Assessment of Splints Applied for Pediatric Fractures in an Emergency Department/Urgent Care Environment

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Background: Fractures are common in the pediatric population. The initial evaluation is rarely by an orthopaedic surgeon, but commonly an emergency room or urgent care center physician/extender. This typically involves splint application by a nonorthopaedist to immobilize the extremity and provide stabilization. Iatrogenic injuries from inappropriate splint placement are a potential public health and legal concern that can lead to complications. The primary purpose of this study was to prospectively evaluate the adequacy of all splints placed on patients who presented to a pediatric orthopaedic office; secondary outcomes included assessing prevalence and types of complications that were associated with inadequate splints.

Methods: Patients aged 0 to 18 years who presented with a splint were prospectively enrolled. Information was obtained regarding demographics of the patient and splint placement. Splints were evaluated for functional position, appropriate length, and presence of elastic bandage on the skin. Photographs were taken of each splint, and the extremity was examined for any soft tissue complications. Splints were not removed in 31 patients who had undergone fracture reduction.

Results: In total, 275 patients were prospectively enrolled. Splints were improperly placed in 93%, with application of elastic bandage directly to the skin accounting for 77%. Improper positioning was observed in 59%, and inappropriate splint length was present in 52%. Skin and soft tissue complications were observed in 40%. The most common iatrogenic splint-related complication was excessive edema, seen in 28%. Direct injury to the skin and soft tissue was seen in 6%.

Conclusions: Many practitioners incorrectly apply splints, potentially leading to suboptimal results or causing injury. Complications of poor splint placement include excessive swelling, skin breakdown, and poor immobilization. Health care workers who treat pediatric fractures may benefit from more extensive education regarding proper splinting techniques.

Level of Evidence: Level 2—therapeutic study.

Key Words: splint, fracture, pediatric, emergency department, urgent care

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Trauma is extremely common in the pediatric population with nearly half of all boys and one quarter of all girls sustaining a fracture.[1] The initial evaluation of children following these injuries can occur by the pediatrician, an orthopaedic surgeon, or most commonly by an emergency room physician/extender or a physician/extender in an urgent care center. Initial treatment of the injured extremity is typically splint application when the child is seen and evaluated in an emergency department or urgent care center, as this immobilizes the extremity to decrease pain and stabilize the fracture. However, correct splinting techniques including proper padding, suitable elastic bandage application, functional positioning, and appropriate length are necessary to provide the intent of the splint and prevent potential complications, such as excessive edema, skin irritation, pressure ulcers, stiffness, or inadequate immobilization.[2–12]

Iatrogenic injuries from inappropriate splint placement are a potential public health and legal concern that can lead to severe skin and soft tissue complications or loss of alignment of a fracture. Although proper technique can avoid the vast majority of these potential complications, numerous examples of complications do exist.[11] However, the burden of injury may be underreported as there are limited studies and case reports regarding poor splinting techniques and associated complications.

The primary research question for this study was "how commonly do patients arrive in a pediatric orthopaedic clinic with improperly applied splints from emergency room or urgent care centers?" The hypothesis was that a majority of children would arrive in clinic with improperly applied splints. Primary outcomes included the prospective evaluation of the adequacy of all splints placed on patients who presented with a splint already in place. Secondary outcomes included assessing prevalence and types of complications that were associated with inadequate splints.

METHODS

Institutional Review Board

Institutional Review Board approval had been granted for the above prospective study, and informed consent was obtained from all patients and/or their guardians.

Study Subjects and Methods

All patients aged 0 to 18 years who presented to the pediatric orthopaedic practice for evaluation with a splint in place were prospectively enrolled in the study after obtaining informed consent from the appropriate party. At the time of presentation to the ambulatory pediatric orthopaedic clinic, all patients initially had a survey performed by one of the authors (B.S.S.). Patients or their care providers who could not provide answers to the questions, or were unwilling to participate, were not included in the study. In addition, patients who had casts or splints applied under the direction of the senior author (J.M.A.) were excluded as all casts or splints applied at the senior author's (J.M.A.) institution must be reviewed by the senior author. Any splint that does not meet the specifications described herein must be repeated before the patient leaving clinic or the emergency department. All patients then had photographs taken by the same author, including 2 orthogonal views of the splint. If splint removal was indicated, photographs of the underlying skin were then taken. Diagnoses were collected on all patients. Two of the authors (A.J.J. and J.M.A.) independently reviewed all photographs to determine splint adequacy and the presence or absence of underlying skin complications.

