Training Surgeons to Perform Arthroscopic All-Inside Meniscal Repair

A Randomized Controlled Trial Evaluating the Effectiveness of a Novel Cognitive Task Analysis Teaching Tool, Imperial College London/University College London Meniscus Repair Cognitive Task Analysis (IUMeRCTA)

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Background: All-inside meniscal repair is an increasingly common technique for the surgical treatment of meniscal tears. There are currently no standardized techniques for training residents in this procedure. Cognitive task analysis (CTA) is a method of analyzing and standardizing key steps in a procedure that allows training to be conducted in a validated and reproducible manner.

Purpose: (1) To design a digital CTA teaching tool for a standardized all-inside meniscal repair. (2) To evaluate whether CTA-trained residents would perform better in a meniscal repair task compared with a control group who underwent traditional apprenticeship methods of training.

Study Design: Controlled laboratory study.

Methods: Three expert knee surgeons were interviewed using a modified Delphi method to generate a consensus among the ideal technical steps, cognitive decision points, and common errors and solutions for an all-inside meniscal repair. This written information was then combined with visual and audio components and integrated onto a digital platform to create the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis (IUMeRCTA) tool. Eighteen novice residents were randomized into an intervention group (digital CTA tool) and control group (equipment instruction manual). Both groups performed an all-inside meniscal repair on high-fidelity, phantom knee models and were assessed by expert surgeons, blinded to the interventions, using a validated global rating scale (GRS). After a power calculation, median GRS scores were compared between groups using the Mann-Whitney *U* test; significance was set at $P < .05$.

Results: For the IUMeRCTA tool design, the procedure was divided into 55 steps across 9 phases: (1) preoperative planning, (2) theater and patient setup, (3) portal placement, (4) meniscal examination, (5) tear reduction, (6) suture planning, (7) suture insertion, (8) repair completion, and (9) postoperative care and rehabilitation. For the trial, the intervention group (mean $\pm$ SD GRS, 32 $\pm$ 2.9) performed significantly better than did the control group (GRS, 24 $\pm$ 3.3; $P < .001$).

Conclusion: This is the first CTA tool to demonstrate objective benefits in training novices to perform an arthroscopic all-inside meniscal repair.

Clinical Relevance: The IUMeRCTA tool is an easily accessible and effective adjunct to traditional teaching that enhances learning the all-inside meniscal repair for novice surgeons.

Keywords: meniscus; meniscal repair; training; simulation; cognitive task analysis; global rating scale

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Meniscal repairs are most commonly performed arthroscopically and can use inside-out, outside-in, or all-inside approaches.[16,24,34,45] While early repair techniques involved open, inside-out, and outside-in methods, there has been an increase in the use of all-inside techniques in the past decade,[36] perhaps because of the improvement of repair devices.[17] However, these techniques have a steep learning curve[21] and are challenging to teach because of the arthroscopic nature of the procedure and the potential complications, which include neurovascular damage, implant breakage, and damage to chondral cartilage.[43] Earlier studies have suggested failure rates of meniscal repair of up to 20% at 5 years, with more recent studies reporting lower although still substantial failure rates (5%-10%).[24]

It is essential that all-inside meniscal repair is not only well performed by the established arthroscopic knee surgeon[4,29] but also well taught to residents with a high regard for patient safety. For residents to learn and be considered competent to independently conduct this procedure, they require sufficient time to practice and demonstrate proficiency in the operating room.[35] However, the recent changes to training programs, albeit designed to reduce residents' working hours and improve patient safety, introduce considerable limitations to hands-on experience, which may hinder resident development.[3] These include working time regulations, reduced operating time, increased malpractice cases, and a shift toward fatigue management strategies.[19,37] A survey assessing perceptions of the reduced working time showed only 56% of residents and 17% of training program directors thought that residency graduates would be able to practice as attending surgeons.[33]

