A Supplemental Video Teaching Tool Enhances Splinting Skills

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Abstract

Background The ability to apply casts and splints is a technical skill that requires practice and understanding of basic principles of musculoskeletal medicine. A video in which a given procedure is simulated on a dummy can represent reality under controlled conditions. A decrease in physician competency in musculoskeletal medicine is the result of educational deficiencies at the medical school level. **Questions/purposes** We asked whether (1) a supplemental video educational program enhances performance of

medical students' musculoskeletal clinical skills and (2) factors such as the proportion of orthopaedic professors to students, sex, age, and previous scores of medical students affected the clinical skills of medical students.

Methods We allocated 474 medical students into one of two groups: all participants received 90 minutes of lecture instruction on how to splint and cast but one group viewed the supplemental instructional video and the other did not. There were no differences in terms of sex, age, basic science exam scores, or grade point average of the groups. Thirteen specific skills in splinting an injured limb were evaluated. We recorded grade point averages. We developed a 10-point scoring system and graded each student on their splinting skills 6 months after the lectures.

Results The medical students who watched the video had an average score of 7.6, whereas the control group's average score was 2.0. We observed a positive association between watching the educational video and clinical exam score. A higher professor-to-student ratio was associated with lower student Objective Structured Clinical Examination score.

Conclusions Our observations suggest a supplemental video instructional program improved the performance of

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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musculoskeletal clinical skills in comparison to only a traditional lecture series.

Introduction

Splinting and casting are well recognized as priorities in the management of fractures and musculoskeletal injuries. Splinting a fracture can reduce pain and the incidence of fat embolism and shock minimizes further soft tissue injury and facilitates safe transportation [13]. Applying proper casts and splints are technical skills that require understanding of the basic principles of musculoskeletal medicine followed by adequate practice. Improving the casting and splinting skills for medical students has been recognized as a priority in medical education [7]. Despite this and the high incidence of fractures and injuries, medical students continue to describe poor confidence in applying musculoskeletal skills like casting and splinting [18].

Some studies [9, 15, 25] suggest that the decrease in physician competency in musculoskeletal medicine is the result of educational deficiencies at the medical school level. This finding is a challenge faced by many medical care systems worldwide [2, 5, 6].

We presume that practicing casting and splinting skills several times enables medical students to apply their theoretical knowledge in an appropriate way, although doing so would require changes in teaching strategies. Using educational videos in which a given procedure was simulated on a dummy allowed undergraduates to watch it as many times as they believed necessary. Lee et al. reported that the use of instructional videos improve clinical skills of students in comparison to the traditional teaching method [19].

Previous studies [1, 4, 11, 21, 30] suggested different media have differing effects on promoting understanding and retention of information. According to some surveys, learners retain more information after reading printed instructions (traditional method) than after viewing a video [4, 11, 21], whereas others have reported a positive effect for video over print [1, 30], or an equivalence of the two media [10, 14]. In another study, Shippey et al. revealed that practice with a video is an effective method for improving medical students' surgical skills [26]. Based on these findings, we performed a pilot study before our main project with 20 students, 10 of whom watched a training video to supplement lectures on splinting and 10 students who did not view the video. The pilot study indicated that supplemental video learning could have an additional effect over the traditional lecture method alone.

We therefore asked whether: (1) whether a supplemental video educational program enhances performance of medical students' musculoskeletal clinical skills and (2) factors such as the proportion of orthopaedic professors to

students, sex, age and previous scores of medical students affect the clinical skills of medical students.

Materials and Methods

Between January 2010 and February 2011, we enrolled 474 sixth-year medical students from three university hospitals in the study. We divided subjects from each hospital into two groups to eliminate the potential confounding effect of any hospital educational facilities and training on the score. Group 1 with 238 students viewed the supplemental while Group 2 with 236 students did not (Table 1). Students (the students were assigned to the groups by generating random variables in SPSS [IBM, Armonk, NY, USA]) were tested for splinting skills 6 months after receiving the instruction. The study protocol was reviewed and approved by the Research and Ethics Committee of our institute. The participants were given clarification individually regarding the study and signed informed consent forms.

We presumed the background general knowledge and education of the students would be the same as students who enter medical school immediately after graduation from high school (after 12th grade) and having the highest ranks among approximately 500,000 applicants. According to the Comprehensive Basic Sciences Exam score (a multiple-choice examination that all third-year medical students have to pass), all students have to choose one of three academic hospitals for clinical skills education. The students who watched the video were similar in age to the students in the other group (mean age, 24.1 versus 24.2 years) (Table 1). There were no differences in terms of sex, Comprehensive Basic Sciences Exam score, or grade point average. The proportion of medical professors to medical students was 0.4

Table 1. Baseline characteristics of the study population

Factors	Group 1 N = 238	Group 2 N = 236	p value
Male	91 (38.2%)	89 (37.7%)	0.95
Age (years)	24.1 ± 0.58	24.2 ± 0.29	0.72
OSCE score	7.55 ± 2.61	1.99 ± 2.60	0.001
Basic science score	137.16 ± 21.28	137.41 ± 20.43	0.89
GPA	16.09 ± 1.19	15.86 ± 1.16	0.38
Hospital			
Sina	92 (39.9%)	93 (39.4%)	0.95
Imam Khomeini	95 (38.7%)	95 (40.3%)	0.95
Shariati	51 (21.4%)	48 (20%)	0.93

Group 1 = students who watched the video; Group 2 = students who did not watch video; continuous variables are presented with mean and standard deviation and were evaluated with t-test; categorical variables are expressed with percentage and were analyzed with χ^2 test; OSCE = Objective Structured Clinical Examination; GPA = grade point average.

in Shariati Hospital and was similar to that in the other two hospitals, with a proportion of 0.5. In addition, students in both groups had the same hospital distribution (Table 1).