Demographics

In total, 275 patients were prospectively enrolled in the study after their injury at their initial presentation to the pediatric orthopaedic clinic, including 160 males and 115 females. All patients had a splint applied by an outside emergency departments or urgent care center for initial immobilization. The average age was 8 years (range, 0 to 18 y). In total, 206 splints were applied to the upper extremity and 69 to the lower extremity. The most common fracture seen was a distal radius buckle fracture (35/275), followed by Salter-Harris I and II fractures of the distal radius (33/275). The most frequent lower extremity injury was a distal tibia fracture (31/275). Table 1 provides a complete listing of all injuries.

Patient Questionnaire

One of the authors (B.S.S.) administered a standardized questionnaire to all patients and their care providers present at the clinic visit. Information in the questionnaire included patient demographics, the type of splint, the type of facility where the splint was applied (ie, emergency department, urgent care center, or primary care physician's office), type of practitioner that placed the splint (ie, orthopaedic physician, orthopaedic resident, emergency department physician, emergency department resident, physician's assistant, nurse, nurse practitioner, cast technician, etc.), and the amount of time from splint application until the orthopaedic evaluation.

TABLE 1. Distribution of Fractures

Fracture Location	Number Observed [N (%)]
Distal radius buckle-type	35 (13)
Distal radius Salter-Harris I and II	33 (12)
Distal tibia	31 (11)
Both-bone forearm	20 (7)
Supracondylar humerus	19 (7)
Radial neck	15 (5)
Tibial shaft	7 (3)

Assessment of Splint Adequacy

All photographs were reviewed by 2 of the authors (J.M.A. and A.J.J.). All images were independently reviewed; responses were then collated and reviewed by the third author (B.S.S.). When there was disagreement upon adequacy of splint type or position of immobilization, these were reviewed as a group a second time to reach a consensus. The authors who reviewed the splint images were provided with information regarding the diagnosed injury, and they then evaluated the photographs for the following: (1) if the appropriate splint was applied; (2) if the appropriate joint(s) were immobilized (ie, was the splint the appropriate "length"); (3) if the joint(s) were immobilized in an appropriate position of function; and (4) if any aspect of the elastic bandage was placed directly in contact with the skin. The last assessment was performed because it has been documented that patient populations, specifically pediatric patient populations, may be at risk for injuries from the elastic bandage being applied directly to the skin[11,13] Bias wrap, such as Coban (3M Health Care, St Paul, MN) or cotton tubular stockinette were considered acceptable if they were in contact with the skin. A splint was considered improperly applied if any one of the above were deemed to be inappropriate. Adequacy of splint padding was not directly assessed, as the splint or cast must inherently be destroyed during its removal, and none of the authors were present for the splint or cast application. A marker of adequate padding was considered to be the assessment of skin complications (discussed below).

Although there are a variety of splinting techniques that may be considered "appropriate," for the purposes of this study the splint type was considered "appropriate" if the joint above and below the injury was immobilized. If too many or too few joints were immobilized [ie, a sugar-tong splint for a distal radius fracture that extended distal to the distal palmar crease, thus immobilizing the metacarpophalangeal (MCP) joints], this was considered an inappropriate length of splint, and consequently an inappropriate splint applied.[3–7,12] Furthermore, specific fractures were considered on an individual basis.

The position of function was considered on an individual basis depending on which joint was immobilized.[1,3,4,6,12,14,15] Buckle fractures were considered appropriately immobilized if only the wrist was immobilized in a short arm cast or splint. Ankle injuries were considered properly immobilized if either a short leg splint, tall fracture boot, or rigid postoperative shoe was applied. Table 2 summarizes the specifics of each splint type, the injuries they are used to treat, and their appropriate functional positions.

