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Enhancing Splinting Confidence through Inter-Residency Education: An Educational Workshop

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ABSTRACT

Introduction. The initial treatment for many orthopaedic injuries is splinting. Unfortunately, formal musculoskeletal training is limited in primary care leading to deficiencies in competency and confidence. Suboptimal splints can result in complications such as skin breakdown, worsening of deformity, and increased pain. Our orthopaedic surgery clinic often cares for patients who initially present to an emergency department or primary care clinic for their orthopaedic injury. Previous studies have shown that a high number of splints are applied improperly in the primary care setting, which could result in in avoidable skin complications and fracture instability.

Methods. Orthopaedic surgery residents held a splinting workshop for family medicine residents. The workshop involved didactic and skills portions. Pre- and post-surveys were administered using a 10-point scale to assess confidence in applying three common splints. The data were analyzed using student's t-test and qualitative feedback.

Results. Confidence in applying and molding each splint type improved significantly ($p < 0.05$). Knowledge in splint construction improved significantly as well ($p < 0.05$). Subjective feedback was positive.

Conclusion. These results showed inter-residency education can increase residents' confidence in skill-based medical care significantly. The results are encouraging and should facilitate further collaboration between multispecialty residency programs to improve patient care. Further investigation is needed to determine how well skills gained in workshop are retained. ***Kans J Med 2020;13:29-37.***

INTRODUCTION

Even though orthopaedic injuries are very common with 15% of the population presenting to primary care physicians (PCP) each year, the care these patients receive can be suboptimal.[1] One deficiency is in injury splinting by PCPs. Even though splints are the initial treatment for many musculoskeletal injuries, they often are applied incorrectly. For example, soft tissue complications were found in 40% of patients who were splinted in the emergency room setting with ulcerations present in 6% of all splints.[2] Furthermore, these injuries can lead to a patient enduring unnecessary pain, undergoing additional procedures, and increasing the overall cost of healthcare. Hence, these soft tissue complications due to inadequate splinting techniques is the second most common iatrogenic cause for a referral to plastic surgery.[3]

The deficit in splinting proficiency may be due to lack of formal training. It has been illustrated that medical school graduates report splinting as a skill in which they had the third least experience, behind thoracentesis and central venous access.[4] This may be due to the limited time spent on musculoskeletal rotations. Only 33 - 66% of PCPs reported that they rotated on a clinical service related to musculoskeletal medicine in medical school.[5,6] During residency, clinical experiences in musculoskeletal medicine are limited as well, with 71 - 82% of primary care residents and 70% of attending physicians failing a basic musculoskeletal knowledge exam.[6,7] Pediatric residents reported similar lack of experience and confidence with musculoskeletal care. A recent study showed that 62% of graduates wanted more experience with applying a temporary splint and 22% did not apply a splint successfully during their training. This was second only to reduction of dislocation while ahead of procedures including intraosseous line placement, endotracheal intubation, and lumbar punctures.[8] Similarly, McGrath et al.[9] demonstrated that splinting education was only taught to 67% of emergency medicine residents during their orientation. Fortunately, more exposure, confidence, and knowledge can improve in those completing musculoskeletal training.[5,7,10]

Our program is based in a large community with two Level-1 trauma centers. Their outlying clinics and emergency departments serve as the main sources for orthopaedic referrals. Additionally, patients seek care at many smaller, more remote community hospitals, then are referred to our clinic. Thus, a recent study showed that splints applied by non-orthopaedists were inappropriately applied in 93% of patients.[2] These inappropriate splints could result in avoidable skin complications and fracture instability. Although the types of health care professional applying splints in these settings varies widely, many of the emergency medicine clinics and emergency rooms are staffed by family medicine physicians.

Our aim was to increase confidence in splint application by educating family medicine residents on proper splint technique by holding an educational workshop. An educational curriculum was created that may be used by other departments seeking to educate providers. Detailed technique guides may be used as a resource to providers who need to apply these types of splints in the future.

