Articles & Publications

Fibula Lengthening Using a Modified Ilizarov Method

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Abstract

A unique combination of external and internal fixation techniques, for a fibular lengthening procedure using the Ilizarov method is described. The technique is minimally invasive, allows precise deformity correction, enables early weight bearing, and minimizes the time that the patient wears the external fixator.

Introduction

Bone lengthening procedures have, over time, been approached in a variety of ways. The variables have included the use of bone graft, acute or chronic distraction and different methods of distraction and stabilization. The Ilizarov method, practiced in relative isolation by its namesake since 1951, has received considerable attention in the West in the last two decades. With this approach, a percutaneous osteotomy is performed and this is followed by gradual distraction. No bone grafting is needed and weight bearing is encouraged during the treatment.[1,2] The main disadvantage of this technique is the often need for lengthy periods of external fixation.

Lateral malleolar insufficiency or fibular shortening may result from congenital, traumatic, iatrogenic or tumor related causes. The importance of the integrity, alignment and length of the lateral malleolus has been firmly established. The position of the lateral malleolus as the lateral wall of the ankle is critical for talar alignment and dictates the corresponding degrees of joint surface pressure and cartilage wear.[3,4,5,6] The subject of fibular lengthening about the ankle to restore this relationship is one that has received little attention in the literature.[7,8]

This article describes a technique for fibular lengthening with a modified Ilizarov method using a combination of the EBI monolateral fixator (Parsippany, NJ) and Ilizarov frame (Memphis, TN) parts and syndesmosis screws, to lengthen a shortened distal fibula and correct a valgus ankle deformity. We use a small and relatively comfortable frame for distraction and lengthening of the fibula. The length and proper ankle position are achieved after approximately 3 weeks. The frame is then removed and the position is maintained with percutaneously placed syndesmosis screws.

Case Presentation

A 13 year old girl, initially complaining of pain in her right ankle was treated for a unicameral bone cyst in 1993. This bone cyst, which partially occupied the distal fibular growth plate, was curettaged and filled with Grafton and iliac crest aspirate. Growth arrest resulted in a shortened distal fibula. Acute lengthening with bone grafting and plate fixation in 1998 failed to completely restore the length discrepancy and deformity. She was referred to us for treatment, and was noted to have a distal fibular growth arrest with longitudinal deficiency of 1cm and lateral ankle instability with lateral talar shift. The angle drawn between a line that crosses the distal aspect of both malleoli and the mid diaphyseal line was 90°, in comparison to the normal side which was 81° representing the shortening and deformity (Fig. 1; Fig. 1B; Fig. 1C)

Fibula Lengthening Surgical Technique

Two 3.5mm pins were placed in the distal fibula through a percutaneous approach. These were spaced based on the template of the external fixator system. Through a percutaneous approach, soft tissue dissection and spreading were done, and with a soft tissue protector in place, two additional pins at the junction of the middle and distal fibula were inserted. These two pin clusters surrounded the planned osteotomy site. Care was taken to avoid injury to the superficial peroneal nerve.

The external fixator was placed in line with the longitudinal axis of the fibula in the coronal and sagittal planes. The fibula was then approached through a 1cm incision. Care was taken to avoid injury to the neurovascular structures, in particular the superficial peroneal nerve. Multiple drill holes were made in the fibula with 1.8mm wire and an osteotome was used to create a transverse, low energy, osteotomy.[9,10] The EBI frame was applied by tightening the pins into the pin clamps. The proximal pin clamp was fixed and a distraction rail was placed to enable gradual distal movement of the distal pin clamp along the rail.

Fixation into the tibia as an anchor was necessary. This is to prevent proximal migration of the fibula during lengthening. This was accomplished by connecting an Ilizarov half-ring to the monolateral frame via cubes from the Ilizarov set. Tibial fixation was then accomplished with two, 6mm half pins connected the Ilizarov half ring.

A latency phase of one week was used. During this time, no adjustments are made and the early steps of bone healing begin.[1,2] Distraction was then started at a rate of 1/4mm four times per day. After 12 days of lengthening, the fibula length and the talar alignment was noted to be correct. The angle between the malleoli and the mid diaphyseal line of the tibia was noted to be 81° which matched the normal side. The patient was then taken back to surgery for placement of syndesmosis screws and removal of the frame (Fig. 2A; Fig. 2B; Fig. 2C).

Insertion of Syndesmosis Screws and Frame Removal: Surgical Technique

A 12mm lengthening of the fibula and an intact ankle mortise were confirmed by fluoroscopy (Fig. 3A). The leg, including the frame, was prepped and draped. Betadine soaked sponges were wrapped around the pin sites to minimize contamination, and the frame was covered although it was included in the sterile field. Two guide wires were placed from the tibia to fibula, from the lateral side across the syndesmosis in a percutaneous fashion using fluoroscopy. Two stab incisions were made medially. The guide wires were then used to guide the drill. Two synthes cannulated screws (4.0 and 4.5mm, Synthes, Paoli, PA) were inserted. They were parallel on AP and slightly divergent on lateral view. Care was taken to avoid contact between the external fixation pins and the internal fixation screws to decrease the chance of infection (Fig. 3B). Care was taken not to over tighten the syndesmosis by keeping the foot in neutral position and not using lag screws. The ankle mortise was symmetrical an intact. At this point the external fixator was removed. The mortise was again checked with fluoroscopy and no change in fibula position was noted (Fig. 3C).

