

Artificial Intelligence Algorithm Estimates Vestibular Schwannoma Volume from Simple 2D Measurements

Bartłomiej Roj¹, MBBS; Camille Milton², MD; Michael Poon¹, MBChB, PhD; Cristina Cernei¹, MBBS; Crispin Wigfield¹, MBChB, MD, FRCS; Nitin Mukerji³, MD, FRCS; Mario Teo¹, MBChB, PhD, FRCS;

¹ Department of Neurosurgery, Southmead Hospital, Bristol, UK; ²Department of Neurosurgery, University of Tennessee Health Science Center, TN, US; ³Department of Neurosurgery, James Cook University Hospital, Middlesbrough, UK

Introduction

Vestibular schwannoma (VS) are frequently assessed using a single linear measurement on standard 2D MRI. While convenient, this approach is inaccurate: tumours seldom align with imaging axes and placement variability can alter management. Post-operatively, small or irregular remnants are especially difficult to quantify, complicating follow-up and influencing decisions about stereotactic radiosurgery (SRS). This pilot study evaluated the feasibility of a clinic-ready, publicly accessible calculator that estimates 3D VS volume from two routine 2D measurements, enabling volumetric assessment without specialist software.

Methods and Materials

Pre-operative imaging from patients who underwent VS micro-surgery was retrospectively analysed. The dataset comprised of 94 patients with 103 gadolinium-enhanced MRI studies between 2017 and 2022. 5 scans were excluded due to a cystic component, making volumetric estimation inconsistent. Coordinate placement was standardised across axial, coronal and sagittal planes —the endpoints of the tumour in each orientation were marked giving twelve points in total (four per plane, two measurements per slice) (Figure 1).



Figure 1 – Standardised x,y,z co-ordinate extraction

The medial-lateral axial line was always drawn from the IAM to the brainstem–VS interface to guarantee consistency (Figure 2). Ground-truth volume for full tumour and only canicular segment was obtained separately with the Brainlab smart volumetric tool.

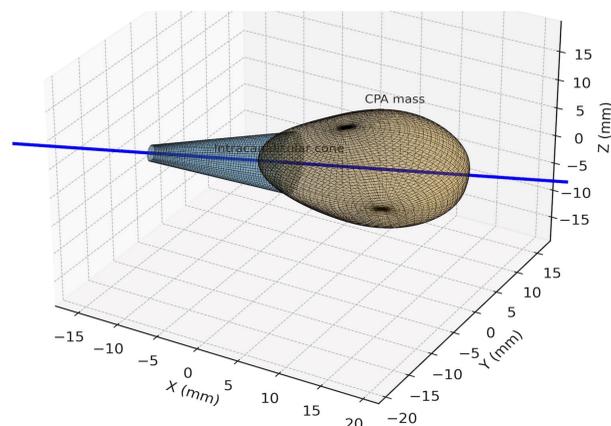


Figure 2 – Standardized model used for volume extraction

Two predictive models were trained to obtain volume from two axial measurements. The models included a gradient-boosted machine (GBM) and a Set Transformer deep learning model. Evaluation used grouped cross-validation by patient to avoid leakage. Testing was performed in two cohorts: all scans (VS a) and those with ground-truth volumes $\geq 2\text{cm}^3$ (VS-2), given the expected variability in small tumours.

Results

98 scans were analysed. The Set Transformer model achieved an accuracy of 92.8% in the VS-2 model (Figure 3) and 85.7% in the VS-a model.