A curriculum was developed by the senior author that is a fellowship trained trauma orthopaedic surgeon who has over a decade in educating orthopaedic residents on proper splinting techniques. Hence, a curriculum following previously published guidelines was used and orchestrated to develop this quality improvement workshop.[11] This project was unique in that it outlined a curriculum and included technical details in teaching appropriate splint application. A recently published quality improvement project has examined the use of a casting workshop to decrease skin complications.[12] While promising, this study involved casting, not splinting, and its main subjects were orthopaedic surgery residents who have significant exposure to musculoskeletal care prior to the intervention.

METHODS

Due to the design of this study being a quality improvement project, the home institution determined that Institutional Review Board (IRB) approval was not needed. A 20-minute didactic session was held at the beginning of an educational session that included rationale for holding the workshop. Examples of inadequate splints and instruction about appropriate splint applications for several common fractures were presented. Thirty-two family medicine residents were separated into four small groups of 4 - 6 learners with 1 - 2 orthopaedic surgery residents at a station. Orthopaedic residents spent 15 minutes teaching each group the indications, application, and molding technique of the following four splint types: posterior leg splint with stirrup, ulnar gutter, sugar tong, and thumb spica. Materials used in the workshop are listed in Appendix A. After 15 minutes, family medicine residents rotated to a new station and learned the next splint type. During each small group session, the family medicine residents practiced the application of each splint type under supervision of the orthopaedic surgery residents. Prior to the start of the workshop, a pre-test was administered to each family medicine resident to assess their confidence in each of the splinting techniques (Appendix B). Following the workshop, the same questions were re-administered as a post-test.

The pre-/post-test rated participants' confidence on a 10-point scale in both applying and subsequently molding the following splint types: sugar tong, long arm, and short leg.[13,14] Participants were asked to identify the appropriate number of layers of plasters needed to make a splint. This question was important as it identified an easily testable piece of information presented in the didactic portion of the workshop and was clinically relevant when making a splint. A plaster thickness of 10 or 12 was counted as correct. A prompt also was included asking for general comments and feedback regarding the splinting workshop.

Technique. Key points in teaching the various splints are described below. The first splint technique will describe, in detail, key points of splinting and basic splinting techniques that are applicable to each subsequent splint applied. Images highlighting key points of each splint are available in Appendix C.

Posterior Leg Splint with Stirrup. This splint may be applied for injuries to the ankle. Fracture dislocations must be reduced prior to splinting and techniques at reduction fall outside the scope of this workshop. Prior to splinting, the length of the posterior slab and length of the stirrup need to be measured. Padding material will be rolled out over the patient's uninjured leg to simulate the placement of the plaster application. Starting at the plantar aspect of the toes distally, the padding is rolled posteriorly over the ankle and up the posterior aspect of the calf. It should be stopped several centimeters short of the knee crease. Once the appropriate length has been determined, the padding is torn to use a length template. The process is repeated for the stirrup which courses from the medial aspect of the calf, plantarly to the heel and back proximally along the fibula. The stirrup should be placed several centimeters distal to the head of the fibula to prevent compression of the peroneal nerve. Once templates have been measured, they are laid flat on a table and plaster rolled out 10 - 12 layers thick. With fewer layers, the plaster will be too weak to protect the injury. With too many layers, the hardening splint may become too hot and burn the patient.

After the splint has been measured and rolled out, the patient is positioned in a supine position. An assistant will stand on the side of the patient that is to be splinted at hip level. The patient's hip and knee will each be flexed to 90 degrees. The assistant will assist by putting their arm closest to the patient and over the patient's thigh and forearm under the patient's knee. The contralateral hand will grab the patient's toes. Care must be taken to keep the ankle in dorsiflexion. With plantar flexion, three problems may arise. If the splinted leg remains in plantar flexion, a gastrocnemius contracture may develop. Also, if the ankle is plantar flexed while padding is applied and an attempt is made to put the ankle in dorsiflexion during molding, the padding will be compressed which puts pressure on anterior skin of the ankle. Additionally, a plantar flexed foot can result in frictional forces on the heal with can result in skin ulceration.

Once correct patient positioning has been confirmed with the help of an assistant, padding may be applied. For ankle injuries, a 4-inch padding is preferred. If padding is wider, it loses its ability to contour to the patient. With 2- or 3-inch padding, it increasingly becomes difficult to cover the amount of surface area required for the splint. Padding is wrapped in a circumferential manner around the extremity, starting distally and working proximally. Each successive circumferential layer should overly the previous layer by approximately 50%.