In view of the above, there is a need for surgical training programs to use more accessible training adjuncts to help residents meet the required competencies.[12] Several studies have evaluated the use of simulation training to foster orthopaedic skills development before performing in the operating room.[10,15,25,30,38] However, high-fidelity simulation, such as practice on cadaveric specimens, is expensive and not readily accessible.[25] Other types of simulation, such as virtual reality or phantom models, are more cost-effective and accessible and have been shown to help with the early part of the learning curve, in particular the learning of the steps in the procedure and the handling of instruments and implants.[10]

One well-established method of analyzing and standardizing the teaching of steps in a procedure is cognitive task analysis (CTA). This is a validated method through which elements of a complex task can be captured and analyzed to allow effective transfer of knowledge from experts to novices to accelerate their learning curves.[46] Means and Gott[31] contended that 5 years of advanced knowledge could be transmitted within 50 hours of CTA-based training. Cognitive training may therefore provide an effective and affordable adjunct to orthopaedic training programs.

To assimilate a CTA, observation of and semistructured interviews with experts are required to determine strategies, approaches, and decision-making steps vital to the task. These are supplemented using critical incident analyses and expert advice to identify possible novice errors and solutions.[32] Finally, an in-depth description of technical and nontechnical steps involved can be created to provide greater detail compared with conventional lectures or textbooks, thereby allowing better comprehension of the task.[13]

CTAs have been extensively used in training pilots and military personnel[39] and, more recently, have been adapted in surgery through online programs and mobile applications.[18,46] Studies have suggested they improve residents' acquisition of both technique and knowledge within laparoscopic[14,44] and robotic[40] procedures, including flexor tendon repairs[30] and colonoscopies.[47] In orthopaedics, there is evidence demonstrating the effectiveness of CTA in training novices in knee arthroscopy,[7,8] femoral intramedullary nailing,[9] and total hip arthroplasty.[28] However, there are no reported studies of CTA in meniscal repair.

The aims of this study were the following:

1. Utilize CTA to develop a digital standardized method for teaching an all-inside arthroscopic meniscal repair technique using the FasT-fix 360 device (Smith & Nephew).
2. Conduct a randomized controlled trial to evaluate its effectiveness in training novices to perform an all-inside meniscal repair on a phantom knee simulation.

METHODS

The first phase of the study was the design and creation of a CTA tool using a modified Delphi technique. The Delphi technique is a method of gaining group consensus via several rounds of surveys with a panel of experts. The answers are aggregated and shared with the group after each survey round where adjustments are made until a consensus is reached.[27] This Delphi-derived CTA tool was subsequently tested for effectiveness using a randomized controlled trial assessing novice surgeons on phantom knee simulation models (Knee Arthroscopy Simulator; GM Simulators).

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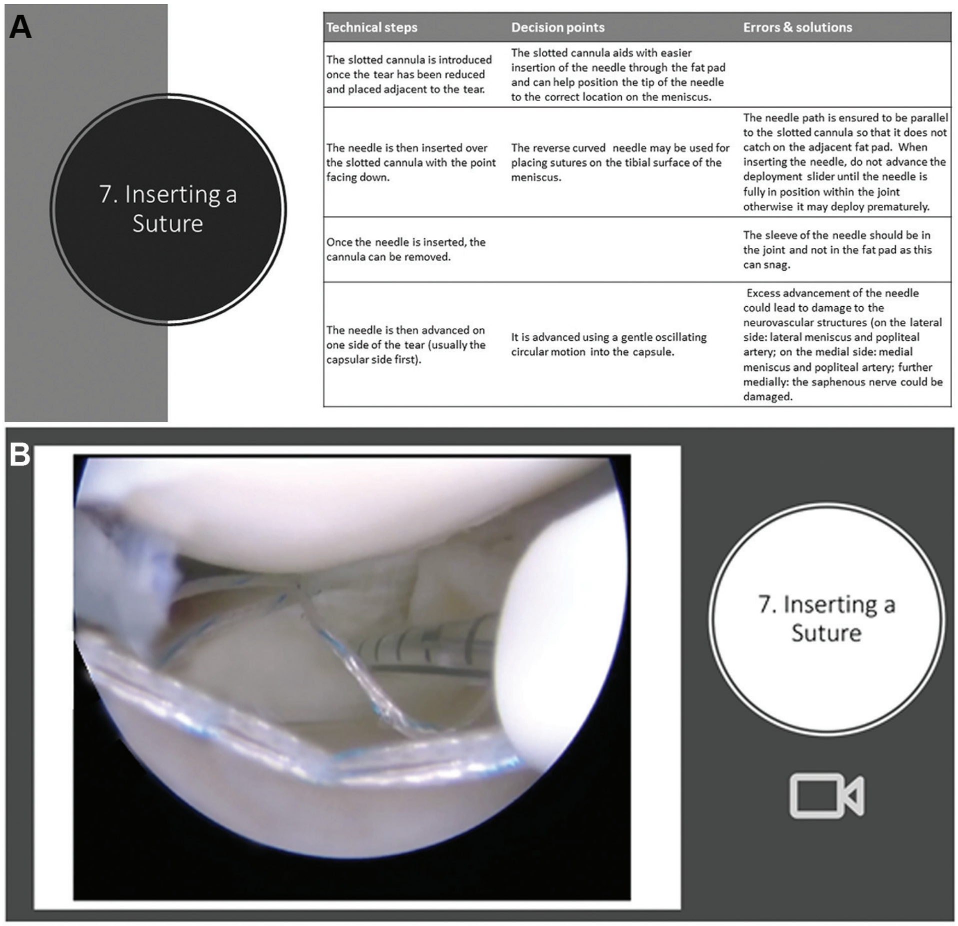

