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Original Article

Single incision pediatric flexible intramedullary tibial nailing

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ABSTRACT

Background: There has been a trend towards flexible intramedullary nailing for unstable tibial shaft fractures in the pediatric population, traditionally, utilizing a 2-incision technique with passage of one nail medially and one nail laterally. Our study aims to compare a single incision approach for flexible nailing of unstable tibial shaft fractures in pediatric patients to the traditional 2-incision approach.
Methods: Patients were selected for operative fixation if they had a length unstable tibial shaft fracture confirmed by fluoroscopy. Exclusion criteria included length stable tibial fractures that could undergo nonoperative treatment. Single incision technique utilized the medial incision only. Patients were monitored in the hospital for one postoperative day and followed up at 4 week, 8 week, and 12 week marks. Radiographic analysis was performed to evaluate for malunion or nonunion. Operative times, infection rates and complications were recorded and analyzed.
Results: All patients achieved complete fracture healing at the 12-week follow up. There were no delayed unions, nonunions or malunions in either treatment group.
Conclusions: Single medial incision for tibial flexible nails had equivalent outcomes with no difference in primary healing rate, malunion or nonunion rate when compared to the dual incision technique.

1. Introduction

Management of tibial shaft fractures in the pediatric population has historically occurred through non-operative means, such as closed reduction and casting.[1] For stable fractures, this is an acceptable and effective form of treatment and is currently the gold standard of care.[2] However, the treatment of unstable pediatric tibial shaft fractures continues to develop over time. In the past, plate and screw fixation and external fixation was performed for fractures requiring surgical fixation.[3–5]

Recently, there has been a trend towards flexible intramedullary nailing for these fractures.[6] The reason is because there is a significant complication rate that accompanies fixation with plates and screws as well as with external fixation, such as infection, delayed union, refracture, malalignment and joint stiffness.[4,5,7–10] With the use of flexible intramedullary nailing, unstable pediatric tibial shaft fractures can be safely treated with a much smaller risk of wound or infectious complications.[11]

Traditionally, the surgery consists of a 2-incision technique with passage of one nail medially and one nail laterally. The 2-incision technique allows for the application of standard biomechanical principles that stress the importance of 2 nails with opposing curves.[12] With this technique, both opposing curves are created with concavities facing each other, while the apex of each curve is located at the fracture site. In addition, it has also been proposed that each nail should be equal in length and should be inserted from opposing sides.[13] Potential complications of a 2-incision technique include an increased risk of wound complications secondary to a larger number of incisions along with an increased surgical time and time under anesthesia. An increased operative time equates to an increased financial burden to both the patient and hospital. Also, when using the 2-incision approach, the lateral incision is generally made 2–3 cm proximal to the planned entry point; the entry point itself being at the level of the tibial tuberosity. With this in mind, it is reasonable to conclude that the lateral incision poses a potential risk of injury to the peroneal nerve as it courses into the anterior compartment of the leg.

Due to these potential risks, we have developed a single incision flexible intramedullary nail technique for pediatric tibial shaft fractures and have compared this to the more traditional dual incision method. We have hypothesized that a single medial incision will offer equivalent outcomes to dual incisions with improvements in cosmesis and operative time.

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2. Materials and methods

Eleven patients underwent intramedullary fixation of tibial shaft fracture from January 2009 to September 2015. Patients were selected for operative fixation if they had a length unstable tibial shaft fracture confirmed by fluoroscopy (Fig. 1). Exclusion criteria included length stable tibial fractures that could undergo nonoperative treatment.

A total of 6 patients comprised the single incision group of which 5 were male and 1 was female with an average age of 12.17 (10–14; standard deviation of 1.3). The average weight of these 6 patients was 55.6 kg (38.6–89; standard deviation of 18.7). Four of the fractures involved the right tibia and 2 involved the left tibia. Additional demographic data is included in Table 1. Single incision technique utilized the medial incision only. A medial incision approximately 2 cm distal to the growth plate was localized. Dissection was carefully performed down to the periosteum. The periosteum was split, and carefully elevated from the bone. A 4.5 mm drill was passed unicortically at an oblique angle aiming distally. Flexible nails with diameters approximately 40% of the isthmus canal were passed down and fixed into the distal metaphyseal bone. A second 4.5 mm drill hole was placed next to the first hole, and another flexible nail was passed down the canal. The configuration of the nails was such that both nails were apart from each other to provide better rotation control. Final placement of the nails is demonstrated in Fig. 1.

