Contextualization of Simulation-based Training
for Basic Arthroscopic Skills

BY

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THESIS

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I can’t believe I am done!

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<tr>
<td>CPF</td>
<td>Challenge Point Framework</td>
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<td>FLS</td>
<td>Fundamentals of Laparoscopic Surgery</td>
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<td>GRS</td>
<td>Global Rating Scale</td>
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<td>MCMD</td>
<td>Motor and Cognitive Modeling Diagram</td>
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<td>MISTELS</td>
<td>McGill Inanimate System for Training and Evaluation of Laparoscopic Skills</td>
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<td>OR</td>
<td>Operating room</td>
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<td>VAS</td>
<td>Visual analog scale</td>
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ABSTRACT

Background: Arthroscopy is a type of orthopaedic minimally invasive surgery very commonly performed but difficult to teach and learn.

Objective: The purpose of this project was to explore the differences in learning to perform simulated basic arthroscopic skills relative to different contexts: scenarios, simulator features. We hypothesized that using a contextualized approach, with scenarios and knee arthroscopy simulator features, would result in better performance by novices.

Methods: After conducting two preliminary studies defining generic basic arthroscopic skills, we conducted the present project as a prospective, randomized, two-arm pilot study with de-contextualized and contextualized arms. The study design included a pre-test/post-test during one session, and a retention test one month later. A checklist and a global rating scale were used to assess performance and a survey was used to elicit participants’ perceptions about the training sessions and simulator.

Results: On the post-test, all participants demonstrated improvement in their basic arthroscopic skills. Participants in the contextualized group maintained their skills at the post- and retention tests as well as participants in the de-contextualized group. Their improvement on the post- and retention tests, compared to decontextualized group, was not as good. On the survey, 90% of participants evaluated the experience, during both testing sessions, as very good/excellent. Only 25% of participants were aware that the context provided during the practice time impacted their performance on the post-test.

Discussion: Our study results did not support our hypothesis. We demonstrated that any practice improves novices’ performance. However, as the amount of information increases (more contextualized), improvement in practice is not as great as in decontextualized practice. This
finding suggests that educators designing a curriculum should carefully take into consideration what aspects of the context should be adjusted in order to facilitate novices’ learning.

**Conclusion:** Depending on the skill level of learners, conditions of practice can make tasks more or less difficult by influencing the amount of available information. To inform the design of simulation-based training of basic surgical skills to provide a more effective learning experience for trainees, the effects of contextualization should be further tested with a larger group of participants or more advanced trainees.

Key words: Arthroscopy, simulation, basic skills, contextualization.
I. INTRODUCTION

Today’s society demands highly skilled surgeons. As with any psychomotor activity, technical surgical skills improve with practice. Long hours of practice are needed to master the basic technical aspects of surgery. The same principle applies to other skills, such as swimming and running: these athletes, swimmers and runners, need regular and intense practice to maintain their levels of performance[1]. Regular practice for learning and developing new technical skills, or for maintenance of competence, requires clear and focused training goals, essential to reach higher levels of performance. To enhance the learning experience, these goals should be associated with appropriate methods for learning and improvement [2].

There is good evidence showing that, in various fields, at least 4 hours a day for 10 years, or over 10 000 hours of deliberate, focused and dedicated practice, are needed before being able to reach an expert and exceptional level of performance [3-6]. But as Ericsson and Smith suggested, we need to identify “the essence of expertise”, the skill levels that experts consistently achieve and maintain when compared with novices. In surgery, as in sports and other domains of activity, there is a need to identify the set of basic skills that must be mastered to obtain good and safe outcomes for patients [7].

Within the operating room (OR), the learning process can be stressful for both surgeons and residents alike, because the context can make the experience overwhelming for the resident who is just beginning to learn a procedure. Development of technical surgical skills involves the use of different senses (i.e., touch, vision, hearing [8, 9]) and often cannot be explained without live demonstrations. Inexperienced residents are often slow to learn technical skills and risk
causing irreparable damage to patients' joint surfaces while learning. Another problem with traditional training in the OR is lack of standardization of training provided to residents, with residency training mostly based on the apprenticeship model [10-17]. For example, some residents will get exposed to, and practice with, open surgeries more than minimally invasive surgeries. Ideally, as an alternative to traditional OR training, a simulated training environment could provide trainees with a risk-free environment and a more standardized training experience to learn and develop essential surgical skills [18, 19].

With restricted working hours and reduced time for surgical exposure, experience and practice, a method is needed to help residents train for real surgeries [19-23]. Moreover, providing a means to assess their basic skills would facilitate the teaching done by experienced surgeons and afford increased opportunities for practice with feedback [17, 23, 24]. Such training in generic basic surgery skills would result in greater efficiency and less time spent in the OR per procedure [25, 26], improved outcomes [19, 27], greater patient and surgeon satisfaction, better patients' quality of life, better surgeons’ work/productivity, better use of health care resources, decreased risk of complications [19, 27] and reduced costs [28]. General surgery and laparoscopic procedures share similar challenges with orthopaedic surgery and arthroscopic procedures; therefore, the same benefits can be expected in either of these specialties.

Surgical simulation has been used for learning and assessment, and studied for effectiveness, in various surgical specialties, such as general surgery, cardiac surgery, and neurosurgery, but has not been used or studied as extensively in orthopaedic surgery. Arthroscopic knee surgeries are widely performed around the world, with more than four million knee arthroscopies performed.
worldwide each year [29]). Therefore, it is very important to provide appropriate training in arthroscopic knee surgery for our trainees and it is crucial to understand how we can better teach scoping skills. As stated above, and as in general surgery, effective orthopaedic, and specifically arthroscopic, skills training can have a beneficial effect at different levels: productivity, procedural time, patient outcomes, reduced costs, etc. To this end, it is important to identify the basic arthroscopic surgical skills the trainees should learn, both to improve outcomes and patient-safety [18] and residents’ satisfaction. This is important because teaching and learning arthroscopic surgery skills are challenging due to a very steep learning curve [9, 30-32]. It is also necessary to determine the most appropriate way to teach those basic skills to provide a better and more effective learning experience [9].
II. BACKGROUND/LITERATURE REVIEW

General surgeons have adopted an approach to define and standardize basic laparoscopic skills, which have been incorporated into a curriculum. Specifically, the McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) [33] was developed and validated [34] as a standard for the evaluation of laparoscopic skills. MISTELS consists of five tasks performed in a laparoscopic trainer box using inanimate materials. The curriculum incorporating the MISTELS is called the “Fundamentals of Laparoscopic Surgery (FLS)” [35].

Studies have demonstrated that MISTELS has been successful in helping trainees to develop their technical skills. In 2004, Fried et al. [34] showed that the metrics associated with MISTELS are reliable and valid. MISTELS is an education tool incorporated in the Fundamentals of Laparoscopic Surgery (FLS) program, which is a comprehensive standardized curriculum. In Fried’s study [34], residents who were MISTELS trained were significantly more skillful and efficient in laparoscopic skills after six weeks of practice than residents not MISTELS trained. Fried also showed evidence of transferability of technical skills acquisition for more complex suturing drills in laparoscopy.