Technical steps	Decision points	Errors & solutions
The slotted cannula is introduced once the tear has been reduced and placed adjacent to the tear.	The slotted cannula aids with easier insertion of the needle through the fat pad and can help position the tip of the needle to the correct location on the meniscus.	
The needle is then inserted over the slotted cannula with the point facing down.	The reverse curved needle may be used for placing sutures on the tibial surface of the meniscus.	The needle path is ensured to be parallel to the slotted cannula so that it does not catch on the adjacent fat pad. When inserting the needle, do not advance the deployment slider until the needle is fully in position within the joint otherwise it may deploy prematurely.
Once the needle is inserted, the cannula can be removed.		The sleeve of the needle should be in the joint and not in the fat pad as this can snag.
The needle is then advanced on one side of the tear (usually the capsular side first).	It is advanced using a gentle oscillating circular motion into the capsule.	Excess advancement of the needle could lead to damage to the neurovascular structures (on the lateral side: lateral meniscus and popliteal artery; on the medial side: medial meniscus and popliteal artery; further medially: the saphenous nerve could be damaged.

Figure 1. Snapshot of the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis tool showing part of the written task analysis and video (with audio voiceover) of a suture being inserted into a meniscal tear. (See Supplemental Video for full tool.)

Design of the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis Tool

Four fellowship-trained senior (attending) knee surgeons (C.G., S.O., R. Bhattacharya, R.P.) with >10 years of experience, who perform >50 meniscal repairs per surgeon per year, were interviewed independently to generate a list of technical steps, cognitive decision points, and common errors and solutions for an all-inside meniscal repair technique. These steps were grouped into 9 phases: (1) preoperative planning, (2) theater and patient setup, (3) portal placement, (4) meniscal examination, (5) tear reduction, (6) suture planning, (7) suture insertion, (8) repair completion, and (9) postoperative care and rehabilitation. Procedural steps that differed among the 3 expert surgeons were highlighted for review during subsequent rounds of interviews with each of the surgeons until a common consensus was found. The procedural steps from this were then compiled into a digital master document that was provided to each of the surgeons again for a final review. This final document constituted the written component of the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis (IUMeRCTA) tool.

The written component was then combined with audio and visual modalities. The supervising knee surgeon for our research group (C.G.) recorded a video during live arthroscopic surgery demonstrating the technique for an all-inside meniscal repair. This video was then divided into segments that corresponded with the various phases of the IUMeRCTA tool and overlaid with an audio voiceover to highlight the key components (video editing software, Version 9; Wondershare Filmora). The final IUMeRCTA tool contained 55 steps across 9 phases, providing an in-depth analysis of an all-inside meniscal repair technique (Figure 1; see Supplemental Video, available online). It used a combination of written information, visual video clips, and audio voiceovers to describe each phase of the procedure in detail to create an enhanced and holistic learning experience for residents (Figure 2).

