Surgeon posture and workload demands during TKA

[1]Laura Y. Scholl, [1]Emily L. Hampp, [1]Vincent Alipit, [2]Jon E. Minter, [3]Steven Myerthall, [4]Michael A. Mont, [5]Antonia F. Chen
1. Stryker, Mahwah, NJ, 2. Arthritis and Total Joint Surgeons Northside Forsyth Hospital, Cumming, GA, 3. The CORE Institute, Gilbert, AZ, 4. Lennox Hill, New York, NY, 5. Brigham and Women's Hospital, Department of Orthopaedic Surgery, Harvard Medical School, Boston, MA

Introduction

- Orthopaedic surgery can be a highly demanding procedure on a surgeon's musculoskeletal health.Studies have reported 44-66% of surgeons surveyed have had a work-related injury with10-31% requiring surgery[1-2].
- Robotic technologies have been introduced into the operating rooms to assist surgeons with ergonomically challenging surgical tasks[3]. These technologies include elements that can reduce the physical stress on the surgeon, such as heads-up displays to visualize the surgical case and self-retaining retractors to minimize assistance during exposure.
- **Objective:** To establish how the use of robotic technology implemented during Total Knee Arthroplasty(TKA) procedures may influence a surgeon's ergonomics as well as to understand their surgical fatigue and overall satisfaction.

Materials and methods

- Manual TKA (MTKA) and robotic-arm assisted TKA (RATKA) were performed on 12 knees (6 cadavers) by two high-volume surgeons.
- Surgeons alternated between MTKA and RATKA.
- Two wearable motion tracking sensors (NotchInterfacesInc.) had been secured to each surgeon to monitor neck and trunk rotations **(Fig. 1)**. Trunk angles were measured by deviations from the gravity line, while neck angles were measured as the deviations from the trunk sensor's angle.
- Static motion was defined when angle velocity was less than 1°/sec.
- Following each surgery, the surgeon was asked to perform the Surgery Task Load Index (SURG-TLX) questionnaire[4] to compare the workload demands between MTKA and RATKA. A further question assessed overall surgeon satisfaction. All questions were assessed on a Low(0) to High(20) scale.
- Statistical analyses were performed by the use of unpaired Student's t-test with 95% confidence intervals

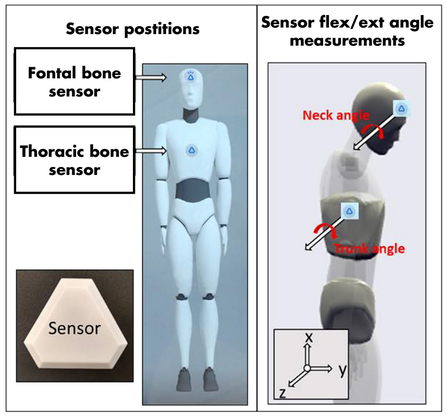
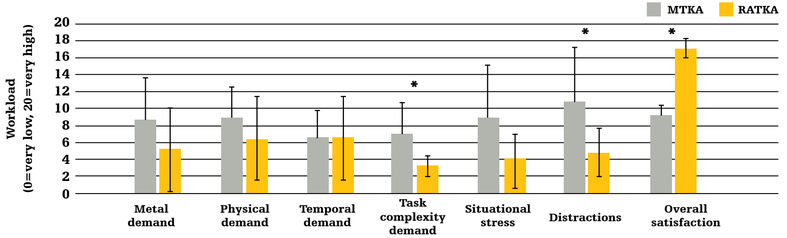


Fig. 1

Two wearable sensors were placed on surgeons: the first on the frontal bone and the second on the thoracic spine (approximately T5 region). Sensors collected rotation in the sagittal plane, and flexion and extension angles of the surgeons' neck and trunk regions.

Results

- For trunk motion, the surgeons remained in a static position significantly longer in MTKA than RATKA (36% vs 28%,p=0.03). This was not seen for neck motion.
- There were no significant differences in angle between MTKA and RATKA.
- RATKA had significantly higher overall satisfaction, lower distractions, and lower task complexity than MTKA (a=0.05, **Fig. 2**).



Experience	Question
Metal demand	How mentally fatiguing was the procedure?
Physical demand	How physically fatiguing was the procedure?
Temporal demand	How hurried or rushed was the pace of the procedure?
Task complexity	How complex was the procedure?
Situational stress	How anxious did you feel while performing the procedure?
Distractions	How distracting was the operating environment?
Overall satisfaction	What was the overall satisfaction of the procedure?

Fig. 2

SURG-TLX questionnaire was used to assess workload demands of the surgeon for MTKA and RATKA. Overall satisfaction was added to the survey. The questions used to ask the surgeon about each experience above. Error bars represent standard deviation and *represents statistical significance (p<0.05).

Discussion

Although neck and trunk angles were similar for MTKA and RATKA, MTKA had longer static trunk pose compared to RATKA. Prolonged static posture maybe correlated to prolonged muscle exertion that can result in musculoskeletal injury[5]. Additional studies are needed to understand kinematics for different body regions and including EMG data would better describe risk to musculoskeletal injury. Surgeons in this study reported MTKA was a more complex task than RATKA, which may be due to the many procedural steps and instruments used with MTKA. This study provides initial insights into the posture demands and stressors present during TKA. Further studies are on-going to validate this methodology.

Significance

Injuries in orthopaedic surgeons have been attributed to ergonomically challenging postures held by surgeons during surgery. The purpose of this study was to understand posture and workload stressors between manual and robotic-arm assisted TKA.

Reference:
1. Alqahtaniet al. JoA. 2016, 31:1194-1198. [2] Davis et al. J Bone Joint SurgAm. 2013 Aug 7;95(15):e107. [3] Elhageet al. Rehabilitation Robotics. Aug 1, 2017. 6:81-90. [4] Wilson et al. World J Surg; 2011, 35:1961-1969.. [5] Yu et al. SurgEndosc; 2017, 31:877-886.