A minimum of four layers of padding should be applied. Distally, the padding should cover the toes and proximally the padding should end prior the knee crease. Care should be taken to keep wrinkles out of the applied padding. This may require some tension that is placed on the padding as it is applied. More than four layers should be applied over bony prominences. In the case of ankle injuries, this would include the malleoli, heel, and metatarsal heads. There are numerous ways to accomplish the additional layers. Additional layers may be applied in a circumferential fashion or the provider applying the splint may choose to tear off several layers of padding and apply them in a manner that covers the prominences. In the case of ankle injuries, this often means placing padding in a "U" type configuration around the posterior and plantar aspect of the ankle and foot. There need not be additional layers over the anterior aspect of the ankle as there will be no overlying plaster placed. For the posterior slab of the lower leg splint, a foot pad is applied that consists of several rolls of padding which are longer than the plaster slab. After the plaster has been wet and applied, the extra length of the padding is folded back over the plaster to provide protection and padding for the toes.

Once the extremity is padded, plaster may be applied. Each component is dipped into lukewarm water. The higher (or lower) the water temperature, the quicker (or slower) the plaster will harden. The plaster sheets will need to be annealed into one plaster slab. To do this, either the slab is placed on a flat surface and pressure applied while rubbing the slab or holding the plaster sheet upright and running it through your fingers. Each splint component is placed in its position.

Once the plaster is in place, a layer of padding is applied. This will keep the plaster in place while a compressive bandage is applied and aid in its removal. Without the additional padded layer, the compressive bandage will stick to the plaster and be difficult to remove. A compressive bandage is applied. The provider then will apply a mold to the splint which will prevent malalignment of the fracture.

For lateral ankle injuries such as a fibula fracture, a varus mold will be applied. The provider should stand at the foot of the patient. With the hip and knee flexed to 90 degrees, the foot will rest on the provider's chest. An axial load will be applied to maintain dorsiflexion. One hand will be placed at the mid-tibia and the other will be placed at the lateral aspect of the calcaneus and distal fibula with hand cupping the posterior aspect of the heel. The provider will apply constant medially directed force with the more distal hand. The three points of contact constitute a "3-point technique". This prevents rotation of the extremity during molding. With two points of contact, the extremity will rotate freely and the mold will be difficult to apply. This position will be held until the splint has hardened.

Sugar Tong Splint. This splint will be applied to wrist injuries. The patient's elbow is flexed to 90 degrees with wrist and fingers in extension. An assistant will hold the patient's fingertips and midshaft of the humerus. Measurement proximal is started to the metacarpophalangeal joint (MCP) palmarly in the distal palmar crease, allowing the patient to have motion of the MCP and prevent contractures. The splint will run proximally around the posterior aspect of the elbow, then back distally to the dorsum of the hand just proximal to the MCP. Three- or four-inch padding is applied. Care should be taken to pad the elbow, ulnar styloid, and radial styloid. The provider will apply plaster, padding layer, and compressive dressing. During molding, attention is paid to the "3-point technique". For injuries that are unstable dorsally, one hand is placed dorsally and distally on the hand and forearm. Another is placed at the volar aspect of the mid-forearm. For the third point, either the provider's knee may be placed on the lateral side of the elbow or an assistant may hold the elbow. For injuries that are unstable volarly, the volar-palmar position of each molding point is reversed.

Ulnar Gutter Splint. This splint will be applied to injuries to the 4th and 5th rays of the hand. The splint should run from the distal interphalangeal joint to the mid-forearm. One dorsal slab and one palmar slab is measured. These should cover the width of the 4th and 5th rays. Often, this is accomplished with 2-inch plaster. Alternatively, 4-inch plaster may be used then splint it longitudinally with the forearm portion left intact, measuring in an intrinsic plus position. The wrist should be extended 30 degrees, MCP should be flexed 90 degrees, and the distal and proximal interphalangeal joint should be in zero degrees of flexion. Prior to splinting, a couple layers of padding are placed between the fingers to be splinted which prevent chance of a pressure sore. The extremity is padded by wrapping the ring and small fingers, the palm, and the forearm. Space for thumb motion should be provided. Plaster, padding layer, and compressive bandage are applied. Molding this splint may be difficult. One hand is placed palmarly so that the index finger runs in the concavity of the MCP flexion. The thumb of this hand is placed on the dorsal aspect for stability. The provider's other hand is placed dorsally along the patient's fingers and is used to keep them in extension. The splint position is held until the plaster has hardened.

