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Research Abstracts

Objective Metrics Based on Hand Rotation for Vascular Suturing Skills Assessment

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Introduction: Suturing is a basic yet vital part of vascular surgery that requires excellent cognitive, sensorimotor, and technical skills critical for managing delicate vasculature. This study explores the value of rotational motions along the hand-roll axis for skills assessment on a radial suturing task patterned after the Fundamentals of Vascular Surgery curriculum. 99 subjects at various skill levels completed four trials with 12 interrupted sutures per trial in two conditions (superficial and deep) on a clock face pattern affixed on a bench-top suturing simulator.

Methods: The dataset consisted of 4675 sutures [393 trials: 146 from attending surgeons and fellows, 122 from residents PGY1-5, 125 from students]. Four gyroscope-based suturing performance metrics were used: 1) average number of rotational hand motions, 2) average range of rotations, 3) log dimensionless jerk (LDLJ), 4) spectral arc length (SPARC). All metrics were computed from the roll axis of the gyroscope data during active suturing cycles of each trial. Segmentation of each suture cycle was done automatically from needle entry to exit based on the feedback of a camera placed at the simulator bed.

Results: Mann-Whitney U tests were used to investigate if metrics demonstrated significant differences between skill levels (Table I). All four metrics were able to differentiate between surgeons and students. The number of rotational hand motions metric showed a significantly greater economy of rotational motions between surgeons vs. residents and between residents vs. students. The range of rotational hand motions metric was able to differentiate between both the surgeon and resident groups vs. students. LDLJ demonstrated significantly better rotational smoothness for surgeons in comparison to residents and students, respectively. SPARC showed a significant difference between students vs. the other two groups.

Conclusions: Overall, metrics quantifying hand roll during suturing used in this study demonstrated the ability to differentiate between surgeons/fellows, residents, and students. As such, there is value in using gyroscope-based metrics for suturing skills assessment which holds promise for finer grade comparisons between surgeons, residents, and medical students.

Table I. P-values from Mann-Whitney U test comparisons of gyroscope-based metrics.

<i>Populations/Metrics</i>	Num of Discrete Rotational Hand Motions	Avg Range of All Rotational Hand Motions	Avg Rotational LDLJ-V on the Roll Axis	Avg Rotational SPARC on the Roll Axis
Surgeons vs. Residents	7.6e-05	0.065	0.0015	0.055
Surgeons vs. Students	5.6e-23	3.2e-16	0.0012	8.7e-14
Residents vs. Students	1.04e-12	4.7e-13	0.85	3.4e-09