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Research Article

Management of Diaphyseal Fractures of Humerus in Children Using Titanium Elastic Nailing System by Lateral Dual Entry Point Approach: A Prospective Study

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Abstract: The aim of this study is to describe the indications, technique and results of operative stabilization of pediatric humeral shaft fractures with titanium elastic nails by lateral dual entry point technique. Ours is a prospective study of all traumatic humeral shaft fractures operated at our hospital between 2009 and 2013. Seven pediatric patients ranging in age from 9 to 15 years (mean age 12.8 years) were treated surgically with titanium elastic nails (TENs) by lateral dual entry point approach and follow up done at 3, 6, 12, 24 weeks and at 36 weeks. Relative surgical indications included open fractures, inability to maintain an acceptable reduction, concomitant lower extremity fractures, and closed head injury. One patient had associated radial nerve injury at presentation. The patients were followed for 9 months. All fractures healed in good alignment. There were no intraoperative complications including neurologic or vascular injury and one patient developed superficial infection postoperatively. One patient with preoperative radial nerve injury recovered on conservative treatment by eight weeks. All the 7 patients return to sports and other activities with no limitations or discomfort. And we conclude that titanium elastic nail fixation is an ideal procedure for treating humeral shaft fractures in which stabilization is indicated as it provides stable fixation, with minimal soft tissue stripping at the fracture site and allows early mobilization of the extremity. In addition, patients with concomitant lower extremity fractures can be mobilized more rapidly because of the increased ability to weight bear through the extremity. The lateral dual entry point approach is better and avoids the injury to ulnar nerve.
Keywords: Tens, Humerus, Diaphyseal fracture, lateral approach, Dual entry point

INTRODUCTION

Children with traumatic humeral shaft fractures require operative treatment only infrequently, primarily in cases where surgical stabilization of humeral shaft fractures is required to assist with patient mobilization, wound care, or the maintenance of adequate alignment [1]. The aim of this study is to describe the indications, technique and results of operative stabilization of pediatric humeral shaft fractures with titanium elastic nails by dual lateral entry point technique.

MATERIALS AND METHODS

The children admitted with humeral shaft fractures (Fig. 1) treated operatively at our institution between 2009 and 2013. Seven patients(Table 1) were identified who were treated with a titanium elastic nail system. Anteroposterior and lateral radiographs were reviewed to evaluate fracture healing. Healing was defined as cortical contiguity in all four cortices seen on standard Anteroposterior (AP) and lateral radiographs of the humerus. All the patients werefollowed at 3, 6, 12, 24 weeks and 36 weeks for clinical and radiological asessment.

Fig. 1: Fracture shaft of humerus

Surgical technique

The surgical technique was based on the principles described by the originators of the flexible nail implants in France [1]. When retrograde insertion was utilized, a longitudinal incision is made laterally at the level of the lateral epicondyle. The cortex is opened with a 3.2 or 4.5mm drill bit, depending on the size of the implant desired and the drill is advanced under image intensification through the lateral column of the distal humerus into the medullary canal. The size of the implant is selected to be approximately 40% of the diameter of the canal and two equally sized implants should be used to prevent asymmetric force on opposite cortices through the lateral approach. In general, implants were in the range of 2.5–3.5 mm. The nail is prebent and driven to the fracture site, reduction is then obtained in a closed or open manner, and the implant is subsequently driven proximally to stabilize the fracture. The nails are driven proximally to within 1–2 cm of the proximal humeral physis, cut as close as possible to the insertion site and impacted into place.

Table 1: Patient demographics

Age In yrs	M/F	Side of fracture	Mechanism of injury	Closed/open	Radial nerve injury	Associated injury	Indication for surgery
9	M	left	RTA	Closed	Nil	Head injury	Closed head injury
10	M	left	FALL	Closed	Nil	Nil	Not maintained acceptable alignment
14	M	Right	FALL	Closed	Neuropraxia	Nil	Not maintained acceptable alignment
15	M	left	RTA	Grade 1 open	Nil	Pelvic fracture	Pelvic fracture
15	M	left	RTA	Closed	Nil	Right sided femur Shaft fracture	Right sided Shaft of femur fracture
12	F	left	FALL	Closed	Nil	Nil	Not maintained acceptable alignment
15	F	Right	RTA	Closed	Nil	Crush injury left foot	Crush injury left foot

Postoperative care

Patients were either splinted or placed into a soft dressing and given a sling for comfort for 10–14 days. No routine physical therapy was prescribed. Mobilization out of bed without restriction was permitted for patients. Radiographs were typically obtained immediate(Fig.2), 2 weeks postoperatively to check for loss of reduction, 3,6,12(Fig. 3), 24 and 36 (Fig. 4) weeks postoperatively to evaluate healing and functional status of the limb.

