Purpose/Objective(s): The brainstem is a critical structure of dosimetric concern for most intracranial radiation treatment. This study is to obtain better understanding of brainstem dose tolerance limits applicable to stereotactic radiosurgery (SRS).

Materials/Methods: RTOG has introduced the dose tolerance limit for brainstem to be 60 Gy at maximum point (defined as a volume greater than 0.03 cc) for conventional radiation therapy. The QUANTEC report has concluded that the risk of brainstem complications increases markedly at doses greater than 64 Gy. For stereotactic radiosurgery and radiation therapy (SRT), few studies have been published on brainstem toxicity with clearly defined data. There are currently no definitive criteria regarding more subtle dose-volume effects or effects after SRS or SRT. Gamma Knife radiosurgery of trigeminal neuralgia (TGN) treatment typically prescribes 75 Gy to 90 Gy to 100%. A single shot of 4 mm collimator without blocking is placed at trigeminal nerve with 50% isodose line touching the brainstem. Brainstem consequently receives significantly higher dose. Nevertheless, no major complications associated with radiation have ever been reported. Base on our experience, less than 10% of the patients had mild facial numbness and no unexpected radiographic change was seen in the post-op MRI. Our follow-up time ranges from 4 months to 41 months. The risk of numbness seems not increase with higher prescription dose. The QUANTEC report has pointed out that understanding of brainstem tolerance thresholds is hampered by the ambiguous data of the range of doses and volumes in the literature. In this study, a retrospective analysis was performed on 30 TGN cases treated with Gamma Knife Perfexion at Cooper. The dose volume data are converted to different fractionations using LQ model and discussed with the published data points on brainstem from QUANTEC report and RTOG protocols.

Results: Based on the dose-volume histogram (DVH) data of our trigeminal neuralgia cases, the brainstem has got the dose-volume relationship in mean dose as such, 45.1 Gy for maximum to a volume of 0.1 mm$^3$, 18.5 Gy for maximum point to a volume of 0.03 cc, 11.0 Gy to a volume of 0.1 cc, 3.3 Gy to a volume of 1 cc and 9.9 Gy to 1% volume of brainstem. Our dose points are plotted out and compared with the published tolerance limits in one, five and conventional fractionation using the LQ model.

Conclusions: A maximum point dose of 18.5 Gy in one fraction is equivalent to about 80 Gy in 2 Gy per fraction, which is 20 Gy beyond the brainstem dose limit recommended by RTOG. The LQ model is questionable in the very high dose regime. Our data has shown that the dose tolerance limits in hypofractionated SRS and SRT may not agree with that predicted by conventional fractionation.

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