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The timing and importance of motor skills course in knee arthroscopy training

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ABSTRACT

Objectives: The aim of this prospective study is to evaluate the impact of the simulation training program in learning duration of arthroscopic motor skills. Furthermore, we investigated the difference between junior and experienced residents in the improvement of arthroscopic motor skills duration.
Methods: We established 2 study groups according to participants' year of experience in orthopedic residency with junior group residents with three years or less than three years experience as group 1 and experienced group with over 3 years of experience as group 2. We calculated duration change of motor skill test results for each participant before and after the course. The tools used were; auto scoring mirror tracer(ASMT), 0'Conner the tweezer dexterity test(OCTDT), etch-a-sketch with overlay(ESOT), purdue the pegboard test(PPT), two-arm coordination test(TACT) and grooved pegboard test(GPT) which were all produced by Lafayette firm. These instruments were used to practice and measure the basic motor skills.
Results: All post–course test durations for participants decreased significantly when compared to pre-course. We calculated percentage change of motor skill test results for each participant before and after the course. All motor skill test percentage changes were similar between two groups. In comparison of participants according to their experiences, results revealed that there was no difference in test results of experienced and junior surgeons. Both groups had provided equal improvement in terms of motor skills.
Conlusion: As our results revealed, residents will be able to act with a strong motivation to learn applications through basic arthroscopic information gained in early period of orthopedic training and will make more successful applications of real patients.

Introduction

Arthroscopic surgery is one of the most frequent surgical methods employed by orthopedic surgeons throughout the world. Special training in addition to classical surgical training is required to acquire arthroscopic skills. Due to changing circumstances imposed on training environments by liability regulations, limited working hours and increased patient awareness has forced surgeons to search better and more effective training methods.

This study was conducted at Marmara University, Department of Sports Science and Athletes Health Research and Implementation Centre Dr. Veli Lök Skills Improving Laboratory, Istanbul, Turkey.

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As in other surgical disciplines, arthroscopic skills have the tendency to improve through experience, but due to aforementioned reasons, training of the surgeons should reach a certain level before they are allowed for hands-on training to reduce the risks that may occur during operations in the initial stage of training.

There are several studies stating the improvements with arthroscopic motor skill courses. In our knowledge, there is no study that shows the objective results in improving duration period.

The aim of this prospective study is to evaluate the impact of the simulation training program on learning duration of arthroscopic motor skills. Furthermore, we investigated time improvement of arthroscopic motor skills of junior and senior residents.

Material-method

We recorded the results of basic arthroscopic motor skills course organized five times a year in Marmara University, Department of Sports Science and Athletes Health Research and Implementation Centre Dr. Veli Lök Skills Improving Laboratory. A total of 70 participants took part in five courses of the arthroscopic training program. All participants are male. They all accepted to take part in the study, and the respondent rate was 100%. The score was known for one of the participants, however personal information remained anonymous. We divided the study group according to their years of experience as orthopedic residents. The first group consisted of 37 residents with an experience of three years or less, they were labelled as the junior group. The second group consisted of 32 residents and specialists with a more than 3 years of experience, this group was labelled as the senior group. We calculated duration change of motor skill test results for each participant before and after the course. All percentage changes were analyzed between the two junior and senior groups. All participants were assessed at the same time and in the same educational environment. The tools which simulated the basic motor skills were individually introduced to each participant. The course began with an introduction followed by establishing expectations for participants and elaborating on the teaching objectives for the course instructors. The program of the course had 4 steps. The first step included 4 h theoretical but interactive sessions about arthroscopic technology (arthroscopic imaging and light technology, image and video capture techniques, arthroscopic equipment), basic knee pathologies and the most common associated findings in physical examination of the knee, theory behind basic arthroscopic approaches for meniscal, soft tissue, ligamentous, and chondral pathologies.

