



Management Of Pediatric Femur Fractures With A Single Semi-Rigid Retrograde Nail

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Introduction

Treatment of femur fractures in children and young adults between the age of five and twelve years old has been in transition over the past two decades.

In many developing countries the 90cc motorbike has become the family vehicle of choice. The associated incidence of pediatric femur fractures and poly trauma is subsequently increasing.

Small femoral canal size and proximal and distal femoral epiphyses frequently limit the use of standard adult fracture care techniques. Options that have been described for the treatment of femur fractures in children include the use of spica casting, 90/90 traction, plating, external fixation, and retrograde rodding with dual flexible nails. Each technique has its own set of advantages, complications, and economic limitations.

This management technique describes the use of a single retrograde semi-rigid nail such as a Rush rod or any stock 4.0mm to 4.2mm stainless pin that can be cut, bent, and placed retrograde from a distal medial approach. There is a major difference between this technique and the dual flexible rod technique. The stiffness of this diameter rod requires a specific pre-insertion bending pattern whereas the elasticity allows relatively easy insertion and removal. Only one rod is required and it is placed from a single incision. Sur-

geons have been successfully trained in this technique in Vietnam, Myanmar, and Bhutan where flexible nails were not available or economically feasible to purchase.

Indications

Femoral shaft fractures in patients weighing between 20 kilograms and 50 kilograms located between the lesser trochanter and the flare of the distal femoral metaphysis may be treated with this technique. This includes open and closed fractures with transverse, short and long oblique, and segmental fracture patterns.

Solution

The set-up for this technique utilizes inexpensive and readily available standard orthopedic tools and implant options commonly found in developing countries. Pre-operative planning should be done with plain radiographs. Use of C-arm fluoroscopic guidance and a fracture table are helpful but not an essential requirement.

Instruments include (Fig. below):



4.0mm to 4.2mm Rush rods or medical grade stainless rod equivalent, vice grips, a 6 or 7 mm drill (cannulated is better), 2 small Homan retractors, rongeur, mallet, bending irons or plate bender. A rod cutter may be necessary if a complete set of Rush pins is not available.

The approximate length of the rod, distal and proximal bends, and insertion site may be templated from of a radiograph of the uninvolved femur (Fig. below).



Proper pre-operative rod length selection and bending are the keys to success with this technique. The rod must be bent at the distal tip to deflect off the lateral cortex and continue up the femoral shaft during insertion. The second bend should allow the rod to rest slightly outside the distal femoral cortex. A semi-rigid rod without bends will be nearly impossible to insert from distal medial and will push the distal fracture fragment into valgus. If the distal rod bend (tip) is too small there is difficulty with the lateral cortex deflection and a sharp rod may

penetrate the lateral cortex during insertion. If the distal rod bend is too great the radius of the bend may prevent travel up the small canal and crossing the fracture site during reduction may be difficult.



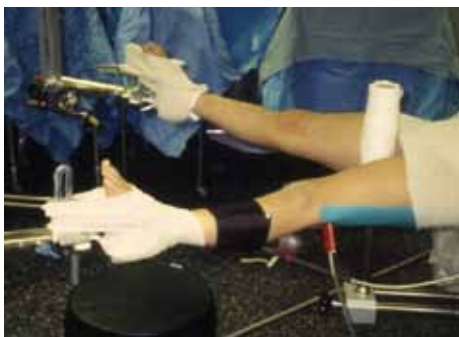
If the proximal rod bend (near knee) is too small the distal fracture fragment will be pushed into valgus by the rod. In general, the proximal rod bend should be slightly greater than the flare of the distal medial femoral contour. After insertion it should be barely palpable under the skin and ready for uncomplicated removal after fracture union. Fortunately, the learning curve for proper rod bending is short and curvatures may be modified intra-operatively without problems. Remember, a properly bent rod is C-shaped, not S-shaped.

Technique

Bend rod

After bending the rod (Fig. above) can then be autoclaved or the rod may be bent intra-operatively if C-arm is available.

