Development of Simulated Educational Joint Mobilization Module Using Leap Motion Controller

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Abstract

Background: Joint mobilization is a complicated task in terms of learning as well as teaching and is characterized by great inter subject variability. With reference to the acquisition of skills such as joint mobilisation, only a few studies have investigated the effectiveness of the provision of real-time visual feedback on a computer screen in terms of students' ability to establish optimal force and demonstrate adequate performance. There is lack of training in theory and practical skills in mobilization given to the Physiotherapy students. Thus, an effort has been made in to practice it virtually using Leap Motion Controller.

Method: Total 138 participants will be recruited as per the inclusion and exclusion criteria. A brief explanation about the study will be given. Participants will be given exposure to the software and modality being used along with demonstration. Followed by, a questionnaire to evaluate the effective learning using the System Usability Scale.

Conclusion: The results from the study will significantly provide efficacy of the simulative device and evidence on the use of LMC for learning joint mobilization using the System Usability Scale.

Key words: *Biomechanics, Glenohumeral Joint, Mobilization, Shoulder Joint, Simulation*

Introduction

In healthcare professions, innovative methods and modalities are actively pursued to improve teaching and learning, and followed by patient care and outcomes[(1)]. Digital education could include a range of approaches focused on learning tools, ideas, material, objectives, teaching methods and delivery environment. Studies on the use of digital technologies in healthcare education have generally shown its advantages over traditional learning in terms of improved diagnostic reasoning skills, interpersonal and professional skills, long-term knowledge retention, problem-solving skills, self-direct / life-long learning skills, higher-order thinking skills, self-perception and trust[(2)]. Virtual Reality (VR) is a groundbreaking advanced system of technology that allows users to share a ' virtual world'. Potential advantages for VR in medical education are massive and recent advances in technology and improved accessibility has made it the exciting and evolving sector today. Their use in undergraduate training as a complement to conventional seminars, lessons and self-directed learning continues to be less well studied; however, there is evidence that VR has been shown to improve the retention of information and study drive. VR headsets produce 360-degree immersive images that can shift as the person moves around the world in real time[(3)].

Therapeutic touch has been used in human beings to soothe aches and pains. Manual therapy techniques are skilled hand movements intended to improve tissue extensibility; increase range of motion (ROM); induce relaxation; mobilize or manipulate soft tissue and joints; modulate pain; and reduce soft tissue swelling, inflammation, or restriction. The primary techniques included in manual therapy are mobilization and

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manipulation of joints and associated soft tissues[4]. Rationales for the reasons why manual therapies may work have been investigated and include reducing muscle inhibition, correcting joint displacement, adjusting joint subluxations, restoring bony alignment, reducing nuclear protrusion[5], and placebo effect[6,7]. Manual therapy is indicated for pain and loss of motion that occurs secondary to neuromusculoskeletal dysfunction. The patient may have pain with motion or rest, pain in the midst of available ROM or at the end of available ROM, or pain or stiffness caused by postural changes[4].

Joint mobilization is a complicated task to learn and to teach and is characterized by great inter subject variability. Joint mobilization, a form of passive movement with the application of force to the joint in a specific direction, is a common therapeutic technique used by orthopedic physical therapists to reestablish the arthrokinematics, osteokinematics, and function of a joint[8]. Skill acquisition usually involves the use of different modes of feedback to enhance motor learning. The traditional methods of learning joint mobilization include instructor demonstrations and students practicing on each other. Information, including the perceived resistance and movement by instructors, is conveyed to the student while the technique demonstrated on the student. The nature of feedback given to the subject is one of the empirical factors affecting a skill-acquisition process and its outcome[9].

The last decade has seen the proliferation of simulation in health care education. This trend has reached physical therapy education and is redefining experiences for physical therapy learners[10]. Physiotherapy education aims to prepare students to practice independently by developing complex clinical skills such as patient assessment, clinical reasoning, technical, communication and therapeutic skills[11].

Within clinical practice, simulation can support skill development, continued competency, and be part of a risk management approach to revisit a breakdown of care, evaluate a near miss event, or rehearse new workflow procedures. Simulations must be thoughtfully designed, executed, and followed with effective, structured debriefing to achieve the positive learning that will translate to improved clinical practice[10].

In the field of manual therapy with reference to the acquisition of skills such as joint mobilisation, only a few studies have investigated the effectiveness of the provision of real-time visual feedback on a computer screen in terms of students' ability to establish optimal force and demonstrate adequate performance[11]. There is lack of training in theory and practical skills in mobilization given to the physiotherapy students[9]. Thus, an effort is being made to learn and practice join mobilization using leap motion controller. Leap Motion's leap motion controller provides a means to capture and track delicate hand and finger movements, while manipulating a virtual environment that involves hand-arm coordination as part of virtual tasks[12].

