



Cyberknife Radiation Treatment and Dosing to Healthy Neurovascular Structures in Jugular Foramen Tumors

Yarah M. Haidar, MD¹; Jay Bhatt, MD¹, Yaser Ghavami, MD¹; Hamid Djalilian, MD^{1,2}

¹Division of Otolaryngology, Department of Otolaryngology - Head and Neck Surgery, and

²Biomedical Engineering, University of California Irvine, Irvine, CA



Purpose

To examine the relationship between the prescribed target dose and the dose to healthy neurovascular structures in jugular foramen tumor patients treated with Cyberknife.

Introduction

- Clinical otological complications after fractionated radiation therapy to the temporal bone are well described
- Pathological changes in inner, middle, and external ear structures have been reported

1. Arteries (Carotid or basilar artery)

- Doses 5-7 Gy initiate atherosclerotic processes and predisposes to complications: CVA risk of 10-20%, increases with time; increased risk of lacunar lesion, telengectasias, and intracranial hemorrhage

2. Trigeminal nerve

- If <13 Gy, the complication rate is less than 5%
- Risk of cranial neuropathy increases by a factor of six with each 2.5 Gy increase over 12.50 Gy
- No clear evidence that fractionation spares CN5

3. Facial Nerve

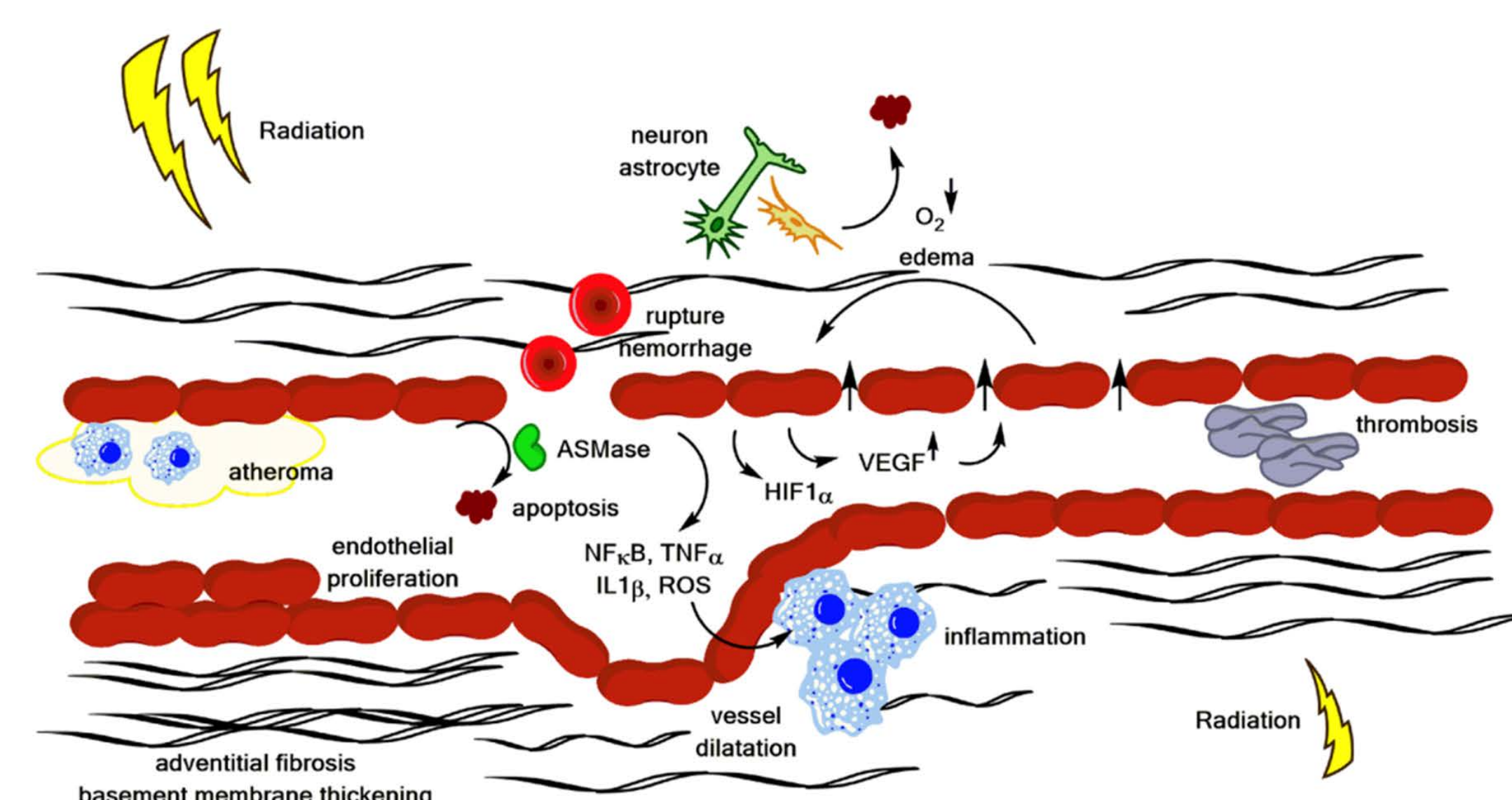
- Can go 70 Gy without injury
- Preservation rate 94-100%
- <1% facial weakness in stereotactic radiosurgery if <13 Gy used
- Some report no weakness in doses <15 Gy

