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Introduction

CyberKnife stereotactic radiosurgery (SRS) for trigeminal neuralgia (TGN) administers non-isometric, conformational high-dose radiation to the root entry zone, with possible post-procedural numbness from excessive brainstem exposure. We evaluated outcomes from two treatment plans differing in their maximum brainstem dose.

Methods

A retrospective, single-institution review of 91 TGN patients treated with CyberKnife from January 2005-May 2007 (Plan A, N=47) and January 2009-August 2013 (Plan B, N=44) was conducted. Plan A (vs B) aimed for a maximum brainstem dose of 40 vs 25 Gy, respectively, both in one fraction with 75 Gy to the 100% isodose line. Primary outcome was self-reported pain control. Secondary outcomes included change in Barrow Neurologic Institute (BNI) pain and numbness scores. Pre-pontine nerve length, maximum brainstem dose, and treatment history were additionally recorded for their predictive contribution by matched-cohort regression.

Results

Patients were followed for a mean of 23 months, and 62% were naïve to treatment. Plans A and B exhibited treatment failure, durable improvement, and pain recurrence in 6.4% vs 18.0% (p=0.084), 68.1% vs 36.4% (p=0.002), and 25.5% vs 45.5% (p = 0.047), respectively. Mean BNI pain scores improved for 74.5% vs 61.3% (p=0.18), while BNI numbness scores increased for 45.2% and 72.7% (p=0.042). Cohorts differed in baseline nerve length at 10.1 mm vs 7.5 mm (p<0.001). Regression analysis on cohorts matched by length demonstrated that treatment plans allowing higher brainstem maximum dosing was associated with pain improvement (p=0.05), and univariate analyses showing longer nerve length predicted decreased numbness (p=0.03). Furthermore, under Plan A, improvement was predicted by age, prior decompression and prior SRS (AUC=0.82).

Conclusions

These outcomes show a higher maximum brainstem dose constraint may result in better pain control without worsening rates of facial numbness. Future application of CyberKnife SRS may consider higher doses in patients with longer nerves and no prior treatment history.

Learning Objectives

1) Appreciate isodose-planning adaptations in high-dose, confined spacing of TGN treatment

2) Optimize patient selection based on history, dosing, and anatomic considerations

3) Consider the permissive brainstem dosing to safely improve pain-control

References

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