Percutaneous Distraction Lengthening in Brachymetacarpia

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Abstract

Brachymetacarpia is a condition manifesting a shortened metacarpal that is caused by early closure of the epiphyseal plate and believed to arise idiopathically. The correction for brachymetacarpia is usually for cosmetic reasons as brachymetacarpia does not impair function. The literature indicates several different approaches to lengthening digits, including single-stage lengthening and rapid distraction lengthening with a bone graft. However, gradual distraction is the preferred method due to excellent cosmetic outcomes and few postoperative complications. This article reports a case of brachymetacarpia treated with distraction lengthening using a minimally invasive, percutaneous approach.

A 16-year-old girl presented with a shortened left ring finger and underwent surgery to correct the deformity. The left ring finger measured 12 mm shorter than her right ring finger; however, there was normal mobility at the joints. In the operating room, an external fixator was attached using 4 self-drilling, self-tapping pins through several 3-mm skin incisions. The total fixation time was 14 weeks; however, the achieved length of 12 mm was achieved 6 weeks postoperatively. The healing index of the fixation period was 81 days/cm. The postoperative course and fixation period were uneventful, with no complications except for 2 pin infections that were treated with oral antibiotics. The method of gradual distraction lengthening in this case successfully achieved the desired length and yielded an excellent cosmetic result.
Brachymetacarpia is abnormal shortness of the metacarpals. The cause of brachymetacarpia may be due to a syndrome, may be acquired from diseases in childhood, or may arise idiopathically.\(^1\)\(^3\) Early closure of the epiphyseal plate, however, is the ultimate cause for the underdevelopment of the bones.\(^1\)\(^2\)\(^3\)\(^5\) The incidence of brachymetacarpia is less than 1 in 1000, and the occurrence rate in females is 5 times greater than in males.\(^3\) The ring finger is the most frequently involved digit.

Brachymetacarpia does not impair function, and surgical treatment is usually for cosmetic reasons.\(^3\)\(^5\)\(^7\) Although there are several methods to correct brachymetacarpia, the most common surgical intervention is distraction lengthening.\(^1\) Callus distraction is preferred because the lengthening is gradual and has a high success with good cosmetic results and few complications.\(^1\) Other methods such as single-stage lengthening or rapid distraction lengthening with a bone graft make it difficult to lengthen the metacarpal >10 mm in a single stage or require multiple surgeries with a bone graft.\(^5\)\(^8\)

This article presents a case of brachymetacarpia of the ring finger treated with distraction lengthening and a percutaneous technique.

**Case Report**

A 16-year-old girl presented with brachymetacarpia. She noted that her left ring finger was shorter and deformed in relation to her other fingers (Figure 1). The patient was concerned about the appearance of her hand in the future when wearing an engagement and wedding ring. She felt that the rings would draw attention to her deformity. She reported no pain or functional problems associated with the brachymetacarpia.

Physical examination of the left hand revealed a shortened ring finger. The left ring finger was 12 mm shorter than the ring finger on her right hand. Range of motion was 100° of flexion and 90° of extension at the metacarpophalangeal joint. The patient had some ligamentous laxity in all of her metacarpophalangeal joints, which included increased excursion with positive anterior draw. In addition, she had normal adduction and abduction, and normal mobility of the proximal and distal interphalangeal joints. The left hand was neurovascularly intact with 2+ radial and ulnar pulses, normal capillary refill, normal sensitivity to light touch, and normal power of the wrist and all of the digits.

Assessment of the patient showed brachymetacarpia of the left ring finger with mildly increased laxity of the metacarpophalangeal joint and an abnormal carpometacarpal joint. The risks and benefits of gradual lengthening surgery with a mini external fixator were discussed with the patient, and informed consent was obtained.

The patient was supine on the operating table. Intravenous sedation and a brachial plexus block were administered. No tourniquet was used. Her left hand and upper extremity were prepped and draped in the standard surgical fashion. C-arm fluoroscopy was used.

The Orthofix MiniRail Fixator (Upper Montclair, New Jersey) was used. The first pin was placed percutaneously in the most proximal portion of the fourth metacarpal, through a 3-mm skin incision. The self-drilling and self-tapping pin was placed carefully one cortex at a time using fluoroscopy. A small freer-elevator tapping pin was placed carefully one cortex at a time using fluoroscopy. A small freer-elevator was inserted under the extensor tendon before the percutaneous drilling to protect the tendon from injury.

After the pin position was determined to be ideal, the most distal pin was placed next through the neck of the metacarpal using the straight external fixator as a guide to ensure subsequent pins would be parallel. Two additional pins were placed percutaneously. These were the central pins, and they were inserted in the same manner. There was a total of 4 pins: 2 proximal and 2 distal to the midshaft. One of the central pins was removed after placement to gain exposure to the osteotomy site. This was replaced immediately following osteotomy.

