



# **A Systematic Review on Elastic Intramedullary Nailing in Closed Fractures of the Tibial Diaphysis in Children**

*Submitted for Partial Fulfilment of Master Degree  
in Orthopaedic Surgery*

*By*

***Mohamed Saeed Hassan Morsy***

*M.B.B.Ch.*

*Supervised By*

**Prof. Dr. Mootaz Fouad Thakeb**

*Professor of Orthopaedic Surgery*

*Ain Shams University*

**Ass. Prof. Dr. Shady Samir El Beshry**

*Assistant Professor of Orthopedic Surgery*

*Ain Shams University*

*Faculty of Medicine*

*Ain Shams University*

**2018**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا

لسببائك لا علم لنا  
إلا ما علمتنا إنك أنت  
العليم العظيم

صدقة الله العظيم

سورة البقرة الآية: ٣٢

## Acknowledgment

*First and foremost thanks to **ALLAH**, the most beneficent and merciful.*

*I would like to express my sincere gratitude and deepest appreciation to **Prof. Mootaz Fouad Thakeb** Professor of Orthopaedic Surgery Faculty of Medicine, Ain Shams University for his generous supervision and valuable advices.*

*My profound thanks and deepest appreciation to **Ass. Prof. Dr. Shady Samir El Beshry** Assistant Professor of Orthopaedic Surgery Faculty of Medicine, Ain Shams University for his kind supervision and great help throughout this work.*

*With all my love and respect, I would like to thank all **my family** members especially **my Parents** and **my wife**, for their endless love, support and continuous care, they were behind me in every successful step in my life.*

*Mohamed Saeed Hassan Morsy*

# *List of Contents*

Title	Page No.
List of Tables .....	5
List of Figures .....	6
List of Abbreviations .....	8
Abstract .....	9
Introduction .....	1
Aim of Work.....	4
Review of Literature .....	5
Methodology .....	14
Results .....	17
Discussion .....	47
Conclusion.....	52
References .....	54
Arabic Summary	

## *List of Tables*

Table No.	Title	Page No.
<b>Table (1):</b>	Acceptable alignment of a paediatric diaphyseal tibial fracture described by Heinrich and Mooney .....	6
<b>Table (2):</b>	Male to female distribution.....	18
<b>Table (3):</b>	Summary of patient and study characteristics .....	25
<b>Table (4):</b>	Types of included studies, date of publication and level of evidence of every study according to Jovell and Navarro.....	26
<b>Table (5):</b>	Flynn et al scoring system for titanium elastic nailing .....	29
<b>Table (6):</b>	The average union time (weeks) in every study.....	31
<b>Table (7):</b>	Flynn et al scoring system for TEN in every study.....	33
<b>Table (8):</b>	Number of complicated cases with average-time-of follow-up (months) in every study:.....	36
<b>Table (9):</b>	Number of Major complications detected: .....	37
<b>Table (10):</b>	Number of minor complications (superficial bursitis) detected:.....	38
<b>Table (11):</b>	Number of minor complications (pain at nail insertion site) detected: .....	40
<b>Table (12):</b>	Number of minor complications (Superficial infection) detected:.....	41
<b>Table (13):</b>	Number of minor complications (Limb length discrepancy) detected: .....	42
<b>Table (14):</b>	Number of complicated cases detected in selected studies .....	43
<b>Table (15):</b>	The average time of implant removal (months) in every study.....	45