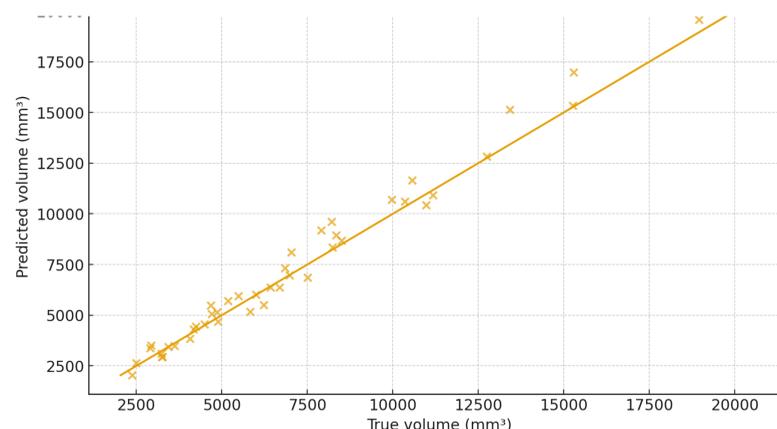


Figure 3 – Calibration plot - predicted volume versus true volume

This was a substantial increase from the GBM model achieving an accuracy of 78.0% in the VS-2 model and 59.7% in the VS-a model, highlighting the importance of relevant model selection in AI development. Deep learning demonstrated clear superiority over traditional machine learning for estimating VS volume from limited inputs (Figure 4 and Figure 5).

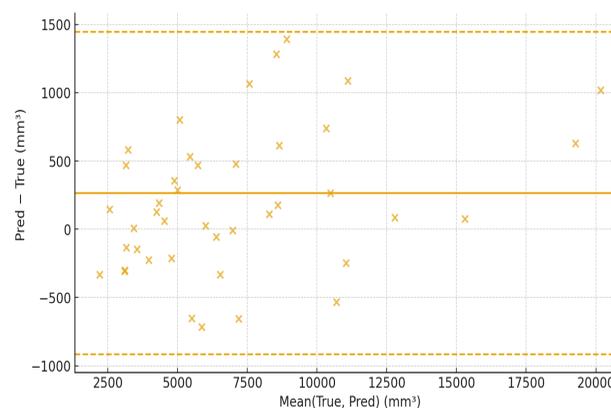


Figure 4 - Bland–Altman plot showing mean predicted vs true volume

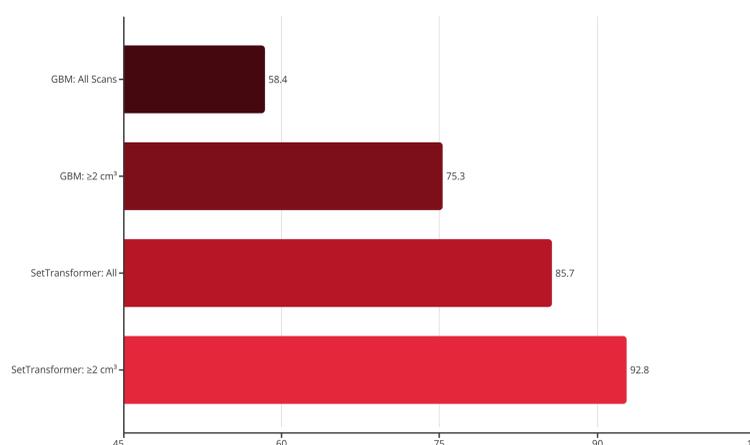


Figure 5 – Model accuracy and performance

Conclusions

This pilot study demonstrates that accurate volumetric estimation of VS is feasible using only two 2D measurements, bringing equity to everyday practice. By standardising what clinicians already do in regular imaging viewing software, this approach has the potential to track growth during follow-up, accurately estimate residual post-op and distinguish true progression from pseudo growth after SRS.

This provides proof-of-concept for larger, multi-centre datasets to train a next-generation deep-learning model. Future work should extend applicability to smaller tumours and incorporate predictive modelling to forecast growth. If validated, such forecasts could reduce the need for some follow-up MRI scans and support earlier decisions about management. By packaging the current method initially as an online tool for volumetric measurements, this provides equity and easily accessible technology to all clinicians.

Contact to collaborate

Bartłomiej Roj
Department of Neurosurgery
Southmead Hospital, Bristol, UK
bartlomiej.roj@nbt.nhs.uk
+447504429468

Mario Teo
Department of Neurosurgery
Southmead Hospital, Bristol, UK
Mario.teo@nbt.nhs.uk

