Radiographic Response in Metastatic Brain Lesions Treated with Stereotactic Radiosurgery

Alireza Mohammad Mohammadi MD; Pablo F. Recinos MD; Michael A. Vogelbaum MD, PhD; Samuel T. Chao MD; Robert J. Weil MD; Gene H. Barnett MD; John H. Suh; Gennady Neyman; Lilyana Angelov MD

Rose Ella Burkhardt Brain Tumor and Neuro-oncology Center

Cleveland Clinic, Cleveland, Ohio

Introduction

- Stereotactic radiosurgery (SRS) is one of the mainstays of treatment for patients with brain metastases (BM)
- Radiographic response to SRS has been reported to be between 85-95% based upon measurement of maximum tumor diameter, but studies evaluating treated lesions with use of precise volumetric measurements are lacking
- In this study, volumetric measurements were used to evaluate the radiographic response of BMs after SRS and associated prognostic factors

Methods

- 116 patients with multiple BMs (763 BMs total) who had been treated between 1999 and 2010 with SRS at the Cleveland Clinic were evaluated
- Volumetric measurements were made on day of treatment and first follow-up MRIs with use of BrainLAB iPlan software (in case of enlargement more follow up imaging were evaluated)
- Volume changes were measured. Greater than 20% volume increase was used as the threshold for tumor enlargement; more than 20% reduction in tumor size was used as tumor shrinkage threshold
- The effects of different prognostic factors on radiographic response were statistically evaluated
- This study has been approved by the Cleveland Clinic IRB

Results

Gender	• Female: **70** patients (**60**%) • Male: **46** patients (**40**%)
Age	• Median: **57** years • Range: **18-79** years
Extracranial metastases	• Single: **43** patients (**37**%) • Multiple: **44** patients (**38**%)
KPS	• ≤ 70: **23** patients (**20**%) • 80: **44** patients (**38**%) • ≥ 90: **49** patients (**42**%)
GPA	• > 1: **60** patients (**52**%)
RPA	• Class I: **18** patients (**16**%) • Class II: **96** patients (**82**%) • Class III: **2** patients (**2**%)
Neurological symptoms	• Asymptomatic: **26** patients(**22**%) • Symptomatic: **90** patients(**78**%)
Post-SRS survival	• Median: **8** months • Range: **1.2-69** months

KPS: Karnofsky performance status
GPA: Graded prognostic assessment
RPA: Recursive partitioning analysis

Primary Pathology	Lung	**51** patients (**44**%) **332** lesions (**44**%)
	Breast	**27** patients (**23**%) **188** lesions (**25**%)
	Radioresistant (melanoma, RCC)	**24** patients (**21**%) **145** lesions (**19**%)
	Others	**14** patients (**12**%) **98** lesions (**13**%)

Prior WBRT	Concurrent WBRT	Concurrent chemotherapy
65 patients (**56**%)	**23** patients (**20**%)	**66** patients (**57**%)
492 lesions (**65**%)	**149** lesions (**19**%)	**446** lesions (**58**%)

Median tumor volume per lesion:
0.14 cm^3 (range: **0.01-36** cm^3)

- Median of total intracranial disease burden:**2.78**cm^3(range:**0.2-37**cm^3)

Median maximum diameter of lesions:
8 mm (range: **2-50** mm)

Radiographic Response

Enlargement:	Stable:	Shrinkage:
52 lesions (**7**%)	**97** lesions (**13**%)	**614** lesions (**80**%)

Progression:	Radiation effects:	Resolution:
30 lesions (**4**%)	**22** lesions (**3**%)	**251** lesions (**33**%)

Prognostic Factors for Post-SRS Resolution

Primary pathology	• **14**% resolution rate in radioresistant versus **37**% in non-radioresistant lesions • P value **< 0.0001**
Volume of lesions	• Median volume of resolved lesions was **0.05** cm^3 versus **0.28** cm^3 in non-resolved lesions • P value **< 0.0001**
Conformality ratio	• Median conformality ratio of resolved lesions was **2.15** versus **1.92** in non-resolved lesions • P value **< 0.0001**

Prognostic Factor for Post-SRS Enlargement

Primary pathology

Radioresistant pathology: **17** lesions (**12**%)	P value= **0.001**
Non-radioresistant pathology: **28** lesions (**4**%)	

Conclusions

- SRS is a very effective method of local control of brain metastases in patients
- When measured volumetrically, BMs treated with SRS had a favorable response rate (shrinkage + stable) of 93% on initial post-SRS MRI scan
- Only 4% of the enlarged lesions had true progression and the other 3% eventually were diagnosed as changes related to the radiation effects
- Primary tumor pathology was the only important factor in radiographic response of BM to SRS. As radio-resistant pathologies had 12% post-SRS enlargement compared with 5% in other tumors (p value = 0.001)
- No impacts of concurrent WBRT or chemotherapy on post-SRS radiographic response were shown by multivariate analysis
- Smaller tumors, non-radioresistant pathology, and those treated with less conformal plans had a statistically greater probability to resolve completely (seen in 33% of all lesion)