To our knowledge, no standardized, generic and widely accepted tools – such as the MISTELS- that are suitable for training and assessment of arthroscopic technical skills have been developed and incorporated into a curriculum. Some investigators [12, 36, 37] have tried to define certain basic skills for arthroscopy, based on their personal preferences. Since this approach does not follow a clear systematic process and methodology, it is difficult to get a good sense, from these descriptions, of what is a “basic arthroscopic skill” and how those skills were
defined. Most of these studies focus on the knee joint, rather than being generic enough to be applicable to multiple joints. Nonetheless, their contributions are informing and advancing current research in arthroscopy simulation-based training. Here is a summary of their findings.

Insel et al. [12] developed and validated a model for evaluating arthroscopic proficiency on a cadaver knee in a skills laboratory. This model, the “Basic Arthroscopic Knee Skill Scoring System”, includes a task-specific checklist and a global rating scale (GRS). The checklist focuses on arthroscopic inspection of the knee joint and performance of a menisectomy. Their 10 GRS items are: “dissection, instrument handling, depth perception, bimanual dexterity, flow of operation and forward planning, knowledge of instruments, efficiency, knowledge of specific procedures, autonomy and quality of final product”[12]. These checklist and GRS items are not all arthroscopic technical surgical skills as they, for the most part, involve more than just the technical aspect of arthroscopic basic skills training, e.g., forward planning, autonomy, efficiency. This team developed and validated a model for evaluating basic arthroscopic proficiency on a cadaver knee. They found a “strong positive correlation between global rating scale scores and both the postgraduate year (r = 0.93, p < 0.01) and the number of knee arthroscopies performed”[12]. Their main contribution was to provide a validated checklist and GRS that are useful to assess trainees during knee arthroscopy only.

Karahan [36] et al. correlated “basic motor skills” with arthroscopic experience. The purposes of their study were to define basic motor skills needed for arthroscopic surgery, to assess the defined skills with different non-surgical devices, and to correlate performance of these skills with surgical expertise. The proposed basic motor skills were: triangulation, depth
perception, response orientation, reaction time and grip strength. However, it was not clear how those skills were defined. In particular, from our perspective, certain items - response orientation, reaction time, grip strength - are not basic arthroscopic technical skills, but involve surgeons’ intrinsic body responses. They found that arthroscopic experience was correlated with mean anticipation time ($r=-0.41$, $p=0.008$) and two-arm coordination time ($r=-0.33$, $p=0.033$). In addition, the mean anticipation time decreased significantly as the number of arthroscopies increased ($r=-0.446$, $p=0.003$). The contribution of this study was to do surgical (e.g., triangulation) and non-surgical (e.g., grip strength) performance assessment using non-surgical devices such as a JAMAR hydraulic hand dynamometer, a Bassin anticipation timer, a visual choice reaction time apparatus, a standard rotary pursuit and a two-arm coordination test.

Safir et al. [37] surveyed, on-line, 600 orthopaedic surgeons who were members of the Canadian Orthopaedic Association, in a preliminary validation study of basic skills in arthroscopy. In their study, a panel of experts revised the basic arthroscopic skills in order to have a list from the most to the least important basic skills for arthroscopy. Thirty-five (35) basic arthroscopic skills were listed on the survey and were divided into three categories: preparation of the patient and instruments, identification of structures and navigation of the arthroscope, and instrument handling. Some non-arthroscopic skills were included, such as: placement of tourniquet, injection of local analgesics, and preparation of the patient and instruments. In the survey, these orthopaedic surgeons were asked to rank order the importance of each arthroscopic skill. The most important six arthroscopic skills, based on the survey of orthopaedic surgeons, are: precise portal placement, triangulating the tip of the probe with a $30^\circ$ scope, identification of the lateral compartment, identification of the medial compartment, identification of the intercondylar notch
including the cruciate ligaments, and insertion of the scope into the anterolateral portal. This study involved a very large number of surgeons with a wide range of experience, who were able to bring information on their views about essential skills for knee arthroscopists. Although they provide clear opinions about which of the proposed skills were important, many of those skills are dependent on the anatomy of the knee joint and therefore are not generic enough to be transferred to surgery on other joints.

In summary, most of the articles in the literature focused on basic arthroscopic skills have defined specific “knee arthroscopy” basic skills. The studies followed a more or less systematic approach to defining the basic arthroscopic skills. The assessment tools rising from these projects have potential for application in orthopaedic curricula, but the defined skills are specific to the knee, rather than being generic enough to be applicable and transferrable to multiple joints.

A. Preliminary work for defining basic arthroscopic skills

Similar to the work that has been done around the MISTELS and the Fundamentals of Laparoscopic Surgery (FLS) in general surgery, defining appropriate basic arthroscopic surgery skills is an important first step for our research. Prior to starting the contextualization project described in this paper, preliminary work had been done in our laboratory to define basic arthroscopic surgery skills, through implementation of two projects. The results of both projects have been published and a short summary is presented here. The projects were: 1) an experimental study to test proposed basic arthroscopic surgery skills [38] and 2) an observation study in the OR to better systematically define and refine the basic skills [39]. The ethics board of the University of Western Ontario (where the studies were conducted) approved the projects.
Project 1:

The first step in Project 1 involved use of a custom-made force-sensing knee physical simulator and actual arthroscopic surgery instruments [40].

Participants: Participants included 5 expert arthroscopists and 10 novices with little to no arthroscopic surgery experience (surgical residents, medical students and engineers).

Methods: All participants performed 14 basic arthroscopic surgery tasks on our simulator. The tasks were chosen based on a literature review and a survey of three expert arthroscopists.

Results: The results showed that performance of basic arthroscopic surgery tasks on our force-sensing physical simulator had the potential to differentiate experts from novices. However, with a limited number of subjects, the analysis of this data does not have sufficient statistical power to clearly demonstrate differences in the forces applied by novices and experts for most tasks. Statistically significant differences between novices and experts for 9 of the 14 tasks were found for the time taken to complete the tasks.

Discussion: The tasks used for this trial were deemed, by the research team, to be not sensitive enough because performance of these tasks on the force-sensing physical simulator differentiated the novices from the experts for only 9 of the 14 tasks. Therefore, a second study was done to systematically define generic basic arthroscopic surgery skills. An observation study was done in the OR to implement the Motor and Cognitive Modeling Diagram tool and deconstruct arthroscopic surgery procedures [41]. Other arthroscopic surgery performance measures (e.g., forces applied on surfaces, hand position, path length of hands and instruments) were also investigated to differentiate experts from novices.
Project 2:

**Purpose:** An observation study in the OR to define the basic arthroscopic surgery skills that are generic enough to be transferred to multiple joints [41].