Participant Recruitment and Ethical Approval

All individuals provided written consent to participate in the study. In addition, ethics approval was granted by

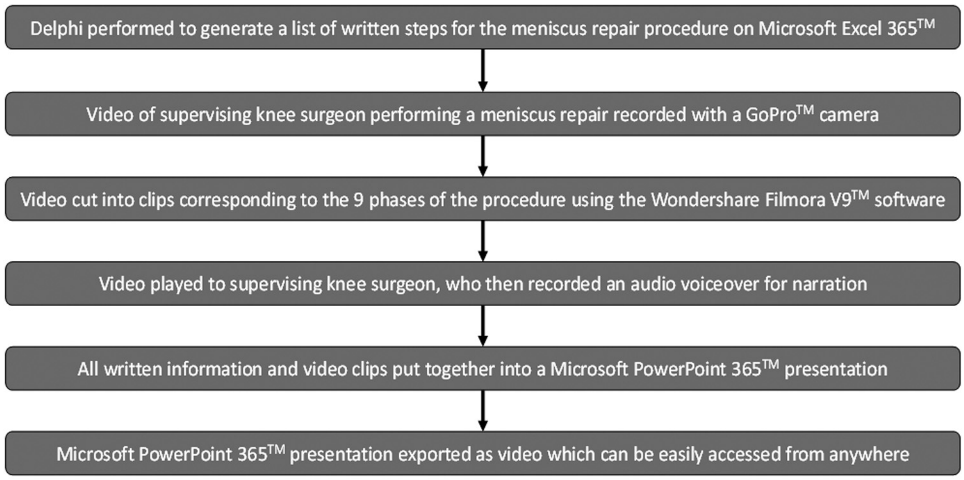

Figure 2. Technical workflow involved in creating the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis tool.

the Imperial College Medical Education Ethics Committee (reference No. 1617-08). Twenty junior orthopaedic and surgical residents from across London registered their interest in the study. All participants completed questionnaires that assessed their experience in performing arthroscopic meniscal repairs. Participants were included in the study if they had not previously performed meniscal repairs in the operating room supervised by a senior surgeon. Two participants were excluded because they were nonsurgical residents.

Power Calculation

A priori power calculation was conducted using mean scores from a previous pilot study where the IUMeRCTA group scored 41.00 and the control group scored 28.75 out of 50 on the validated global rating scale (GRS),[1] with an alpha of 5% and power of 80%. The sample size calculation resulted in a minimum number of 4 per group. The difference in scores was also deemed clinically important according to the expert surgeons.

Randomization

Participants underwent randomization for allocation into intervention (n = 9) and control (n = 9) trial arms using a random group generator. Before randomization, participants were stratified by experience level to ensure both trial arms were equal. This was conducted by an external course organizer who was not given details of the trial. All assessors during the trial were blinded to participants' experience levels and their trial arm. The CONSORT (Consolidated Standards of Reporting Trials) protocol was followed for the recruitment and randomization (Figure 3).

Trial

A double-blinded, randomized controlled trial was conducted. The intervention group was given the IUMeRCTA tool before assessment as well as the equipment instruction manual for the procedure, while the control group was given the equipment instruction manual without the IUMeRCTA tool. The participants were blinded as to whether they belonged to the intervention or the control group. On the day of assessment, all residents were given instructions on the type of arthroscope and instrument set available and were familiarized with the meniscal repair kit to be used in an identical manner.

The residents were asked to perform an all-inside meniscal repair on high-fidelity, phantom knee models with simulated meniscal tears (GT Simulators, Davie, Florida), using standard arthroscopic instruments and the FasT-fix meniscal repair device (Smith & Nephew). To standardize the technical requirements for the procedure, all knee models had identical longitudinal tears in the medial and lateral menisci. While conducting the procedure, the residents in the study were observed and assessed by expert knee surgeons blinded to whether the participants belonged in the intervention or the control group. Although several objective assessment scoring systems for arthroscopic surgery are in use,[1,6] we chose to adopt the GRS by Alvand et al,[1] as it has previously been validated for meniscal repair assessment. Each resident was scored using a scale ranging from 10 to 50 points for their performance (Figure 4).

