PRE-CLINICAL AND INITIAL CLINICAL EXPERIENCE OF A NOVEL RAPID INTRA-OPERATIVE REGISTRATION TECHNIQUE OF OPTICAL MACHINE-VISION TO PRE-OPERATIVE IMAGING FOR SPINAL SURGICAL NAVIGATION

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ABSTRACT

Introduction: Computer-assisted navigation is standard for most cranial procedures, and is employed in the spine to guide instrumentation, bony decompression and soft-tissue resection. Current navigation techniques register patient surface anatomy to either pre- or intra-operative imaging. The former is hampered by lengthy setup and registration protocols as well as an inability to account for intra-operative tissue movement; the latter requires setup of cumbersome imaging units, and exposes patients to additional intra-operative radiation.

Methods: Anovelstructured-light-basedopticaltopographicimaging(OTI)systemwas developed for spinal neuronavigation (Fig. 1). Initial validation was performed in 4 adult swine, followed 2017 Meeting Abstracts: AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves Neurosurg Focus Volume 42 • March 2017 A44 by clinical validation in 53 patients undergoing open posterior thoracolumbar instrumentation. Registrations to thin- slice preoperative CT imaging were performed using OTI and benchmarked to existing neuronavigation systems (StealthStation/O-Arm, Nav3i). Navigation data was compared to post-operative imaging, and the absolute deviation of final screw positions from intra- operatively planned trajectories computed (Fig. 2). Final screw positions were also graded clinico radiographically using the Heary classification, independently by 7 raters.

Results: For 71 screws placed in 4 adult swine, translational and angular median(95%) errors were 1.67mm(5.12mm)/4.37°(12.95°) and 1.63mm(7.81mm)/6.50°(17.76°) in the axial and sagittal planes, respectively. In human clinical trials, with 129 screws placed with OTI in 22 patients and 209 screws placed with benchmark systems in 31 patients, OTI registration was achieved using 2251+/-1047 surface points per vertebral level (mean+/-SD). Registration and manual verification of navigation accuracy were performed significantly faster than both benchmark systems (mean 40s vs. 258s and 794s). Translational and angular median(95%) errors of 1.21mm(2.99mm)/1.80°(6.60°) and 1.45mm(3.57mm)/2.02°(7.62°) in the axial and sagittal planes, respectively, were achieved with OTI. No significant differences in clinicoradiographic grading or absolute quantitative errors between OTI and benchmark systems were observed.

Conclusion: Optical machine vision is faster and comparably accurate for spinal neuronavigation. Rapid structured-light illumination allows efficient initial and repeat registrations with minimal workflow disruption

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