Unstable Pediatric Femur Fractures: Combined Intramedullary Flexible Nails and External Fixation

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Learning Points for this Article:

Flexible intramedullary nails and external fixation combination provide a successful treatment option for unstable pediatric femur fractures.

Abstract

Introduction: The treatment of pediatric femur fractures continues to evolve. In the past, many of these fractures required prolonged hospitalization in traction. More recently, flexible elastic nails have gained popularity. However, length unstable and comminuted fractures can present some unique challenges. To avoid common complications of elastic nailing in the setting of unstable fractures we describe a technique of augmenting this treatment with external fixation for cases requiring additional rotational or longitudinal stability.

Case Report: A series of two patients are described who underwent intramedullary flexible nails and external fixation for a closed unstable midshaft femur fracture: An 8-year-old male that sustained a left periprosthetic femur fracture after a fall on his scooter, and a 5-year-old female that sustained a right femur fracture after a fall from a wet decking. Both patients had their external fixator removed after 4 weeks and achieved radiographic and clinical fracture union at 8-week postoperatively.

Conclusion: Treatment with elastic nails and external fixator for unstable pediatric femur fractures is a minimally invasive technique that safely provides fracture stability.

Keywords: Unstable pediatric femur fracture, length unstable, rotational unstable, flexible nails, flexible elastic nails, titanium nails, intramedullary nails, external fixation, spica cast.

Introduction

The treatment of pediatric femur fractures has undergone significant changes over the past several decades. In the past, many of these fractures required prolonged hospitalization in traction. More recently, flexible elastic nails have gained popularity. The technique was initially developed for patients who had contraindications to traction or casting but has now become a treatment of choice for children from 5-11 years of age.

Pediatric femur fractures treated with elastic nails have been shown to increase early mobilization, decrease hospital costs, provide more predictable recovery, and return to school sooner than traditional spica casting [1, 2, 3]. Length unstable and comminuted fractures can present some unique challenges as evidenced by recent publications describing complications associated with its use in unstable fracture patterns. Complications most frequently seen include nail prominence and loss of reduction leading to soft tissue irritation, wound breakdown and malunion [4]. Sink et al. reported 80% complication rate with treatment of length unstable fractures and a 40% repeat surgery rate to address the complications [5].

To address these issues, alternative methods including locked ender rods, submuscular plating, and locked flexible nails have been used in unstable fracture patterns [6, 7]. These techniques also have drawbacks including larger exposures, longer operative times, increased radiation exposure, and need for specialized equipment [8, 9].

To avoid common complications of elastic nailing in the setting of unstable fractures, we describe a technique of augmenting this treatment with external fixation for cases requiring additional rotational or longitudinal stability.

Surgical technique

The procedure is performed supine on a radiolucent table. First, the distal

Access this article online

Website: www.jocr.co.in

DOI: 2250-0685.838

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Figure 1: (a to c) Initial injury images patient 1

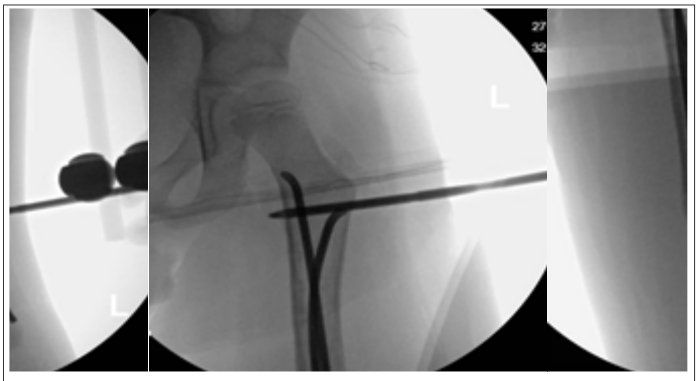

Figure 2: (a to c) Intra-operative images patient 1.

femoral physis is identified using fluoroscopy. Then, separate 2 cm medial and lateral incisions are made just proximal to the physis. Blunt dissection carried out down to the level of fascia. The fascia is incised in line and blunt dissection is carried out down to the level of the periosteum. Then, using fluoroscopy an oblong corticotomy is created by aiming 45° cephalad upon entering the intramedullary canal. This can be performed using either a drill or hand held awl. Next, 2 flexible titanium elastic rods are contoured by the surgeon into a "C" shape to fill a combined total of 80% of the canal diameter. The nails are then advanced to the fracture site. The fracture is then reduced, and the nails are advanced to the proximal femoral metaphysis.

