenoma	Partial surgical removal	0.2	14	1	4	15	7	100
42/F	Pituitary adenoma	Partial surgical removal	0.58	14	1	4	17.5	7	100
50/F	Pituitary adenoma	Partial surgical removal	4.1	14	2	8	27.5 25 12.5	6	85.4

Fig.1 Summary of clinical and dosimetric data of the first ten patients treated with radiosurgery in Albania

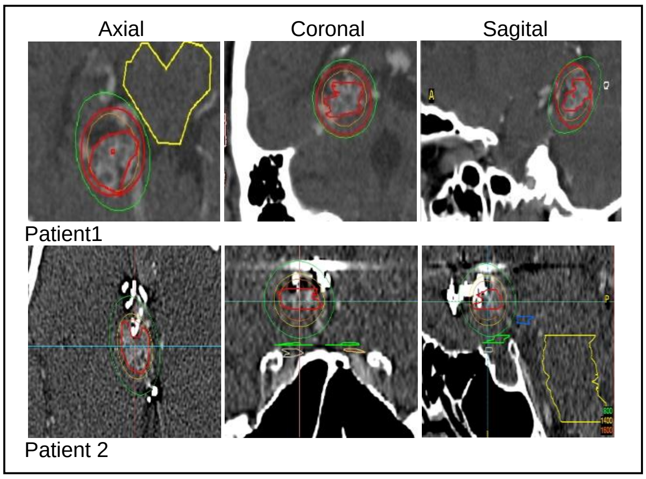

Fig.2 MAV patients- prescribed dose 16 Gy at 90% isodose.

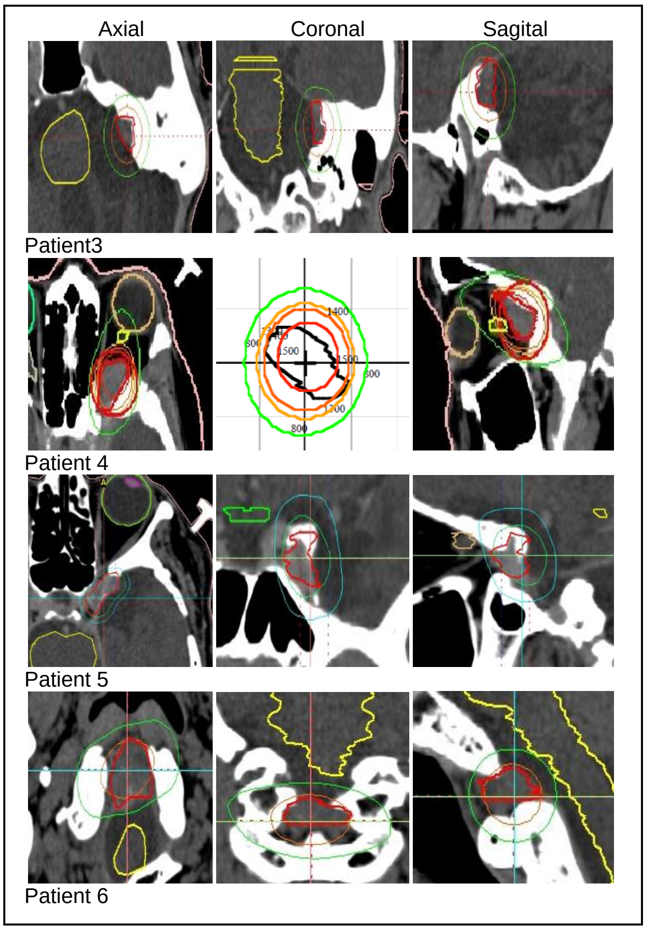

Fig.3 Vestibular schwanoma,Spheno-orbid meningioma, Cavernous sinus meningioma, Clival Cordoma patients-prescribed dose respectively: 13Gy, 14Gy, 14Gy, 15Gy at 90% isodose.

