

Assessment of the Accuracy of a Multimodality Surgical Navigator

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INTRODUCTION

THE objective was to study the working accuracy of the surgical navigator used at Oulu University Hospital with a phantom and accuracy assessment protocol that was developed by the research group at the University of Oulu, Oulu, Finland.

The purpose of the study was to assess the accuracy of a navigational device routinely used in the hospital. Both optical tracking and electromagnetic tracking system (EMTS) modalities were assessed and their accuracy compared..

MATERIALS AND METHODS

The navigational device was the StealthStation Treon+ by Medtronic Inc. (Minneapolis MN, USA). The operating environment was the Neurosurgical Research Unit at Oulu University Hospital. The phantom consisted of three circular levels 220 mm in diameter with calibration points at 22 mm intervals. [1, 2]

Accuracy testing of the navigator was divided into three key steps: (1) Phantom image data was collected with a high-field (1.5 T) MR-scanner (General Electric, Fairfield CT, USA) using a 3D T₁ –weighted sequence with no gap between the slices. (2) The phantom was registered to the image data using landmark based technique. (3) The surgical navigator's accuracy with both tracking modalities was tested by touching the calibration points on the phantom with a calibration instrument and noting the displacement errors with respect to the known distances. [1, 2]

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RESULTS

The test data was collected from the three phantom level calibration points using the same accuracy assessment protocol and set-up [1, 2] for both tracking modalities. The error analysis comparison was made point-by-point and the overall error difference between the modalities was then calculated for the entire phantom. Table 1 shows the accuracy analysis results of the position errors, E representing the accuracy error.

TABLE 1
COMPARISON OF THE NAVIGATOR MODALITIES (MM)

	E, Optical vs. Phantom	E, EMTS vs. Phantom	E, Optical vs. E, EMTS
Mean Position Error, E	0,27	0,63	0,36
Standard Deviation, σ	0,18	0,52	0,44
Variance, μ	0,03	0,27	0,24
Min. position error, E _{MIN}	0,048	0,013	0,04
Max. position error, E _{MAX}	0,70	1,71	1,01

The overall error for the optical tracking modality at the compared calibration points was 0.27 mm with a standard deviation of ± 0.09 mm and variance of 0.03 mm and for the EMTS correspondingly 0.63 mm with a standard deviation of ± 0.26 mm and variance of 0.27 mm. Some large outlier errors E_{MAX} for both modalities occurred at the same points on the periphery of the phantom. Comparing the modalities, the overall error difference was 0.36 mm with a standard deviation of ± 0.22 mm and variance of 0.24 mm [1].

CONCLUSIONS

The navigator displays anatomical regions where the surgeon may navigate with confidence that the localization error is ≤ 1 mm [3]. The present phantom study showed that the accuracies of both the optical and EMTS modalities, even after one year of rigorous use in the operating room, were nearly equal and had remained within the safe error range for image-guided surgical procedures.

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