The remaining 5 individuals in the dual incision group included 4 males and 1 female with an average age of 12.8 years (10–14; standard deviation of 1.6). The average weight of these 5 patients was 64.22 kg (49.9–96; standard deviation of 16.9). Three of the fractures involved the right tibia and 2 involved the left. Additional demographic data is available in Table 1. Dual incision included a lateral incision anterior to the fibular head, near the center of the lateral proximal tibia, distal to the growth plate. The anterior compartment fascia was gently elevated and periosteum elevated as well. A starting point, 2 cm distal to the physis was drilled, aiming distal obliquely. The nail was passed down the canal and fixed into the distal metaphyseal bone. Final placement of the nails is demonstrated in Fig. 2.

The nails are cut flush to the skin and advanced by tamp to approximately 1.5 cm outside of the bone. Layered skin closure was performed, and sterile dressings applied. A short leg cast was applied in the operating room.

Patients were monitored in the hospital for one postoperative day, and discharged after physical therapy evaluation. Casts were removed in 6 weeks and initial weight bearing was begun. Patients followed up at 4 week, 8 week, and 12 week marks. Radiographic analysis was performed to evaluate for malunion or nonunion. Operative times, infection rates and complications were recorded and analyzed.

All statistics were done using SPSS for Mac Version 23 (IBM, Armonk, NY). Student *t*-tests were used to compare the 2 groups on continuous variables (age, weight, time to union, and operating room time). χ^2 tests were used to compare categorical variables. Significance was set at $P < 0.05$.

3. Results

Eleven cases of pediatric tibial shaft fractures were included in our study, 6 of which were treated with the single medial incision approach. The remaining 5 patients underwent the standard 2-incision approach.

The operative time was 43.34 min (30–50; standard deviation of 7.5) for the single incision group and 45 min (25–55; standard deviation of 10.5) for the dual incision group. There was no statistical significance for operative time ($p = 0.40$). All patients achieved complete fracture healing at the 12-week follow up. The single incision group was 69.83 days (60–85; standard deviation 12.1) and for the dual incision group the average was 72 days (55–92; standard deviation 14.0). Time to union was also not found to be statistically significant ($p = 0.39$) between the two groups. There were no delayed unions, nonunions or malunions in either treatment group (Table 2). None of the patients had a course complicated by infection or any other significant complications.

4. Discussion

Tibial shaft fractures are the third most common type of long bone fractures in the pediatric patient, surpassed only by those of the femur and forearm.[14,15] Since the arrival of flexible intramedullary nails, many studies have demonstrated their efficacy and treatment technique in the management of unstable tibial fractures.[1,10,11,16–19] With the continuous enhancement of unstable fracture management, flexible intramedullary nailing is becoming a more commonly used technique. Traditionally, unstable tibial shaft fractures have been stabilized via a 2-incision approach, employing both a medial and lateral nail insertion point in the proximal tibial metaphysis.

Our study demonstrated that a single medial incision for tibial flexible nails had equivalent outcomes with no difference in primary healing rate, malunion or nonunion rate when compared to the dual incision technique. The single medial incision technique is technically easier with less potential risk of peroneal nerve damage. Furthermore, a single incision is preferable to two

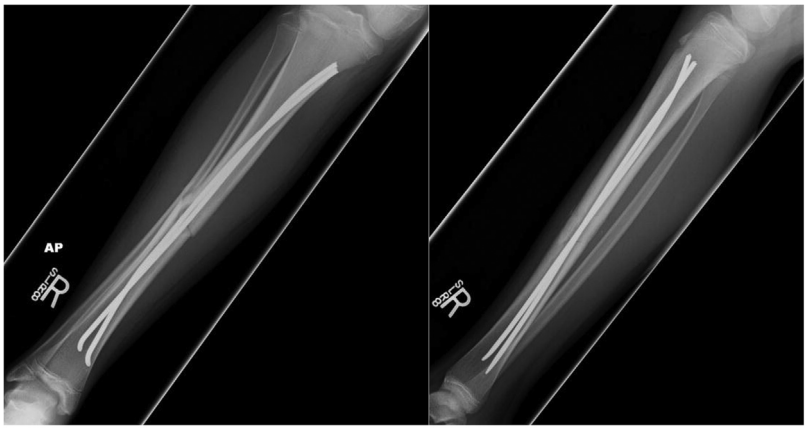

Fig. 1. Post-operative films of nail placement after single incision approach for tibial nail insertion.