The osteotomy was performed at the level of the metacarpal midshaft through a 4-mm incision. The tendon and neurovascular structures were protected, and the osteotomy was then predrilled with the multiple drill hole technique.
using a K-wire. Imaging was used to ensure that the drill holes were in the correct plane and perfectly spaced in between the 2 pin blocks.

After multiple passes with the wire, a 3-mm osteotome was passed through the predrilled osteotomy site. This was done gently and the bone cracked transversely through the predrilled location. Rotation osteoclasis proved this was a complete osteotomy.

The fixator was reapplied, tightened in place, and checked with final images to show a non-displaced osteotomy. The wounds were closed, and the patient was admitted for pain control. Range-of-motion exercises were started on the first postoperative day, and fixator adjustments were started 5 days postoperatively at a rate of 0.5 mm/day split into two 0.25-mm adjustments 12 hours apart, for a duration of 10 days.

After radiographs 2 weeks postoperatively, the distraction rate was slowed to 0.25 mm/day for 20 days. New radiographs showed robust healing of the regenerate, and the distraction rate was increased back to 0.5 mm/day for 7 days. The patient underwent follow-up visits every 2 weeks during distraction.

At 3.5 months postosteotomy, the total osteotomy regenerate length was 12 mm indicating that the original goal was achieved. Radiographs showed 4 cortices of healed regenerate, and the external fixator was removed. Postframe removal, the patient underwent hand therapy for strengthening and range-of-motion exercises. For dermal scarring prevention, the patient wore a compression glove, used silicon pads to cover the wounds, and massaged the scars daily.

The patient underwent follow-up for 30 months. The total distraction length achieved was 12 mm after 6 weeks postoperatively. This represents a 28% increase in the length of the metacarpal. The total time with external fixation was 14 weeks. This indicated tightness of her lumbral muscles, and there likely was scarring of the extensor tendon as well. She began extensive, formal hand therapy, and the stiffness resolved completely after 14 weeks.

Routine postoperative radiographs confirmed that the metacarpophalangeal and carpometacarpal joints did not sublux or dislocate at any point during treatment (Figure 2). Two years postoperatively, the ring finger on her left hand was normal length with minimal scarring at the external fixator site (Figure 3).

**DISCUSSION**

The surgical correction of brachymetacarpia is primarily performed for cosmetic reasons. Several different methods are used to lengthen the metacarpals, and each method has certain advantages. Some authors recommend gradual distraction lengthening, arguing that with this technique more lengthening is possible, there is a high cosmetic success rate, and a low complication rate. In contrast, Saito et al recommend a single-stage lengthening with bone graft since it does not require the patient to wear an external fixator on their hand for a prolonged period of time.

In our patient, gradual distraction lengthening was used with excellent results. After 6 weeks of fixation, the target lengthening of 12 mm was achieved. The healing index for this case was 81 days/cm, which is typical compared to other studies. This healing index compares to the average healing index of 143.35 days/cm reported by Erdem et al, 62 days/cm reported by Kato et al, 49.6 days/cm reported by Bozan et al, and 88.46 days/cm reported by Matsuno et al. The average lengthening was 16.4 cm for several of these series.

Saito et al performed single-stage elongation for short metacarpals primarily because of the conspicuous scars left by external fixators and callotasis lengthening. However, in our case of distraction lengthening, the operative procedure was percutaneous with minimally invasive incisions, and the patient was satisfied with the cosmetic outcome. The percutaneous approach used in this procedure aided in the rapid healing process experienced by our patient and allowed for the use of a smaller and less noticeable fixation device.

The percutaneous method is what sets this case apart from the other studies mentioned. Saito et al used a zig-zag skin incision on the metacarpal or palm to expose the tendons and bone. Kato et al
used a straight skin incision on the dor-
soradial side of the metacarpal to expose
fixation sites. Erdem et al\textsuperscript{4} and Bozan et
al\textsuperscript{1} also used a larger incision to dissect
the extensor tendon.

Our case demonstrates that gradual
metacarpal lengthening using distraction
osteogenesis and a percutaneous approach
can achieve superior results. The patient
had no residual stiffness, the scarring was
minimal, no subluxation of either the carpo-
metacarpal or metacarpophalangeal joints
occurred, and the patient was satisfied with
the results. Superficial pin infections were
treated with oral antibiotics, with no evi-
dence of deep or residual infection. We rec-
ommend this treatment for patients consid-
ering metacarpal lengthening.

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