Six weeks partial weight bearing on crutches with a short leg splint was implemented. During this period, ankle range of motion was also encouraged. After six weeks, excellent regenerate was noted in the fibula lengthening gap and full weight bearing without assistance was allowed. Range of motion and ankle strengthening exercised were continued.

At three months after the start of treatment, ankle range of motion was 25° dorsiflexion, 70° plantarflexion. The patient had no pain. Complete bony healing of the regenerate was noted on radiographs (Fig. 4A; Fig. 4B; Fig. 4C; Fig. 4D; Fig. 4E; Fig. 4F).

Discussion

Studies have shown a direct correlation between the proper restoration of ankle congruity in the treatment of bimalleolar fractures and long-term clinical outcomes.[3,4] More specifically, authors have demonstrated that the integrity of the lateral malleolus plays a critical role in the long-term maintenance of the talus in its proper anatomical and biomechanical position.[6,8] Even, lateral talar tilt of just 1mm has been shown to decrease joint surface area contact by 42%.[5] Another study showed that in the short term, 75% of fractures healing with talar tilt went on to develop stiffness and swelling.[3] Such a joint incurs increased stress per unit area and in such, an increased risk of developing post-traumatic arthrosis.

Most of the discussion concerning lateral malleolar reconstruction has centered around revision of malunion of distal fibula following reduction of bimalleolar fractures.[6,8] The same issues probably also apply to the situation of fibular shortening resulting from other etiologies. Late correction of the lateral malleolus by fibular lengthening can correct residual talar tilt and recreate proper anatomical alignment.[6,8]

Limb lengthening as a whole, has lately received a fair amount of attention in the literature. And while tibial and femoral lengthening procedures using the Ilizarov method are reported fairly commonly in the literature, cases reporting this methodology for fibular lengthening are quite scarce. Catagni described a technique for the management of various grades of fibular hemimelia using the Ilizarov method.[7]

Yablon[8] described a technique for fibula lengthening that involves acute lengthening, syndesmosis takedown and plate fixation with bone grafting. In contrast, the Ilizarov method uses a percutaneous osteotomy, followed by gradual distraction allowing for precise correction of the deformity. Soft tissue stripping at surgery is minimal and a large amount of lengthening without bone graft is possible. The need for the patient to be in the frame during the consolidation phase is a major disadvantage of the classic Ilizarov technique. The currently reported technique is unique and advantageous because it integrates the use of two different concepts -internal and external fixation- to speed the recovery time. By switching from an external fixator to syndesmosis screws after distraction is complete, the need for an external frame during the consolidation phase is eliminated. In addition the combination EBI and Ilizarov frame is also unique. In tandem, the two have a lower profile than the traditional Ilizarov frame alone and are thus more comfortable to the patient.

A critical concept in this lengthening procedure is the tibial anchor point. This insures distraction of the fibula in the distal direction without proximal migration. While this can be accomplished using the traditional Ilizarov frame, we have done it using the modified monolateral frame that is smaller and more comfortable for the patient.

Another important issue is prevention of infection. Since the external fixator pin sites are contaminated, precautions are taken to avoid infection of the internal screws. Although the frame is prepped into the surgical field, we cover as much of it as possible, wrap the pin sites with betadine soaked sponges, and insert the screws from the medial side.

In summary, fibula lengthening can be successfully performed using a modified Ilizarov method. A monolateral frame with an Ilizarov attachment is used to lengthen the fibula gradually using the concept of distraction osteogenesis. Once fibula length is restored and ankle congruity is optimal, the fibula position is maintained with internal fixation and the frame is removed. In this way, the time in a frame is kept to a minimum.

Take Home Pearl:
One can integrate the use of two different concepts - internal and external fixation- to speed the recovery time. By switching from an external fixator to syndesmosis screws, we obviate the need for an external frame during the consolidation phase.

Legend of Figures:

Figure 1:
A. Anterior-posterior (AP) radiograph of the normal ankle showing an 810 angle between a mid-diaphyseal line of the tibia and the tips of the malleoli.
B. Preoperative AP radiograph of the ankle with deformity showing shortening of the fibula and lateral tilt of the talus. Note a 90 angle between the mid-diaphyseal line of the tibia and the tips of the malleoli.
C. Preoperative clinical photo showing valgus deformity of the ankle and hindfoot.

Figure 2:
A. AP radiograph after 10 days of fibula lengthening.
B. Clinical photo showing improvement in deformity at the end of distraction.
C. Clinical photo (front view) showing frame.

Figure 3:
A. Intraoperative AP image prior to syndesmosis screw insertion.
B. Intraoperative AP image after syndesmosis screw insertion with frame still in place.
C. Intraoperative mortise view image with sydesmosis screws and after frame has been removed.

Figure 4: Followup at three months after the beginning of treatment.
A. AP radiograph of the ankle showing improved fibula position and complete bony healing of the regenerate.
B. Lateral radiograph of the ankle.
C. Clinical front view
D. Clinical back view
E. Clinical side view with ankle plantar flexion
F. Clinical side view with ankle dorsiflexion.

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