The Reel Splint: Experience with a New Traction Splint Apparatus in the Prehospital Setting

A new lower extremity splint apparatus was applied by paramedics to 50 patients in the prehospital setting to manage a total of 60 injuries. The Reel Splint® was designed to provide stabilization with or without traction to a variety of angulated lower extremity fractures/dislocations. In 37 instances (62%), the splint was judged by the rescuers to be superior to the standard Thomas splint. In this series the splint was used successfully for extirpation, to immobilize deformed limbs, and to provide traction for the restoration and maintenance of peripheral circulation, with frequent pain relief. No deleterious functional complexities or manufacturing defects were identified. The Reel Splint is a uniquely useful alternative to currently available splints. [Auerbach PS, Geehr EC, Ryu RKN: The Reel Splint: Experience with a new traction splint apparatus in the prehospital setting. Ann Emerg Med June 1984;13:419-422.]

INTRODUCTION

The prehospital management of orthopedic injuries traditionally is to splint injured extremities in an effort to restore and maintain vascular patency and limb viability, and to rapidly transport the victim to an appropriate trauma facility.

We evaluate a new splint appliance designed to be used by trained personnel for prehospital stabilization of the lower extremity.

MATERIALS AND METHODS

The Reel Splint®, supplied by Reel Research and Development, Inc, Ben Lomond, California (Figure 1), consists of an anodized tubular aluminum frame that measures 100 cm fully extended (nontraction) and 70 cm in the retracted position. In full extension the length of the upper (thigh) section is 40 cm and that of the lower (leg) section is 60 cm. With the traction apparatus attached, the splint length can be adjusted to between 100 cm and 128 cm. The splint weighs 5.5 lb; the traction ratchet apparatus weighs 1.5 lb. For storage, the splint folds on itself to a length of 36 cm (Figure 2). A smaller pediatric version of the splint is available.

The splint is hinged at the midsagittal to allow angulation at the knee in either the lateral or medial direction to 45 degrees and in the direction of flexion (posterior) to 90 degrees. Hyperextension (anterior) at the knee is essentially unlimited. A proximal hinge allows the thigh to be splinted at angles of up to 45 degrees in a medial-lateral deviation from the midline. There is no adjustment for flexion-extension at the hip or for rotation at the knee.

The splint is placed on the dorsal or volar aspect of the extremity and is attached with elastic webbing straps, fastened by snap-release buckles (Figure 3). The straps are permanently attached to the splint but may be repositioned. The splint crossbars are padded with closed-cell polyurethane. A single nylon ankle strap attaches to the ankle with a Velcro closure and to the pressure-release ratchet traction apparatus by a ring mechanism. The adjustment options are limited to frame length, angulation, strap placement, and traction adjustment.

Seven paramedics from the San Francisco City Ambulance Service were instructed in the proper use of the appliance in a one-hour didactic session. For the following ten weeks, the splint was used by these paramedics in
Fig. 1. The Reel Splint is hinged at the proximal crossmember to allow lateral angulation of the upper leg in positions of up to 45 degrees from the midline. Dual hinges at the knee allow 45 degrees of angulation in either lateral direction, flexion to 90 degrees, and unlimited hyperextension.

Fig. 2. The splint is folded upon itself for storage. It may be assembled in advance by leaving the distal crossmembers attached. The traction apparatus is a separate component.

Fig. 3. Demonstration of the Reel Splint applied to the lower extremity, with (A) and without (B) traction. The splint is held in place by elastic straps and quick-release buckles that may be shifted for proper positioning. By rotating the distal crossmembers, one may apply the splint above or below the extremity.

substitution for the standard Thomas splint or cardboard/sheet techniques.