## *List of Figures*

<b>Fig. No.</b>	<b>Title</b>	<b>Page No.</b>
<b>Fig. (1):</b>	Anteroposterior and lateral radiographs of the right tibia and fibula of a 14-year-old, male who sustained closed mid-shaft tibia and fibula fractures.....	8
<b>Fig. (2):</b>	Tibia fracture was stabilized with two 4.0 mm titanium elastic nails with acceptable postreduction alignment.....	9
<b>Fig. (3):</b>	The double frame model. ....	11
<b>Fig. (4):</b>	The flexural stability of (ESIN). ....	12
<b>Fig. (5):</b>	The rotational and axial stability of (ESIN). ....	12
<b>Fig. (6):</b>	The translational stability of (ESIN).....	13
<b>Fig. (7):</b>	PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram for study selection. ....	17
<b>Fig. (8):</b>	Male to female distribution.....	19
<b>Fig. (9):</b>	The average union time (weeks) in every study.....	31
<b>Fig. (10):</b>	Percentage of Flynn et al scoring system for TEN in selected ten studies. Excellent: 87.1%, Satisfactory: 11.7 %, Poor: 0.6%. ....	33
<b>Fig. (11):</b>	Percentage of complicated cases in selected ten studies.....	36
<b>Fig. (12):</b>	Percentage of major complications detected. ....	37
<b>Fig. (13):</b>	Percentage of complicated cases with minor complications (superficial bursitis) detected.....	39
<b>Fig. (14):</b>	Percentage of complicated cases with pain at nail insertion site detected.....	40

## *List of Figures cont...*

<b>Fig. No.</b>	<b>Title</b>	<b>Page No.</b>
<b>Fig. (15):</b>	Percentage of complicated cases with superficial infection detected.....	41
<b>Fig. (16):</b>	Percentage of complicated cases with limb length discrepancy detected.....	42
<b>Fig. (17):</b>	Percentage of complicated cases detected in selected studies. ....	43
<b>Fig. (18):</b>	The average time of follow-up and implant removal (months) in selected studies. ....	46

## *List of Abbreviations*

<i>Abb.</i>	<i>Full term</i>
<i>ESIN</i> .....	<i>Elastic Stable Intramedullary Nailing</i>
<i>FIN</i> .....	<i>Flexible Intramedullary Nailing</i>
<i>PRISMA</i> .....	<i>Preferred Reporting Items for Systematic Reviews and Meta-Analyses</i>
<i>TEN</i> .....	<i>Titanium Elastic Nailing</i>



## *Abstract*

**Introduction:** Closed reduction and cast application is still regarded as first line treatment for paediatric tibial fractures. Over the past few decades, management of paediatric tibial fractures has shifted more towards operative intervention because of quicker recovery, shorter rehabilitation period, less immobilization, lack of stiffness of adjoining joints, and less psychological impact to the children. Flexible intramedullary nails not only fulfill the above advantage but also maintain alignment and rotation

**Aim of the work:** This systematic review aims to review the currently available evidence for the use of ESIN in the skeletally immature paediatric patient with closed fracture of the tibial diaphysis.

**Methodology:** Ten articles addressed the use of ESIN in the skeletally immature paediatric patient with fracture of the Tibial diaphysis by searching in Pub Med, Cochrane library, Google scholar, Medline, To update, DARE, Ovid, ACP journal club, Embase and other medical databases to identify relevant studies.

**Results and Conclusion:** This systematic review documented the clinical results of elastic intramedullary nailing in closed fractures of the tibia in the children, There are varieties in the ten studies in conclusions and results but the main conclusion is that elastic nail fixation is a simple, easy, rapid, reliable and effective method for management of paediatric tibial fractures in patients with operative indications. There may be the chances of complication following the ESIN in tibia but these are avoidable as well as manageable with careful precautions.

**Keywords:** Children, Nailing, paediatric, Tibial Fractures, Titanium Elastic Intramedullary Nails, Functional Outcomes.

## INTRODUCTION

**F**racture tibia is one of the common fractures in pediatric age group. It accounts about 10 to 15% of cases and is the second most common cause of post traumatic pediatric orthopedic hospital admissions.<sup>1</sup>

Tibial shaft fractures have been shown to have an annual incidence in children (infancy-18 years) of 190 per 10,000 in boys and 110 per 10,000 for girls.<sup>2</sup>

Overall, the annual incidence of hospitalization for a pediatric patient sustaining a fracture of the tibia/fibula is 27.0 per 10,000.<sup>3</sup>

Twenty years ago, Shannak<sup>4</sup> has suggested that conservative treatment of pediatric tibial fractures using cast immobilization produces adequate results, with surgery seldom indicated or justified. However, surgical stabilization is often used for open fractures, those associated with neurovascular compromise, those associated with polytrauma, fracture with compartment syndrome, fractures failing to meet acceptable closed reduction criteria, Unstable fracture in children of more than 10 years of age is also one of the indications for surgical intervention.<sup>5</sup>

