Use of a Multiplanar Distracter for the Correction of a Proximal Interphalangeal Joint Contracture

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Proximal interphalangeal (PIP) joint contractures are common complications in hand injuries and conditions such as Dupuytren's contracture. Conventional treatment such as splinting and serial casting may result in inadequate improvement. Operative release of the contracture may be complicated by neurovascular overstretch with injury to the digital nerves or vascular compromise. Gradual distraction of the contracted joint may prevent this neurovascular injury. The multiplanar distracter was designed for three-dimensional distraction of the mandible. Distraction may be obtained in the X, Y, or Z planes. With this device, the angular relationship between two planes may be altered. A 22-year-old male with a PIP joint contraction following replantation failed conventional treatment for release. With the use of a multiplanar distracter, the flexion contraction was reduced from 95 degrees to a more functional 30 degrees using gradual angular distraction. The angle between the proximal and middle phalanges were gradually changed using the ability of the distracter to change the angular relationship in the X-Y plane. At 3 and 6 months postdistraction, the patient has maintained his 30-degree flexion angle. The multiplanar distracter is a simple technique that may be useful for the treatment of PIP joint contractures that fail conventional therapy.

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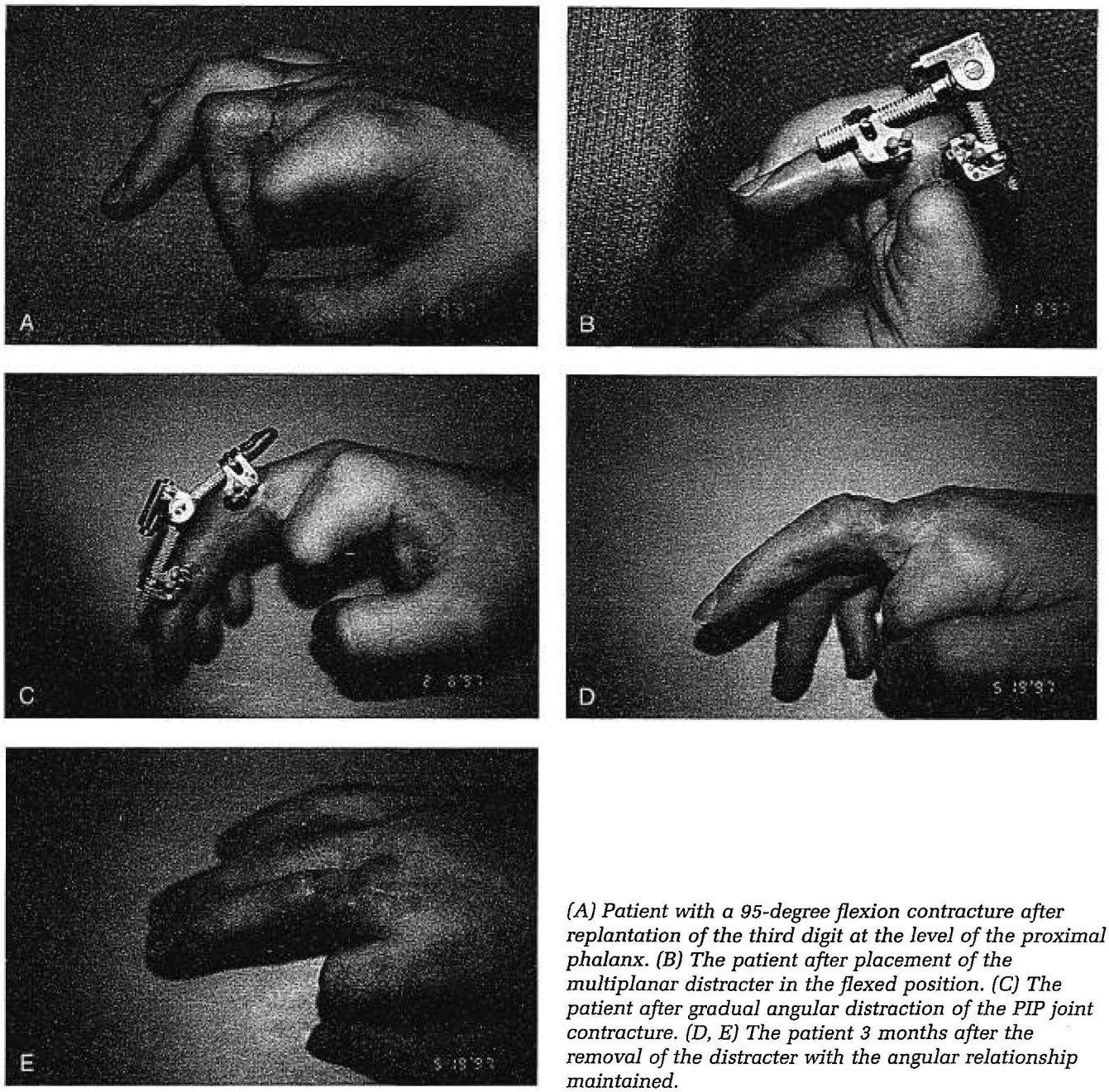
Proximal interphalangeal (PIP) joint contractures are common problems following hand injuries. Following injury to the hand, tissue fluid may increase in the joints, causing shortening of the collateral ligaments and capsules. The increased power of the finger flexors compared with the extensors contribute to maintaining the flexed position at the PIP joint after injury. When left in this position, combined with the tissue edema, leads to shortening of the collateral ligaments and the capsule. With continued lack of motion, fibrosis can occur proximal to the volar plate and may form bands that have been called the *check-rein ligaments.*[1,2]