TABLE 2. Attributes of Splints Placed for Specific Fractures

Splint	Fracture	Functional Position	Length
Finger (volar)	Phalangeal fractures	IP joints in full extension	
Radial gutter	Index/middle finger metacarpal fractures and phalangeal fractures	Wrist at 20 degrees of extension MCP joints at 70 degrees of flexion	Proximal forearm to just distal to MCP joints of the index and middle fingers for metacarpal fractures; need to extend distally for phalangeal fractures
Ulnar gutter	Ring/small finger metacarpal and phalangeal fractures	Wrist at 20 degrees of extension MCP joints at 70 degrees of flexion IP joints in full extension	Proximal forearm to just distal to MCP joints of the ring and small fingers for metacarpal fractures; need to extend distally for phalangeal fractures
Thumb spica	Thumb metacarpal and phalangeal fractures Scaphoid fractures	Wrist at 20 degrees of extension Thumb in MCP and IP joints in full extension	Proximal forearm to just distal to MCP joint of thumb for metacarpal fractures; need to extend distally for phalangeal fractures
Forearm (volar)	Metacarpal fractures (2nd-5th) Distal radius buckle/nondisplaced fractures	Wrist at 20 degrees of extension MCP joints at 70 degrees of flexion for splints extended beyond the MCP joints	Proximal forearm to just proximal to midpalmar crease (patient should be able to flex MCP joints 90 degrees) for distal radius fractures; extend distally to stop just distal to MCP joints for metacarpal fractures
Forearm sugar-tong	Distal radius and ulna fractures	Elbow at 90 degrees of flexion Forearm in neutral rotation	Dorsal hand proximal to MCP joints, wrapping around posterior elbow, and ending just proximal to midpalmar crease (patient should be able to flex MCP joints 90 degrees)
Long arm posterior	Both-bone forearm fractures Proximal radius/ulna fractures Distal humerus fractures Supracondylar humerus fractures	Elbow at 90 degrees of flexion Forearm in neutral rotation	Posterior upper arm to ulnar border of hand ending proximal to the midpalmar crease (patient should be able to flex MCP joints 90 degrees)
Short leg	Midshaft or distal tibia/fibula fractures Nondisplaced malleolar fractures Tarsal/metatarsal fractures	Ankle at 90 degrees	Posterior leg (just proximal to fibular neck) to the metatarsal heads
Long leg	Proximal tibia fractures Distal femur fractures	Knee at 20 to 30 degrees of flexion Ankle at 90 degrees	Posterior thigh to the metatarsal heads

IP indicates interphalangeal; MCP, metacarpophalangeal.

The same 2 authors (J.M.A., A.J.J.) also reviewed the images of the patient's limb after removal of the splint, when indicated. These were evaluated in the same manner as described above for the presence or absence of the following: excessive soft tissue swelling out of proportion with what would be expected for the given injury (eg, some swelling after a both-bone forearm fracture reduction may be considered normal, whereas, swelling should not be noted for a buckle fracture), soft tissue marks from elastic bandages, superficial skin breakdown (eg, partial thickness ulceration), deep skin breakdown (full-thickness ulceration with exposed underlying adipose tissue, fascia, muscle, or tendon), and any signs of infection.

Splints were not removed in 43 patients who had required a reduction of a displaced fracture before their presentation. These patients were maintained in the splint to optimize the postreduction stability and to prevent redisplacement. Therefore, those patients remaining in a splint were excluded from analysis of splint complications. Following evaluation of the splint and any complications, the pediatric orthopaedic physician performed a full musculoskeletal examination of the patient and a diagnosis was obtained.

Data Collection and Analysis

All data were collected and collated using Microsoft Excel (Microsoft Corporation, Redmond, WA). Following data collection, descriptive statistics were performed. Comparative statistics were used to compare complication rates between cohorts. A Fisher exact test was used to compare proportions. Multivariate analysis was performed to determine if there was a difference in outcomes based upon what type of facility performed the initial fracture immobilization. All statistics were calculated using JMP 8 (Statistical Analysis System Institute Inc., Cary, NC). A $P < 0.05$ was considered statistically significant.

RESULTS

Splints were improperly placed in 93% (256/275) of cases. The most common reason for considering a splint to be placed inappropriately was application of an elastic bandage directly to the skin, which occurred in 77% (213/275) of cases (Fig. 1). Excessive edema distal to the elastic bandaging occurred in 23% (50/213) of patients.