A series of 50 consecutive patient uses was accumulated [Table]. Following each use the paramedics were required to record the following patient and procedure information: sex, age, weight, situation, injury, presence or absence of peripheral pulses, splint size, site of application, traction utilization, use in extrication, application time, repositioning, number of rescuers, use of antishock trousers [MAST], pain estimate, and overall evaluation of the splint. Each trial was
**TABLE. Data accumulated from a field trial with the Reel Splint**

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Injury</th>
<th>P</th>
<th>Size/Loc</th>
<th>Trac</th>
<th>Ext</th>
<th>App/Time</th>
<th>Repos</th>
<th>Resc/No.</th>
<th>MAST</th>
<th>Pain</th>
<th>Unique</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>T/F (C-7) (O-4) (ST-1)</td>
<td>P:10</td>
<td>L/D:11 L/V:1</td>
<td>2</td>
<td>1</td>
<td>2.4</td>
<td>2</td>
<td>1.7</td>
<td>1</td>
<td>1.7</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>Fem (C-5) (D-3) (ST-3)</td>
<td>P:10</td>
<td>L/D</td>
<td>3</td>
<td>1</td>
<td>2.5</td>
<td>2</td>
<td>1.6</td>
<td>0</td>
<td>1.7</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Knee (D-3) (ST-5)</td>
<td>P:4</td>
<td>L/D:4 L/V:1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1.8</td>
<td>0</td>
<td>1.6</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Patella (O)</td>
<td>P</td>
<td>L/D</td>
<td>0</td>
<td>0</td>
<td>1.5</td>
<td>0</td>
<td>1.5</td>
<td>0</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Ankle (C-2) (CD-1) (O-3) (ST-2)</td>
<td>P</td>
<td>L/D</td>
<td>1</td>
<td>0</td>
<td>2.3</td>
<td>2</td>
<td>1.6</td>
<td>0</td>
<td>1.5</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Mult LE (T/F &amp; Fem:4) (T/F &amp; Ankle:1) (T/F, Fem &amp; Ankle:2) (Fem &amp; Ankle:1)</td>
<td>P:6</td>
<td>L/D</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>2.1</td>
<td>0</td>
<td>2.3</td>
<td>8^-</td>
</tr>
<tr>
<td>4</td>
<td>UE (W-1) (E-2) (W &amp; H:1)</td>
<td>P</td>
<td>S/D</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1.3</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

T/F = tibia/fibula fracture.
Fem = femur fracture.
Ankle = ankle fracture.
C = closed injury.
O = open (compound) injury.
ST = soft tissue injury.
Mult LE = multiple lower extremity injuries.
UE = upper extremity.
W = wrist.
E = elbow.
H = humerus.
Pulses = peripheral pulses, P (present) or A (absent).
Size/Loc = size of splint, L (large) or S (small); location of splint, D (dorsal, under leg or over arm) or V (volar, over leg or under arm).
Trac = number of patients with traction applied.
Ext = number of patients evacuated with splint applied.
App/Time = average time of application in minutes.
Repos = number of splints repositioned.
Resc/No = average number of rescuers necessary to position splint.
MAST = number of patients with military antishock trousers placed over splint.
Pain = on a scale of 1 to 5 (min-max).
Unique = number of cases in which splint was interpreted as improved technique.

**RESULTS**

The splint was used 50 times to manage a total of 60 injuries (Table). The following injuries were managed: fractured femur, 15 [25%]; dislocated femur, 2 [3.3%]; fractured tibia and/or fibula, 17 [28.3%]; dislocated knee, 3 [5%]; dislocated patella, 2 [3.3%]; fractured ankle, 8 [13.3%]; dislocated ankle, 2 [3.3%]; fractured wrist, 2 [3.3%]; and soft tissue, 9 [15%].

**Femur**

Of the 15 femur fractures and two hip dislocations managed with the Reel Splint, 11 fractures and one dislocation involved a deformed extremity, multiple injuries in a single extremity, or the absence of peripheral pulses. Rescuers noted that the Reel Splint was applied easily and allowed traction, restoration of pulses, pain relief, and splinting in the presenting position.

**Tibia/Fibula**

Of the 17 lower leg fractures managed with the Reel Splint, ten were complicated by angulation, open wounds, or absent pulses. Rescuers noted that the Reel Splint allowed the stabilization of multiple injuries in a single extremity, visualization and dressing of wounds, restoration of pulses, pain relief, and splinting in the presenting position. In one case the MAST suit was used, and it accommodated the splint without difficulty. In another case a cachectic patient required the addition of rolled sheets as bolsters to achieve immobility of the lower extremity.
Knee/Patella
In one case of knee dislocation, the Reel Splint allowed splinting in angulation for extraction, and it maintained the peripheral pulses with reduction and traction.

