Temporizing Management of Pediatric Femur Fractures Using J-splints

Alan H. Daniels, MD; Patrick M. Kane, MD; Craig P. Eberson, MD; Christopher T. Born, MD

Abstract: This article describes a novel splinting technique for the temporizing management of pediatric femur fractures. The J-splint is a reliable, simple, and rapidly applied splint that prevents many of the complications and pitfalls of other described temporizing measures, such as skeletal traction, skin traction, traction splinting, and posterior splinting. This technique of J-splinting femur fractures has low morbidity and provides many advantages in the temporizing management of pediatric femur fractures.

Femur fractures are common injuries, accounting for 1.6% of all fractures in children and affecting 19 in 100,000 children annually in the United States. Two peaks occur in the incidence of these fractures in children, with the first peak in toddlers after a fall and the second peak in adolescents after a high-energy trauma. Pediatric femur fracture is the most common orthopedic diagnosis among pediatric trauma patients admitted to hospitals.

Acute management and stabilization of these fractures is controversial. Current initial management includes skeletal traction, skin traction, traction splinting, and posterior splinting, all of which have advantages and disadvantages. Literature on the initial temporizing management is limited.

Skeletal traction in children is effective in the initial management of pediatric femur fractures, yet the potential morbidity of placing a skeletal traction pin is substantial. Physeal growth arrest following proximal tibial or distal femoral traction in children is a potential serious complication. The psychological trauma of skeletal traction is also potentially detrimental. Skeletal traction has been shown to increase the pain medication and anxiolytic dose requirements and carries the morbidity of pin-site infections, as well as the risks associated with conscious sedation.

Imprecise traction pin placement has been shown to increase the incidence of varus or valgus alignment of the fracture. Traction splinting using modern, commercially available variations of the Thomas splint is commonly used in the field for transportation of femur fractures. Risks of traction splinting include skin breakdown on the foot and nerve stretch with peroneal nerve palsies. These splints can also limit neurovascular examination sensitivity due to their compressive nature. Traction splints should not be used for more than 6 hours.

Long posterior fiberglass or plaster splints are largely ineffective for stabilizing femur fractures, especially if they are midshaft or more proximal (Figure 1). In the authors’ experience, posterior splints do not provide the desired fracture stability or patient comfort.

Numerous studies have discussed the definitive treatment of these fractures.
yet few studies focus on the acute management and temporization of pediatric femur fractures. An optimal method for temporization in the acute setting would provide patient comfort, fracture stabilization, and minimal patient morbidity while allowing comfortable and relatively easy patient transfers.

The authors’ technique of J-splinting femur fractures has low morbidity and provides excellent temporizing management for many pediatric femur fractures. This technique is indicated for any femur fracture in children too large for treatment in a Pavlik harness up to approximately 100 lb. This technique is more challenging to perform on larger children and adolescents, and skeletal traction may be recommended for adolescents if preferred by the treating surgeon.

**Technique**

Placement of the J-splint can be performed along with oral, intravenous, or intranasal analgesics and anxiolytics, with or without conscious sedation. The procedure can be performed by the emergency medical technicians in the field or by the orthopedist or emergency physician with 1 or 2 assistants, depending on resources available.

The patient should be provided with adequate analgesic and anxiolytic medication, as determined by the orthopedist and emergency physician. Plaster splint material works well for this technique due to its ability to retain molding in the J configuration, although fiberglass material can also be used. The authors use 4-inch-wide plaster rolls for children weighing less than 50 lb and 6-inch wide plaster for children weighing more than 50 lbs using a slab 8 to 10 layers thick (Figure 2).

The length is measured using the contralateral leg as a template, from the axilla down the lateral torso and leg, around the foot, and up the medial contralateral leg into the groin. The plaster should be measured accurately and not overestimated, and folding over the ends of the plaster material should be avoided to avoid burns in the axilla or groin.

Once the plaster slab has been created, at least 5 layers of Webril (Covidien, Mansfield, Massachusetts) or other cast padding should be laid over the top of the plaster longitudinally, with 6 inches of excess padding on each end. Adequate padding is necessary to avoid compression on bony prominences and to prevent skin burns. Additional padding with abdominal dressing pads may be placed at the ends of the splint to pad the axilla and groin more.