Improper positioning, including inappropriate flexion or extension, of the immobilized joints was observed in 59% (163/275) of cases (Fig. 2). Upper extremity splints accounted for 64% (104/163) of splints placed in a poor functional position. The most common positioning infraction seen in upper extremity splints was immobilization of the wrist in excessive flexion, observed in 63% (66/104) of cases. (Fig. 2A) Other prevalent problems of upper extremity positioning during splint application

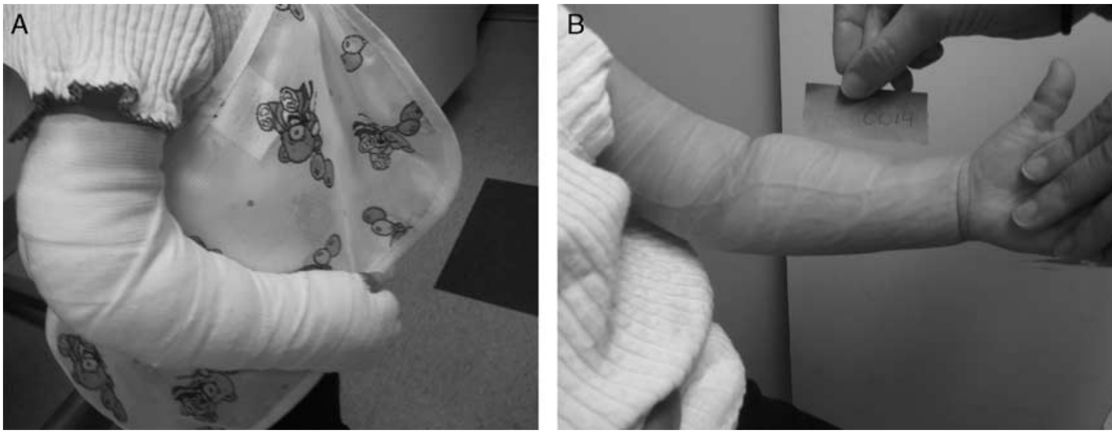

FIGURE 1. A, B, An example of a splint with elastic bandage applied directly to the skin. A, 1-year-old female with a left lateral condyle fracture placed in a long arm posterior splint at a hospital emergency department by an emergency department attending physician. B, Following splint removal, note the circumferential lines present due to the elastic bandage being applied directly to the skin. Also visible is a longitudinal pressure point secondary to the edge of the splint material. Lastly, there is increased erythema in the elbow flexion crease secondary to the elastic bandage "rolling up" on itself.

FIGURE 2. A–C, Examples of splints placed that are not in functional positions. A, A volar forearm splint incorrectly immobilizing the wrist in flexion, as opposed to the functional position of 20 degrees of wrist extension, in a 14-year-old female with a distal radius Salter-Harris II fracture. The splint was applied in an urgent care center by a medical assistant. B, A long arm splint where the elbow is immobilized in excessive extension in this 8-year-old girl with a supracondylar fracture. Note the elastic bandage applied directly to the skin proximally. This splint was applied in a hospital emergency department by an emergency department resident. C, A long leg splint immobilizing the knee in excessive extension (< 20 to 30 degrees) and the ankle in excessive plantar flexion (< 90 degrees) in a 3-year-old female with a proximal tibia fracture. This was placed in a hospital emergency department by an emergency department resident.