All participants subjectively rated their experience of the CTA tool using a 5-point Likert[26] rating scale (Figure 5). Participants also completed a validity questionnaire to score, on a scale ranging from 0 to 100, the realism and usefulness of the simulation training experience (Figure 6). The questionnaire was derived from previous studies assessing the validity of knee[42] and hip[5] arthroscopy simulators.

Statistical Analysis

The median GRS score was calculated for both groups. The data analysis showed that they were nonparametric, independent data, and therefore the Mann-Whitney *U* test was

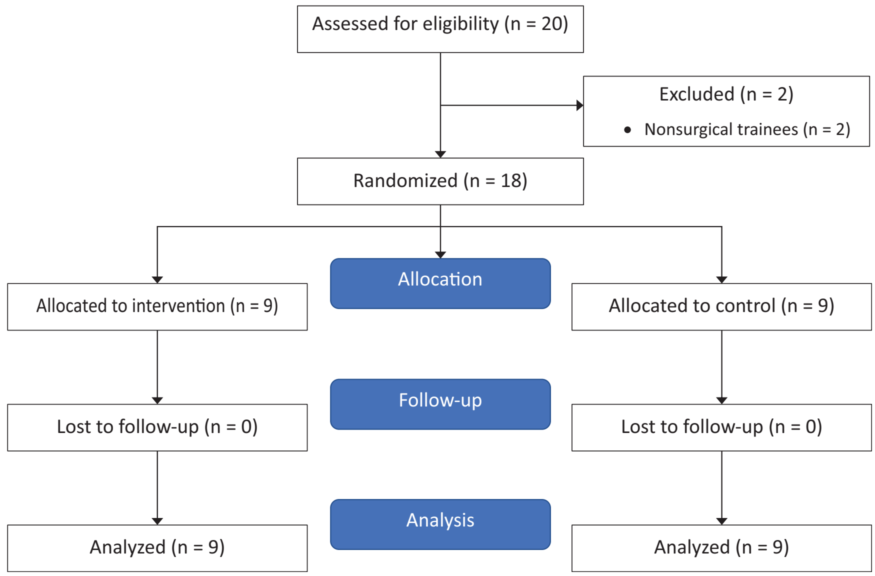

Figure 3. CONSORT (Consolidated Standards of Reporting Trials) diagram for recruitment of participants.

TABLE 1
Training Levels of Surgical Residents in the Study[a]

Surgical Training	CTA Group	Control Group
Surgical junior doctor (1 y preoperative training)	1	1
1 y	3	2
2 y	1	1
3 y	4	5
Total	9	9

[a]Data are shown as number of participants. CTA, cognitive task analysis.

used to compare the 2 groups. The significance level was set at $P < .05$. The data was analyzed using IBM SPSS Statistics Version 26.

RESULTS

Participant Characteristics

The study was completed by 18 participants (Table 1).

GRS Score

The median ± SD GRS scores were 32 ± 2.9 for the CTA group and 24 ± 3.3 for the control group. The difference between groups was significant ($P < .001$) (Figure 7).

IUMeRCTA Tool Rating

All participants who were given the CTA agreed the learning tool was a useful training adjunct to learning in the operating room and enjoyed their experience of using the IUMeRCTA tool (Table 2).

TABLE 2
IUMeRCTA Rating (n = 9)[a]

Statement	No. of Participants Who Agreed
This tool was useful to understand the key technical steps required to perform this procedure.	9 (100)
This tool was useful to understand the decision-making process behind the key technical steps involved in this procedure.	9 (100)
This tool was useful in highlighting the common potential errors that can occur while undertaking this procedure.	9 (100)
This tool will be a useful training adjunct to learning how to perform an arthroscopic all-inside meniscal repair in the operating theater.	9 (100)
This tool is easy to use.	8 (89)
You enjoyed using this tool.	9 (100)
You would like to use this tool before attending a theater session on meniscal repairs.	9 (100)

[a]Data are reported as n (%). Number of participants stated are those who “agreed” or “strongly agreed” with the statements. IUMeRCTA, Imperial College London/University College London Meniscus Repair Cognitive Task Analysis.