**Methodology:** The Motor and Cognitive Modeling Diagram (MCMD) tool [42] was used to map knee arthroscopic surgery ligament reconstructions and decompose/deconstruct that type of arthroscopic surgery into individual tasks and basic skills. This tool is comprised of a set of diagrams that present the flow of actions and decisions during a surgical procedure. It was initially designed and validated for laparoscopic cholecystectomy, laparoscopic colectomy and cardiac bypass surgery. The MCMD methodology borrows from both hierarchical decomposition and information processing analysis [43]. For this observational study, three expert surgeons were observed performing eight real and standard knee arthroscopy cases (ligament reconstructions and meniscal procedures) and eight real and standard shoulder arthroscopy cases (decompressions and rotator cuff repairs) each; they were asked to verbalize the steps and their cognitive choices.

**Results:** The preliminary MCMD was created and then reviewed by the surgeons to ensure the content validity of the tool. With the task decomposition and the qualitative data derived from the interviews, basic arthroscopic surgery skills were identified and defined in a systematic way.

**Discussion:** MCMDs provide accurate representations of the motor and cognitive aspects of arthroscopy surgery skills and the basic skills required to do during arthroscopic surgeries. Generic (transferrable to multiple joints) basic arthroscopic surgery skills were extracted from the newly created MCMD for arthroscopic surgery. Future research will integrate these decompositions into a simulation-based orthopaedic training curriculum at our University.
B. **Theoretical frameworks/Model**

Some authors have conceptualized surgical simulation on models representing body parts, in a skills laboratory, as a context-free activity [44, 45]. However, in “the real surgical world”, the whole context, the “entire scenario”, i.e., the information presented by the patient and the pre-operative investigations, provide important data that the surgeon should take into consideration when operating.

For the model used in this study, the terms “context”, “to contextualize”, “contextual interference” and “contextualization” are defined below.

- The term *Context*, derived from the Latin term *contextere*, means “to weave/join together” [46]; the Merriam-Webster Dictionary defines “context” as “the interrelated conditions in which something exists or occurs; environment, setting” [47]; and in the clinical literature, Durning [48] refers to the setting or physical location or content of a clinical problem.

- *To contextualize* means: “To place (e.g., a word or idea) in a particular context” [46].

- *Contextual Interference (CI) Framework* refers to the impact of different practice environments (e.g., practice settings: real world vs laboratory) and practice conditions (e.g., practice schedule, levels of difficulty) on learning [49, 50]. (See Table I)
We define “contextualization” in our education setting as the use of different contexts (scenarios) in a learning environment (physical knee simulator) to influence the learning experience. These scenarios are a combination of a short vignette and changes made to a simulator or simulation training sessions during practice and assessment. Contextualization can be used to inform research studies in the realm of assessment, feedback, practice conditions and task difficulty. Contextualization is also part of the Contextual Interference Framework through changes made in the practice environment (See Table I).
TABLE I: THEORETICAL FRAMEWORK/MODEL

Contextual interference

1. Battig, Shea & Morgan, Brady, Magill & Hall, Lee & Simon

Practice environment

2. Schmidt, Jarus

Contextualization: Content, Scenarios

7. Durning, LeBel

Practice conditions

3. Maslovat, Lee et al, Russell & Newell

Practice schedule

4. Tsutsui, Meira

Type/ Difficulty of tasks

6. Magill & Hall

Number of tasks

5. Maslovat

Order of tasks

6. Magill & Hall

1. [50-54]
2. [53, 55, 56]
3. [49, 57, 58]
4. [59, 60]
5. [49]
6. [53]
7. [48]
There are different contexts, or scenarios, for patient care. For example, in the wider context of care, there are differences in treating a patient with a cardiac event in the emergency room, versus in the intensive care unit, or on the hospital ward, including interactions with different health care professionals, such as nurses, physiotherapists, and doctors. In specific situations, for example, there are differences in operating on a slim young patient’s knee with good tissues versus operating on a morbidly obese patient’s knee with degenerative changes. The challenges in learning the same skills in different contexts will certainly be different for every learners depending on their own level of expertise.

Therefore, *contextualization* of skill learning and of the information is extremely important for effective learning because, for developing procedural competence, contextualization is the basis for moving from performance imitation of a motor task to competent performance [44, 61]. As DeBourgh and Atherton [61, 62] suggest, contextualization facilitates flexibility, heightened skills of discrimination and discretion, and the ability to select among options the most appropriate method for the situation. Learning is a function of the activity and context in which it occurs: learning in different contexts will provide learners with different experiences, knowledge, information about the environment, skills, ways to control their stress level, etc. For example, a clerk who sees a patient in a noisy emergency trauma room will have a different experience than if he/she sees the same patient in a quiet examination room. The clerk in the trauma room will have to deal with nurses, paramedics, noise, a stressful environment and be precise/concise in information gathering, etc; the clerk in the examination room will most likely be more relaxed and potentially be able to retrieve more information about the reason for consultation and also about the general/social situation of the patient.
Kneebone [44] commented that the “wider context of care is missing when learners practice on benchtop models representing isolated body parts, and procedures learned in a skills centre. Therefore, simulation may provide a misleading sense of confidence, hiding the messy, uncertain and unpredictable nature of clinical reality.” But what if we look at the Contextualization Framework within a simulation session? What if the simulation, itself, provides different contexts in which to learn and practice new skills? What is the influence on the learning experience and the outcomes? For example, is learning to perform basic arthroscopic skills on a simulator different if the simulator offers different contextual features, such as the presence or the absence of cartilaginous surfaces or surfaces that are damaged or not?
III. PURPOSE AND HYPOTHESES

The purpose of this research project was to provide evidence about appropriate simulation training for basic arthroscopic skills. Specifically, should simulation training of basic arthroscopic skills be contextualized? The purpose of this project was to determine whether basic arthroscopic skills learned in the context of a particular clinical problem will lead to better performance, compared to basic arthroscopic skills learned without the context of a particular clinical problem.

A basic skill is different from a basic task. The Merriam-Webster Dictionary [47] defines “skill” as the “ability to use one’s knowledge effectively and readily in execution or performance, a developed aptitude or ability.” For example, a motor skill is a certain number of movements learned in sequence to produce an efficient action in order to master a certain task [63]. The Merriam-Webster Dictionary [47] defines “task” as a “usually assigned piece of work often to be finished within a certain time” therefore, a task is comprised of various skills and has a start and an end clearly established.