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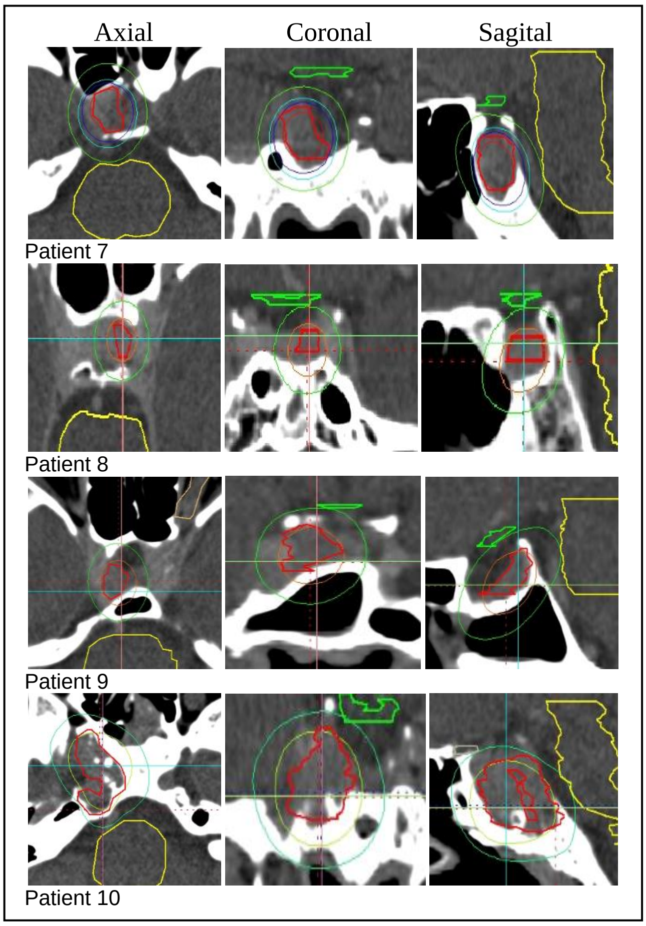

Fig.4 Pituitary Adenoma patients- prescribed dose 14 Gy at 90% isodose.

The DVH for the Target and OAR is plotted and a detailed statistical analysis of the target and of the organs at risk (OARs) is summarized.

B. Target dose Stratistics

Throughout the analysis, the minimum and mean dose values within the target were evaluated. The target minimum dose is a critical parameter under various points of view: to calculate and the significance.

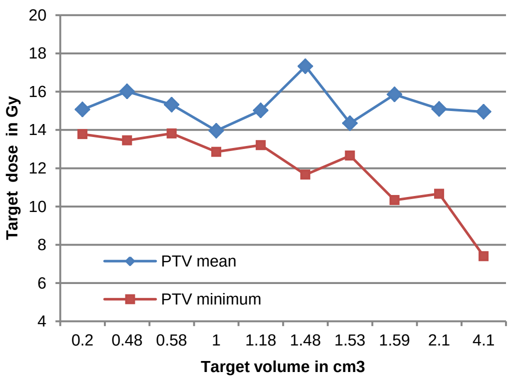

Fig. 5 Target dose mean and minimum versus target volume.

Target coverage (TVR) and conformity index (PITV) are the most frequently cited parameters for evaluation of plans in radiosurgery and Xknife TPS is taking into account the coverage and conformity defined by RTOG guidelines, where TVR is the ratio of minimum dose in target per prescription dose and PITV is the ratio of total volume included by prescription dose per target volume.

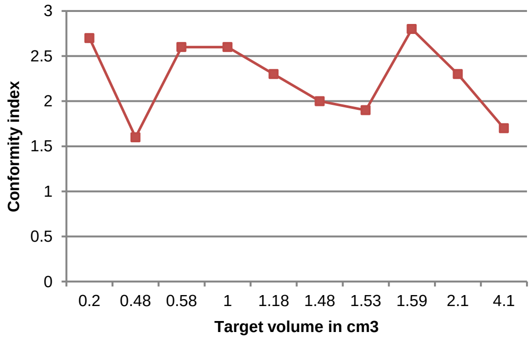

Fig. 6 Conformity index versus target volume.

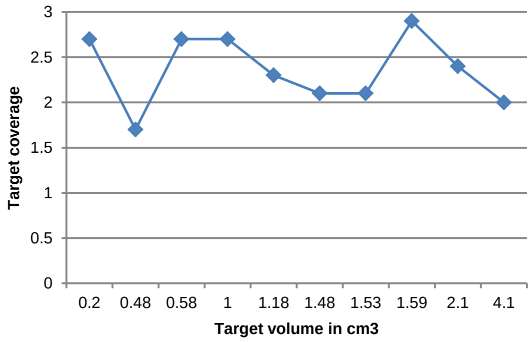

Fig. 6 Target coverage versus target volume.

These goals for PITV and TVR were achieved for 6 of the plans. The plans that did not fulfill the condition were evaluated using dose distribution and the V95.

Treatment plans when using SRS in some cases is often challenging because of the vicinity of the optic nerves and chiasm and they have been the planning priorities for the other four cases that has TVR and PITV over the value of 2.5.

C. OAR Statistics

In spite of the fact that stereotactic radiosurgery has been used for so many years no definite information of different dose response values for different cranial nerves and other critical structures exist. Here it is given a detailed analysis of OARs is presented. In the figure 7, the mean and maximal dose grouped by organ are summarized. For these organs, we limited the parameters to those relevant to the analysis of the impact of different techniques on tolerance levels.

The brain stem is a crucial structure and it is normally considered as a serial structure. In the literature no significant evidence exists that the brain stem is more radiosensitive than other white matter structures. However, the risk for complications must be kept to a minimum. From a detailed analysis of the DVHs, optical nerve optical nerve has exceed the limits of 8

Gy and that was the case of spheno orbid meningioma, while chiasma in two cases of adenoma had a maximum of 10.4 GY. In general the dose to OAR has been kept inside the limits and as low as possible.