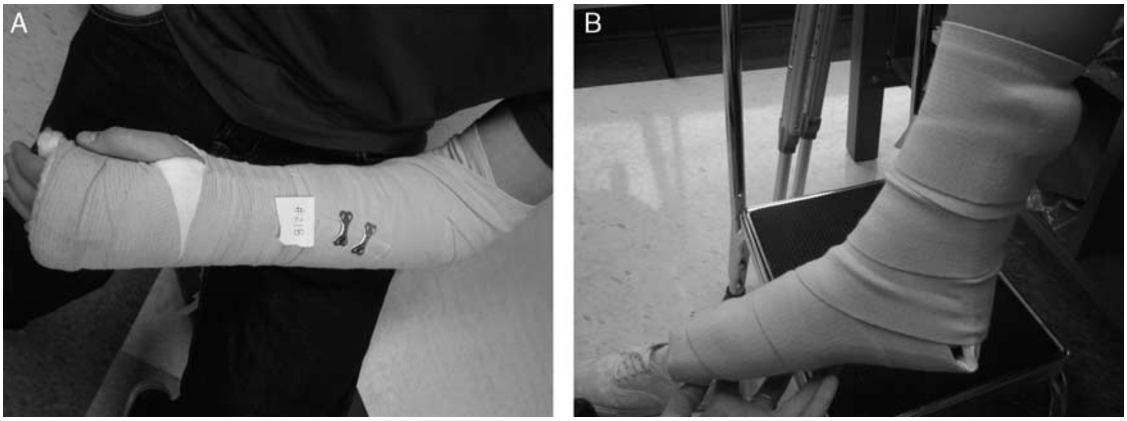

FIGURE 3. A, B, Examples of splints placed that are suboptimal regarding length. A, A volar slab splint applied to treat a left distal radius Salter-Harris II fracture in a 13-year-old male that is too long distally, preventing metacarpophalangeal (MCP) joint movement. In addition, the splint places the wrist in flexion and the MCP joints in extension, thus neither are in a position of function. This splint was applied in a hospital emergency department by a physician assistant. B, A posterior short leg splint placed for a lateral malleolus fracture in an 11-year-old female. The splint does not extend far enough proximally. In addition, note the lack of underpadding and that the elastic bandage has been applied directly to the skin. This splint was applied in an urgent care center by a medical assistant.

were excessive extension of the elbow (Fig. 2B), which accounted for 18% (19/104) of cases, as well as excessive extension of the MCP joints in 18% (19/104) of cases. The vast majority of lower extremity splints applied in an inappropriate functional position exhibited excessive plantar flexion of the ankle (Fig. 2C). In total, 95% (56/59) of improperly positioned lower extremity splints immobilized the ankle in excessive plantar flexion, whereas 5% (3/59) did not properly flex the knee to 20 to 30 degrees.

Inappropriate splint length was present in 52% (143/275) of cases. (Fig. 3) Upper extremity splints accounted for 82% (117/143) of all poorly sized splints. The most prevalent upper extremity length disparity was excessive distal length, seen in 79% (93/117) of cases. (Fig. 3A) The majority of length errors observed in upper extremity splints involved unnecessary immobilization of the MCP joints followed by unnecessary immobilization of the interphalangeal joints. Although the majority of improperly sized upper extremity splints were excessively long, 13% (15/117) were too short to immobilize the joint distal to the fracture, and 8% (9/117) were too short to immobilize the joint proximal to the fracture. In total, 77% (20/26) of improperly sized lower extremity splints were excessively short in length. The most frequent length discrepancy observed in lower extremity splints was insufficient proximal extension, which accounted for 65% (17/26) of poorly sized lower extremity splints. (Fig. 3B)

Skin and soft tissue complications associated with splint application were observed in 40% (92/232) of patients. Furthermore, 12% (28/232) of patients demonstrated ≥ 2 complications. The most common iatrogenic splint-related complication was excessive edema, which was present in 28% (66/232) of patients. It was noted that the swelling was most commonly located in the distal extent of the extremity secondary to a tight elastic bandage directly compressing the skin and soft tissues just proximal to the area of swelling. Pressure points as a result of splint application were observed on the skin in 19% (44/232) of patients (Fig. 4), whereas pressure points overlying bony prominences were only seen in 2% (5/232) of cases (Fig. 5). Direct injury to the skin and soft tissue, including abrasions, blisters, and ulcerations caused by the splint or elastic bandage, was seen in 6% (14/232) of patients presenting in a splint (Fig. 6). Fortunately, none of these wounds required intervention other than local wound care.

The average time in the splint before the initial orthopaedic evaluation was 6 days (range, 1 to 42 d). In the group of patients who had skin complications, the average time to the initial orthopaedic evaluation was 6 days (range, 1 to 37 d), compared with an average of 7 days (range, 2 to 42 d) in the group who did not have skin complications ($P = 0.39$).

In total, 67% of patients (183/275) presented to an emergency department in a hospital setting at the time of the initial injury, and 93% (170/183) of splints applied in this setting were placed incorrectly. The second most common site of initial presentation was urgent care centers, where 32% (89/275) of patients had a splint placed. In total, 93% (83/89) of these splints were inappropriately applied. Three patients enrolled in the study were initially evaluated in a primary care setting, and all 3 splints were placed incorrectly.

