**MOVEMENT CONSISTENCY BY OPTICAL TRACKING CORRELATES WITH SURGICAL EXPERTISE**

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**Introduction**

Automated, objective evaluation may lead to an improved understanding of surgical dexterity. Previous research has identified the discriminating power of simple measures such as instrument path length and motion smoothness in differentiating expert and novice surgeons. However, these approaches provide limited feedback to trainees and are not able to reliably distinguish between higher levels of surgical skill. This study presents a novel method of automatically assessing surgical expertise that may be used to objectively evaluate surgical skill and provide surgeons with more detailed feedback.

**Methods and Procedures**

Ten participants performed simple interrupted sutures on synthetic tissue using a pair of laparoscopic needle drivers instrumented for optical motion tracking. Each of the recorded stitches was manually segmented into *surgemes* (the individual movements that comprise the suturing task). The movement of the needle drivers, including force and torque applied, was recorded. The curvature of the trajectory and the energy between the instrument tips and synthetic tissue was calculated. The curvature and energy signals from each surgeme were cross-correlated between stitches to measure movement consistency.

**Results**

For simple surgemes, experts performed similar movements. These similarities were reflected in the cross correlation of the curvature and energy signals. Surgical skill was evaluated by comparing the cross correlations to a noise model. Participants with high skill had a high correlation (8 of 10 surgemes correlate strongly $p<0.05$ between stitches). Participants with lower skill had more varied movements on the simple surgemes and the cross correlations were lower (only 2 of 10 significant correlations). This method also provides qualitative information on where and how the gestures differed within a surgeme. Sections of the gesture with low correlation were indicative of low skill and could be used to guide further training.

**Conclusions**

We have developed a new method for evaluating surgical proficiency by measuring the consistency of a surgeon's movements. This method is capable of identifying surgical skill for simple movements and identifying how movements differ. This method has the potential to increase the accuracy of current evaluation methods and to provide more detailed feedback to trainees. This information could also be used in virtual reality training systems to provide haptic guidance to correct a surgeon's movements. Furthermore, the data can be viewed directly to understand why the movements differ, as curvature and energy are intuitively understandable when visualized. This method of analysis can be applied to any surgical task without extensive training of the system and it does not use complex statistical modeling. Further work in automated segmentation will likely improve the effectiveness of this method and make it robust to more complex movement sequences.