EVALUATION OF THE VIRTX TRAINING SYSTEM FOR SIMULATION OF C-ARM OPERATION IN THE OPERATING ROOM SETTING

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INTRODUCTION

The operation and manoeuvring of a fluoroscopic C-arm in the operating room (OR) is typically performed, in Canada, by a radiology technologist (RT). However, C-arm training for an RT is largely limited to theoretical education, lacking hands-on practice in a surgical environment. Thus, a large proportion of the learning curve is carried out in the real OR setting where lack of training can be stressful and frustrating for both the RT and the surgeons. Moreover, achieving the surgeon's desired radiographic views can take longer for new RTs, requiring more trial and error shots. This results in higher amounts of radiation for both the patient and the staff, as well as prolonged surgery times.

A computer-based simulation system may help bridge this experience gap by providing a practical, interactive training tool for radiology technology students. Existing radiology training systems are either limited to plain X-ray imaging simulations (Gong 2014) or are purely based on virtual software (Cosson 2012). virtX is a simulation package that integrates a physical C-arm and patient manipulation with virtual software (Bott 2011). virtX offers simulated training with two modules (Fig. 1): 1) software that displays a virtual scene that consists of three-dimensional models of a C-arm, an operating room table and a patient, and 2) motion trackers that enable physical manipulation of a real C-arm and a manikin to be used in combination with the aforementioned virtual scene. In both modules, virtual radiographic projections are generated based on where the C-arm is positioned relative to the patient.

virtX is a promising training tool for experienced C-arm users (Bott 2008; Bott 2009; Bott 2011); however, its effectiveness is yet to be proven in new C-arm users. Thus, our objective is to evaluate the usefulness of virtX for training RT students, specifically those based in British Columbia, with no prior C-arm experience. We hypothesize that participants that receive training with virtX will perform specific imaging tasks faster, and with fewer X-ray shots, than those who do not receive the training.

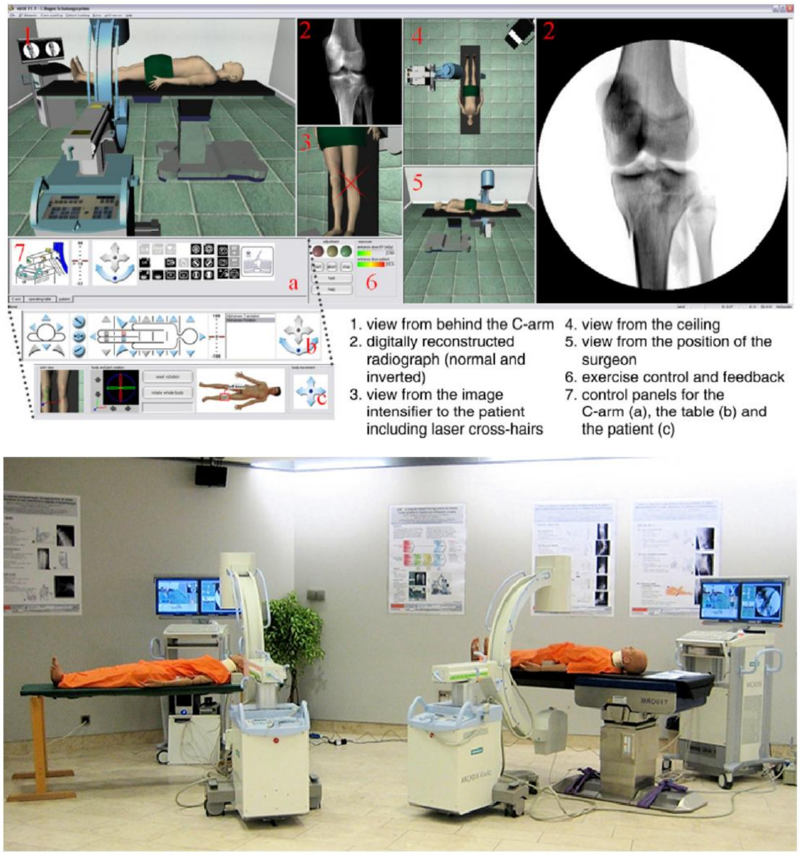

Figure 1: virtX simulation system: (a) software interface; (b) physical simulation system.

MATERIALS AND METHODS

Our ultimate goal is to conduct a user study of the physical virtX system with students who are enrolled in the first year of the medical radiography program at the British Columbia Institute of Technology. Before conducting this study we performed a preliminary pilot study to evaluate the virtual component of the virtX system. The pilot study consisted of 6 participants from our research team (who are not RT students), where the main aim was to refine the protocol for the larger scale study. The participants were evaluated on the time and number of X-ray shots required to achieve specific anatomical views. We present the pilot results here, but we plan to carry out the RT study shortly.

