ORIGINAL REPORTS

Using Touch Surgery to Improve Surgical Education in Low- and Middle-Income Settings: A Randomized Control Trial

Gisele Juru Bunogerane, MD,*[,1] Kathryn Taylor, BS,†[,1,l] Yihan Lin, MD, MPH,†[,‡] and Ainhoa Costas-Chavarri, MD, MPH, FACS†[,§]

*Department of General Surgery, College of Medicine and Health Sciences, University of Rwanda, Kigali, Republic of Rwanda; †Program in Global Surgery and Social Change, Department of Global Health and Social Medicine, Harvard Medical School, Boston, Massachusetts; ‡Department of Surgery, University of Colorado, Denver, Colorado; and §Department of General Surgery, Rwanda Military Hospital, Kigali, Republic of Rwanda

BACKGROUND/OBJECTIVE: There is a severe surgical workforce shortage in Rwanda. Innovative educational tools must be introduced to train more residents and increase surgical capacity. Touch Surgery (TS) is a smartphone application that offers trainees the opportunity to practice operations; however, its effect is unknown in low- and middle-income countries. Our objectives were to determine the training effect of TS and its feasibility for use in surgery education in a low-resource setting.

DESIGN: We performed a randomized control trial of University of Rwanda surgical residents. Participants were blocked by postgraduate year and randomized to textbook or TS for learning tendon repair surgical technique. After the learning period, participants performed a tendon repair simulation, evaluated by blinded expert raters. Presimulation and postsimulation questionnaires tested their knowledge of tendon repair.

SETTING: The study was conducted at the simulation center of the University Teaching Hospital of Kigali, a tertiary referral and teaching hospital.

PARTICIPANTS: The study included University of Rwanda surgery residents. A total 27 of 51 surgery residents (52.94%) were enrolled. Participating residents represented the following specialties: general surgery (51.85%), orthopedics (40.74%), and urology (7.41%).

RESULTS: TS users scored 89.7% on tendon repair simulation, compared to textbook users who scored 63.4% ($p < 0.001$). Postsimulation questionnaires showed a significant improvement in cognitive scores for TS users (38.6%, $p < 0.001$), as compared to nonsignificant improvement for textbook users (15.9%, $p = 0.304$). About 92.3% of TS users reported that TS represents a useful training tool, and 61.5% reported that it would be a good or very good required part of the curriculum.

CONCLUSIONS: TS is a useful tool to improve both technical skills and knowledge of tendon repair procedure steps; however, its role may be limited to a supplemental tool as it does not improve the theoretical knowledge. TS has the potential to be implemented in a surgical academic curriculum in low- and middle-income countries. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2017 Association of Program Directors in Surgery Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical education, surgery training, simulation, low- and middle-income country, LMIC, Touch Surgery

COMPETENCIES: Medical Knowledge, Practice Based Learning and Improvement

INTRODUCTION

There is a severe surgical workforce shortage in Rwanda. In 2016, there were only 74 qualified surgeons for a population of 10.1 million.[1] This is in contrast to the recommended number of 20 to 40 surgical, obstetric, or anesthetic providers per 100,000 population.[2] To address this surgical workforce shortage, efforts must focus on increasing the rate and quality of training medical students

Correspondence: Inquiries to Gisele Juru Bunogerane, MD, Department of General Surgery, General Surgery Resident, College of Medicine and Health Sciences (CMHS), School of Medicine and Pharmacy (SMP), University of Rwanda, Kigali, Republic of Rwanda; e-mail: jurugizela@gmail.com

[1] Joint first authorship.

1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2017.06.016

and surgery residents. However, a lack of faculty trainers significantly limits the mentorship and education necessary for surgical human resource capacity-building. Innovative tools are essential to provide new and effective ways of training a surgical workforce. By increasing access to surgical simulation and improving surgical education in Rwanda, we may ultimately meet the surgical burden of disease.