Simulated Knee Validity Questionnaire

On the validity questionnaire, mean scores for participant experience of the simulation study were 75/100 for realism and 86/100 for usefulness of the training environment (Table 3).

Score Category	Score Descriptions	Score (1-5)
1) Dissection	1- Appeared excessively hesitant, caused trauma to tissues, did not dissect into correct anatomical plane 2- 3- Controlled and safe dissection into correct anatomical plane, caused minimal trauma to tissues 4- 5- Superior and atraumatic dissection into the correct anatomical plane	
2) Instrument handling	1- Repeatedly makes tentative or awkward movements with instruments 2- 3- Competent use of instruments, although occasionally appeared stiff or awkward 4- 5- Fluid moves with instruments and no awkwardness	
3) Depth perception	1- Constantly overshoots target, slow to correct 2- 3- Some overshooting or missing of target 4- 5- Accurately directs instruments in the correct plane to target	
4) Bimanual dexterity	1- Noticeably awkward with nondominant hand, poor coordination between hands 2- 3- Uses both hands but does not maximize interaction between hands 4- 5- Expertly uses both hands in complementary manner to provide optimum performance	
5) Flow of the operation and forward planning	1- Frequently stopped operating or needed to discuss next move 2- 3- Demonstrated ability for forward planning with steady progression of operative procedure 4- 5- Obviously planned course of operation with effortless flow from one move to the next	
6) Knowledge of instruments	1- Frequently asked for the wrong instrument or used inappropriate instrument 2- 3- Knew the names of most instruments and used appropriate instrument for the task 4- 5- Obviously familiar with the instruments required and their names	
7) Efficiency	1- Many unnecessary, repetitive, inefficient movements. Constantly changing focus or persisting without progress 2- 3- Slow, but planned movements are reasonably organized with few unnecessary or repetitive movements 4- 5- Confident, clear economy of movement and maximum efficiency	
8) Knowledge of specific procedure	1- Deficient knowledge, needed specific instruction at most operative steps 2- 3- Knew all important aspects of the operation 4- 5- Demonstrated familiarity with all aspects of the operation	
9) Autonomy	1- Unable to complete entire task, even with verbal guidance 2- 3- Able to complete task safely with moderate guidance 4- 5- Able to complete task independently without prompting	
10) Quality of final product	1- Very poor 2- 3- Competent 4- 5- Clearly superior	
	Total Score	

Figure 4. Validated global rating scale for meniscal repairs.[1]

DISCUSSION

We sought to develop a standardized teaching method for an all-inside meniscal repair technique for the FasT-fix 360 device using a validated CTA method: the IUMeRCTA tool. The randomized controlled trial confirmed that this tool was more effective than was traditional apprenticeship training using instructional documents in training novice orthopaedic residents in this procedure.

Alvand et al[1] correlated motion detection analysis of learning curves in meniscal repair surgery with GRS scores. They found that after 12 practice sessions over 3 weeks, median GRS scores for 21 residents improved from a baseline 44% to 65% of the maximum score. This is similar to our study, where the median score for control participants was 48% on their first attempt. However, use of the IUMeRCTA tool in the intervention group appeared to enhance trainee development and enable a baseline

Statement	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
This tool was useful to understand the key technical steps required to perform this procedure.					
This tool was useful to understand the decision-making process behind the key technical steps involved in this procedure.					
This tool was useful in highlighting the common potential errors that can occur while undertaking this procedure.					
This tool will be a useful training adjunct to learning how to perform an all inside arthroscopic meniscus repair in the operating theatre.					
This tool is easy to use.					
You enjoyed using this tool.					
You would like to use this tool prior to attending a theatre session on meniscus repairs.					

Figure 5. Likert scale used to gauge resident experience using the Imperial College London/University College London Meniscus Repair Cognitive Task Analysis tool.