The second step was the basic motor skill exercises. Basic motor skills in the arthroscopic surgeries are presented in Table 1; instruments used for purposes of measurement are shown in 1. The tools used were; auto scoring mirror tracer, 0'Connor the tweezer dexterity test, etch-a-sketch with overlay, purdue the pegboard test, two-arm coordination test and grooved pegboard test which were all produced by Lafayette firm (Lafayette Instrument Company, Lafayette, Indiana, USA) (Fig. 1). These instruments were used to practice and measure the basic motor skills. Auto scoring mirror tracer which involves reversal ability, hand-eye coordination and learning. Participant had to trace the star pattern while watching only its mirror image. This automated unit comes with an impulse counter which counts every time the metal-tipped stylus leaves the anodized star pattern. O'Connor tweezer dexterity test required the use of tweezers in placing a single pin in each 1/16 inch diameter hole. A high score indicated manual amplitude for work involving the use of precision small tools. Etch a sketch with overlay test allowed the user to practice both two hand and hand-eye coordination while maneuvering through the maze. Purdue pegboard test was used to demonstrate fine and gross motor dexterity and coordination. It measured gross movements of hand, fingers and arms, and fingertips dexterity as necessary in assembly tasks. Two-arm coordination test was a test of motor coordination and learning which requires both arms to work together. The subject's task was to move metal pointer around the anodized star pattern without leaving the pattern. Grooved pegboard test was a manipulative dexterity test that contained holes randomly positioned slots and pegs that had a key along one side. Pegs must be rotated to match the hole before they can be inserted. This procedure measured performance speed in a fine motor task by examining both sides of the body. These instruments were placed in a room with separated tables. Every time a participant began with one of the instruments and tries each in a circular route. One instructor presided over each instrument. The instructor demonstrates the particular procedure once for the participant. All the participants tried each instrument in the first day, and their first trials were recorded. This step was a two-hour segment in the whole program; however, the instruments were kept in the practicing room through the whole course, and the participants were encouraged to exercise more in their free time. Next day, the participants practiced again for 2 h with the instruments and their best scores were recorded. The third step consisted of two sections (first section was suture techniques and the second section was the exercises on the meniscus models that mainly uses suture techniques using inside out, outside in and all inside techniques.). In this section, participants were informed about the difficulties of meniscus repair. The fourth step was the wet lab that was mainly designed to mimic a real arthroscopic procedure with the use of a bovine knee.

Ethical approval from the Medipol University Medical Faculty Ethical Committee was obtained with the protocol number 108400987-213.

Statistical analysis

Categorical variables were presented as number of cases (percentage), continuous variables as mean ± standard deviation, and as median, [maximum value-minimum value]. Normal distribution was tested with skewness and kurtosis. Unpaired *t* test was used to test the difference between the two group continuous variants which showed normal distribution. Two-group comparisons were calculated by the Mann–Whitney *U* test when non-normally distributed. For the pre-course and post-course comparisons of continuous variants, paired *t*-test or Wilcoxon test as appropriate were used to determine the significance of the difference. Percentage change in all motor skill tests duration and mistakes was calculated by $(V_{postcourse} - V_{precourse})/V_{precourse} \times 100$ for each doctor. P-value of <0.05 was considered significant for all tests. Statistical Package for the Social Sciences (SPSS version 11.0, SPSS Inc., Chicago, IL, USA) was used.

Results

This study analyzes the differences of the participant's motor skills in specific tests between precourse and postcourse period. Seventy orthopaedists working as an orthopedist for an average of 3.5 years, (6 month–5 years) were enrolled in the study and separated into two groups; Junior group were the residents of 3 year experience and less, and the senior group were the residents had more than 3 years of experience.

Auto Scoring Mirror Tracer test, Etch-A-Sketch with overlay test, Ground Pegboard test, O'Connor Tweezer Dextending test, Purdue Pegboard test and Two Arm Coordinating test were performed by each participant before and after the two-day course. At each test; participant's test duration and mistakes were calculated pre- and post-course period.

Table 1
Comparison of differences in motor skills tests duration and number of mistakes between pre-course and post-course.

	Pre-course variables	Post-course variables	p
Auto Scoring Mirror Tracer			
Left hand second*	57, [260–27]	28, [112–12]	**<0.001****
Right hand second*	66, [221–30]	24, [101–10]	**<0.001****
Left hand mistake*	2.5, [21–0]	1, [5–0]	**<0.001****
Right hand mistake*	1, [33–0]	0, [5–0]	**<0.001****
Etch-A-Sketch with overlay second	303 ± 78	185 ± 61	**<0.001**
Ground Pegboard test			
Left hand second*	113, [398–54]	85, [250–38]	**<0.001****
Right hand second*	93, [240–56]	68, [159–36]	**<0.001****
O'connor Tweezer Dextending Test			
Left hand second	89 ± 32	70 ± 21	**<0.001**
Right hand second	77 ± 20	61 ± 17	**<0.001**
Purdue Pegboard test			
Left hand second	161 ± 43	131 ± 32	**<0.001**
Right hand second	144 ± 38	113 ± 24	**<0.001**
Two Arm Coordinating Test			
Left hand second*	40, [112–17]	12, [65–10]	**<0.001****
Right hand second*	48, [99–24]	17, [64–8]	**<0.001****
Left hand mistake*	0, [7–0]	0, [1–0]	**<0.001****
Right hand mistake*	1, [15–0]	0, [2–0]	**<0.001****

*Values are expressed as median, [maximum−minimum].
**Wilcoxon test is used because of variable's skewed distribution.

