Frameless stereotactic radiosurgery with linear accelerator-based technology for brain metastases : analysis of the outcomes and risk of brain radionecrosis in 141 patients

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Introduction

- Brain metastases (BM) are the most common intracranial tumors in adults.
- Surgery and frame-based stereotactic radiosurgery (SRS) are well-described and effective treatment options, but have issues regarding side effects and patient quality of life.
- Frameless SRS with linear accelerators (LINAC) is a promising technology that doesnt require the use of a rigid head frame.

Objectives

- The aim of this study was to document the clinical outcome and toxicity of frameless SRS with LINAC-based technology for BM treated at our institution.

Methods and Materials

- We realized a retrospective study including patients that were treated with frameless SRS with LINAC-based technology for BM between October 2010 and July 2016.
- Patients were immobilized with individualised mask molded with a thermoplastic pallet.
- Patients were treated with frameless SRS with LINAC-based technology.
- Patients were followed routinely with MRI scans at 3-month intervals or earlier if there was clinical concern.
- Primary endpoints were brain progression-free survival, local control, overall survival and toxicity related to the treatment.
- All survival times were computed with the Kaplan-Meier method.
- All cumulative incidences were computed using competing risks analyses.

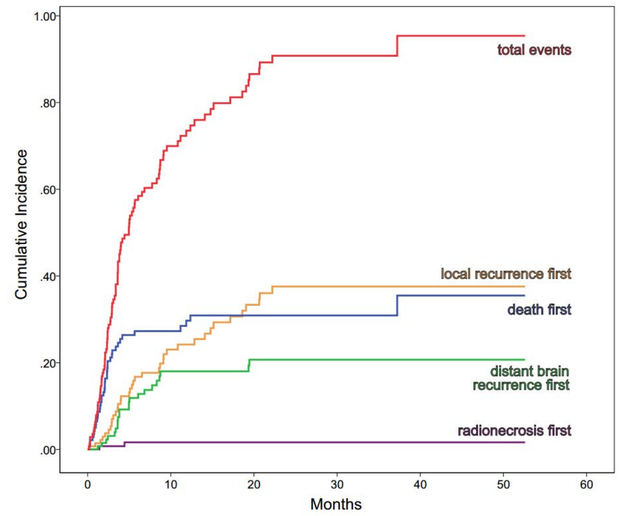


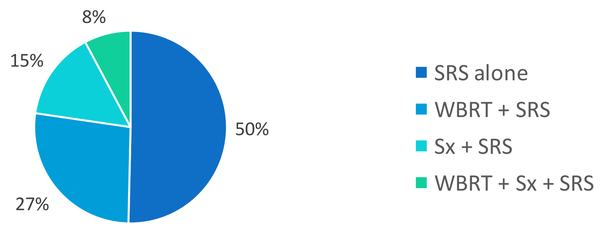
Figure 1. Cumulative incidence of radionecrosis, local recurrence, distant brain recurrence, and death as first event.

Table 1. Baseline patient characteristics.

	[n]	%
Total patients	141	-
Sex		
M	57	40
F	84	60
Age		
Median	62 (range 37-89)	
RPA class		
I	24	17
II	114	81
III	3	2
GPA class		
1	11	8
1.5	45	32
2	32	23
2.5	25	18
3	17	12
3.5	8	6
4	3	2
KPS		
60	3	2
70	63	45
80	34	24
90	35	25
100	6	4

RPA : Recursive Partitioning Analysis, **GPA :** Graded Prognostic Assessment, **KPS :** Karnofsky performance status.

Chart 1. Treatment characteristics.



SRS : Stereotactic radiosurgery, **WBRT** : Whole brain radiotherapy, **Sx** : Surgical resection

Table 2. Baseline tumor characteristics.

	[n]	%
Total lesions	194	-
# lesions per patient		
1	99	70
2	34	24
3+	8	6
Primary diagnosis		
Lung	87	62
Breast	19	13
Colorectal	11	8
Skin melanoma	9	6
Other	15	11
Tumor localisation		
Frontal	70	36
Parietal	30	15
Temporal	20	10
Cerebellar	41	21
Occipital	22	11
Other	11	6
Tumor diameter (mm)		
Mean	17.84	
Median	15.00	

Table 3. Baseline treatments' characteristics.

	Mean	Median
SRS dose (Gy)	16.60	15.00
GTV (cm^3)	6.20	2.91
PTV (cm^3)	10.25	5.23
V10 (cm^3)	21.25	14.17
V12 (cm^3)	12.67	7.81
IC	1.25	1.22
IPaddick's	0.82	0.82

GTV : Gross tumor volume, **PTV :** Planning targeted volume, **V10/V12 :** volume of tissue receiving more than 10 Gy or 12 Gy, **IC :** Conformity index, **IPaddick's :** Paddick's conformity index.

Results

- A total of 194 metastatic lesions in 141 patients were treated in a 69-month interval.
- Baseline patient and tumor characteristics are shown in tables 1 and 2 respectively.
- Most patients (94%) were treated with a single dose of radiation with a median prescribed dose to the PTV of 15 Gy (range 12–24 Gy). Treatment characteristics are shown in table 3 and chart 1.
- The overall survival median was 8.7 months.
- Cumulative incidence of primary outcomes are shown in figure 1.
- At the time of analysis 33 patients were still alive and the median potential follow-up time was 25 months (CI 95% 16.3–27.9).
- The median time to any brain progression was 15 months.
- Local recurrence as a first event was 25% at one year and 38% at two years.
- Distant brain recurrence as a first event was 18% at one year and 21% at two years.
- Death before any brain event occurred in 31% of patients.
- Cumulative incidence of radionecrosis as a first brain event was of 2% (2 events). A multivariate analysis was performed to assess for predictors of radionecrosis, none were found to be statistically significant.

Conclusions

- This retrospective study suggests that Frameless SRS with LINAC technology offers similar survival rates compared to conventional BM treatment while being less invasive and having a better impact on patient comfort.
- Also, this study suggest that Frameless SRS with LINAC technology for BM is safe with a minimal rate of radionecrosis.