Thumb Spica Splint. This splint will be used for thumb and scaphoid injuries. The splint will be measured in neutral rotation of the forearm, wrist in slight extension, and thumb in slight flexion. The tip of the thumb is measured to the mid-forearm. This is applied in a similar manner as the ulnar gutter with a 4-inch plaster split in half along the thumb with the forearm plaster unsplit and padded with 2-inch padding. The splint and mold are applied. The palmar and dorsal aspects of the plaster is compressed while holding the thumb in the aforementioned position.

Analysis. A t-test was used to analyze pre- and post-tests. A p value of 0.05 or less was defined as statistically significant. Comments and feedback were evaluated qualitatively.

RESULTS

Thirty-two family medicine residents from two residency programs participated in 90-minute splinting workshops. Confidence in applying and molding each splint type improved significantly ($p < 0.001$). Mean confidence per Likert scale increased by 5.30, 5.29, and 5.19 on the sugar tong, long arm, and short leg splint, respectively (Figure 1). The percentage of residents able to identify thickness of splint correctly increased from 56% to 100% ($p < 0.01$). Subjective feedback of the workshop was highly positive. There were 18 people who submitted optional general feedback. All 18 (100%) had positive feedback about the splinting workshop and included thanking us for taking the time to teach splinting techniques and acknowledging the need for such a workshop. Three also submitted ideas for improvement that included more time in application of splints.

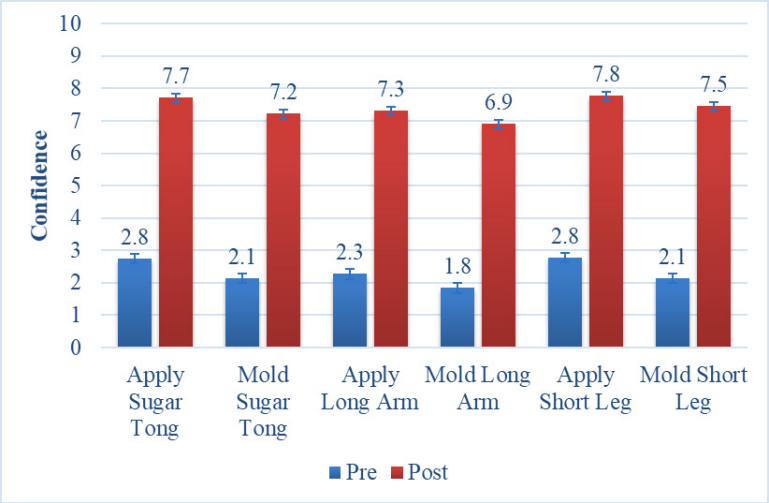

Figure 1. Confidence in applying and molding various types of splints prior to workshop (blue) and after the workshop (red). All pre- and post-workshop differences were statistically significant.

DISCUSSION

Results from our project suggested that an educational workshop can provide increased confidence in application of splints. This is encouraging in several ways. The statistical increase in confidence in each type of splint should manifest in improved patient care. The time investment required to recognize this gain was minimal. In our case, this workshop was held during a regularly scheduled didactic session. Residents and other healthcare providers are busy and learning new skills can be time consuming. It is reasonable that most providers do not seek out education regarding splint application as they either do not recognize the consequences of poorly applied splints or do not have time to seek out proper education. Some participants would have appreciated more time with application of splints. In future workshops, an extra 30-minute session for questions and/or additional practice with splints is being considered.

