

## Diaphyseal femoral fractures in children treated with titanium elastic nail system

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### ABSTRACT

Femur fractures are common long bone injuries in children which account for less than 2% of all paediatric fractures. Although these fractures are dramatic and disabling injuries for the child and parent, the good part is that they unite rapidly with minimal complications if aligned well. Various methods have been used successfully to treat these fractures, but they differ in their stability and potential for complications. The aim of our study was to see the outcome of titanium elastic nailing system in diaphyseal femoral fracture in children. The study included total of 30 children's (19 boys and 11 girls) of diaphyseal femoral fracture treated with titanium elastic nailing system and they were followed up at 2, 6, 12 and 24 weeks. The average duration of callus formation was 3.5 weeks with radiological union mean time of 9.5 weeks. Full weight bearing was possible in a mean time of 10 weeks. According to Flynn's scoring criteria, excellent and good results were in 24 cases (80%) and 6 cases (20%) respectively. The nail irritation was present in 3 children and there was no post operative infection, physeal injury and implant failure.

Titanium elastic nail is a safe and satisfactory mode of treatment and is relatively easy to perform in diaphyseal fracture of femur in children. It avoids the chances of physeal injury, infection and offers rapid healing

**Keywords:** Titanium elastic nailing system, diaphyseal femoral fracture

### INTRODUCTION

Femur fractures are common long-bone injuries in children. These fractures account for less than 2% of all paediatric fractures.<sup>1</sup> The injuries are more common in boys, especially during the toddler years and early adolescence.<sup>2,3</sup> The mechanism of injury varies from simple falls to high energy trauma.<sup>4</sup> Although these fractures are dramatic and disabling injuries for the child and parent, the good part is that they unite rapidly with minimal complications if aligned well.

Various treatment methods are considered acceptable and include casting, external fixation,<sup>5,6</sup> traction,<sup>7</sup> submuscular plating,<sup>8</sup> locked nailing,<sup>9</sup> and intramedullary nailing.<sup>10-13</sup> All these methods have been used successfully to treat these fractures, but they differ in their stability and potential for complications. The main goals of fixation include preservation of physis, anatomic reduction, and stable fixation. Children in the age group of 6-12 years are heavier than the group with less than 6 years of age, and do not tolerate casts as well as their younger counterparts, which confounds treatment further.

Each modality of fixation is fraught with its own set of complications. External fixation for example, has been associated with pin tract infections and refracture,<sup>5,6,14</sup> whereas traction leads to prolonged immobilization and joint stiffness.<sup>7</sup> Plate osteosynthesis has the potential to

expose the child to an extensive scar related to larger incision and extensive soft tissue stripping,<sup>8</sup> and locked nailing may potentially damage the physis.<sup>15</sup>

Several recent studies suggested that elastic intramedullary nailing meets the requirements of this ideal device.<sup>16-20</sup> Over the past few years there has been a marked increase in the use of intramedullary fixation in the management of fractures of long bones in children, notably that of the elastic stable intramedullary nail.

The use of intramedullary devices to stabilise fractures is not new. In the mid-19th century, ivory pins were used for this purpose and were then gradually supplanted by various metal devices.<sup>21</sup> These were generally rigid implants, although more flexible ones were introduced in the 1930s. The school of rigid intramedullary fixation was typified by the Küntscher nail, which achieved great stability in all planes by occupying the entire medullary cross-sectional area of the bone.<sup>22</sup> However, its use in growing children was limited by the difficulties encountered in trying to avoid the physes. The Rush nail was introduced at about the same time as the Küntscher nail.<sup>23</sup> It was the forerunner of modern elastic intramedullary fixation in that the objective was to achieve three-point fixation on the inner aspect of the cortex. Unlike the stiff Küntscher nail, the Rush nail was slightly flexible and it was intended that it should be pre-bent to the appropriate configuration

before insertion.<sup>23</sup> Rotational stability was poor, however, and in most situations the flexibility was insufficient to allow insertion points in the metaphysis which were well away from the active physis in children.

In the early 1980s, surgeons in Nancy, France, developed an elastic stable intramedullary nail based on a theoretical concept by Firica.<sup>24</sup> Previous experience had suggested that elasticity and stability were not easily combined in one construct. However, working from the concept of three-point fixation used with a single Rush nail, these surgeons were able to improve stability significantly by using two pre-tensioned nails inserted from opposite sides of the bone. Metazieau, Ligier and their colleague were able to show that titanium nails which were accurately contoured and properly inserted could impart excellent axial and lateral stability to diaphyseal fractures in long bones.<sup>24</sup> Rotational stability was also better than had previously been experienced, although this was to remain the titanium nails allowed greater elasticity than was available in the steel nails of the Ender system.