All Post–course test durations for participants decreased significantly when compared to pre-course (for Auto Scoring Mirror Tracer test; left hand duration (57, [260–27] vs 28, [112–12], p < 0.001); right hand duration; (66, [221–30] vs 24, [101–10], p < 0.001); for Etch-A-Sketch with overlay test duration; (303 ± 78 vs 185 ± 61, p < 0.001); for Ground Pegboard test; left hand duration; (113, [398–54] vs 85, [250–38], p < 0.001), right hand duration; (93, [240–56] vs 68, [159–36], p < 0.001), for O'Connor Tweezer Dextending Test; left hand duration; (89 ± 32 vs 70 ± 21 p < 0.001), right hand duration; (77 ± 20 vs 61 ± 17, p < 0.001), for Purdue Pegboard test; left hand duration; (161 ± 43 vs 131 ± 32, p < 0.001), right hand duration; (144 ± 38 vs 113 ± 24, p < 0.001), for Two Arm Coordinating Test; left hand duration; (40, [112–17] vs 12, [65–10], p < 0.001), right hand duration; (48, [99–24] vs 17, [64–8], p < 0.001). Also the mistake's number were decreased by the course significantly (for Auto Scoring Mirror Tracer test; left hand mistake; (2.5, [21–0] vs 1, [5–0] p < 0.001); right hand mistake; (1, [33–0] vs 0, [5–0], p < 0.001), for Two Arm Coordinating Test, left hand mistake; (0, [7–0] vs 0, [1–0] p < 0.001), right hand mistake; (1, [15–0] vs 0, [2–0] p < 0.001)).

We calculated percentage change of motor skills test results for each participant before and after course. All percentage changes were tested between two groups (Junior and senior group). All of motor skill test percentage changes were similar between the two groups (for Auto Scoring Mirror Tracer test; left hand duration; (50 ± 16 vs 47 ± 18, p:0.435); right hand duration; (60 ± 18 vs 56 ± 16, p:0.349); for Etch-A-Sketch with overlay test duration; (38 ± 16 vs 39 ± 14, p:0.817); for Ground Pegboard test; left hand duration; (27, [68–3] vs 31, [140–3], p:0.527), right hand duration; (33, [65–1] vs 26, [68–5], p:0.363), for O'Connor Tweezer Dextending Test; left hand duration; (14, [68–0] vs 20, [179–0], p:0.065), right hand duration; (22, [61–2] vs 22, [60–0], p:0.966), for Purdue Pegboard test; left hand duration; (19 ± 11 vs 24 ± 12, p:0.072), right hand duration; (24 ± 14vs 19 ± 12, p:0.143), for Two Arm Coordinating Test; left hand duration; (62, [77–4] vs 57, [77–3], p:0.763), right hand duration; (63, [85–30] vs 63, [84–31], p:0.171), for Auto Scoring Mirror Tracer test; left hand mistake; (88, [300–0] vs 100, [100–50], p:0.224); right hand mistake; (96, [100–0] vs 100, [300–50], p:0.207), for Two Arm Coordinating Test, left hand mistake; (100, [100–0] vs 100, [100–0], p:0.787), right hand mistake; (100, [100–33] vs 100, [100–0] p:0.267)) (Table 2).

Discussion

In this prospective study, we investigated the impact of simulation training program on improving arthroscopic motor skills by recording durations. We recorded the pre-course and post-course times of the participants in arthroscopic simulation training program with motor skill devices and real arthroscopic system in bovine knees. The improvements of the motor skills were achieved in all participants. On comparing participants according to their experiences, results showed that there was no difference in test

