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Joseph O'Sullivan

Adam Rosencrans

Taylor Kong

Alexandra Bray

Carolin Curtze

See next page for additional authors

Authors
Joseph O'Sullivan, Adam Rosencrans, Taylor Kong, Alexandra Bray, Carolin Curtze, Andrea Herzka, Dennis Crawford, and Jacqueline Brady

Handedness and Specimen Chirality Affect Resident Upper Extremity Motion Patterns During Arthroscopic Simulation

Providence Sacred Heart Medical Center

Joseph O'Sullivan, MD[1]; Adam Rosencrans, BS[1]; Taylor Kong, BS[1]; Alexandra Bray, MD[2]; Carolin Curtze, PhD[3]; Andrea Herzka, MD[1]; Dennis Crawford, MD, PhD[1]; Jacqueline Brady, MD[1]

[1]Oregon Health & Science University, [2] UC Irvine School of Medicine, [3]University of Nebraska Omaha

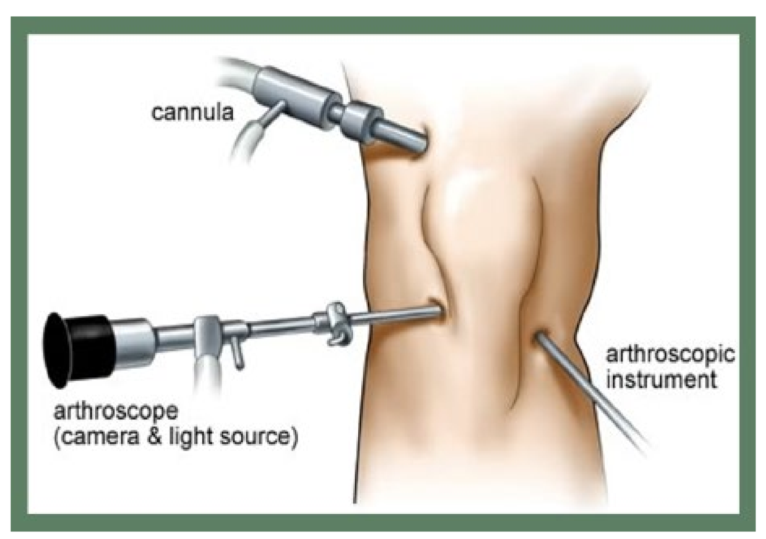
Orthopaedics Rehabilitation OHSU

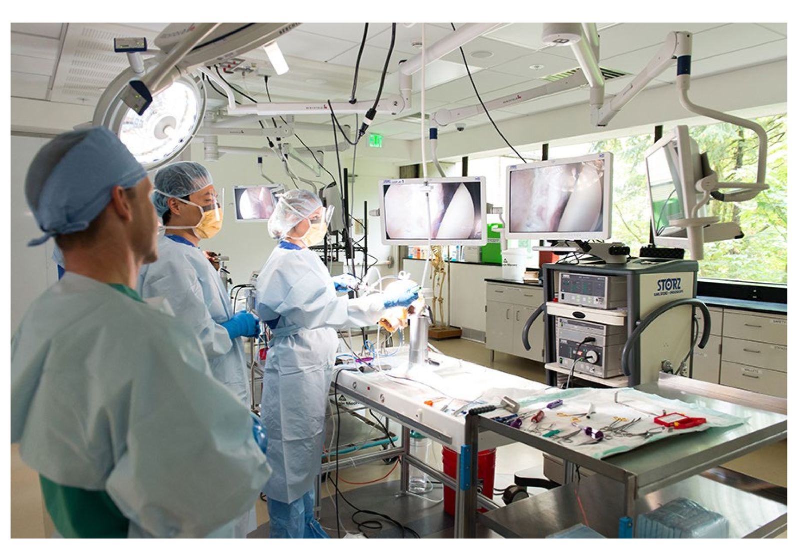
Background

Arthroscopy is a challenging surgical skill that requires careful ambidextrous control of instruments. Simulation using wearable motion sensors provides an alternative method of acquiring arthroscopic skills in a standardized environment with the opportunity for assessment and feedback. As surgeons improve their procedural skills, less movement is observed in the shoulder, elbow, and wrist.[1] This can be detected by sensors through joint kinematics. Therefore, wearable motion sensors may be used to provide a ubiquitous and objective method of evaluating skill improvement over time.

Purpose

To determine the effect of handedness and specimen chirality on performance of arthroscopic simulation, and the ability of wearable inertial sensors to detect improvement over time.





Methods

10 orthopaedic surgery residents were assessed at onset and conclusion of their 10-week sports rotation

Each learner performed diagnostic arthroscopy using right and left cadaveric knees (2 pretests, 2 posttests)

Arm movement data were collected using inertial measurement units (Opal™ Sensors, ADPM® Portland, Oregon)

In total, 6 sensors were placed on each subject for motion assessment (2 lateral arm, 2 dorsal forearm, 1 sternum, 1 lumbar spine).