In our study, a basic arthroscopy skill is defined as an arthroscopic skill that should be generic i.e., is applicable to the anatomy of any joints [64]. These basic skills should be transferrable to any joint in any situation and, therefore, would allow learners to perform tasks irrespective of the specific joints and anatomical structures [64]. “Basic skills in arthroscopic surgery” were defined and these skills were used to develop a simulation-based technical skills training program to be delivered in a de-contextualized versus a contextualized approach. We hypothesized that training novices in basic arthroscopic skills, using a contextualized approach with simulated case scenarios, will result in better performance in simulated knee arthroscopy.
A secondary goal of this project was to collect perceptions of the learners about how the case scenario in which they practiced arthroscopic surgery skills influenced their performance in the simulation and in actual practice. Their perceptions were elicited to determine which part of the training they found useful when learning to perform a more complex activity such as using motorized surgical instruments or moving together the camera and an instrument all around the knee joint. These learner perceptions will be used to develop future iterations of the training scenario in educational content, format of delivery and conditions of practice.
IV. METHODOLOGY

A. **Contextualization of basic arthroscopic skills**

The preliminary work (Projects 1 and 2, above) provided us with the definition of a set of basic arthroscopic surgery skills that we used to test the main hypothesis of this thesis: *training novices in basic arthroscopic surgery skills, using a contextualized approach with simulated case scenarios, will result in better simulation-based performance in knee arthroscopic surgery.* The following sections will describe the design, results and main conclusions from this study.

B. **Participants**

The main focus of the study was to understand the impact of a contextualized approach to surgical simulation training, in a novice population of trainees (as distinguished from intermediate or advanced trainees). Junior medical students (first and second years) at the University of Western Ontario in London, Canada were invited to participate in the study and a purposive sampling \[65, 66\] was used. In addition, snowball sampling\(^1\) \[67\] was used in selecting participants who were part of a homogeneous group of medical students potentially interested in a surgical career but with no previous surgical experience, and who could provide high quality reflective perspectives for the qualitative part of the project. A total of 20 participants were recruited. Exclusion criteria were: previous exposure in observing and/or participating in a scoping procedure (general surgery, orthopaedics, urology, and gynecology). The ethics board of the University of Western Ontario (where the study was conducted) and of the University of Illinois at Chicago approved this project.

\(^{1}\) Snowball sampling is a type of purposive sampling where existing participants provide researchers with contacts to other suitable potential participants. Thus the sample group appears to grow like a rolling snowball.
C. **Study Design**

The design of this study was a prospective, randomized, two-arm pilot study focused on learning basic arthroscopic surgery skills on a simulated physical leg and knee joint, using real arthroscopic surgery instruments [40] (Figures 1 and 2). The two arms of the study were 1) contextualized practice and 2) de-contextualized practice. The “de-contextualized practice” required performance of a series of basic arthroscopic surgery skills on a knee without cartilage surfaces, with intact menisci and with no clinical scenario provided. The “contextualized practice” focused on the same series of basic arthroscopic surgery skills, but they were done in two conditions: 1) a knee with intact cartilage surfaces and menisci (clinical scenario: 22 year-old patient) or 2) in a knee with severely damaged cartilage surfaces (clinical scenario: 82 year-old patient). A pre-test, practice time and a post-test were done during the first session. The second session was done one month later for retention testing and administration of a survey.

![Physical leg and knee joint simulator, custom-designed](image)
Testing session one: All participants initially saw a video explaining the anatomy of the knee, the different arthroscopic instruments they would be using and the different basic arthroscopic surgery skills they would perform on the simulator. All participants took a pre-test of their arthroscopic surgery skills on a custom-built simulated physical leg and knee joint [40] with severely damaged cartilage surfaces and menisci and were provided “the old patient” clinical scenario (contextualized pre-test). The participants were then randomly assigned for simulation training to either contextualized practice or de-contextualized practice of basic arthroscopic surgery skills. The practice time had been determined based on a few laparoscopic studies reporting a practice time ranging from 30 minutes to 4 hours [68-70]. The practice period for this project lasted a maximum of 30 minutes, as many students felt physically tired of holding the instruments after 25 minutes. Performance was measured for all participants immediately after the simulation practice, using the same custom-built simulated surgical knee trainer with damaged surfaces and providing “the old patient” clinical scenario (contextualized post-test).

Testing session two: Retention was measured on the same contextualized knee (with “the old patient scenario) one month after the post-test. Figure 3 outlines the entire program of training and testing.
The performances were recorded with video-capture. For performance assessment, a checklist ("done, done incorrectly, not done" for each item) was developed (Table II) and a previously validated GRS (1 to 5 scale for each item) [12] was used.
### TABLE II: CHECKLIST

<table>
<thead>
<tr>
<th>Basic Skills</th>
<th>Done</th>
<th>Done incorrectly</th>
<th>Not done</th>
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<tr>
<td><strong>Visualization</strong> (this skill will be evaluated independently AND in combination with the other skills)</td>
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<td>- Maintains the action/structures to see well centered on the monitor</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Orient the camera upside up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sees the working area before putting other instruments in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Maintains a general view of the action, close enough to see what is going on/what is done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Triangulation</strong> (camera and instrument tip to tip)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Maintains the tip of the instruments in front of the camera, tip to tip, throughout the arthroscopy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Depth perception: minimal overshooting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Debridement</strong> (shaving/burring)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Puts the instruments gently in the joint</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sees the working area before putting other instruments in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Starts the shaver/burr before touching the structure to shave</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Shaves/burrs with smooth motion, without bouncing back and forth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Maintains integrity of the surrounding structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Depth perception: minimal overshooting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Probing</strong> (Evaluation of anatomical structures)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Puts the probe in the joint gently</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sees the working area before putting other instruments in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Uses the tip of the probe (not the elbow) to touch the structure to evaluate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Evaluates all the structures in a systematic way to avoid forgetting some structures

- Depth perception: minimal overshooting

<table>
<thead>
<tr>
<th>Grasping/cutting (Removal of loose bodies/menisectomy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Puts the instrument gently in the joint</td>
</tr>
<tr>
<td>- Sees the working area before putting other instruments in</td>
</tr>
<tr>
<td>- Grasps the loose body efficiently</td>
</tr>
<tr>
<td>- Retrieves the loose body efficiently</td>
</tr>
<tr>
<td>- Depth perception: minimal overshooting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Need for assistance (after 2 minutes of struggles per task)</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For 1 or 2 tasks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For 3, 4 or 5 tasks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For all 6 tasks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A secondary goal of this project was to elicit perceptions of participants about how the case in which they practiced influenced their performance, in the simulation and in actual practice, and to identify which specific parts of the training were more useful in preparation for this learning experience. A short survey (Table IV) with visual analog 10-point scales (VAS) and short-answer questions was administered at the time of the retention test one month after the first session.
### TABLE III: SURVEY

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>A bit</th>
<th>Neutral</th>
<th>A lot</th>
<th>Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much did you enjoy your practice on the simulator?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the simulation training make your learning time more productive?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What part of the training was most useful to you?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What was the most difficult part of this simulation training?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much time would you be interested in spending to practice on this simulator with these basic skills?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The context (bad/intact/no cartilage) that was provided to you during practice time impacted your performance for the post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, how would you rate your experience during both sessions?</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Very good</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
V. RESULTS

For this pilot study, 21 participants (10 females, 11 males) were recruited and enrolled in the study; one participant did not complete the study. Twenty (20) students completed the study involving all parts (first session: pre-test, practice with simulation, post-test; and second session: retention testing one month later). All participants had no previous experience with arthroscopy, laparoscopy, or any minimally-invasive/scoping procedures. The participants were randomized into two groups while they learned basic arthroscopic surgery skills in a simulation setting: de-contextualized practice (no cartilage, no scenario, n= 7) and contextualized practice, which comprised two conditions (1- normal knee, normal smooth cartilage, “young patient scenario”, n= 7; 2- pathological/arthritic knee, damaged “bad” cartilage, “old patient scenario”, n= 6). Of note, as a result of the small number of participants per group, p-values were not calculated.