Position for procedure

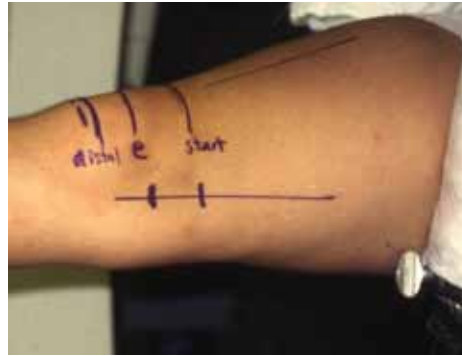


If a fracture table and fluoroscopy are available the patient is positioned as shown (Fig. above). The surgeon is positioned between the legs of the patient and traction is carefully applied between the foot and a perineal post. Required traction force is quite minimal and extreme care is taken at the perineal post site. Traction may be

carefully done by an assistant.

Make incision

A longitudinal 2.0 centimeter incision is made at the level of the medial distal



femoral metaphyseal flare (Fig. above). Blunt dissection is done to the level of the periosteum which is then opened longitudinally. Anterior posterior Place Homan retractors on the anterior and posterior aspects of the femur.

Place guide pin

A guide pin is then placed centrally in the femur 1.5 centimeters above the epiphysis and aimed 45 degrees



cephalad. This is then over-drilled with a 6mm cannulated drill to form an oblique hole at the metaphyseal flare (Fig. above). A rongeur is then used to make a small cortical channel to make the hole keyhole-shaped.

Insert rod

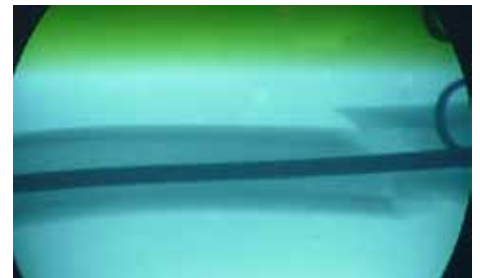
The rod is placed in this hole and aimed extremely cephalad so that the distal rod bend deflects obliquely off the lateral cortex. A vice grip controls

rotation and gentle mallet strikes advance the rod to the fracture site until it protrudes slightly from the fracture (Fig right).



Reduce fracture

The protruding distal end of the semi-rigid rod is then used as a joy-stick to enter the proximal fragment, reduce the fracture (Figs. below), and progresses up the canal with gentle strikes of the mallet on the distal rod or vice grips.



Make final rod position

Ideally, final placement of the rod should allow the distal rod bend (tip) to reach and engage the cancellous bone of the femoral neck or lesser trochanter and control proximal femoral rotation (Figs. below). In the distal metaphysis of



the femur the bend of the rod should engage in the keyhole to increase distal rotational stability. The rod should lie adjacent to the metaphyseal flare without any valgus stress on the distal femur.

Close wound

The wound is then irrigated and closed. If no C-arm is available or the fracture is partially healed with excessive callous, malunited, or shortened, the fracture should be opened and reduced appropriately. Open fractures should have appropriate irrigation and debridement of soft issue and muscle.

Provide post-operative care

Rods are removed with vice grips and mallet between 4 and 6 months once the fractured is completely united.

Lessons Learned

The most important key to this single rod technique is the balance between the rod properties of rigidity and elasticity. Ideal rod diameter is between 4.0mm and 4.2 mm. If rod diameter is too large the rod cannot bounce off the lateral femoral cortex and continue up the canal from the distal medial insertion site. If the diameter is too small it acts like an elastic nail and must be balanced by a second implant placed through a distal lateral approach.

Pre-insertion rod bends are also an extremely important step. Too little bend near the knee will push the fracture into valgus and too much bend will make the rod tip too prominent under the medial skin. Skin breakdown can occur.

Optimal indication

The single semi-rigid rod technique works best with transverse and short oblique fractures of the isthmus and shaft of the femur. Protected weight bearing can be started early within days due to the inherent stability of these fractures. Comminuted and segmental fractures may also be fixed in this manner and the rod acts as an

internal stent to control length and rotation. Supplemental support with a spica cast or splint and protected weight bearing might be needed in these cases. Long oblique and high subtrochanteric fractures are similarly treated with optional support and weight bearing restrictions.

Most difficult fractures

The most difficult fractures to treat with this method are distal oblique fractures at the metaphyseal flare. The single rod does not have enough rotational control of this fracture pattern and it is very difficult to bounce the rod off the lateral cortex. These fractures are best treated with dual elastic nails or other options noted above.

These rods are smooth semi-rigid stents that do not share load and fatigue. They are simple and have no cannulations or interlocking holes. They are easily removed with a vice grips and mallet when the fracture shows complete bridging callous. This is usually 4-6 months after insertion. If supplies are short the option of recycling the rods should be entertained.

References

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