Results

Participants demonstrated more reduction in shoulder movement over time using a probe with the nondominant hand than with the dominant hand (Figure 1).

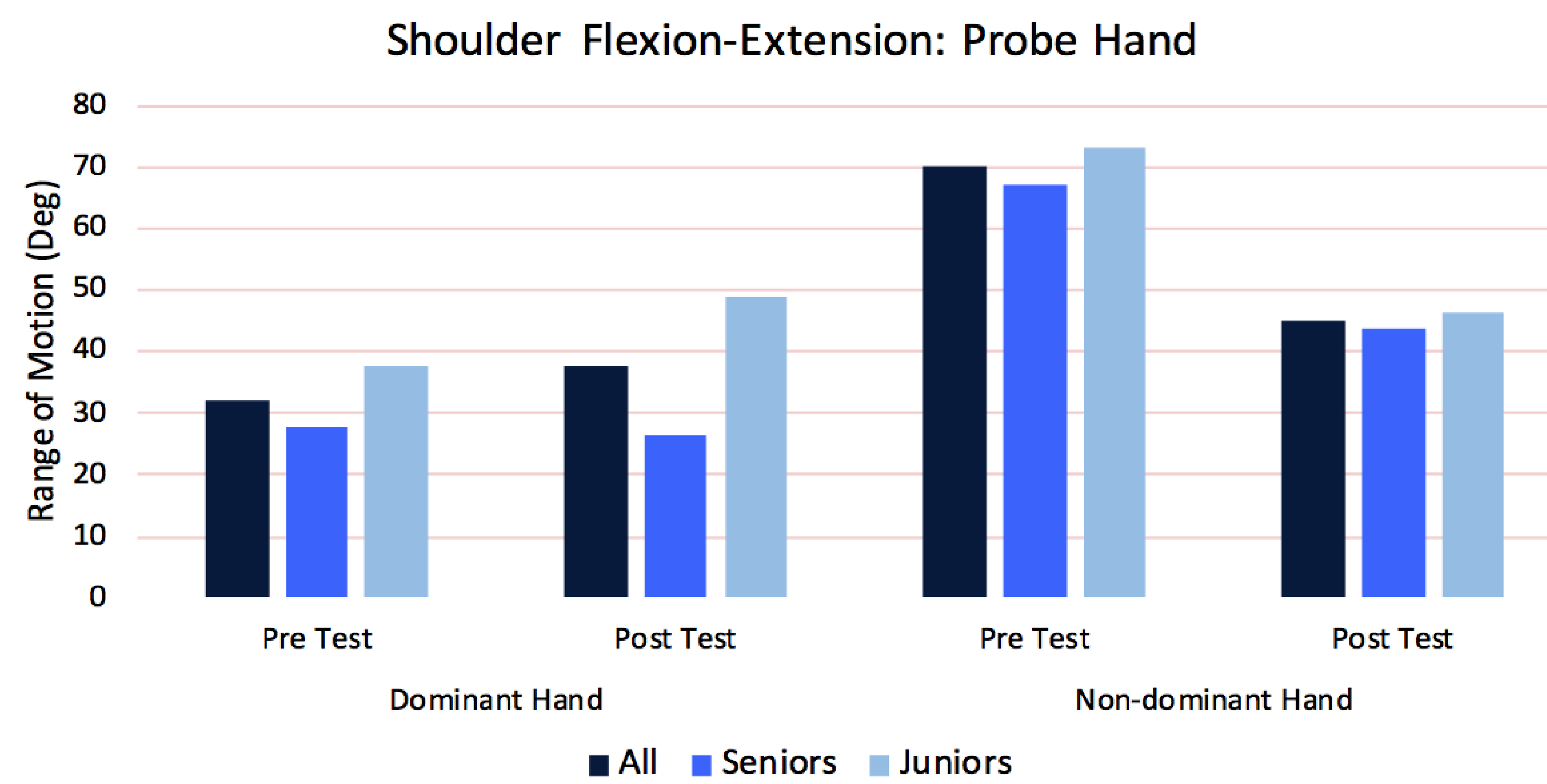


Figure 1. Average shoulder motion in the flexion-extension plane when the probe is held in the dominant versus non-dominant hand

Participants demonstrated more reduction in elbow movement over time using a camera with the nondominant hand than with the dominant hand (Figure 2).