A. Assessment with checklist (Figures 4,5,6)

The results show that very few skills were “not done” during the pre-test, post-test and retention test. Skills that were “not done” were deemed as problematic as if they were done incorrectly because if certain skills are not done, then certain parts of a procedure could have deleterious effects on the patients, either acutely or long-term. For that reason, the “done incorrectly” and “not done” categories were grouped together².

Overall, at the pre-test (baseline), 51% of the “de-contextualized group” performed the skills correctly (“done”), and 61% of the “contextualized group” performed the skills correctly (Figure 4). Even though all participants were completely novices to arthroscopy and had no

² For ease of reading, when values for the two conditions of the contextualized group are equivalent, the conditions will be grouped together.
previous exposure/experience, this difference at baseline is unexplainable. This is probably one of the caveats of dealing with human participants who each come with their unique backgrounds. The post-test showed that all groups improved their basic arthroscopic surgery skills, with 84% of the de-contextualized group, 85% of the contextualized group demonstrating correct performance. During the retention testing done one month after the initial testing session, all participants showed a better level of skills (skills retention) compared to the pre-test, with correct performance in 79% of the de-contextualized group, and in 81% of the contextualized group (Figure 4).
When comparing the pre- and post-test performance, respectively 96% of the de-contextualized group and 94% of the contextualized group maintained the number of basic skills “done”. Comparing again the pre-test with the post-test assessment, 71% of the decontextualized group improved from “not done/incorrectly done” to “done”. Analysis of the two conditions included in the contextualization group provided more information: 58% of the contextualized “old patient scenario” and 74% of the contextualized “young patient scenario” improved from “not done/incorrectly done” to “done” (Figure 5). This potentially suggests that different levels of contextualization may influence more or less the performance of the trainees: more information (contextualized “old patient” scenario) may be detrimental for improving the performance over time.
When comparing the data from the post-test with the retention test, 82% of the de-contextualized group and 88% of the contextualized group maintained their level of correct skills during the retention testing. Sixty-two percent (62%) of the de-contextualized group, and 50% of the contextualized group improved their skills to “done” at the retention testing session when compared to the post-test (Figure 6).
**Figure 6: Results: Maintenance and improvement of skills on retention test based on checklist.**

![Chart showing maintenance and improvement of skills](chart.png)

**B. Assessment with global rating scale (Figures 7-8)**

The ratings of “4 and “5” were grouped together as a good to excellent performance on the global rating scale (GRS) because good to excellent performances are safe for the patients and should lead to better outcomes acutely and long-term. Based on this scale, very few of the participants were rated “4” or “5” at the pre-test: 2% of the de-contextualized group, 7% of the contextualized group “old patient scenario” and 12% of the contextualized “young patient scenario”. At the post-test, global ratings of participants of 4 or 5 were 39% of the de-contextualized group, 64% of the contextualized “old patient scenario” and 43% of the contextualized “young patient scenario”. At the retention testing, global ratings of participants of 4 or 5 were 31% of the de-contextualized group and 36% of the contextualized group (Figure 7).
During the post-test, 38% of the de-contextualized group, 60% of the contextualized “old patient scenario” and 43% of the contextualized “young patient scenario” improved their performance to reach a “4” or a “5” rating on the GRS At the retention test, 19% of the de-contextualized group, 13% of the contextualized group “old patient scenario” and 37% of the contextualized “young patient scenario” improved their performance to a “4-5” on the GRS (Figure 8).
C. Survey

Based on survey ratings using visual analog scales, 95% (19/20) of participants enjoyed their practice with the simulator (8 to 10 on VAS); 90% (18/20) of participants felt that the simulation training made their learning more productive (8-10 on VAS); and 70% (14/20) felt that the simulation was well designed for their knowledge and skills level (8-10 on VAS). Only one quarter of the participants (25%, 5/20) were aware that the context provided during the practice time impacted their performance during the post-test (8-10 on VAS). Overall, the experience during both testing sessions was rated as very good to excellent (8-10 on VAS) for 90% (18/20) of the participants.
More information, using a qualitative method of data collection and analysis, was gathered on the survey using short-answer questions: 15 participants (15/20, 75%) felt that the practice was the most useful part of the training, in orientation (e.g., “in helping me getting orientated with the scope and probe (#3)”, “[…], it wasn’t until I could practice with the scope that I could correctly understand the anatomy (#8”)”; and in providing non goal-oriented practice in a non-stressful environment (e.g., “First time hands-on practice with arthroscopy tools in a controlled, non-stressful environment (#7)”, “Non goal oriented time for exploration was helpful for recognition of anatomy and gaining dexterity with the tools (#10”). The use of motorized instruments, the triangulation of two instruments and understanding the orientation of the camera (arthroscope) were felt, equally, to be the most difficult part of the training (12/20, 60%) (e.g., “Sense of direction, correlating what was on the screen to my movements (#11); “Orienting to anatomical parts, and navigating within the knee (#14)”; “Locating the probe’s position (#15)”;

“Using the shaver/burr was the most difficult part (#20)”;

“Repositioning the camera in the right position if it was getting out of sight (#21)”. The realism of the knee and cartilage surfaces was viewed by participants as the best feature of our model (13/20, 65%) (e.g., “The cartilage seemed realistic and allowed me the opportunity to practice shaving (#8)”;

“The model seems very lifelike and being able to change the cartilage is very useful for training (#9)”;

“Anatomical similarities, textural similarity (#10); “Anatomically to scale (#16); “Seems incredibly lifelike (#20)”;

“I enjoyed working on a model that reproduced the anatomy (#21)”).

