Pediatric Femoral Shaft Fractures: A Comparative Study between Compression Plate Fixation and Flexible Intramedullary Nail Fixation

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ABSTRACT

Femoral shaft fractures are commonly isolated injuries with minor trauma. Various mechanisms of injury can cause femoral shaft fractures ranging from simple falls to severe and complex injury patterns. Spica casting procedures may associate with shortening at the fracture, loss of reduction, angulation at the fracture side and compartment syndrome. Also, Skin Traction followed by Spica casting may lead to with over-distraction, loss of position and pressure sores as complication. Operative treatment of femoral fractures including several methods using Flexible intramedullary nail, internal plate fixation and external fixation. The aim of this study to review the comparison between Compression Plate Fixation and Flexible Intramedullary Nail Fixation in treatment of Femoral Shaft Fractures in pediatrics.

Keywords: Plate Fixation; Femoral Fractures; Intramedullary Nail

INTRODUCTION

Femoral shaft fractures are commonly isolated injuries or associated with minor trauma such as abrasion or contusion. High velocity trauma in children produces unstable fracture pattern, with a constellation of more severe and life threatening injuries (1). Various mechanisms of injury can cause femoral shaft fractures ranging from simple falls to severe and complex injury patterns. It is important to distinguish between low and high energy injuries (2). Low energy mechanisms of injury can cause indirect fractures producing a typical spiral or oblique fracture, and usually they are associated with closed fractures with minor soft tissue trauma (3).

Femoral fractures can be classified in many ways. Usually, Surgeons have always used simple classification such as whether the fracture was open or closed or whether it was located in the upper, middle or lower thirds of the bone. The most comprehensive classification of femoral fractures is AO classification (4).

The Gustilo open fracture classification system is the most commonly used classification system for open fractures. It was created by Ramón Gustilo and Anderson, and then further expanded by Gustilo, Mendoza, and Williams. The classification depends on degree of soft tissue injury, degree of contamination, amount of periosteal damage and the requirement for vascular surgery (5, 6). According to the AO: pediatric comprehensive classification of long bone fractures, shaft femur fractures are classified (Figure 1) (7, 8).
Soft tissue injuries are an intrinsic component of any fracture. Treatment of these soft tissue injuries is challenging, but it is an integral element of fracture care. The initial evaluation of a patient with orthopedic trauma must include a detailed assessment of the soft tissue envelope. The timing and method of fracture fixation are directly influenced by the degree of trauma to the overlying soft tissues and have been shown to have a direct effect on postoperative function. Various classification systems have been proposed to help communicate, classify, and guide the treatment of soft tissue injuries occurring with fractures. The Winquist and Hansen classification is a system of categorizing femoral shaft fractures (Table 1) based upon the degree of comminution.

Figure (1): AO classification of the femur

Table (1): Winquist and Hansen Classification.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>No commination</td>
</tr>
<tr>
<td>I</td>
<td>Insignificant amount of comminution</td>
</tr>
<tr>
<td>II</td>
<td>Greater than 50% cortical contact</td>
</tr>
<tr>
<td>III</td>
<td>Less than 50% cortical contact</td>
</tr>
<tr>
<td>IV</td>
<td>Segmental fracture with no contact between proximal and distal fragment</td>
</tr>
</tbody>
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Non-operative treatment includes Spica casting which indicated for Simple metaphyseal fracture in children 1-6 years old. The cast applied after reduction under sedation or general anesthesia. Single-leg spica or one-and-one-half spica (to control rotation), Hips flexed 30-60° and approximately 30° of abduction. External rotation is typically needed to correct a rotational deformity (Figure 2). The goal of reduction should include obtaining < 10° of coronal plane and < 20° of sagittal plane deformity with no more than 2 cm of shortening or 10° of rotational malalignment.
However, it may complicated with shortening at the fracture, loss of reduction, angulation at the fracture side and compartment syndrome\(^{(11)}\).

**Figure (2): show unilateral hip spica cast effective for low energy fractures.** \(^{(12)}\)

Skin Traction followed by spica casting indicated in younger patients with significant shortening. The Thomas applied after reduction under general anesthesia with care to the bony prominences to avoid pressure necrosis\(^{(12)}\). Used for 2-3 weeks to allow early callus formation, and to avoid redisplacement by action of muscles\(^{(12)}\). Spica casting then applied until fracture healing. However, this technique may complicated with over-distraction, loss of position and pressure sores\(^{(14)}\).

**Figure (3): Shows skin traction as a primary treatment**\(^{(12)}\)

Operative treatment of femoral fractures including some of the techniques include closed reduction and internal fixation (CRIF) with elastic nails, open reduction and internal fixation (ORIF) with compression plates, external fixators and skin traction with spica casting.

1. **Flexible intramedullary nails (FIN):**

The FIN can be used in children with fracture shaft of femur with multiple system injury, multiple fractures and some pathologic fractures. Most length stable fracture patterns in children 5-14 years old weighing <49kg.\(^{(14)}\) Social indication: When conservative treatment alternatives are unacceptable to patient’s parents \(^{(15)}\). By using nail size determined by multiplying the width of the isthmus of femoral canal by 0.4. The goal is 80% canal fill\(^{(16)}\). This techniques is
contraindicated in case of Intra articular fractures and complex femoral fractures, particularly in connection with over weight (50-60kg) or age (15 years or more). Also, in supracondylar fracture femur\(^{(14)}\).

The most common complication is pain at insertion site near the knee due to Soft tissue irritation. Also incomplete union and torsional deformities\(^{(16)}\).

![Figure (4): Xray AP\&lat views showing femoral shaft fracture treated with TENs. \(^{(15)}\)](image)

II. Plate fixation:

This technique indicated in case of failed conservative treatment, unstable simple fractures in children >5 years old and >49kg. Very proximal or very distal fractures and severe comminution\(^{(17)}\).

Typically use 4.5mm narrow LC-DC plate with 3 screws proximal and 3 screws distal to the fracture. Plate may need to be bent to accommodate the natural bend of the femur (Figure 5). The complications associate with Plate fixation were hardware removal, refracture following hardware removal and possibility of infection\(^{(17)}\).

![Figure (5): X-ray showing post reduction by plate in shaft femur. \(^{(18)}\)](image)

III. External fixation:

It indicated for poly trauma patient, open fractures, associated vascular injuries requiring vascular repair and segmental or significantly comminuted fractures\(^{(19)}\). External fixation technique can be used as temporary or final treatment.
Applied laterally and 10-16 weeks of fixation is typically needed for union and graduated weight-bearing (Figure 6) [20]. The complication that occurring during external fixation as risk of pin tract infections, higher rates of delayed union, nonunion and malunion. Also, increased risk of re-fracture (1.5-21%) after removal of fixator especially with varus [21].

![Figure 6: Using external fixator for comminuted mid shaft femur](image)

Although a thorough literature review and screening the study through a watchful institutional review board was done, the primary outcome assessment was restricted in the study.

CONCLUSION

There is a significant association between fracture type and treatment method, so the various fracture and patient factors that should inform implant choice and operative planning are still being determined.

No Conflict of interest.

REFERENCES


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