An assistant holds the fractured limb in anatomic rotational and varus/valgus alignment, pulling enough axial traction to make the limb appear well aligned. The orthopedist wets the splint with cold or tepid water (less than 24°C) to avoid burns and to allow adequate time for fracture reduction and splint molding. The splint should then be applied with the padding facing the patient (Figure 3).
Elastic wrap is applied, with the appropriate size chosen based on the child’s size. Wrapping begins at the foot and should be tight enough to hold the splint in place but loose enough to avoid compression of the soft tissue and cause limitation in peripheral blood flow. The elastic wrap should continue up the injured extremity and include the torso to the ipsilateral axilla (Figure 4). The assistant should hold the limb in a straight position until the plaster is dry. The elastic wrap can be mobilized for physical examination needs based on the child’s associated injuries and necessary distal neurovascular examination.

CASE REPORT
An 8-year-old boy (weight, 28 kg) presented to the emergency department at reporting right leg pain following a collision during football practice. On physical examination, his skin was intact, varus angulation of the leg at the area of the mid-femur was observed, his compartments were soft and compressible, and no neurologic or vascular deficits were found. Radiographic imaging revealed a transverse, right diaphyseal femur fracture (Figure 3). Operative fixation with flexible intramedullary nails was planned for the morning. While the patient was under light sedation in the emergency department, a J-splint was placed to assist with patient comfort and fracture alignment and to simplify patient transfers (Figure 5). The patient was comfortable overnight, receiving 1 dose of 2.5 mg of intravenous morphine for pain control.

DISCUSSION
The J-splint for the temporizing management of pediatric femur fractures is a reliable, simple, and rapidly applied splint that can effectively stabilize most pediatric femur fractures until definitive care can be delivered. It supplants the use of skeletal or skin traction and traction splints and has numerous advantages over other temporizing stabilization techniques. In the authors’ experience, this technique is effective for children with femur fractures who are too large for treatment in a Pavlik harness but weigh 100 lb or less.

Advantages of J-splints include the decreased time and complexity of application as compared with traction, and they are also a low-cost alternative that does not require a traction setup. Furthermore, J-splints can be used in the field and in hospitals and clinics without the resources to place skeletal or skin traction. They can also be used in disaster and mass-casualty scenarios. This technique avoids the nerve stretch and compression seen with traction splinting and can be used for longer than 6 hours.

This technique allows for ongoing physical examination of skin, soft tissues, and neurovascular structures without removal of the splint, especially in the case of high-energy injuries evaluating for compartment syndrome. Femur fractures can be associated with ipsilateral knee ligamentous injury, and J-splints work well to stabilize the knee in contrast with traction, which may cause additional injury to the neurovascular structures by pulling axial traction through a ligamentously injured knee. J-splints also stabilize the ankle and foot if ipsilateral limb trauma is present.

An additional benefit of the J-splint is in the treatment of children with multiple injuries. Femur fractures in children often occur from high-energy trauma, and these patients often require multiple imaging studies; the J-splint...
allows easy transfer into and out of the computed tomography or magnetic resonance imaging scanner. The splint or the elastic bandage can be easily removed to allow a chest and abdominal examination.

**Limitations, Pearls, and Pitfalls**

Compared with skeletal traction, this technique is relatively ineffective in preserving femur length. The J-splint performs well in terms of coronal alignment but is less effective in preserving axial length if significant shortening is present, although the axilla and groin pad allow some axial traction. Although preserving axial length may assist with intraoperative fracture reduction, improved axial alignment from skeletal traction may not decrease narcotic requirement, and its benefits are controversial. The J-splint’s ability to preserve sagittal alignment varies with fracture pattern and the quality of the splint. An additional pitfall of the technique is the possibility of skin burns if the splint material is folded back on itself, if the water used for splint curing is too warm, or if inadequate padding used.

In patients with multiple injuries and severe injuries that will preclude them from definitive fracture treatment within 24 to 36 hours, skeletal traction or skin traction may be beneficial in preserving length, and the J-splint should not be used. An alternative method of temporizing stabilization of pediatric femur fractures is long posterior splinting, which extends proximal to the buttocks and can be effective in some situations. J-splints are only to be used as temporizing stabilization and not definitive treatment. Furthermore, they are more difficult to apply and potentially less effective in children weighing more than 100 lb.

In patients who are uncooperative, require multiple invasive procedures, or request sedation, a conscious sedation may be beneficial during splint application. For splint application, various splinting materials may be used, including plaster, fiberglass, or prefabricated padded fiberglass splint material. Appropriate padding must be used with any splint material to avoid pressure sores and burns.

**Conclusion**

The J-splinting technique has low morbidity and provides optimal temporizing management of some pediatric femur fractures. Further study is needed to examine the ability of J-splints to improve fracture alignment and decrease narcotic requirements in pediatric patients with femur fractures.

**References**