A few students were physically challenged by the pre and post-tests: two became vaso-vagal and had to have a break to sit down and recuperate; one felt “distressed from seeing all that
bad cartilage hanging everywhere”; and three experienced some shoulder/neck pain from the
static position when holding the instruments.
VI. DISCUSSION

Varying the conditions of practice and the amount of information available for training will influence the performance of novice trainees. As shown in this study, even though we had a small sample size, any practice will improve novices’ performance. However, as the amount of information increases (as the tasks become more contextualized), improvement in performance is not as evident as in decontextualized practice. This suggests that trainers designing a curriculum should carefully take into consideration what aspects of the context should be adjusted in order to facilitate novices’ learning. Kneebone [44] states that “a more serious criticism of simulation is that too much emphasis on technical skill offers an oversimplified picture which misses important elements of clinical practice. Technical skills are just one part of a wider picture.” He stresses the importance of combining both technical skills and non-technical skills to achieve functional realism. The main goal in simulation is to have a correct balance between human interaction, feedback (from humans or simulators) and performance of technical skills [71, 72]. Human interactions include such elements as: oral feedback during or after a training session, encouragements, re-positioning of hands during simulated surgery, and model demonstration. Such interactions are all important to the trainees to improve their performance [73, 74]. Simulator feedback includes haptics and performance measures provided by the simulator. The discomfort experienced with the absence of supervised training or feedback from a trainer was evident during this project, as many students were asking for advice (even though they received no feedback) about specific points, such as “how to correct their hand position to not get physically tired in their shoulders, how to get a better view to see more what they were doing in the knee, where the loose body was, what they could do to avoid bouncing with the shaver, etc.” Given these perspectives, the results of this project suggested, on a small scale, that feedback
mechanisms should be taken into consideration when using a contextualized approach to training in order to positively impact the outcome, to avoid development of bad habits (such as inappropriate use of instruments) [75], and to lower the level of stress and anxiety [76, 77] when learning new surgical skills.

The Challenge Point Framework (CPF) [78] can assist in explaining some of the findings of this study. This framework suggests that learning is related to the amount of information provided during performance practice and that optimal learning will take place if the skill level and the task difficulty are appropriately challenging [78, 79]. Guadagnoli et al.[78] state that “learning cannot occur in the absence of information, it can be retarded in the presence of too much information and learning achievement depends on an optimal amount of information, which differs as a function of the skill level of the individual.” An “optimal challenge point” (See Figure 3 in [78]) exists when learning is maximized and the performance conditions are maximized. This means that if the amount of information provided to the learner matches their skills level, maximized learning should happen. Additionally, if the task difficulty and practice conditions are adapted and match the skills level of the learner, performance conditions should be maximized. Therefore, an “optimal challenge point” can be reached. If the task difficulty is increased beyond the optimal challenge point, both learning and skills demonstrated in practice performance decrease. The optimal challenge point will vary depending on the skill level of the trainees, practice conditions, the task difficulty, etc.

Consequently, the conditions of practice can make tasks more or less difficult by influencing the amount of available information to the trainees (See Figure 1, in [78]). It is
expected that within this proposed framework, the learning objectives will be matched with the 
skill level of the learners, the difficulty of the task, the amount of information provided for 
learning and the way it is presented. Therefore, in this study, the information provided by 
contextualization (modification of the practice environment by changing scenarios and the 
appearance of cartilage joint surfaces) might have been well balanced for the participants who 
performed better, or not well enough balanced for participants unable to reach the optimal 
challenge point.

We hypothesized that training novices in basic arthroscopic skills using a contextualized 
approach will result in better performance with simulated case scenarios in knee arthroscopy. 
Our results have suggested that, at the post-test, all groups improved their basic arthroscopic 
skills and retained at least partially these skills a month later. In contrast, the participants in the 
contextualized group, condition “old patient scenario”, seemed to have more difficulties 
improving from “not done/done incorrectly” to “done” on the post-test and retention test, when 
compared to the others. Overall, we were unable to support the hypothesis with our study results. 
This could be explained by the small sample size for this pilot study or by the true absence of 
effect of the contextualization in surgical skills training. Moreover, the vast majority (75%) of 
the participants, in their survey responses, did not see the impact of contextualization on their 
learning or subsequent performance. This sheds light on a possible blind perception of the 
environment due to an inappropriate amount of information from the environment or a lack of 
experience. The inability to understand or recognize how some variables are modified in an 
environment is potentially secondary to the lack of knowledge of the knee anatomy (normal or 
pathological), the lack of experience in knee arthroscopy, and poor utilization of arthroscopic
instruments. A larger study would more likely allow us to better determine the effect of contextualization in surgical skills training.

Even though we were unable to confirm the hypothesis, we can attempt to explain why the contextualized “old patient scenario” group had more difficulties to improve their performance on the post-test and retention test. Based on the Challenge Point Framework, we suspect that the amount of information provided during this study was not appropriately adapted to their skills level: they were presented too much information (too many things to look at, too much cartilage pieces in front of the camera) for their novice skills and knowledge (difficulty to recognize the anatomy, inability to triangulate properly) to allow the contextualized group to improve to the same extent as participants in the other groups. This suggestion can be translated and applied into our residency training programs: to allow our trainees to improve their surgical skills and lower their stress level (to avoid physical distress seen in some participants of this study), we need to tailor surgical training curricula that are appropriate for their individual level of training.

In order to better tailor the appropriate training curricula for surgical trainees, we need to evaluate the trainees’ skills level prior to the training sessions. This evaluation would serve as a baseline so we could actually adapt the degree of contextualization and the amount of information to provide trainees the conditions (type of scenario, features of a simulator, stressful or non-stressful environment, etc.) to reach the optimal challenge point. Some valuable background information would be important to obtain prior to the training sessions. More specifically, the year of training, type and amount of exposure to specific surgical cases and
previous evaluations from clinical teaching units related to the topic of specific training sessions would have to be taken into consideration for designing a training curriculum. For example, a Year-2 orthopaedic resident might have done three months of upper limb rotation with intense exposure to shoulder arthroscopy, but another Year-2 orthopaedic resident might have not done any arthroscopy at all during his second year. These two residents, compared to a final-year orthopaedic resident, would most likely perform at a lower level, as they are less experienced. Even though a certain level of skills is expected per year of training during residency, some intrinsic differences are seen among surgical residents: for example, some senior trainees are just unable to perform very well during any advanced arthroscopic procedure, either because they did not have enough exposure to these techniques or they don’t have the interest to improve their techniques (depending on their planned subspecialty training/fellowship) or because they just don’t have the ability to work in three dimensions (in the patient) and see in two dimensions (on the monitor), etc. Concurrent to the year of training, the type and amount of surgical training and previous assessment forms, a baseline surgical test (on a simulator or cadaver) should be obtained to further confirm the skills level of the surgical trainees. As stated above, all this information will then inform the design of the surgical training curriculum and degree of contextualization required to reach the optimal challenge point.