Numerous types of health care professionals were involved in applying splints, including attending physicians and residents in orthopaedics and in the emergency department, physician assistants, nurse practitioners, and other professionals such as nurses, medical assistants, cast technicians, and athletic trainers. Table 3 summarizes the distribution of splint adequacy by type of health care provider. Splints were nearly universally applied incorrectly. Examples of correctly applied splints are shown in Figure 7.

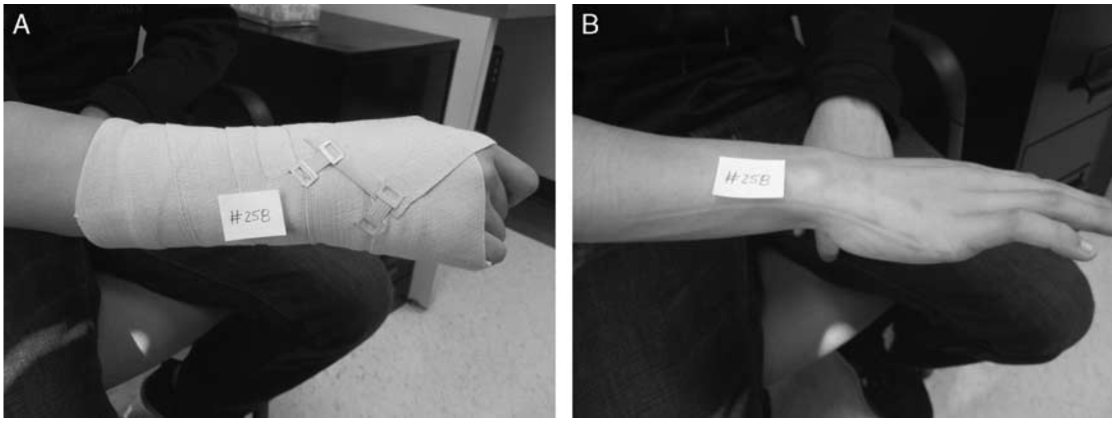

FIGURE 4. A, B, An example of a skin wound occurring secondary to pressure from the splint. A, A short arm volar slab splint applied on a 15-year-old boy for the treatment of a first metacarpal base fracture. This splint was applied in an urgent care center by a medical assistant. B, Following removal of the splint, linear pressure points secondary to the splint material are present on the ulnar aspect of the wrist, far away from the injury location.

DISCUSSION

Splinting is a simple and effective means of immobilization for patients with extremity fractures. Many types of health care workers including physicians, residents, nurse practitioners, physician assistants, medical assistants, and cast technicians provide the initial management of pediatric trauma, and may be required to apply splints. A well-placed and positioned splint is essential for immobilization of the fracture site to prevent movement of the injured bones, thus causing pain or leading to an increase in swelling. However, inappropriately applied splints can be associated with several adverse effects such as malunion or nonunion, excessive edema, stiffness, painful pressure points, and damaging skin breakdown. Although the principles and techniques of splint application are well established, many splints are placed by providers who may not have had extensive training in their proper application. As such, many splints applied are functionally inadequate or inappropriately positioned, and may lead to a preventable iatrogenic injury.

This study has inherent recall bias by relying on patients and their family members to recall where the splint was applied and who applied it. In retrospect, it would have been ideal to directly question patients and their family as to whether or not the splint had been removed or tampered with following the initial placement; however, that information may not have been truly reliable. Without inclusion of this information, the significance of improper splinting technique may be overreported. Another limitation is that the patients were seen at a variety of emergency rooms and urgent care facilities. Although it is unknown what each of these facilities annual pediatric census is, the authors feel that this is an accurate reflection of how the fracture immobilization is performed in the community, where subspecialty pediatric emergency medicine staff or orthopaedic surgeons may not be readily available. Patients often came to clinic without injury radiographs, and there were no instances of patients who had radiographs of the injury after splint application. As such, it is impossible to quantify whether the fracture motion occurred between the injury and splint application, or after splint application and the time of presentation in the clinic. Furthermore, many of the errors in splint application are not pediatric-specific errors, and we have not included controversial areas (ie, short vs. long arm immobilization for distal one third both-bone forearm fractures) as inappropriate. Rather, most of the errors pertained to basic fundamental principles of splint application (eg, avoidance of equinus at the ankle or flexion at the wrist), which should be understood for proper splinting technique regardless of patient age. This study did not distinguish between plaster

FIGURE 5. Heel wound present on an infant who sustained a tibia fracture. This splint was applied in a hospital emergency department by an individual that was either a nurse or medical assistant. Although there may be no good way to prevent this skin complication in a removable splint, the authors use this case as an example to present to urgent care and emergency room providers on the importance of timely follow-up so the patient can be transitioned to definitive long leg casting.