4. Cochlea

- Dose-related toxicity
- Toxicity results in hearing loss
- Larger cochlear volume associated with lower risk of hearing loss

5. Vestibular Nerve

- Dose-related toxicity
- Toxicity results in gait ataxia



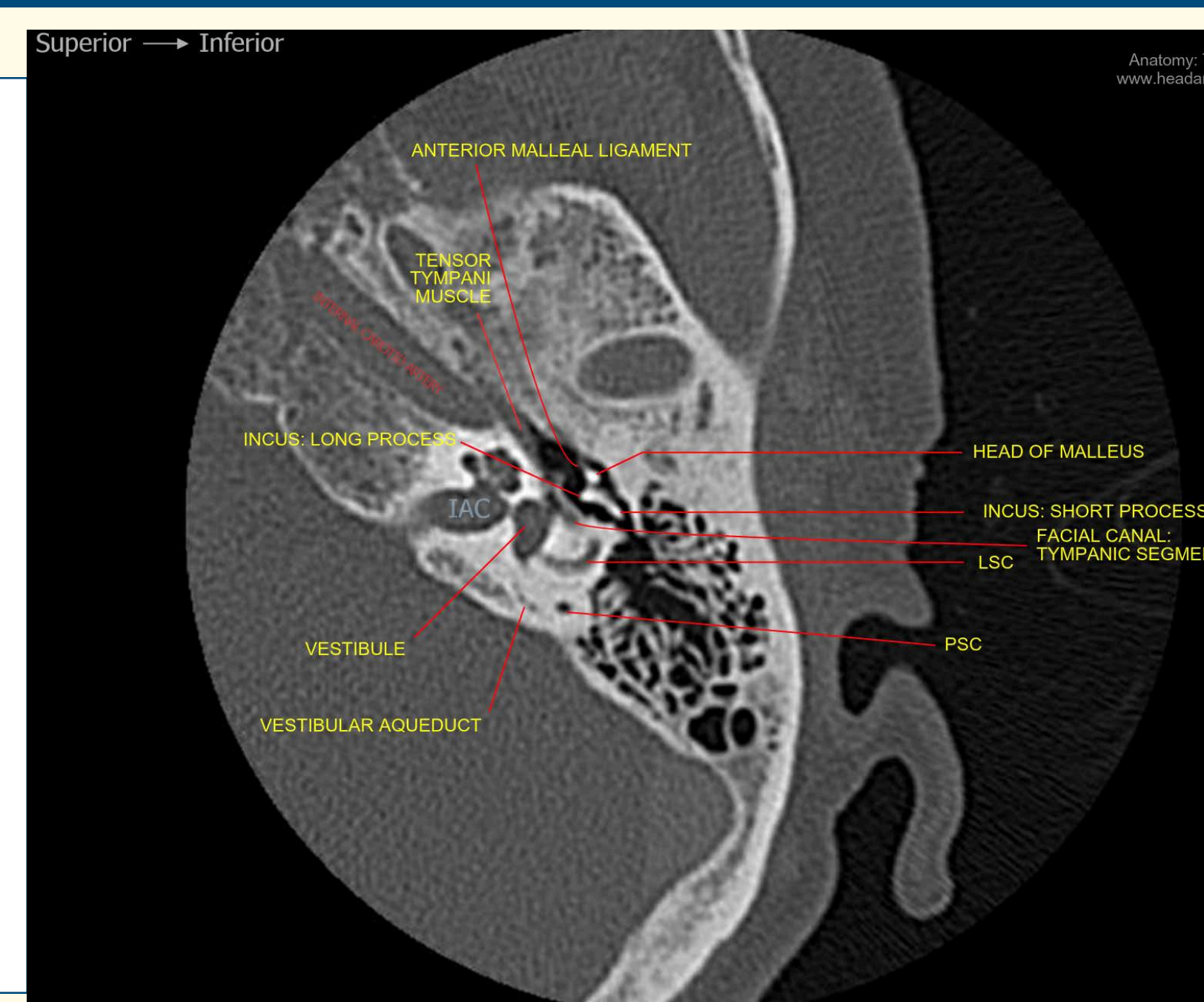
Results

- The prescribed dose ranged from 17.10-23.35Gy over 1-5 fractions to cover 95% of the target tumor volume.
- The mean dose to:
 - Carotid artery - 5.98Gy (range 0.44-17Gy)
 - Basilar artery - 2.68Gy (range 0.98-5.32Gy)
 - Facial nerve - 7.75Gy (range 1.74-18.45Gy)
 - Trigeminal nerve - 3.03Gy (range 0.52-7.75Gy)
 - Cochlea was 6.10Gy (range 1.75 – 18.40Gy)

	Patient #1	Patient #2	Patient #3	Average
Tumor Type	Glomus Tumor	Glomus Tumor	Jugular Foramen Schwannoma	
Minimum dose to 95% of Tumor Volume	1710	1832	2335	1959
Number of Fractions	3	1	5	3
Dose per Fraction (cGy)	600	1500	500	866.7
Tumor Volume (mm³)	3675	1614	2372	2553.7
Tumor Size (cm)	1.7 x 1.3 x 1.7	0.8 x 1.4 x 1.5	2.0 x 1.1 x 1.1	1.5 x 1.3 x 1.4
Carotid Artery Proximal	1300	245	540	695
Carotid Artery Mid	360	69	730	386.3
Carotid Artery Distal	140	44	482	222
Carotid Artery Vertical	1700	535	1032	1089
Carotid Artery - Average	875	223	696	598
Facial Nerve Labyrinthine	516	522	260	432.7
Facial Nerve Geniculate	1038	174	400	537.3
Facial Nerve Middle Ear	1621	314	780	905
Facial Nerve Mastoid	1845	1670	433	1316
Facial Nerve - Average	1255	670	468	797.7
Cochlea Basal Turn	1840	646	540	1008.7
Cochlea Basal Turn opposite end	617	275	644	512
Cochlea Middle Turn	475	248	626	449.7
Cochlea Apex	464	175	756.8	465.3
Cochlea - Average	849	336	641.7	608.9