Smartphones serve an increasing role in medicine, from monitoring and diagnosing patients to more efficient medical education and communication.[3] Technology-enhanced simulation in health professions training has been consistently associated with a large effect on knowledge, skills, and behaviors.[4] Recent studies have shown that smartphone simulation applications can contribute to improve cognitive and technical skills in surgery education in high-income countries.[5] A study done in Kenya showed smartphone-based learning is becoming increasingly popular with medical students owning a smart device.[6] In addition, the use of smartphone-based applications for clinical decision-making was shown to be prevalent among junior clinicians in Ghana.[7] However, to our knowledge, there are no studies regarding the use of smartphone applications for surgical education in low- and middle-income countries (LMICs).

Touch Surgery (TS) is a clinical smartphone application that offers surgeons and trainees the opportunity to practice key stages of common operations, like laparoscopic cholecystectomy, intramedullary femoral nailing , tendon repair, and other procedures. The application provides a hands-on experience for learners to improve knowledge of the steps of an operation.[5] TS has demonstrated construct, face, and content validity.[8,9] When used as a learning tool in a high-income setting, TS users demonstrated a significant training effect with practice.[8] In addition, novices demonstrated cognitive competencies to ensure patient safety before operating.[8] TS has been shown to be an effective adjunct to traditional learning methods with potential for curricular implementation, and in one study was shown to be more productive than traditional reading.[8,10,11] However, its effect on cognitive and technical skills is unknown in LMICs.

This study aims to determine the effect of TS on technical and cognitive skills in low- and middle-income settings. This study also aims to assess the feasibility of TS in surgery education in low-resource settings by assessing opinions of trainees on its usefulness and value in surgical academic curriculum in LMICs. This study hypothesizes surgical simulation with TS improves surgical residents' cognitive and technical performance in Rwanda.

METHODS

Study Setting and Intervention

Rwanda is a country of 11.5 million in East Africa. In 2014, there were 110,857 surgical procedures performed, which is 961 major operations per 100,000 population.[12] There are an estimated 74 surgeons for the population of Rwanda.[1] The University Teaching Hospital of Kigali (Centre Hospitalier Universitaire de Kigali), is a public, tertiary referral hospital in the capital city of Kigali, Rwanda. It is one of the main teaching hospitals for surgical trainees. This study took place at the Centre Hospitalier Universitaire de Kigali Simulation Center with residents in the surgery program at the University of Rwanda.

Study Design and Population

The study design was a parallel-randomized control trial of TS for learning the tendon repair procedure (Fig. 1). TS offers a simulation of tendon repair in both learning and testing modes for residents to review and practice the essential steps of the procedure.

Participants were University of Rwanda surgery residents from the following specialties: general surgery, orthopedics, urology, and neurosurgery. All surgical residents were invited to participate in the study. Of the residents who did not participate, most of them were not living in Kigali city at the time of the study (residents rotate several hours away from Kigali at times). The remaining cited clinical duties as the reason for not participating. Residents were randomized to study tendon repair using either a textbook chapter or the TS tendon repair module (Fig. 2). Randomization was done by first blocking residents by postgraduate year. Then, each resident was alphabetized and given a study ID. Residents with an even ID were assigned to TS, whereas residents with an odd ID were assigned to the textbook chapter, to ensure even distribution of participants.

Data Collection and Analysis

Participants completed a presimulation questionnaire for demographics and possible confounders, including previous experience with tendon repair or TS, and a presimulation multiple-choice test. Multiple-choice test questions addressed both tendon repair theory and technique. Participants randomized to study with TS were provided with a smartphone or tablet with the tendon repair module downloaded, whereas participants randomized to study with the textbook were provided a chapter on tendon repair from Zollinger's Atlas of Surgical Operations.[13] The textbook was chosen for its comparable information on tendon repair technique to the TS module. Participants were then given as much time as needed with either the TS application or the textbook before they felt comfortable performing the procedure with a real tendon (Fig. 3). All necessary materials for the simulation, including the tendons, surgical instruments, and suture were provided for each participant by the research team. Two blinded, independent expert raters rated the simulation as it was performed using a standardized rubric (Appendix 1). As there are no validated rubrics for tendon repair, a scoring rubric was