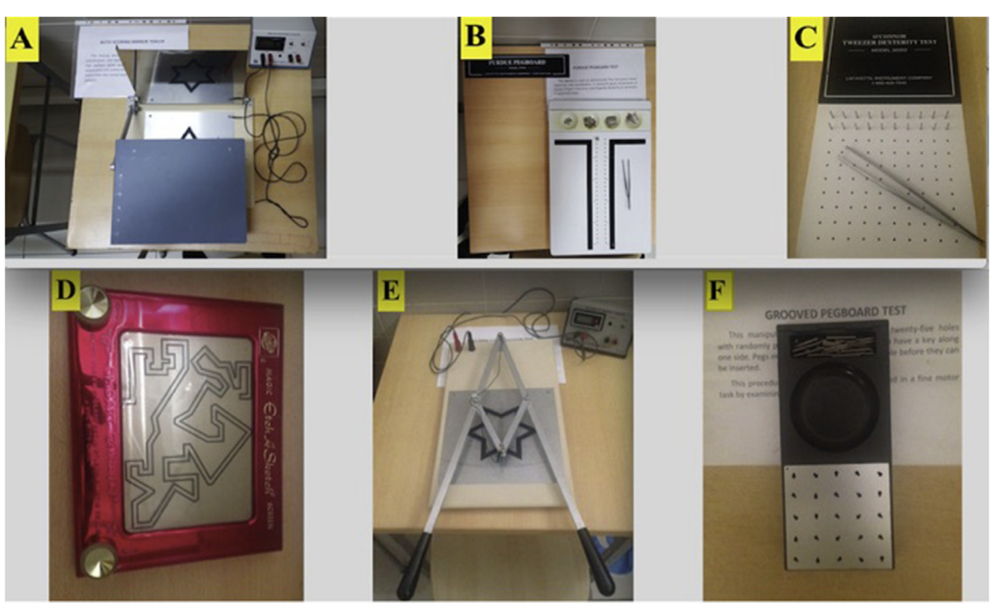

Fig. 1. A) Auto Scoring Mirror Tracer, B) Purdue Pegboard, C) O'Connor Tweezer Dexterity Test, D) Etch-a-Sketch with Overlay, E) Two Arm Coordination Test, F) Grooved Pegboard Test.

Table 2
Comparison of percentage changes based on the skill tests between the less experienced doctors group 1 (≤3 years) and senior group 2 (>3 years) (absolute values).

	Group 1 (≤3 years)	Group 2 (>3 years)	p
Auto Scoring Mirror Tracer percentage change			
Left hand second	50 ± 16	47 ± 18	0.435
Right hand second	60 ± 18	56 ± 16	0.349
Left hand mistake*	88, [300–0]	100, [100–50]	0.224**
Right hand mistake*	96, [100–0]	100, [300–50]	0.207**
Etch-A-Sketch with overlay second percentage change	38 ± 16	39 ± 14	0.817
Ground Pegboard Test percentage change			
Left hand second*	27, [68–3]	31, [140–3]	0.527**
Right han second*	33, [65–1]	26, [68–5]	0.363**
O'connor Tweezer Dextending Test percentage change			
Left hand second*	14, [68–0]	20, [179–0]	0.065**
Right hand second*	22, [61–2]	22, [60–0]	0.966**
Purdue Pegboard Test percentage change			
Left hand second	19 ± 11	24 ± 12	0.072
Right hand second	24 ± 14	19 ± 12	0.143
Two Arm Coordinating Test percentage change			
Left hand second*	62, [77–4]	57, [77–3]	0.763**
Right hand second*	63, [85–30]	63, [84–31]	0.171**
Left hand mistake*	100, [100–0]	100, [100–0]	0.787**
Right hand mistake*	100, [100–33]	100, [100–0]	0.267**

*Values are expressed as median, [maximum–minimum].
**Mann Whitney *U* test is used because of variable's skewed distribution.

results between the senior and junior groups. Both had provided equal improvement in terms of motor skills.

The annual incidence of meniscal tears is 60–70 per 100,000 general populations.[1,2] The annual incidence of the ACL injury is between 100,000 and 200,000 in the United States.[3] In this regard, arthroscopic surgery has becoming more widespread in recent years and especially in basic assistant education, arthroscopic surgery is gaining an indispensable value. From the above numbers, diagnostic arthroscopy is replacing invasive arthroscopy. The increasing prevalence of the medicolegal events leaves the doctors who are in position of educating residents in the dilemma of not harming the patient during arthroscopic procedures in the research and educational and university hospitals and orthopaedics training of those residents. Surgical input simulators, in the context of arthroscopic simulators and motor skills training, have provided an alternative method in recent years. Laboratory-based training offers potential benefits in the development of basic surgical skills, such as using surgical tools and implants appropriately, achieving competency in procedures that have a steep learning curve, and assessing already acquired skills while minimizing concerns for patient safety, operating room time, and financial constraints. Current evidence supporting the educational advantages of surgical simulation in orthopaedic skills training is limited. Despite this, positive effects on the overall education of orthopaedic residents, and on maintaining and improving the proficiency of practicing orthopaedic surgeons are anticipated.