In general, simulation training as an adjunct to the traditional apprenticeship surgical training curriculum at a novice level of training is supported by the format of delivery (physical simulator, non stressful environment, opportunity for practice) and the educational content (scenarios, contexts of practice). Collection of evidence on trainees' perceptions opinions about this project showed that most of the participants thought that this training experience on a
physical knee simulator, using real arthroscopic instruments, was a useful and enjoyable experience. The use of a basic skills physical simulator is felt, by the participants and researcher, to be appropriate for this level of surgical experience. The practice time was an important part of the training as it allowed participants to better understand knee anatomy and how to use the instruments. The fact that just a few participants realized that the contextualization provided during this study influenced their performance indicates that surgical training of novices has to be mostly based on the trainers’ experience with teaching surgical skills to trainees (e.g., seeing how trainees of different levels react to different parts of their training; their performances; the retention of those skills over time, once the trainees come back to their service after a hiatus doing other rotations; complexity of cases; other factors such as provision of feedback, supportive attitudes, technical tips and tricks) as the trainees are not necessarily consciously aware of subtleties or changes in their learning environment. Direct input from the learners should not be discredited as these perspectives may provide some general guidance for the trainers.

This work is unique in the orthopaedic literature as the definition of basic arthroscopic skills was based on a systematic process and methodology grounded on a modelling tool. The proposed basic skills are generic enough that they can be used and applied to any scoping procedure in any joint. In the long term, it can be very beneficial to orthopaedic surgery programs to use such basic arthroscopic skills for effective training of residents, increased safety and improved confidence in the operating room.
The main limitation of this study is that this is a pilot study, involving a small sample size, with all participants coming from a single institution. Self-selection might have happened because participants were volunteers and recruited using a snowball purposive sampling method; therefore they could have been interested in orthopaedics more than other students. Randomization of participants could counteract the potential impact of self-selection. Due to the small sample size, in this project we were not able to confirm the hypothesis and the impact of contextualization seemed to be less evident. The next phase will be to replicate this study with a larger number of participants to further support the claims from the theoretical frameworks.

As part of a larger research program, future work will focus on studying a larger group of randomized participants and comparing novices with intermediate and advanced trainees. Another study would focus on investigating the impact of the contextualization and the use of different scenarios within a wider context of care, including the interactions with different actors such as nurses, physiotherapists, physicians, etc. instead of focusing only on specific surgical skills. This is important as we all work in multi-disciplinary teams, surgical and non-surgical, and a diversity of skills is required for different activities and situations. In addition, there is a definite trend for those multi-disciplinary teams to do simulation-based training and these teams of learners would possibly benefit from the use of the Contextualization framework during their training sessions.
VII. CONCLUSION

With restricted working hours, reduced surgical exposure and time constraints, new methods are needed for appropriate surgical training. Arthroscopy is challenging to teach and to learn, and effective approaches for basic arthroscopic skills training are not well defined. We used a systematic method to define generic basic arthroscopic skills and evaluated the trainees’ performance in simulated situations using a global rating scale and a checklist. All trainees improved their arthroscopic skills on the post-test but, when compared to the other groups, one of the groups, trained using contextualized scenarios, did not improve as much as the others on the post-test and retention test. As discussed in this dissertation, our hypothesis could not be confirmed, either because of the small sample size for this pilot study or by the true absence of effect of the contextualization in surgical skills training. To help understand how to teach basic arthroscopic surgical skills to provide a better and more effective learning experience for trainees, there may be value in studying the effect of contextualization of surgical skills in more advanced trainees and with a larger sample. Ultimately, the right amount of information, based on skill level of the individual, practice conditions, task difficulty, and feedback, is required to allow learners to reach an optimal challenge point to enhance and maximize the learning experience.
IX. BIBLIOGRAPHY


CURRICULUM VITAE

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POSITION TITLE
MD, FRCSC, MHPE cand.
Associate Professor, Orthopaedic surgery,
University of Western Ontario, London (Ontario)

EDUCATION/TRAINING

<table>
<thead>
<tr>
<th>INSTITUTION AND LOCATION</th>
<th>DEGREE (if applicable)</th>
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<tbody>
<tr>
<td>Laval University, Quebec city (Quebec)</td>
<td>-</td>
<td>1993-1995</td>
<td>Physiotherapy</td>
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<td>Laval University, Quebec city (Quebec)</td>
<td>MD</td>
<td>1995-1999</td>
<td>Medicine school</td>
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<tr>
<td>Laval University, Quebec city (Quebec)</td>
<td>FRCSC</td>
<td>1999-2004</td>
<td>Orthopaedic surgery</td>
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<tr>
<td>University of Western Ontario, London (Ontario)</td>
<td>Fellowship</td>
<td>2004-2005</td>
<td>Orthopaedic surgery, sport medicine</td>
</tr>
<tr>
<td>University of Illinois at Chicago, Chicago</td>
<td>MHPE</td>
<td>July 2009-present</td>
<td>Masters in Health Professions Education (MHPE), main interest in surgical simulations</td>
</tr>
</tbody>
</table>

A. Personal Statement

Dr. LeBel grew up in Québec city and, following studies in physiotherapy, she graduated from Laval University Medical School in 1999. From 1995 to 2002, she had a very good experience with sports related injuries as a team physician and physiotherapist for AAA Men’s and Women’s College Basketball national and provincial Tournaments. She completed her orthopaedic surgery training in 2004 before completing a Sport Medicine Orthopaedic Fellowship at the University of Western Ontario and the Fowler Kennedy Sport Medicine Clinic. Dr LeBel worked for one year in Québec's Eastern Townships as a sport medicine orthopaedic surgeon before coming back in London as an Assistant Professor. She worked for 6 years at the Fowler-Kennedy Sport Medicine Clinic, treating knee and shoulder athletic injuries. Dr. LeBel was recently recruited to join the renowned Hand and Upper Limb Centre in September of 2012. Dr. LeBel now specializes in the arthroscopic treatment of athletic injuries and disorders of the shoulder. She is completing a Masters in Health Professions Education at the University of Illinois in Chicago and her main research focus is in surgical simulation and motor skills learning.
Dr LeBel has been awarded the University Student Council Award of Excellence for excellence in teaching in medicine and she represented the Canadian Orthopaedic Association as a CFBS Travelling Fellow in the Fall 2012.

B. Positions and Honors

POSITIONS
Associate Professor, Orthopaedic Surgery, Hand and Upper Limb Centre, University of Western Ontario, London (Ontario), 2013-present. Main interest in shoulder pathology in orthopaedic sport medicine.
Assistant Professor, Orthopaedic Surgery, Hand and Upper Limb Centre, University of Western Ontario, London (Ontario), 2012-2013. Main interest in shoulder pathology in orthopaedic sport medicine.
Fellow, Centre for Education, Research & Innovation, AMOSO Opportunities Fund Grant, 2011-present.
Assistant Professor, Orthopaedic Surgery, Fowler-Kennedy Sport Medicine Clinic, University of Western Ontario, London (Ontario), 2006-2012. Main interest in shoulder and knee pathology in orthopaedic sport medicine.
Orthopaedic Surgeon, Brome-Missisquoi-Perkins Hospital, Cowansville (Quebec), 2005-2006

Reviewer: Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA) journal, 2012-present
Leader of CSTAR Orthopaedic Simulation 2009-present
Member CSTAR Education Committee, 2009-2012
Member of the CSTAR Surgical Simulation Committee 2009-2012
Member Undergraduate Surgical Education Committee, University of Western Ontario, London (Ontario), 2008-2009
Examiner, Medical Council of Canada, 2008-2012
Examiner, Centre for the Evaluation of Health Professionals Educated Abroad (CEHPEA), Toronto (Ontario), 2007-2012

Maternity leave, March 2008-August 2008
Maternity leave, March 2010-September 2010

HONORS AND AWARDS

2. Canada-France-Belgium-Switzerland (CFBS) traveling fellowship, through the Canadian Orthopaedic Association, October-November 2012.