Following fracture reduction and nail insertion we perform a telescope test as well as check for rotational instability. This is traditionally performed before reduction to determine stability and treatment options [10]. However, with inherently unstable fracture patterns, this test is used to determine construct stability and possible need for additional fixation.

The flexible nails provide alignment of the fracture. However, those fractures with continued rotational and length instability are then supplemented with external fixator using a single bicortical pin for proximal and distal segments.

5 mm self-tapping, self-drilling titanium pins are then place in a lateral to medial fashion. The pins can be placed either anterior or posterior to the flexible nails; however, posterior placement is preferred to avoid weakening of the tension cortex of the anterior femur. The external fixator is assembled with a single carbon fiber rod with a single universal clamp on each pin. This is typically sufficient however a second bar can be added if there is continued instability.

Pin sites are then wrapped with dry sterile gauze. Patients and family are instructed to care for pin sites by leaving dressings in place for first 5-10 days. After this time, the gauze can be replaced. Showering is then allowed after 10-14 days. Daily showering is preferred and warm soapy water can be used to clean the pins and fixator.

The patient is allowed to weight bear as tolerated if there is only rotational instability. If there is length instability, weight bearing is restricted until evidence of fracture healing.

Removal of the external fixator is performed after sufficient callus formation is evident which typically occurs at 4 weeks. This can be performed in the office or in the operating room under light sedation. Flexible nails are then removed after complete fracture healing, usually before 1 year from initial surgery.

Case Report

Patient 1

An 8-year-old male that sustained a left periprostheric femur fracture after prior ipsilateral ORIF for subtrochanteric femur fracture after a fall on his scooter (Fig. 1). Intraoperatively, following removal of prior hardware and insertion of elastic titanium nails in retrograde fashion it was found that he had an unstable rotational deformity. For improved rotational stabilization a single pin was placed in each the proximal and distal femur (Fig. 2). Postoperatively, the patient was weight bearing as tolerated. He was discharged from the hospital on postoperative day number 2 after he demonstrated safe ambulation with physical therapy and pain was controlled with oral medications. He returned to clinic and after adequate callus formation the external fixator was removed at 6 weeks postoperative. Fracture healing was followed clinically and radiographically until elastic nail removal at 11 months postoperatively. (Fig. 3) demonstrates the progression of post-operative radiographs for Patient #1.

Patient 2

A 5-year-old female that sustained a right femur fracture after a fall from a wet decking (Fig. 4). Intraoperatively, following fixation with retrograde titanium elastic nails, her fracture was found to have continued length instability. A

Figure 3: Post-operative images patient 1(a) 2 weeks, (b) 1 month, (c) 2 months, (d) 3 months, (e) 9 months

Figure 4: (a to b) Initial injury images patient 2.