5th Nerve Cisternal	460	118	775	451
5th Nerve Temporal	125	52	290	155.7
Trigeminal Nerve - Average	292.5	85	532.5	303.3
Basilar Artery	175	98	532	268.3

Methods

- Retrospective study
- Three patients with jugular foramen tumors (two patients with glomus tumors and one patient with a jugular foramen schwannoma) who were treated with fused CT/MRI-guided Cyberknife radiation therapy were examined.
- Average radiation doses delivered to healthy neurovascular structures (e.g. carotid artery, basilar artery, and facial nerve, trigeminal nerve, and cochlea) during treatment were analyzed.



Conclusion

- Doses to carotid artery and basilar artery can reach levels that initiate atherosclerotic processes in jugular foramen tumors treated with Cyberknife
- Doses to facial nerve and trigeminal nerve remain low in the various segments on the nerve during Cyberknife treatment of jugular foramen tumors
- As expected, doses to adjacent healthy neurovascular structures increases with larger tumor volume, increasing the risk of toxicity.
- Overall, image-guided treatment using Cyberknife allows for sufficient dose delivered to the target with low radiation dose to most surrounding neurovascular structures, making radiation safe and effective in the treatment of jugular foramen tumors.



DEPARTMENT OF OTOLARYNGOLOGY
HEAD AND NECK SURGERY

UNIVERSITY of CALIFORNIA, IRVINE • SCHOOL OF MEDICINE

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Please address correspondence to Yarah M. Haidar at haidary@uci.edu or Dr. Hamid Djalilian
Otolaryngology-5386
19182 Jamboree Road
Irvine, CA 92697