Please rate the following statements on a scale of 0-100 (0 = completely disagree, 100 = completely agree)

	Realism	Score (0-100)
1	The external instrumentation was realistic.	
2	The visual experience of arthroscopy was realistic.	
3	The visual experience of the instruments on the screen was realistic.	
4	The feel of the bone was realistic.	
5	The feel of the soft tissue was realistic.	
6	The arthroscopy procedure was realistic.	
7	The steps performed in the simulator accurately reflected the steps taken during the actual procedure.	
8	The simulator gave a sense of what arthroscopy would be like.	
	Training environment	**Score (0-100)**
1	The simulator provided a non-threatening learning environment.	
2	I enjoyed using the simulator.	
3	The simulator is a useful training tool for junior doctors and surgical trainees.	
4	The simulator is a useful training tool for specialty trainees and fellows.	
5	The simulator is a useful training tool for consultants.	

Figure 6. Validity questionnaire for assessing the realism and usefulness of the meniscal repair program.[5,42] Participants rated each statement from 1 to 100 (with higher scores showing greater agreement with the statements).

median score of 64%, thereby matching the scores of those with greater practical experience in the technique. We suggest this is a result of the CTA allowing better understanding of psychomotor skills, technical sequence, and procedural variants, which improve success. Given that residents in our study only had 1 attempt at the procedure, it is likely that practice and repeated attempts using the tool would further accelerate their learning process.

Achieving proficiency in any surgical technique requires residents to master a series of skills. They must first attain fundamental knowledge of the procedure including relevant anatomy, procedural steps, instrument identification and handling, and development of strategies to minimize errors.[11] This knowledge must then be integrated into practice and with multiple repetitions until they are able to efficiently perform the technique whilst minimizing errors.[35] This may initially be with supervision from senior surgeons, but they will eventually be able to conduct the procedure independently. With more practice, they will encounter various scenarios where they may be required to take the initiative and adapt to unexpected events in a calm and effective manner to achieve the desirable outcome. The completion of this final step demonstrates mastery over the procedure. Use of the IUMeRCTA tool is an effective way for residents to gain a head start on the fundamental knowledge of the procedure as well as providing

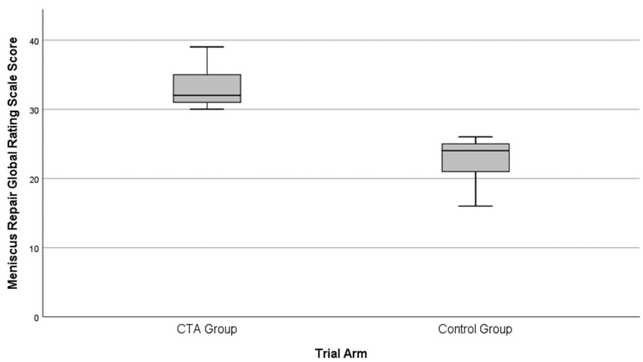

Figure 7. Meniscal repair global rating scale scores. Median scores were 32 ± 2.9 for the cognitive task analysis (CTA) group and 24 ± 3.3 for the control group ($P < .001$).

them with tried-and-tested strategies for adaptation, which they can use later.[31] It is therefore an effective adjunct to the training pathway, as it allows residents to improve their understanding of cognitive steps. We believe that the IUMeRCTA enables the resident to progress through the early part of the surgical learning curve away from the operating room environment, thus reducing the risk to the patient while the resident is learning the procedure. In addition, we propose that it will enhance the efficiency of resident training in the operating room.

When participants in the IUMeRCTA training group were asked to rate their subjective experiences using the tool, all believed it successfully aided their understanding of key technical steps, cognitive decision processes, and common errors and solutions for the procedure. The majority also found it easy and enjoyable to use. Overall, all participants agreed they would use the tool before attending a meniscal repair procedure in the operating room, as it provided a useful adjunct to learning the procedure.