There have been an increasing number of reports demonstrating the effectiveness of surgical treatment of tibial shaft fractures in children. Surgical options in skeletally

immature patients include intramedullary, internal, transcutaneous and external fixation. The ideal internal fixation device for such pediatric tibial fractures would be a simple load sharing device that would maintain alignment, allow mobilization until bridging callus forms, not cross the physes, and be both easy to insert and remove. The introduction of elastic intramedullary nails, which satisfy most of these criteria, has led to an increasing number of surgeons using these implants to treat a variety of pediatric long bone fractures including the tibial shaft.<sup>2,7</sup>

Proposed advantages of elastic stable intramedullary nailing (ESIN) include immediate fracture stabilization, early mobilization, little soft tissue disruption, low infection and refracture rates, the procedure being minimally invasive with low blood loss comparing to plating added to the short hospital stay and more rapid return to daily function and avoids complications of prolonged immobilization in contrast to conservative treatment with immobilization alone.<sup>2,6,7</sup>

This approach to pediatric fracture fixation has also been commonly referred to as Nancy nailing based on its French city of origin. ESIN has shown to be effective in fixation of this type of pediatric fractures due the elasticity of the implants that promotes callus formation by limiting stress shielding and promoting oscillation at the fracture site.<sup>8,10</sup>

Advantages of ESIN over other fixation techniques include a lower infection rate, lower refracture rate, an aesthetically pleasing scar, lack of secondary displacement and a greater ease of management for the patients and their parents owing to early mobility and reduced school absenteeism. All of these could compensate for this technique's greater direct cost.<sup>11,12</sup>

Disadvantages include exposure to the risk of infection, and the need for a second surgical procedure for removal of implant<sup>10</sup>.

## **AIM OF WORK**

**T**his study aims to review the currently available evidence for the use of ESIN in the skeletally immature paediatric patient with closed fracture of the Tibial diaphysis.

This review will show different literature, research and statistical analysis of results concerned with methods of using ESIN of pediatrics tibial fractures up to 1/ 3/2017 in English publications.

## **REVIEW OF LITERATURE**

### **Diaphyseal Tibial Fractures**

Fractures of the tibial diaphysis and fibula are the third most common paediatric long bone injury, after forearm and femoral fractures. The fibula is fractured in 30% of tibial fractures. They are most commonly seen in children aged 11 years or below.<sup>13</sup>

Most fractures are due to a torsional force causing a spiral configuration at the middle/distal third of the tibia.

Fractures of the diaphysis form a spectrum of patterns from low energy toddler's fractures to high-energy open fractures.

The child will present with pain and a reluctance to weight bear on the affected side. On examination, there is local fracture site tenderness with exacerbation of pain when dorsiflexing the ankle.

### **Treatment and Indications for Surgery**

#### ***Non-operative.***

Closed reduction and above knee casting for 4–6 weeks. Indicated in toddlers fractures and displaced fractures with acceptable reduction, depending on age and remodelling potential<sup>13</sup>

Suggested threshold for non-operative to operative management for diaphyseal tibial fractures in children (Table 1)

**Table (1):** Acceptable alignment of a paediatric diaphyseal tibial fracture described by Heinrich and Mooney <sup>14</sup>

Patient age	<8 years	>8 years
Valgus	5 °	5 °
Varus	10 °	5 °
Shortening	10 mm	5 mm
Rotation	5 °	5 °
Anterior angulation	10 °	5
Posterior angulation	0	0

### ***Operative***

Indicated if there is unacceptable reduction outside the parameters described above. Furthermore, in cases of polytrauma to facilitate mobilisation, or in the presence of compartment syndrome, neurovascular compromise or an open fracture. Treatment options include the use of K-wires, flexible intramedullary nails and plate fixation.

### **Flexible intramedullary nails**

Flexible intramedullary nails are blunt-ended nails made of the finest quality of titanium. The nails are 45 cm long with diameters of 2, 2.5, 3, 3.5, or 4 millimeters depending on the child's age.

Flexible nails are indicated in children who have not reached skeletal maturity with failure to maintain reduction