

1. Center for Hyperbaric Medicine, Dartmouth-Hitchcock Medical Center, Lebanon, NH 2. Section of Radiation Oncology, Dartmouth-Hitchcock Medical Center, Lebanon, NH

INTRODUCTION /BACKGROUND

Hyperbaric Oxygen Treatment (HBOT) is used commonly for treating soft tissue radionecrosis. But, the use of HBOT for treatment of central nervous system radiation injury remains controversial. Stereotactic radiosurgery (SRS) is an effective and commonly used treatment for brain metastases and arterio-venous malformations (Figure 1). Radiation necrosis is a potential complication from stereotatic radiosurgery. Radiation necrosis was found in approximately 6% of patients receiving SRS for brain metastases (Chang et al. 2009), and the rate of radiation necrosis can be as high as 50% for those retreated with SRS (Kocher et al. 2014).

Hyperbaric oxygen is an attractive treatment option since it has few side effects, and in most cases of the radiation injury, the effect is durable.

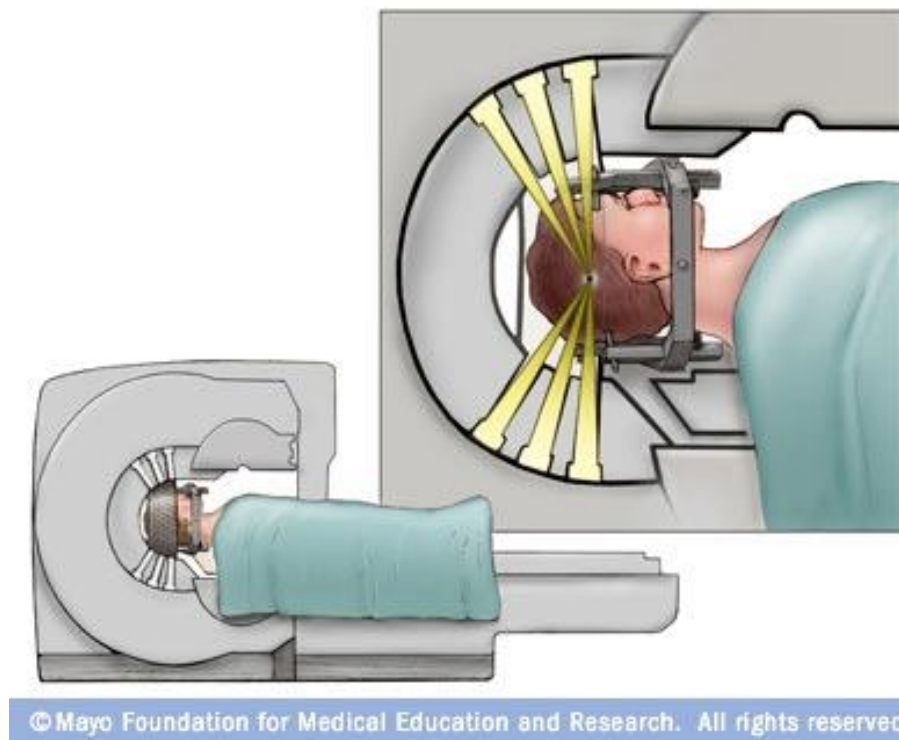


Figure 1. Stereostatic radiosurgery. Convergent beams are used to target a lesion. The technique provides a high dose inside the target volume, a steep dose gradient at the margin, and a low dose outside. The dose is given as a single fraction, usually in the range of 15-24 Gy.

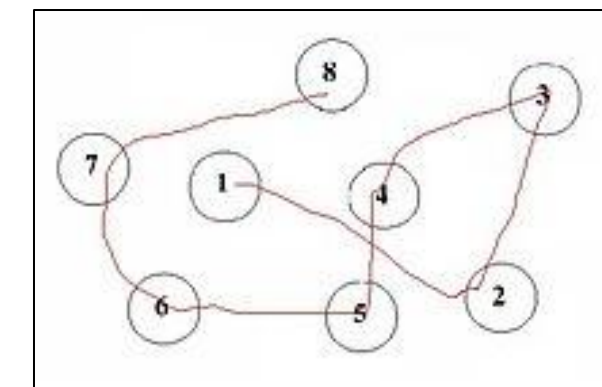
MATERIALS & METHODS

From 2004 through 2013 four patients with brain radionecrosis after successful sterotactic radiosurgery (SRS) treatment of arterial venous malformations were referred to our HBOT center. Neurologic symptoms arose 3 to 47 months after SRS and worsened despite medical management. All 4 patients had MRI evidence of edema at the AVM site prior to HBOT.

Our center has now instituted a hyperbaric registry, for which we collect trail making test and 9-hole peg test results to follow individuals with neurological problems. One person in this series was treated after the registry program was initiated.



9 Hole Peg Test measures dexterity. The subject takes pegs from a container and places them, one by one, into holes on the board as quickly as possible.



Trail Making Test measures visual attention and task switching. The test consists of 2 parts in which the subject connects a set of 25 dots as quickly as possible.

RESULTS

Subject	Gender	Age	Dose (Gy)	#HBOT	ATA	Symptoms	MRI	Clinical status	9-hole peg	Trail making test
1	F	47	18.0	30	2.0	A, S	I	I	ND	ND
2	M	56	15.0	26	2.0	W, S	I	I	ND	ND
3	F	54	20.4	33	2.4	HA, V	I	NI	ND	ND
4	M	70	18.8 x2	40	2.4	W, V	I	NI	I	I

HA=Headache, W=Weakness, V=Visual Problems, A=Aphasia, S=Seizure, I=Improved, NI=Not Improved, ND=Not Done

RESULTS (con't)

- The MRIs of all 4 patients improved after HBOT
- Clinical neurologic symptoms improved for 2 patients.
- Symptoms didn't worsen in the remaining patient who reported no symptomatic improvement
- One patient denied symptomatic improvement, but had significantly improved performance on the 9 hole peg & trail making tests.

SUMMARY / CONCLUSIONS

- MRIs improved in all patients after HBOTs.
- Symptomatic progression halted in all patients.
- 3 out of 4 patients had improvement in signs and symptoms of disease.
- This series supports other case series showing improvements in brain radionecrosis with HBOT.
- Consistent standards for outcomes and entry of all hyperbaric patient data into a registry would allow data comparison from multiple centers.

REFERENCES

Chang EL, Wefel JS, Hess KR, Allen PK, Lang FF, Kornguth DG, Arbuckle RB, Swint JM, Shiu AS, Maor MH, Meyers CA. Neurocognition in patients with brain metastases treated with radiosurgery or radiosurgery plus whole-brain irradiation: a randomised controlled trial. *Lancet Oncol.* Nov;10(11):1037-44, 2009.

Kocher M1, Wittig A, Piroth MD, Treuer H, Seegenschmiedt H, Ruge M, Grosu AL, Guckenberger M. Stereotactic radiosurgery for treatment of brain metastases : A report of the DEGRO Working Group on Stereotactic Radiotherapy. *Strahlenther Onkol.* 2014 Apr 9