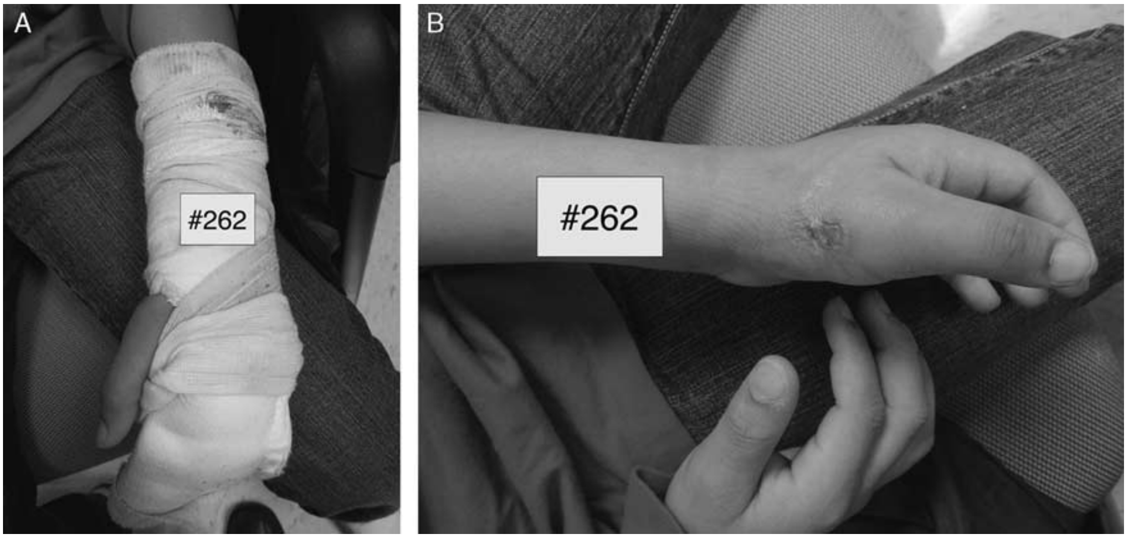

FIGURE 6. A, B, Skin and soft tissue injuries caused by inappropriate splint application. A, A short arm volar slab splint placed on an 8-year-old boy for the treatment of a left ring finger proximal phalangeal fracture. This splint was applied in a hospital emergency department by an individual that was either a nurse or medical assistant. B, Following removal of the splint, an ulceration is noted where the splint terminated at the base of the first metacarpal, far away from the site of injury.

and fiberglass, or between prefabricated and nonprefabricated splints. Furthermore, range of motion was not assessed as a part of this study. These can be addressed separately in future studies, as the main emphasis of the present study was to assess the basic splinting technique that is used when the child is initially seen. Future plans will include the evaluation of an outreach program to educate urgent care center and emergency department personnel to determine if such a program could enhance the quality of fracture immobilization.

The majority of splint-related iatrogenic injuries involve inappropriate splint placement resulting in excessive local mechanical stress to the skin and soft tissues. Skin abrasions and ulcerations are typically associated with an underpadded or unpadded area leading to constant pressure over a bony prominence or region of soft tissue prominence. Prolonged mechanical stress to these regions can become problematic and may eventually lead to degeneration of the underlying soft tissue.[13] Adequate padding is critical to prevent iatrogenic injuries resulting from splint placement. Padding should be wrapped circumferentially around the extremity, with 1 layer overlapping the previous layer by 50%. Two to 3 layers of padding should be added while not being overly constrictive. Additional padding should be positioned at each end of the splint and over areas of bony prominences. The ulnar styloid, heel, olecranon, and medial and lateral malleoli are specific regions at increased risk of excessive pressure.[3]

TABLE 3. Characteristics of Health Care Practitioners

Health Care Practitioner	Splints Applied [N (%)]	Incorrectly Placed Splints [N (%)]
Emergency department attending	80 (29)	74 (93)
Emergency department resident	9 (3)	9 (100)
Physician assistant	18 (7)	17 (93)
Nurse practitioner	7 (3)	7 (100)
Other including nurse, medical assistant, cast technician, athletic trainer, etc.	120 (44)	109 (91)