Fine motor skill is an improvable motor system component that develops by using the coordinated muscles of hands and fingers. A well-improved motor skills can be defined as an action completed fast, simultaneous and coordinated. Eye co-ordination directed movement also improves the quality of motor skills. Fine motor skill starts to occur in childhood and develops over time. From simple daily functions (fastening buttons, tiing shoelace) to the professional life, it is used in many processes unconsciously. The most important feature is that it is improvable and correctable. In our study, we used the devices that improve arthroscopic motor skills of the participants.

In this context, authors displayed that efficient basic motor skills combined with visual spatial skills will provide a better performance before proceeding the surgical arthroscopy for real patients.[4–6] Similarly, in our study, we found that with the arthroscopy course, error of all physicians is lessened and process duration is shortened. Due to the lack of standards in orthopedic training, with reference to that such course has brought a standard to the resident training and has significant positive effect to the motor development, we believe, dissemination of these courses in orthopedic resident training and being a part of the orthopedic specialization training will be beneficial.

One of the main problems here is the necessity to decide when to start these programs. Even though Karahan et al proposed that surgeons who are more experienced seem to be more skillful in certain basic motor skills, our results are inconsistent with the previous findings.[7] Our test results displayed that there was no difference in test results of senior and junior surgeons. Both groups had provided equal improvement in terms of motor skills. Motivational beliefs act as favorable contexts for learning especially in young surgeons. The second reason fort he equality of the tests may be the fear of making a mistake of experienced surgeon. Most importantly, the motor skills were increased in both groups with no significant statistical difference. We believe errors due to nervousness and anxiety when faced with real patients can be reduced through improving these motor skills using simulated arthroscopic surgery.

Also leadership and communication skills are required in surgical practice and in certain circumstances may be of greater importance than technical amptitude. Stirling et al concluded that training methods must therefore address this and develop these skills alongside procedural learning.[8]

Atesok et al reviewed article for the effects of surgical skill laboratories, cadaver models and synthetic bones, software tools, haptics, virtual reality simulators for arthroscopy training.[9] He concluded that laboratory-based training offers potential benefits in the development of basic surgical skills, such as using surgical tools and implants appropriately, achieving competency in procedures that have a steep learning curve, and assessing already acquired skills while minimizing concerns for patient safety, operating room time, and financial constraints.[10–13]

Braman et al described a basic arthroscopy skills simulator that has face and construct validity.[14] They designed and built a lowcost simulator that addressed 3 concepts identified by the panel as core arthroscopic skills: visualization, triangulation, and object manipulation. Two modules were prototyped and tested, focusing on triangulation with visualization and triangulation with object manipulation. These arthroscopic skills simulators were effectively able to differentiate between expert and novice arthroscopists.

Chami investigated whether the forces applied through the surgical instruments could be used to assess the quality and skill of arthroscopic surgeons.[15] They presented a new method and defined parameters or features to assess performance during real knee arthroscopy and they suggested that these parameters could be recorded and analyzed completely by a computer rather than by a human observer, supporting the potential for an objective scoring system for assessment of performance in real knee arthroscopy based on the pattern of forces and torques applied to the arthroscopic instruments.

The importance of experience is an undeniable fact in surgery. We did not compare arthroscopic adequacy or lead in this study. Of course, we believe that rate of professional success will increase through experience however as evidenced by our work to gain motor skills through such courses at any stage of residency or specialization period make no difference between acquisition and in terms of usefulness.

There are several limitations to our study. The lack of a post-course participant survey is the main one. Additionally, we could not assess the improvements of surgical performance with assistance of the motor skill course. Moreover, we did not have the ability to compare our results with knee arthroscopy cadaver courses.

Conclusion

Our results show that residents will be able to perform with strong motivation to learn applications through basic arthroscopic information gained in early period of orthopedic training and will make more successful in applying what they learned on real patients. However, existence of conflicting results indicates the need for more studies on this topic.

Conflicts of interest

No conflict of interest.

Ethics

This study was approved by the institutional review board. Ethical review committee approval number and date: 108400987-213/16.04.2015.

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