This project is limited in several ways. The participants were limited to family medicine residents. Although family medicine residents perform splint applications, there is a large number of primary healthcare providers, such as emergency medicine residents, internal medicine residents, nurse practitioners, and physician assistants, that also apply a high number of splints. Thus, our results may be only applicable to family medicine residents and may differ if we were to include these other primary health care providers to our study's results. Also, our intervention addressed confidence in applying splints, but relatively little data were gathered on how competently splints were applied or for how long providers in attendance remained confident. Thus, further studies are needed to validate if participant's competence in splint application increased and to have participants retake the same post workshop quiz at a later date (e.g., six months after workshop). Another potential limitation to this study was that we used a 10-point Likert scale to collect our results. Even though there was a previous study that found no significant test-retest reliability in scales up to 10-points,[14] other studies demonstrated that results from different Likert scales (5-point, 7-point, and 10-point) can differ in their results.[15] Also, we did not have "neutral" responses in our pre-/post-test. Both of these variables have the potential of skewing our results. Application to patient care and wound complications were not measured in our study.

Future studies should investigate the period of time family medicine residents remained confident and also assess the integrity of splints once they are applied. Lastly, it is difficult to tell whether the workshop ultimately will result in a clinically important difference in patient outcomes. Thus, further studies are needed to evaluate how incorporating splinting technique education can correlate with soft tissue complications.

Our project demonstrated that splinting application confidence can be increased significantly with an inter-residency education workshop. Our project also suggested that there should be more multispecialty inter-residency education to enhance resident's medical knowledge and to improve the quality of care for our patients.

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Keywords: splints, internship and residency, education, orthopaedic surgery, family practice

Appendix A

Splint workshop materials

Per Pair of Learners	
25	5 x 30 inch plaster sheets
8	4 inch rolls of plaster
1	Bag of 6 inch webril
2	Bag of 4 inch webril
1	Double 4 inch ACE bandage
1	Double 6 inch ACE bandage
2	3 inch ACE bandage
Per Workstation	
1	Tub of water
1	Trauma shear

Appendix B

Orthopedic Splinting Survey
(Pre & Post)

Please rate your confidence in performing the following splints (10 being the highest):

1. Sugar tong splint for a dorsally displaced distal radius fracture
1 2 3 4 5 6 7 8 9 10

2. Appropriate 3-point mold once splinted
1 2 3 4 5 6 7 8 9 10

3. Sugar tong + posterior slab splint for a dorsally displaced both bone forearm fracture
1 2 3 4 5 6 7 8 9 10

4. Appropriate 3-point mold once splinted
1 2 3 4 5 6 7 8 9 10

5. Posterior slab + ankle stirrup splint for an ankle fracture with lateral shift of talus
1 2 3 4 5 6 7 8 9 10

6. Appropriate 3-point mold once splinted
1 2 3 4 5 6 7 8 9 10

7. How many sheets of plaster (thickness) do you think is appropriate for each slab
a. 8 b. 10 c. 12 d. 14

Please provide any comments/suggestions to help us improve this Workshop:

Appendix C
Splint Technique

Top left: A sugar tong splint is being measured with padding.
Top right: Padding application on a lower leg splint. Tension maintained on padding while applying layers to prevent wrinkling.
Below: Images of a plaster slab that has been annealed together. Note the congealed look of the plaster on the right compared to the left.

Lower Leg Splint

Left: Two plaster slabs have been rolled. The top slab is a posterior slab with a foot pad. After dipping plaster in water the extra padding will be folded over to protect the toes.
Right: Posterior slab and stirrup applied. Padding has been wrapped over plaster to aid in holding slabs. This may be useful if the number of assistants is limited.

Left: A 3-point, varus mold is being applied to a lower leg splint.
Right: Completed lower leg splint.

Sugar Tong

Left: Plaster slab being placed over padding in a sugar tong splint.
Right: Mold being placed on sugar tong splint. This mold is for dorsally unstable fractures of the distal radius. The knee of the provider is against the patient's elbow. The provider's left hand is on the volar aspect of the mid forearm proximal to injury. The provider's right hand is distal to the injury and is applying a volarly directed force.

Ulnar Gutter Splint

Left: A mold is being applied to an ulnar gutter splint. The provider's right hand is on the palmar aspect of the patient's hand and extending the wrist. The provider's left hand is keeping the patient's interphalangeal joints extended and MCP flexed.
Right: A finished ulnar gutter splint. Note only the ring and small fingers are contained within the splint.

Thumb Spica

Finished thumb spica splint. Two-inch plaster has been placed on volar and dorsal aspects of the hand and runs to the mid forearm.