Although the basic principles and techniques of splinting are easily learned, several reported cases of injury due to incorrectly applied splints exist in the literature.[11,13] In a retrospective review of 196 patients, Lee and colleagues reported that splint-induced skin ulcers were the second most common iatrogenic skin and soft tissue injury in all ages, accounting for 28% of cases. Furthermore, in their series, 63% of splint-induced ulcers required a surgical procedure such as skin grafting or flap surgery.[11]

Elastic bandages are commonly utilized to wrap splints. Although wrapping is a simple process, it can be difficult to accurately gauge the magnitude of pressure being applied. Furthermore, elastic bandages should never be applied to exposed skin, as the excessive pressure can lead to skin irritation, edema, and possible ischemia. Lee et al[11] reported ∼6% of iatrogenic skin and soft tissue injuries in children and adults were related to inappropriate elastic bandage application. Splints placed in neonates and infants are especially worrisome, as these patients cannot adequately express feelings of pain or discomfort.

Immobilization of the fracture is one of the primary goals of splint application. One of the general principles of application of a splint is application of the splint beyond the level of the joints above and below a fracture (ie, the joint proximal and distal to the fracture) without

FIGURE 7. A–D, Examples of well-applied splints. Coronal and sagittal views of a volar resting wrist splint is demonstrated (A, B). Note the appropriate position of function of the wrist, length of the splint to leave the metacarpophalangeal joints free, and the amount of padding present. Similar views of a short leg splint that demonstrate the appropriate position of function and length are shown (C, D).

compromising motion of unaffected areas. Although there is currently no evidence demonstrating harm due to overextension of a splint, it is believed that splinting to an appropriate length is optimal for patients to prevent unnecessary stiffness as well as to encourage movement of adjacent joints in hopes of reducing swelling. In contrast, splints that do not span the appropriate length of the extremity insufficiently immobilize the extremity and may lead to increased pain or motion about the fracture site.

Another general principle of splint application is that splints should be applied in a functional position to minimize stiffness and loss of function once the splint is removed. Positions of function differ based on the type of splint applied and the joints being immobilized. For example, volar wrist splints should place the wrist in 20 degrees of extension, while splints that immobilize the hand should place the MCP joints in 70 to 90 degrees of flexion and the interphalangeal joints in full extension. Forearm sugar-tong splints should immobilize the elbow at 90 degrees of flexion while maintaining a neutral forearm alignment. Short leg splints should maintain the ankle at 90 degrees and should not allow for excess plantar flexion while long leg splints should be positioned to immobilize the knee at 20 to 30 degrees of flexion and the ankle at 90 degrees.[4]

Although this study reports on the epidemiology of adverse outcomes related to poor splinting techniques in the pediatric population, further research should be performed to identify the cause of inappropriate splint application. Furthermore, special care must be given to infants and noncommunicative patients in splints who cannot effectively convey pain or discomfort. Increased education regarding the specific techniques involved during the placement of splints as well as awareness of the possible injuries associated with improper application may be universally beneficial to members of the primary treatment team.

Splints are effective for immobilization of fractured extremities in children and adolescents when placed appropriately. Unfortunately, many practitioners in emergency departments and urgent care centers have not been properly trained to safely apply splints, potentially providing suboptimal care and leading to unnecessary injuries. Many splint-related iatrogenic injuries result from an inadequate amount of padding leading to excessive pressure from the splinting material. Furthermore, application of an elastic bandage directly to the skin is associated with excessive swelling in the distal extremities. Proper immobilization may be compromised if splints are not adequately sized to incorporate the joints proximal and distal to the fracture site, and stiffness as well as functional impairment may occur if the splint is not placed in a position of function. Complications of inappropriate splint application include swelling, skin breakdown, and poor immobilization, which can lead to unnecessary pain and/or stiffness. Health care workers who apply splints in emergency departments and urgent care centers may need to undergo more extensive education regarding proper splinting techniques, and as orthopaedic surgeons it may be our responsibility to advocate for the safety of our patients and to initiate outreach programs to providers who may be less experienced in splint application to educate them regarding the importance and risks of unsafe splinting.

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