Flexible intramedullary nailing is a rapidly emerging technique of femoral shaft fracture fixation in children. It involves the insertion of one or more stainless steel or titanium elastic nails into the medullary canal to provide stable fixation. The fixation is not rigid but allows enough stress at the fracture site to encourage abundant callus formation and promote healing.

Our aim of study is to see the outcome of titanium elastic nailing system in diaphyseal femoral fracture in children.

**MATERIALS AND METHODS**

The study included total of 30 children’s admitted in Nepal Medical College Teaching hospital from September 2010 to October 2012 with the aim of studying the outcome of titanium elastic nail in diaphyseal femoral fractures in children. Only those children’s were included who were between 6 – 12 years of age, had traumatic fracture of diaphysis of the femur with no associated neurovascular compromise. Out of 30 children’s, 19 were boys and 11 were girls which had involvement of 17(65%) and 13 (35%) right and left sided respectively.

All the children’s were operated by retrograde titanium elastic nail and received antibiotics. Postoperatively children were advised for non weight bearing with range of motion exercises and partial to full weight bearing was gradually started after 6 weeks taking in view of pain relief clinically and callus formation radiologically. The patients were followed up at intervals of 2,6,12 and 24 weeks. During the follow up, these patients were evaluated clinically by flynn’s scoring criteria and radiologically for union and callus formation.

**RESULTS**

All 30 children’s were available for evaluation after 24weeks of follow up. Average duration of callus formation was 3.5weeks. Radiological union in all cases was achieved in a mean time of 9.5 weeks. Full weight bearing was possible in a mean time of 10 weeks. All the results were clinically evaluated using flynn’s scoring criteria (Table-1) The results were excellent in 24 cases (80%), good in 6 cases (20%) and poor in no cases (Table-2). The nail irritation was present in 3 children’s due to slightly larger nail size. There was no post operative infection, physeal injury and implant failure.

**Table-1:** Flynn’s scoring criteria

	Excellent	Good	Poor
Limb length discrepancy	< 1cm	< 2cm	> 2cm
Angulation in degree	< 5cm	5-10 cm	>10cm
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major/extended period for resolvable morbidity

**Table-2:** Showing the results of flynn’s scoring criteria

Results	Number of cases
Excellent	24 (80%)
Good	6 (20%)
Poor	0 (0%)

**DISCUSSION**

The femoral shaft fractures constitute less than 2% of all children fracture and the ideal choice of treatment has remained a constant challenge. Conservative treatment for children diaphyseal femoral fractures was preferred in children and young adolescents. However to avoid the effects of prolonged immobilization, the operative approach has been gaining popularity for the last two decades.<sup>13,25,26</sup> It is also important to consider the additional home care required for a children, the costs of rehabilitation and of missed school for the children.

The ideal treatment of diaphyseal femoral fractures in children is defined as one that controls the length and alignment, does not compress or elevate the extremity excessively, and is comfortable for child and convenient for family and cause the least physiological impact possible.

The ideal device to treat paediatric femur fractures would be a simple, load-sharing internal splint allowing mobilization and maintenance of alignment for a few

weeks until bridging callus forms. The device would exploit a child's denser bone, rapid healing, and ability to remodel, without risking the physes or blood supply to the femoral head, titanium elastic nail offers these features.

The Titanium elastic nail seems advantageous over other surgical methods particularly in the age group of 6-16 because it is simple, a load-sharing internal splint that doesn't violate the physis, allows early mobilization and maintains alignment.<sup>25,26</sup> Micro motion conferred by the elasticity of the fixation promotes faster external bridging callus formation. The periosteum is not disturbed and being a closed procedure there is no disturbance of the fracture hematoma, thereby less risk of infection.<sup>25,26</sup> Ligier et al. treated 123 femoral shaft fractures with elastic stable intramedullary nail, all fractures united with 13 children's developed entry site irritation.<sup>10</sup> Similarly, Narayanan et al. found good outcome in 79 femoral fractures stabilized with titanium elastic nailing.<sup>12</sup> Fracture geometry and the location is an important determinant for selection of surgical techniques. Transverse, short oblique and minimally comminuted fractures are suitable for titanium elastic nailing as stated by Flynn et al.<sup>25</sup> Narayanan et al stated that transverse, short oblique, short spiral fractures with minimum comminution in the 5-12 years age group were the best indications for titanium elastic nailing.<sup>12</sup> The most common complication of titanium elastic nail is entry site irritation and pain.<sup>11,12</sup>

In our study average duration of callus formation was 3.5 weeks, radiological union in all cases. According to Flynn's scoring criteria 24 cases (80%) and 6 cases (20%) had excellent and good results respectively.

There were 3 children who had nail irritation with no post operative infection, physeal injury and implant failure.

Titanium elastic nail is a safe and satisfactory mode of treatment and is relatively easy to perform in disphyseal fracture of femur in children. It avoids the chances of physeal injury, infection and offers rapid healing.

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