The simulated joint to be used in the study will be the glenohumeral joint. The glenohumeral joint is a multiaxial, ball and socket type of synovial joint. The joint has 3 axes and 3 degrees of freedom involving flexion, extension, adduction, abduction, internal rotation and external rotation. With the contraction of the rotator cuff muscles, the humeral head is pushed or translate anteriorly, posteriorly, inferiorly, superiorly or in combination of these movements. The common pathologies occurring at shoulder joint are frozen shoulder, impingement syndrome, stiffness, shoulder pain, etc. for which the joint mobilization is frequently used treatment.

This study aims to evaluate the impact of leap motion controller(LMC) for training and practicing joint mobilization techniques at shoulder joint.

The objective of the study is to bear out the suitability of the system to be used as an aided method for learning mobilization of the shoulder joint. Aiming this, we'll investigate the following three aspects:

1. The capability of the system to assign different levels of mobilization grades of the shoulder joint; thus, to elucidate whether, despite the variable working loads, the training remained under controlled and moderate motion conditions according to the current clinical condition of the patient, to avoid any harmful movement, as a fundamental requirement in rehabilitation.

2. The effects of the variable difficulty training conditions on the kinesiologic participant's performance; then, to design a new predictive model of the participant's

progress, as a tool for the therapist for individualising the training intensity.

3. The evaluation and acceptance of the system by participants.

Materials and Method

Study Setting: This trial will be carried out in the HumEn research lab of Ravi Nair Physiotherapy College, Sawangi (Meghe), Wardha, after approval from Institutional Ethics Committee of Datta Meghe Institute Of Medical Sciences, Deemed to be University.

Study design: Quasi experimental study (one group design)

Sample size: The participants enrolled in this experimental study is 138 (n = 138). Before inclusion, all the participants will be explained about the purpose and procedures of the research.

Participants:

The inclusion criteria for the participants are as under:

1. Second to final year undergraduate students of physiotherapy.

2. Those who are willing to partake in the study and sign the informed consent form.

The exclusion criteria for the participants are as under:

1. Those with fracture of upper limb.

2. Those with any neurological pathology of the UL

3. Those having any psychological problems.

4. Those unwilling to participate.

Study duration: 6 months

Outcome measures:

Primary Outcomes:

1. SUS (System Usability Scale)

2. Student satisfaction with the approach used

Secondary Outcomes:

1. Time to teach the technique

2. Time to perform the technique

Instrumentation:

1. Leap motion controller

2. LED screen

Study procedure:

In collaboration with IIT, Nagpur, a software program will be developed depicting the virtual 3D anatomical model of the shoulder joint , which will be mobilized with Leap Motion Controller. It will be designed such that the participants can view the model in 360 degrees. Glides will be given virtually in real time to carry out mobilization. Different pathological conditions of shoulder will be demonstrated in the virtual environment and the subjects will be instructed to carry out mobilization under the supervision of PI. The direction of the glides will be marked by an arrow. The subjects will be trained by the PI to carry out mobilization via LMC. Further the use of haptic gloves can also be considered so that the subjects will have the actual feedback of how much pressure to apply while giving the glides.

After getting approval by the ethical committee , informed consent from the participants will be taken. Proper Information about the shoulder joint's osteokinematics and arthrokinematics will be given before training the participants. Further, the subjects will be trained to use the devices properly for which practical demonstration will be given.

The subjects are required to fill the questionnaire for feedback at baseline and after the completion of the program.

Mobilizations that are commonly used include posterior/anterior glides, superior/inferior glides. Posterior glide is used to increase flexion and internal rotation. Anterior glide is used to increase extension and external rotation. Inferior glide is used to increase abduction range ofshoulder joint. Grade I and grade II mobilization will be considered first[13].

Statistical analysis plan:

Analysis of data will be carried out using concise and inferensive statistics using unpaired t test students in chi square. The software used in the study will be the SPSS 24.0 version, the Graphpad prism 7.0 version and the degree of significance < 0.005 (p>0.005 m) is considered.

Ethics And Dissemination:

The approval of the Committee on Institutional Ethics must be obtained prior to the start of the study. Patients must be treated with respect first. Upon meeting the requirements of inclusion and exclusion criteria, the patients are taken for review.

Observation And Expected Results:

The study's expected outcome will concentrate on evaluation of efficacy of the simulative device using the System Usability Scale to develop shoulder joint mobility. The results from the study will significantly provide evidence on the use of LMC for learning joint mobilization.

Discussion

This study protocol aims to assess the efficacy of the simulative device using the System Usability Scale to develop shoulder joint mobility. The purpose of this study will help to explain the process of creation of the simulative device designed to improve shoulder joint mobility. The study's expected outcome will concentrate on the evaluation of the usability of simulative device and the impact of LMC for training and practicing joint mobilization techniques at shoulder joint.

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Informed Consent: Written & Oral informed consent will be obtained from all individual participants included in the study. Additional informed consent will be obtained from all individual participants for whom identifying information is included in this manuscript.

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