Residents in this study were not directly assessed during an operation in the "real" operating room environment. However, a previous study has shown transfer validity of arthroscopic skills from simulation models to the operating room.[20] Moreover, the simulation validity questionnaire for this study showed that residents found the experience of using a high-fidelity knee model within an assessment environment both realistic and useful. Although the feel of the soft tissue was not as realistic as the other simulation components, overall it accurately reflected the steps of the procedure and was thought to be a good training tool. Other validated training models outside the operating room include cadaveric courses[25] and virtual reality simulation,[10] but they are often expensive and not readily accessible.[23] A CTA tool therefore negates these drawbacks by providing a low-cost and effective adjunct that will accelerate learning in the operating room. Importantly, the CTA design is superior to a conventional simulator session, as it allows residents to independently access the cognitive decision-making processes of expert knee surgeons and repeat the learning process as many times as needed.

The current COVID-19 pandemic has significantly affected surgical training, which is likely to alter training needs in the foreseeable future.[2] There is likely to be a risk-assessed program of training that incorporates remote learning and simulation using practical hands-on surgical learning.[22] The technique of CTA learning is contact-free, remote, web-based, and validated, which is easily accessible and allows repeated, sustained practice. It would therefore form a useful adjunct in the early acquisiton of surgical skills.

TABLE 3
Simulation Study Validity Scores (N = 18)

Realism	Mean Score (0-100)
The external instrumentation was realistic.	80
The visual experience of arthroscopy was realistic.	80
The visual experience of the instruments on the screen was realistic.	87
The feel of the bone was realistic.	68
The feel of the soft tissue was realistic.	57
The arthroscopy procedure was realistic.	70
The steps performed in the simulator accurately reflected the steps taken during the actual procedure.	77
The simulator gave a sense of what arthroscopy would be like.	80
Mean total score	75
Training Environment	**Mean Score (0-100)**
The simulator provided a nonthreatening learning environment.	93
I enjoyed using the simulator.	94
The simulator is a useful training tool for junior doctors and surgical trainees.	92
The simulator is a useful training tool for specialty trainees and fellows.	86
The simulator is a useful training tool for consultants.	66
Mean total score	86

The assessment of residents' competency in performing particular procedures has historically been based on the trainers' subjective judgment. However, over the past decade more standardized assessment tools have been developed. Some of these are generic assessment modalities such as motion detection in training,[1] but more procedure-specific tools provide a useful guide for trainers and assessors alike.[1,6] Therefore, as well as delivering a comprehensive cognitive learning platform, the IUMeRCTA tool provides the opportunity for all surgical residents to learn a standardized method of performing an all-inside meniscal repair. We believe the modified Delphi procedure, in gaining consensus among experts, provides a technique that can be readily standardized and assessed. This is especially important given the increasing demand for the procedure as a result of improved outcomes.

Strengths and Limitations

The strengths of this study included its design, which was a prospective, double-blind, randomized controlled trial, where the control and intervention arms were matched for training and experience level. Participants were recruited from multiple centers across the country, which allows our results to be more generalizable and comparable with all apprenticeship learning models. Moreover, a post hoc power analysis showed 100% power was achieved with our sample size. The tool itself was designed using a thorough Delphi methodology with multiple expert surgeons and several rounds of edits to achieve consensus.

There are some limitations to the study. We did not measure the length of time each participant spent using the IUMeRCTA tool before assessment. Although this could have introduced variations in knowledge base, it was a pragmatic decision to reflect reality where residents will study for varying amounts of time to suit individual requirements. The study also did not assess for transfer validity to the operating room, as this is the first CTA tool developed for meniscal repair training and we were ethically obliged to initially study this in a simulation setting. Another potential limitation is the number of residents (N = 18) who participated in the study. However, this exceeded the numbers required from our sample size (power) calculation, and this number is comparable with that of previous simulation studies.[8,41] Future studies should address the transfer validity of the tool.

CONCLUSION

The IUMeRCTA tool is a CTA–derived teaching tool in arthroscopic meniscal repair that has demonstrated objective benefits in training novices in this procedure. It is user-friendly, inexpensive, and readily accessible to residents allowing repeated sustained practice, which is the cornerstone of simulation training. Given the current changes that reduce operating training times, we believe it is a key adjunct to the apprenticeship model to standardize and improve efficiency in teaching this procedure.

A Video Supplement for this article is available online.

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