A Spheroid Weighted-Axis Converter of Vestibular Schwannoma Size: Maximum Diameter and Cisternal Volume

Brandon L. Prendes, MD1, Eli R. Groppo, MD1, Catherine L. Reynolds, MD2, Andrew T. Parsa, MD1, PhD2, Steven W. Cheung, MD1
1Department of Otolaryngology - Head and Neck Surgery & 2Department of Neurosurgery, University of California, San Francisco

INTRODUCTION

Vestibular schwannomas (VS) comprise nearly 85% of tumors in the cerebellopontine angle. Medical decision-making for these benign neuraxis tumors is complex, with several primary treatment options including observation, radiation therapy (Gammaknife or CyberKnife); and (3) observation with serial magnetic resonance imaging (MRI) scans. However, there is not yet consensus on a universal reporting standard for measures of tumor size. Linear measurements predominate in the microsurgical literature, whereas tumor volume is typically reported in the radiosurgical literature. Reporting variability of VS tumor size has made it difficult to reconcile outcomes studies. We propose an accessible tool for bidirectional conversion of volumetric and linear indices of tumor size to unlock potential for meta-analyses of disparate data sets.

METHODS

1) Meatal Component: Modeled from linear measurements “L” and “T” using the average volume of a cone and cylinder.
2) Cisternal Component: Measured maximum tumor length in the axial IAC plane, use the median of an ellipse.
3) Ellipsoid (df = 3): a, b, and c are independent.
4) Spheroid (df = 1): a is independent; b = g(a); c is a weighted function of a [b = g(a)].

Model Optimization:

Pairwise comparisons of the four models were performed using the t-test with Bonferroni correction. Linear predictive models were evaluated for goodness of fit using the sum-of-squares R². The spheroid model was subsequently mathematically inverted to provide an inversion model for estimates of tumor size has made it difficult to reconcile outcomes studies. The spheroid model was subsequently mathematically inverted to provide an inversion model for estimates of maximum cisternal diameter, a parameter that is commonly reported throughout previous case reports.

RESULTS

The overall strategy for developing ellipsoid models with progressively fewer input parameters was to transform the data from linear measurements to a single independent input factor into this model.

REFERENCES


CONTACT

Email: bprendes@ohns.ucsf.edu

The Microsoft Word document contains the full text of the research paper, including the introduction, methods, results, discussion, references, and conclusion. The paper discusses the development of a spheroid weighted-axis converter for predicting cisternal tumor volume from linear measurements of tumor size. The converter is designed to address the variability in reporting tumor size, which has made it difficult to reconcile outcomes studies. The paper includes a mathematical model that requires only a single independent input value of maximum cisternal diameter, a parameter that is commonly reported throughout previous case reports. The model utilizes dependent input parameters of: 1) minor axis length as a linear function of major axis length (2) craniocaudal axis length as the geometric mean of measured major and modeled minor axis lengths. The model was subsequently mathematically inverted to provide an inversion model for estimates of maximum cisternal diameter, which is a parameter that is commonly reported throughout previous case reports. The success of the proposed spheroid weighted-axis converter is demonstrated by the near-zero mean error range of 3% for prediction of tumor volume and the interquartile error range between 2 and 3 mm for the inversion model prediction of linear maximum cisternal diameter. The model was further validated by clinical studies, which demonstrated high levels of performance for the spheroid weighted-axis converter.