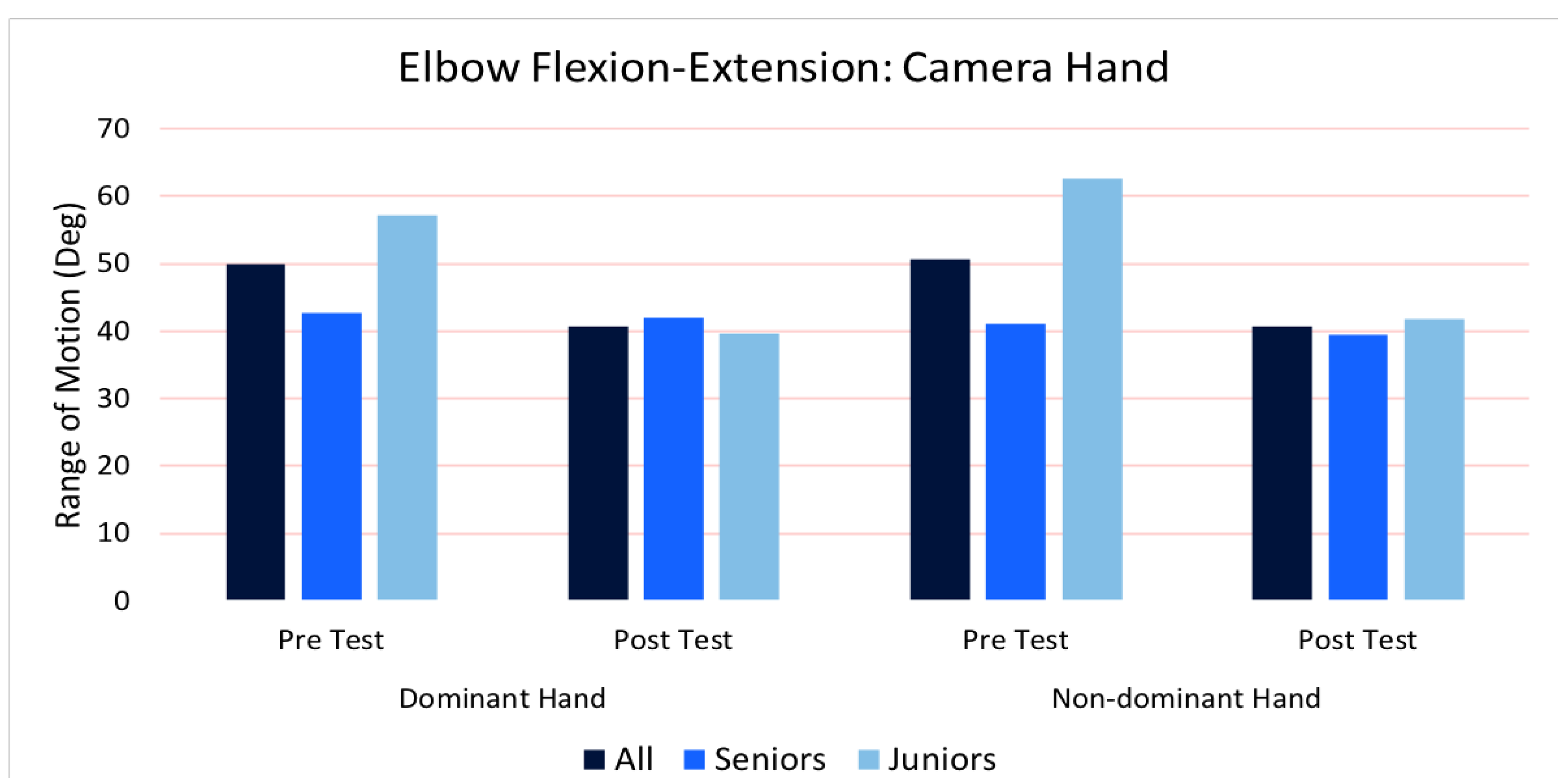


Figure 2. Average shoulder motion in the flexion-extension plane when the probe is held in the dominant versus non-dominant hand

Average ASSET scores increased and average time (seconds) to complete the procedure decreased for both senior and junior participants (Table 1).

	Seniors		Juniors	
	Pre Test	Post Test	Pre Test	Post Test
ASSET Score	24.8 ± 3.4	24.9 ± 2.8	20 ± 2.8	23 ± 1.7*
Time to Completion (Seconds)	221 ± 67	181 ± 47	317 ± 126	217 ± 66*

* Indicates statistically significant difference between pre test and post test ($p<0.05$).
Table 1. ASSET score and time to completion for diagnostic knee arthroscopy as recorded on blinded video.

Discussion

- On average, learners used significantly less shoulder motion to complete the diagnostic procedure at the end of the rotation compared to baseline testing using their non-dominant hand.
- Inertial sensors objectively illustrated progression of arthroscopic skill with respect to non-dominant hands.
- Further investigation is needed to determine sensor utility in tracking alteration in dominant hands of resident learners.

Conclusion

- Resident hand dominance and specimen chirality affect performance in the arthroscopic environment.
- Wearable inertial sensors can be an effective tool in measuring improvement in ambidexterity over time.

References

[1] Rose M, Curtze C, O'Sullivan J, et al. Wearable inertial sensors, allow for quantitative assessment of arthroscopic skill in a cadaveric knee model. *Arthroscopy*. doi:10.1016/j.arthro.2017.06.042.