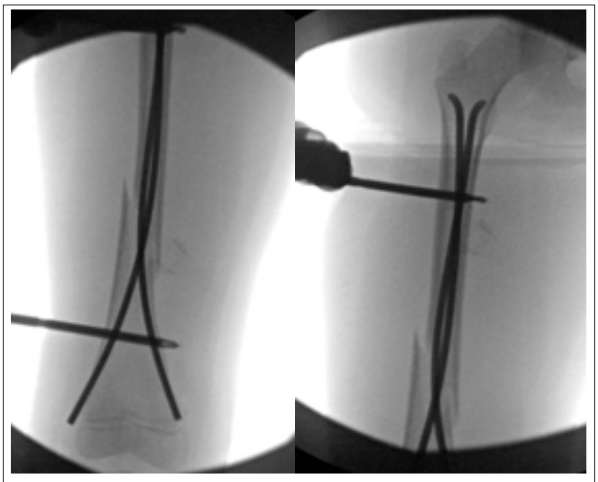

Figure 5: (a to c) Intra-operative images patient 2

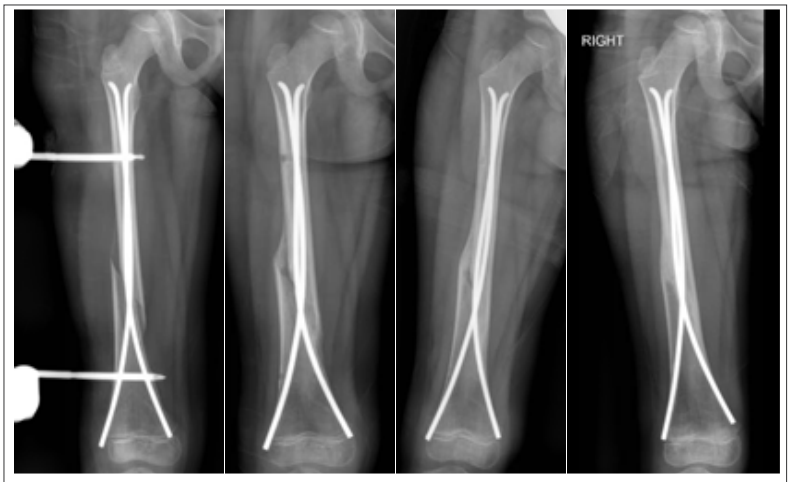

Figure 6: Post-operative images patient 2 (a) 2 weeks, (b) 1 month, (c) 2 months, (d) 7 months.

proximal and distal femoral pin was placed and an external fixator device was assembled for improved stability (Fig. 5). Weight bearing was restricted immediately postoperative. She was discharged from the hospital after demonstrating adequate transfers and pain control with oral medications. She returned to the operating room to have her external fixator removed at 4 weeks from her initial surgery and was allowed to weight bear as tolerated 2 weeks after external fixator was removed. Flexible nails were removed at 7 months from initial surgery (Fig. 6) demonstrates the progression of post-operative radiographs for Patient #2.

Discussion

Fractures treated with supplemental external fixation in conjunction with elastic nails achieved union with acceptable angular and rotational alignment without any significant leg length discrepancy. There were no complications due to pin site infections from external fixator. Patient follow-up was a minimum of 7 months. There were no unplanned returns to the operating room or surgical site infections.

Treatment with elastic nails and external fixator for unstable pediatric femur fractures is a minimally invasive technique that safely provides fracture stability. In many situations, it is difficult to predict whether adequate fracture stability can be obtained with flexible nailing alone. Sometimes seemingly stable fractures develop intra-operative comminution. This technique uses readily available equipment that can easily be applied to any case where desired stability is not obtained with flexible nailing alone. This avoids having to resort to a different method of treatment intraoperatively and potentially expands the indications for flexible nailing. Using this adjunct treatment, the surgeon can be assured of adequate stability and predictable results.

The hospital stay was only 2 days for both cases, which is less than average for other studies with external fixation (4.9 days) and elastic nails (3.6 days) [11].

In prior studies where external fixation is used as definitive treatment, there are increased rates of pin-tract infections, unacceptable shortening, and refractures as compared to intramedullary nails. The use of external fixators alone as definitive treatment had less callus formation at 6 week follow-up. In addition, use of the external fixator alone required an average time of 12 weeks before external fixator removal [11, 12]. The abbreviated use of the supplemental external fixator used in our cases is constructed with a single pin above and below the fracture at an average distance of 10 cm. This avoids the complications associated with too rigid of a construct. Its removal at 4 weeks likely decreases the risk of pin site infections [11, 12].

Removal of the external fixator in the operating room setting may be a deterrent due to additional cost and time for surgery. This can be avoided, as recent studies suggest increased patient satisfaction and decreased cost with removal of external fixators in the office setting [13, 14]. These costs, however, are decreased as compared to prior treatment with 90-90 traction for several days and sometimes weeks in the hospital followed by delayed spica casting or definitive fixation [15]. The parental and patient convenience as well as tolerance of internal fixation, with or without external fixation, in contrast to supplemental spica casting, is also a factor to consider.

Conclusion

External fixation used as an adjunct for femur fractures that are not adequately stabilized by elastic nailing alone provides a simple method for assuring adequate stability and predictable results. Further studies comparing this method to other treatment methods are needed to validate the effectiveness of this treatment.

Clinical Message

Treatment with elastic nails and external fixator for unstable pediatric femur fractures is a minimally invasive technique that safely provides fracture stability.

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Conflict of Interest: Nil
Source of Support: None

How to Cite this Article

Anderson SR, Nelson SC, Morrison MJ. Unstable Pediatric Femur Fractures: Combined Intramedullary Flexible Nails and External Fixation. Journal of Orthopaedic Case Reports 2017 July-August;7(4):32-35.