OPTICAL TOPOGRAPHIC IMAGING FOR SPINAL INTRAOPERATIVE 3D NAVIGATION IN MINIMALLY INVASIVE APPROACHES: INITIAL PRECLINICAL EXPERIENCE

Authors: Daipayan Guha[1], Raphael J akubovic[2], Shaurya Gupta[1], Albert Yee[1,3],Victor Yang[1,3]

ABSTRACT

Background: Computer-assisted3Dnavigationmayguidespinalinstrumentation.Anovel optical topographic imaging (OTI) system for spinal navigation has been developed and described separately. Although it offers comparable accuracy and significantly faster registration relative to current navigation systems, OTI to date has been applied only to open posterior exposures. Here, we explore the utility of OTI in minimally invasive (MIS) approaches.Methods: Mini-open midline posterior exposures were performed in 5 human cadavers. The spinous process and medial half of the bilateral laminae were exposed at T2, T6, T10 and L3. The retractor widthwas increased serially to create exposures of 25, 30, 35 and 40 mm^2. The exposed anatomy at each size was then registered to a pre-operative thin-slice computed tomography (CT) scan. Using the second-smallest exposure resulting in successful registration, screw tracts were created using a tracked awl and gearshift probe, and an appropriately sized screw was placed. Navigation data were compared with screw positions on postoperative CT imaging, and the absolute translational and angular deviations were computed.

Results: Thirty-seven cadaveric screws were analyzed: 8 pedicle screws at T2, 10 pedicle screws at T6, 9 pedicle screws at T10, and 4 pedicle and 6 cortical screws at L3. Overall absolute translational errors were 1.79 mm ± 1.43 mm and 1.81 mm ± 1.51 mm in the axial and sagittal planes, respectively. Absolute angular deviations were 3.81° ± 2.91° and 3.45°± 2.82°, respectively. There were no differences in errors between levels, nor between L3 cortical and pedicle screws. The number of surface points registered by the navigation system correlated positively with the likelihood of successful registration (odds ratio 1.02, 95% CI 1.009–1.024, $p < 0.0001$), but not with any absolute navigation error, independent of the size of the exposure. Conclusion: Optical machine vision is a novel navigation technique previously validated for open posterior exposures. OTI has comparable accuracy for mini-open MIS exposures, with the likelihood of successful registration affected more by the geometry of the exposure than its size.

Partners: [1]University of Toronto, Toronto, Ont.; [2] Ryerson University, Toronto, Ont.; and [3]Sunnybrook Health Sciences Centre, Toronto, Ont.

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