For the pilot study, the participants were randomly allocated to two groups: the control group (who received no training with virtX) and the intervention group (who received virtual training with virtX). The intervention participants were given a brief introduction on how to use the virtX system (e.g. how to manoeuvre the C-arm in the virtual scene) and then asked to complete two tasks that required taking virtual radiographs of the left ankle and the pelvis at specified angles. The participants were allowed to take as much time as required to complete the tasks, which took between 5 and 26 minutes for the participants.

To assess whether virtX training could reduce the time and number of shots required for an imaging task, both the control and intervention participants performed an evaluation exercise using a real C-arm and a radiopaque phantom knee joint. Participants were given reference radiographs of two desired views of the knee (an anteroposterior (AP) and a lateral view radiograph). They were asked to replicate these two X-ray images while the time and the number of attempted shots were recorded for each task. The adequacy of each X-ray was determined by the investigator. Due to the small number of participants, the groups in this pilot study were not compared statistically.

RESULTS

The number of X-ray shots taken to achieve the desired AP view of the knee ranged from 3 to 11 (Fig. 2a). The mean number used was 7 for both the control group and the intervention group. The number of X-ray shots taken to achieve the desired lateral view of the knee ranged from 2 to 13. The mean number was 7 and 6 shots for the control group and the intervention group, respectively.

The mean times to achieve the AP view for the control group and the intervention group were 152 seconds and 291 seconds, respectively (Fig. 2a). The mean times to achieve the lateral view for the control group and the intervention group were 224 seconds and 353 seconds, respectively (Fig. 2b).

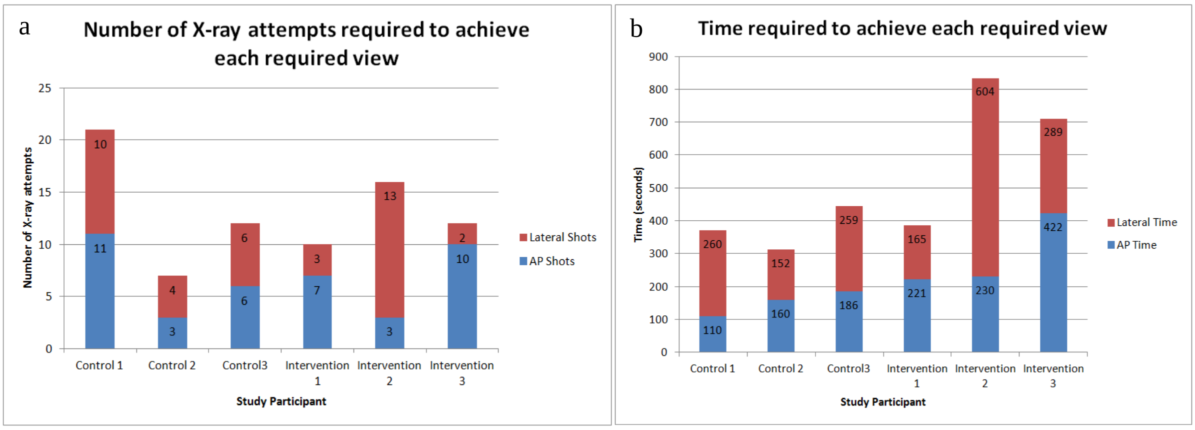

Figure 2: (a) Number of X-ray attempts required to achieve each required view; (b) Time required to achieve each required view.

DISCUSSION

On average, the number of X-rays and the amount of time required to achieve the desired radiographic views was not better with simulation-only virtX training. Previous studies have also reported no significant improvement with the virtual module only (Bott, 2008). As with these previous virtX studies, our participants varied in their previous C-arm knowledge and experience, which may explain the large variation in these results (despite randomization, those in the control group had more previous C-arm knowledge and experience through their research work). Cosson and Willis (2012) reported modest improvements in task completion time (average of 8 seconds) with a virtual training program in users with no prior radiographic experience; however, participants were given four weeks of training. Thus, our next step is to collect data on novice users (with no previous C-arm experience) with a longer training period; since no improvement was found with the virtual simulation portion of virtX, we will also evaluate the physical (i.e. real C-arm plus manikin) module. Despite the lack of demonstrated improvement with the virtual simulation portion of virtX in this pilot study, these results directly inform our next steps in further evaluating the effects of virtX training on RT students.

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