All participants were taught orally and shown how to splint or cast by an orthopaedic surgeon trainer. Both groups had some traditional teaching such as lectures, textbooks, and individual written assignments. In addition one group received the video instructional program. The instructor presented a computerized PowerPoint presentation with an accompanying script titled: “Splinting and Casting”. Thumb spica, ulnar gutter, sugar-tong, posterior ankle, above knee, Jones bandage, and Velpeau bandage were taught. The lecture and illustrations were the same for all students. The oral lecture and instructional video covered all of the issues on the exam, separately.

One of the authors (SRM) produced a 26-minute audio-visual recording about splinting and casting using one volunteer student who acted as a simulated patient. The video was made in June 2009 in an audiovisual unit. The video showed how to perform casting and splinting in 13 steps (Table 2 [3]). In addition, each step was described in detail and all initial information such as material, equipment, and advantages and disadvantages of casting and splinting were shown during the video. The video showed how students can use the equipment and the approach to casting and splinting.

The experimental group of medical students attended the skill laboratory 2 days after the lecture where they were shown a supplemental instructional video to provide some

initial understanding of the technique they would be asked to perform. All were given a DVD copy of the video for reviewing and practicing at home. Students were told they would be tested on their skills 6 months after the lecture and in Group 1 the supplemental video. We chose a 6-month interval to allow for some decline in skills with time. After this period, we asked all students to splint and cast the prepared dummy under the observation of two evaluators (RSK and MT), who were blinded to the identity and the allocations at the time of examination. The examination comprised evaluation of students in performing 13 skills in casting and splinting an injured limb (Table 2). Every student casted and/or splinted a trained model, and an attending professor (RSK) and senior resident (MT) observed and scored the performance (Table 2). All students were evaluated by the same professor and resident.

We used the Objective Structured Clinical Examination (OSCE) and the score sheet to assess the competency, knowledge, and skills of medical students [8, 16, 27, 29]. The score sheet and the provided video were based on a literature review [3, 8, 16]. We examined the reliability of the 13-item modified OSCE scale with the internal consistency coefficient Cronbach’s alpha [24]. Cronbach’s alpha is dependent on the number of items in the OSCE scale and on the mean summed scores of these items indicating the extent of technical skills performance. A higher score indicates better performance, whereas a lower overall score means worse performance. The score

Table 2. Question and scoring for casting and splinting

Question	
Supposing the simulated patient you are seeing is a patient with a 2nd metacarpal fracture who needs a proper splint, please show how you perform the procedure.	
Checklist	Points
1. Universal precaution: put on gloves	0.5
2. Patient notification	
Introduce yourself	0.5
Notify about the procedure	0.5
3. Estimate the splint length from the tip of the fingers to 5 cm to the elbow.	0.5
4. Measurement of splint length must be done on the unaffected limb.	0.5
5. Measure and fold the appropriate number of sheets (8 to 12 layers) for the desired splint.	0.5
6. Use an appropriate amount and type of padding on bony prominences and high-pressure areas.	1
7. Submerge dry layered splint material in water until bubbling from the materials stops.	1
8. The splint should be removed from the water and excess water squeezed out.	0.5
9. The splint should be placed on a hard surface and smoothed to remove any wrinkles and to ensure even wetness of all layers.	1
10. The wet splint should be placed over the padding and molded to the contours of the extremity, and the padding edges should be folded back to create a smooth edge.	1
11. The splint should be placed on the volar side of the hand and forearm.	0.5
12. The joints should be placed in their proper functional position before, during, and after padding.	1
13. The dried splint should be secured with an elastic bandage wrapped in a distal to proximal direction.	1

range was between 0 to 10 points. The internal consistency of the 13-item OSCE overall performance scale was acceptable and yielded a Cronbach's alpha of 0.91.

The baseline continuous demographic data were expressed with mean and SD. The categorical variables are presented with percent and evaluated with the chi-square test. We used the log-transformed scale (Naperian logarithm) of students' scores to improve the approximation to normal distribution. We determined differences in OSCE scores between the group that received an instructional video and the group educated by the traditional oral lecture using Student's unpaired t-test. To estimate the effect of watching the video on students' OSCE scores, the multivariate regression model was used; other covariates in this model were sex, age, Comprehensive Basic Sciences Exam score, grade point average, and the proportion of the number of medical professors to medical students in each hospital orthopaedic ward. We used unstandardized coefficient (β) to assess the magnitude of the effect of each covariate. All statistical analyses were performed using SPSS software.