Ankle
Ten cases of ankle fracture and/or dislocation were managed with the Reel Splint. Rescuers noted that the sling formed by the elastic cross-straps provided good immobilization and pain relief.

Wrist
The pediatric-sized splint was used to stabilize two wrist fractures. In one case the single device managed two injuries, in the other (gunshot), full exposure of the wound allowed dressing application.

Soft Tissue
Nine soft tissue injuries were managed with the Reel Splint; five rescuers noted extraordinary wound visualization with immobilization.

Extraction
The splint was used twice in the extraction of victims from automobile wreckage. In both cases the splint was affixed to the volar aspect of the leg, and repositioned after extraction to restore anatomy and for pain relief.

Rescuer Number
The average rescuer number was 1.7, and the average time of application was 2.38 ± 1.07 minutes. In no case was the splint inoperable, similarly there were no specific complaints about complexity. The splint was repositioned by the paramedics 11 times (22%) in order to restore anatomy, for pain relief, or because of incorrect initial positioning. In no case did the splint “slip” in transport or did the ratchet traction device release spontaneously.

DISCUSSION
Fractures, dislocations, and major soft tissue injuries of the lower extremity are encountered frequently in the prehospital setting. Unnecessary or unknowing manipulation of an injured body part can aggravate the damage by disrupting neurovascular integrity, increasing the soft tissue insult, or converting a closed to an open fracture. Furthermore, motion markedly increases patient discomfort, frequently to the limits of tolerance. Additional benefits of stabilization include facilitation of roentgenography, ease of transport and wound dressing changes, and institution of advanced life support without undue motion to the injured extremity.

A number of splinting techniques are available. In the primitive setting, splints may be improvised with tree limbs, backpack frames, tent poles, or by affixing a leg to the adjacent extremity. In urban or recreational outdoor settings, it has become the standard of care to provide prehospital rescue personnel with portable splints (with or without traction devices) for the lower extremity. These include wooden or cardboard splints, rolled sheets, preformed universal extremity splints, plastic zipperable inflatable splints, Cramer wire splints, and Keller-Blake, Thomas, or Hare™ splints. Each of these splints has advantages and disadvantages, however, none is designed to stabilize the angulated extremity. Similarly no traditional splints have facilitated the preextrication fixation of the lower extremity.

We evaluated the Reel Splint with the intention of demonstrating whether the apparatus is operational and, if so, superior in any fashion to the Thomas splint now carried by the San Francisco City Paramedic Service. The Thomas splint is constructed of two rigid rods that extend the length of the lower extremity, affixed to a curved crossbar that provides a buttress against the dorsal or volar hip. The splint may be placed above or below the leg, and traction devices may be affixed to the distal portion.

In our series the Reel Splint was judged to be superior to the Thomas splint in 37 of 50 cases (74%). Although no direct comparison was practicable, evaluation of relative merit was based on extensive prior experience with the Thomas device. The splint was thought to be extraordinarily beneficial in cases of angulated extremities (19/50), for extrication (2/50), to stabilize multiple injuries in a single extremity (3/50), for visualization of the wound dressing changes (3/50), and for general immobilization with pain relief (9/50). With regard to the latter, paramedics commented frequently on the degree of support provided by the elastic webbing straps. Of special note was a case in which a MAST suit was applied over the splint without difficulty.

Although we did not record any uses of the smaller model in the stabilization of the pediatric lower extremity, in two instances the splint was used successfully to stabilize the adult upper extremity.

Our operators did not find the splint to be cumbersome or complicated in its use. Repeated field use facilitated the ease of application.

Although we could not compare the Reel Splint directly with the commonly used Hare™ splint (a non-angulating Thomas-like splint with traction apparatus), the Reel Splint appears to offer all the traditional advantages of the Thomas or Hare™ splints, with the additional features of improved portability, application to the angulated limb, and use in the preextrication phase of fracture management. It may be transported and used in such settings as climbing expeditions or in helicopters where longer, noncollapsible splints are cumbersome and difficult to maneuver. We suggest it to those who routinely manage trauma to the lower extremity. Inherent in this suggestion is the caution that it be introduced with proper instruction for those who undertake manipulation of the injured limb.

REFERENCES