	OAR Mean and Max Dose summary for 10 patients									
	Mean/Max									
	1	2	3	4	5	6	7	8	9	10
Optic Chiasma	1.50	4.20	not	1.11	2.50	Not	3.78	3.78	3.45	3.59
	2.50	7.90	painted	2.21	5.00	painted	5.88	7.62	10.41	10.21
BrainStem	2.00	0.50	0.97	0.87	0.20	0.50	1.22	0.75	2.25	9.33
	11.80	1.50	3.10	3.30	2.30	9.00	7.38	3.01	7.46	9.33
Optic Nerve L		0.80	0.20	9.33	1.80	Not	1.90	0.62	0.30	1.36
		1.20	0.56	15.58	7.00	painted	4.64	5.93	1.82	2.65
Optic Nerve R		1.00	Not	0.72	0.10	Not	3.08	0.38	0.39	3.94
		4.50	painted	1.42	0.70	painted	7.84	2.54	1.26	8.39
Eye L		0.08	0.09	3.70	0.10	not	0.70	0.44	0.19	0.39
		0.70	0.09	10.27	0.50	painted	1.32	1.41	0.76	1.04
Eye R		0.20	0.09	0.11	0.10	Not	0.78	0.40	0.24	1.86
		1.90	0.10	0.14	0.20	painted	1.56	1.37	0.85	3.26
Cristalin L		0.10	not	2.52	0.00	1.14	0.54	0.89	0.10	0.24
		0.15	painted	4.70	0.30	1.14	0.78	1.23	0.21	0.25
Cristalin R		0.10	Not	0.10	0.00	0.10	0.65	0.82	0.20	2.18
		0.30	painted	0.11	0.12	0.10	0.99	0.96	0.35	2.56
hipotalamus L		3.80								
		5.00								
Hipotalamus R		4.90								
		7.10								
vein drainage	not painted	11.00	Not painted							
		16.20								

Fig. 7 OAR mean and mac Dose summary for 10 patients

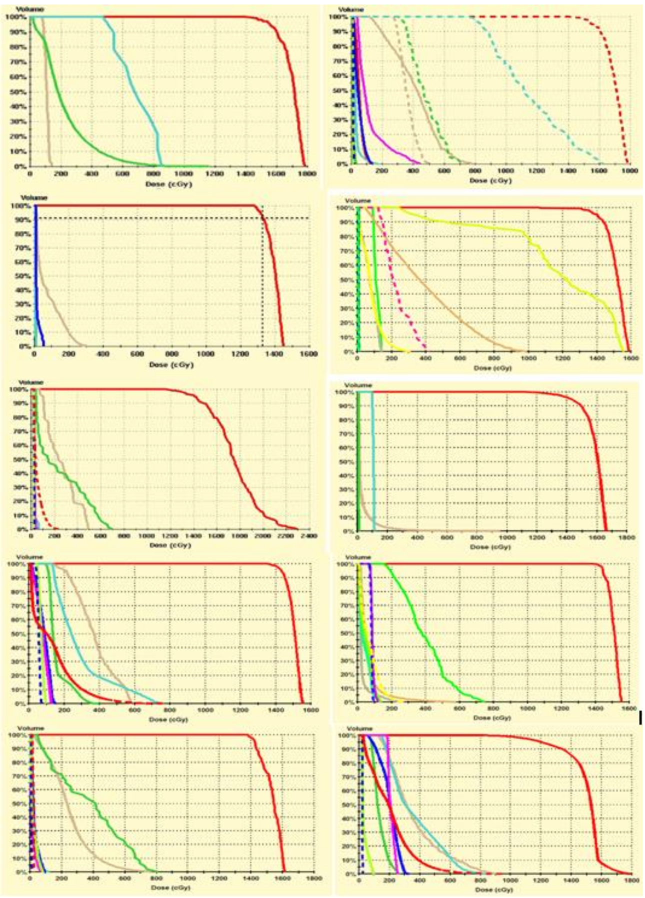

Fig. 8 DVH summary for 10 patients

From a detailed analysis of the DVHs, optical nerve optical nerve has exceed the limits of 8 Gy and that was the case of spheno orbid meningioma, while chiasma in two cases of adenoma had a maximum of 10.4 GY. In general the dose to OAR has been kept inside the limits and as low as possible.

Conclusions

With SRS the target coverage and conformity is achievable. The planning objectives were met in most of the cases. Optimisation of planning parameters to achieve dose distributions minimizing the dose to healthy tissue should be done. SRS is a minimally invasive treatment alternative to open surgery. In most cases, SRS requires no general anesthesia; procedures are relatively pain free. SRS can be used in combination with open surgery for especially difficult or aggressive tumors and conditions. SRS patients can return to normal daily activities within hours or days, rather than weeks as with open surgical procedures.

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