Results

Watching the video had an additive effect in students' clinical learning reflected by the OSCE score. Group 1 students had a higher mean score ($p < 0.001$) compared with Group 2 students: 7.6 versus 2.0, respectively.

By taking into account many potential confounders such as age, sex, the hospitals where the students learned basic clinical orthopaedic skills, and the proportion of medical professors to medical students, the students' clinical performance in the orthopaedic OSCE score was approximately 7% better ($\beta = 0.69$, $p = 0.001$) for those who watched the video compared with those who had the

traditional lecture (Table 3). A higher proportion of medical professors to medical students in orthopaedic wards tended to be associated with a decreased (-1.12 , $p = 0.21$) OSCE score. Shariati Hospital had the lowest proportion of medical professors to medical students and the best students' clinical scores among others.

Discussion

Casting and splinting constitute basic musculoskeletal clinical skills that medical students are required to learn and perform. To perform these skills, the students need good knowledge and practice. We asked whether (1) a supplemental video educational program enhances performance of medical students' musculoskeletal clinical skills and (2) factors such as the proportion of orthopaedic professors to students, sex, age, and previous scores of medical students affected the clinical skills of medical students.

We note limitations to our study. First, although we asked students in the experimental group not to share the DVDs with other students, we do not know whether they did. However, all students were blinded to each other's education method. Because we observed a difference between the two groups, we suspect there was not a great deal of sharing, if any. Second, while we cannot rule out bias from the examiners, the evaluators were blinded to group allocations, so it seems unlikely the results were so biased.

Our findings suggest video-assisted training enhances musculoskeletal skills in medical students. Practice with the aid of an instructional video can provide sustained improvement in technical performance. Participants in the educational video group performed substantially better than students in the group that did not view the video, suggesting they learned a marked amount of information

Table 3. Unstandardized coefficient (β) from linear regression model with students' OSCE scores as the dependent variable

Independent variable	Unstandardized coefficient (β)	95% CI	p value
Sex	0.730	0.59 to 0.78	0.312
Age (years)	-0.210	-1.37 to 1.06	0.214
Basic science score	0.002	-0.001 to 0.005	0.260
Grade point average	-0.700	-0.200 to -1.20	0.507
Professor to student ratio in orthopaedic ward	-1.123	-2.89 to 0.64	0.217
Shariati Hospital	-0.071	1.18 to 1.25	0.322
Imam Khomeini Hospital	-0.034	-1.33 to 1.26	0.245
Sina Hospital	-0.024	1.26 to 1.32	0.355
Watching the video	0.696	-0.61 to 2.00	< 0.001
Constant	6.700	3.31 to 10.07	< 0.001

OSCE = Objective Structured Clinical Examination; p value is considered significant at 0.05.

about splinting and casting compared with the group that did not view the video. The effect of supplemental video learning was reported in another study which indicated that a score improvement of approximately 0.5 (−0.37 to −2.74) is acceptable [19]. Moreover, Nau et al. reported an increase in score from 2.50 to 3.70 in a comparison of nontrained and trained students [22]. Our findings are consistent with these in showing a score improvement of 5.56 and approximately 7% difference in the adjusted model between the students who watched the video compared with those trained by the traditional method. In addition Kohls-Gatzoulis et al. [17] considered learning a procedure a complex task that requires cognitive and effective skills apart from knowledge of its indications and contraindications. According to previous research, video-based education interventions appear to improve medical students' procedural skills [17, 28]. A similar study was conducted to show students who practiced with video instructions had substantial improvements in procedural skills in comparison to students who used a manual after watching instructions directly one time from an expert [28]. Although the results of that study were similar to ours, a notable difference from our design is that participants in that study were provided materials and allowed to practice using either the manual or video during the interval between the instructional sessions and the followup evaluations. Nousiainen et al. [23] compared performances of students who practiced using a combination of instructor feedback and video assistance with performances from those whose practice included video assistance alone. They showed comparable sustained improvements in procedural skills between their two groups. In addition, they observed a positive impact of video on learning. In contrast, Mahmud et al. [20] reported that dissection videos did not have an impact on improvement of final examination scores; however, students favored their use. In a previous study, repetitive deliberate practice was reported to enhance motor skills [12]. According to this consideration, the video can be used as an aid to student practice, which we found improved their procedural skills. When referring to the video to resolve their uncertainties regarding how to perform components of the task, the students were able to spend their time efficiently on the practice by focusing only on the portions of the video that addressed their questions. Therefore, the video served as a tool for modeling steps of the task and as a visual reference for the desired outcome.

We found a higher professor-to-student ratio was associated with lower student OSCE score. There is a potential explanation for this discrepancy. Despite that Shariati Hospital had a lower professor-to-student ratio compared with other hospitals, it is a leading national orthopaedic center and therefore could have better educational and

clinical skill performance compared with other centers with higher professor-to-student ratios.

The use of video-based instruction in a curriculum of musculoskeletal skills can help enhance allocation of teaching resources. We recommend this theory be evaluated for other medical procedural skills.

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