Fig. 2: Immidiate post op showing fracture fixed with TENS

Fig. 3: 12 weeks follow up- showing healed fracture

Fig. 4: 36 weeks follow up- showing healed fracture

Fig. 5-:9 months follow up- showing post implant removal

Observations

We identified 7 patients (five boys, two girls) who had humeral shaft fractures treated surgically with elastic nails at our hospital between 2009 and 2013. The average age of the patient at the time of injury was 12.85 years (range 9–15 years). The mechanism of injury was road traffic accident in four patients and fall while playing in three patients. There was one Gustilo and Anderson grade I injury. One patient had radial nerve injury of neurapraxia type. Associated injuries include one had closed head injury, three with pelvis and/or lower extremity injury. The indications for surgical stabilization included three fractures that could not be maintained in acceptable alignment by conservative treatment and were, therefore, treated operatively. The indications for surgery in the remaining 4 patients were open fracture in one, closed head injury, pelvic fracture and crush injury left foot. The average follow-up was 9 months. Two patients had elective removal of their implants after healing at a 9 months post-surgery (Fig. 5).

RESULTS

All the patients were operated by dual lateral entry portals technique. All fractures were reduced with the closed technique under image intensifier guidance. There were no immediate postoperative complications. All fractures united without an angular or translational deformityof>10° within 12 weeks.

There was clinical evidence of superficial infection in one of our patient, managed by regular dressing and antibiotics. All the fractures were united radiographically.

One patient with a preoperative radial neurapraxia recovered function spontaneously within eight weeks after injury. All the 7 patients return to sports and other activities with no limitations or discomfort**.**

DISCUSSION

Humeral shaft fractures comprise approximately 2.5% of all traumatic fractures in children. They are second only to the clavicle in birth fracture incidence [2, 3].

Most closed fractures of the humeral shaft can be treated successfully with closed methods; union rates of more than 90% are often reported [4, 5].Multiple closed techniques are available, including the employment of traction, as well as the use of the hanging arm cast, co-aptation splint, Velpeau dressing, abduction humeral/shoulder spica cast, or functional brace [4, 6].

A Velpeau dressing or a sling and swathe (which is similar to the Velpeau dressing but is less restrictive) is typically used in nondisplaced or minimally displaced fractures in children younger than 8 years, as well as in elderly patients who are unable to tolerate other treatment methods. Pads can be placed in the axilla to control fracture angulation [5].

Acceptable alignment of humeral shaft fractures is considered to be 3 cm of shortening, 30° of varus/valgus angulation, and 20° of anterior/posterior angulation [7, 8].

Newborns and infants have substantial remodelling capability and deformities up to 45° [2]. Older children also have a certain remodelling potential.Recommended that the deformity should be reduced to <30° for proximal third, <20° for middle third, and <15° for distal third shaft fractures before proceeding with non-operative treatment [2, 9, 10].

If number of fractures are unable to be reduced adequately or maintained in adequate alignment by

conservative treatment, these should also be treated surgically. Titanium flexible nails are the preferred implant for stabilizing humeral shaft fractures operatively in children.

Titanium Elastic Nail for Elastic Stable Intramedullary Nailing is intended for fixation of diaphysealfractures of long bones where the medullary canal is narrow or flexibility of the implant is paramount [11].

The surgical technique of stabilizing humeral shaft fractures with titanium elastic nails is straightforward. It can be performed in either a retrograde or ante grade manner. Establishing an ante grade entry is perhaps more straightforward; however, it requires that the rotator cuff be incised in line with its fibers. Retrograde entry is our current preference, although it also requires careful opening of the cortex to avoid iatrogenic distal humeral fracture and careful dissection in order to avoid iatrogenic nerve injury. Antegrade entry is used when severe soft tissue trauma about the elbow contraindicates an entry point at the medial or lateral epicondyle. Retrograde lateral dual entry point approach avoids the complication of nerve injury [1].

The results presented here demonstrate that flexible nails provide the stability required to allow for timely fracture healing in children with traumatic humeral shaft fractures. Most of the children in our study have returned to full activity. While all fractures healed without delay or malunion. Any child with evidence of nail migration and especially impending skin breakthrough should return to the operating room for revision of fixation or trimming of the implants. After healing, the removal of implants need not be done routinely; however, our experience suggests that many families prefer that the nails be removed.

CONCLUSION

Titanium elastic nail fixation is an ideal procedure for treating humeral shaft fractures in children. It provides stable fixation, with minimal soft tissue stripping at the fracture site, and allows early mobilization of the extremity. Additionally, patients with concomitant lower extremity fractures can be mobilized more rapidly because of the increased ability to weight bear through the extremity.

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