5. 2010 Best MHPE 502 Core Paper Award, “Instruction and Assessment”, University of Illinois at Chicago, USA, 2011.


C. Research Endeavour

MEDICAL EDUCATION/SURGICAL SIMULATION

1. Improvement of shoulder arthroscopic technical skills in senior residents: impact of pre course independent didactic teaching, 2013. Principal investigator. Goal: To assess the residents’ knowledge and surgical skills performance for the placement of the first anchor when doing an arthroscopic Bankart repair prior to and after the Canadian Review Course for shoulder surgery. Sponsor: Arthrex Canada.

2. Eye tracking in simulated arthroscopic surgical training, 2012-present. Principal investigator. Goal: To evaluate what novice arthroscopists focus on while watching a split screen video of a trainer performing arthroscopy on a simulator.

3. Development of an orthopaedic simulator for glenoid reaming, 2012-present. Collaborator. Goal: to develop a system integrating computational techniques with haptic and visualization interfaces for accurate prediction and simulation of bone removal and to integrate the developed system within the training routine of the surgical trainees and staff.

4. Contextualization of Simulation-based Training for Basic Arthroscopic Skills, 2011-present. Principal investigator. Goal: To primarily investigate the issue of determining what is the appropriate way to deliver simulation training for basic arthroscopic skills. Specifically, should simulation training of basic surgical skills be contextualized, instead of the traditional stepwise approach.


6. 3-D Laparoscopy: A New Frontier in Surgical Visualization, 2011-2012. Collaborator. Goal: To examine the effect of stereo-visualizations in surgical skill acquisition will be evaluated via the MISTELS (McGill Inanimate System for Teaching and Evaluation of Laparoscopic Skills) test parameters.

new skills in the most effective way and examine the observational learning paradigm in the context of arthroscopic surgical training using simulation.


9. **Mapping and task decomposition of arthroscopic procedures for basic skills training**, 2010-2012. Principal Investigator. Goal: to decompose knee arthroscopic procedures to define the basic skills required to teach and learn arthroscopy more efficiently.


11. **Determination of Standardized Tasks for Simulator-Based Skills Development and Assessment in Arthroscopic Knee Surgery**, 2011-present. Principal investigator. Goals: To develop standardized tasks for arthroscopic skills assessment and training based on experiments performed on a surgical physical simulator with force and position sensing capabilities.

12. **Uncertainty and surgical challenges**, 2011-present. Collaborator. Goals: To better understand how expert surgeons face challenging surgical situations and how we can make this process explicit.


14. **Task Identification for Skills Development and Assessment in Arthroscopic Knee Surgery**, 2009-present. Principal investigator. Goals: to improve a prototype knee-shaped simulator for basic arthroscopic surgical training that has been developed by our personnel, and (2) to develop and execute experiments with residents and surgeons in order to assess the effectiveness of the system and identify those tasks that are best suited to clinical skills development and assessment.

15. **Arthroscopic Skills Development and Assessment for Orthopaedic Knee Surgery**, 2009-present. Principal investigator. Goals: To develop a system for the training and assessment of the skills required for arthroscopic knee surgery by developing a minimally-invasive training environment to simulate the knee joint, developing standardized tasks and assessment measures for surgical proficiency and developing sensorized arthroscopic instruments.

CLINICAL RESEARCH
1. **Systematic analysis of the Latarjet technique in shoulder instability**, 2011-2012. Co-investigator. Goal: To review the English and French literature since 1950 with regards to the Latarjet coracoid bone transfer for shoulder instability. The second part is to study a historical review of the different techniques that have been described to treat shoulder instability.


3. **Shouldering the load: Characterizing dynamic 3D scapular dyskinesis to direct subject-specific clinical care of the painful shoulder**, 2010-2013. Principal investigator. Goals: To quantify the exact 3D nature of in-vivo, dynamic scapular dyskinesis during functional shoulder motion using the gold standard of fluoroscopic radio-stereometric analysis in patients with frozen shoulder, impingement, painful rotator cuff tear, total joint replacement.


5. **The role of rotator interval closure in Bankart lesion repair**, 2010-2012. Co-principal investigator. Goal: This study will attempt to answer the following research question; does Bankart lesion repair with rotator interval closure result in differences in quality of life, range of motion and dislocation recurrence at 3 weeks, 6 weeks, 3 months, 6 months, 1 year and 2 years in similar patients with Bankart lesions who are treated with Bankart lesion repair alone? Randomized clinical trial.


7. **Determination of correct normal and pathological gleno-humeral joint motion using bi-planar x-ray fluoroscopy**, 2009. Principal investigator. Goals: Pilot study on the feasibility of using bi-planar fluoroscopic radio-stereometric analysis for measuring normal and pathological gleno-humeral motion in a clinical population. The target pathologies are instability, rotator cuff tears, impingement and in shoulders following surgical treatment as they all present an abnormal joint motion.

D. Grants awarded


E. Presentations

Presentations


Invited talks


Poster presentations


F. Peer-reviewed Abstracts/Publications


Book chapters:
Submitted for publication:


Manuscripts in preparation:


3. M.-E. LeBel, T. Dwyer, D. Rouleau, “Improvement of shoulder arthroscopic technical skills in senior residents: impact of pre course independent didactic teaching”

F. Other


3. Chairperson, “Training in Surgery”, at the Association for Medical Education in Europe (AMEE) 2011, Vienna, Austria, August 29th, 2011.


5. Workshop Instructor, “Rotator Cuff and Biceps Repairs”, at the Canadian Orthopaedic Association (COA) Annual Meeting, St-John’s, Newfoundland, July 7th, 2011.

G. Student supervision and Teaching

Fellows do 3-4 months rotations on our service (1 fellow with 1-2 surgeon), 2006-present
Residents do 1 to 3-months rotations on our service (1 resident with 2 surgeons), 2006-present
Residents/Fellows weekly teaching sessions, 2006-present
Medical Students: students come on a regular basis for 2-weeks rotations, 2006-present
Year-2 Clinical Methods to medical students, 2007-present


47. Merriam-Webster Dictionary.