The best treatment for PIP joint contractures is prevention. This includes splinting of the PIP joints in extension, early edema control, and early motion. Despite these efforts, PIP joint contracture may develop.

The treatment of established early PIP joint contracture is splinting to apply pressure in the dorsal direction on the proximal and middle phalanges, and pressure in the volar direction on the PIP joint. Various devices have been developed to apply the required forces.[3,4] If this is unsuccessful, serial casting may be applied, for which casts with decreasing angulation at the PIP joint are applied and changed serially.

In severe cases, splinting and serial casting may be unsuccessful and surgical release of the contracture may be necessary. Release of the contracture may involve release of the accessory collateral ligaments, the check-rein ligaments of the volar plate, and possibly release of the collateral ligaments and joint capsule.[1,5–7] In established PIP joint contractures, there may be shortening of the neurovascular bundle. Release of the joint contracture and extension of the digit may result in excessive tension on the nerve and artery and cause both a nerve injury and vascular compromise.

The technique of distraction osteogenesis for bone lengthening has become a widely accepted technique. Ilizarov is recognized as the primary force behind the development of the technique.[8] This technique was developed in the 1950s, and was recently adopted and modified in the West. By performing an osteotomy, gradual distraction of the long bones results in new bone formation and effective lengthening of the bone. As the bone is being lengthened, the soft tissues and neurovascular structures are also lengthened without injury.



(A) Patient with a 95-degree flexion contracture after replantation of the third digit at the level of the proximal phalanx. (B) The patient after placement of the multiplanar distracter in the flexed position. (C) The patient after gradual angular distraction of the PIP joint contracture. (D, E) The patient 3 months after the removal of the distracter with the angular relationship maintained.

The principles of distraction osteogenesis have been applied to the bones of the craniofacial skeleton.[9,10] The bones of the craniofacial skeleton are more complex than the long bones, and distraction with a good anatomic result may require manipulation in multiple planes.[11]

The multiplanar distracter was designed for the distraction of the mandible. The device can be used as a uniplanar distracter by lengthening the distance between two points in the X plane. The device also allows changing the angle between two planes and allows rotation in the third plane. For the purposes of a PIP joint contracture, the device may be applied to the proximal and middle phalanges while in the flexed position. The angle of the two planes can then be changed gradually by daily distraction. While this angle is changed, the shortening of the collateral ligaments and capsule may be corrected and the check-rein ligaments may be disrupted. Because the distraction is gradual, there may be no injury to the neurovascular bundle.

Patient Report

A 22-year-old male sustained amputations of his second and third digits. The second digit was not replantable and an amputation was performed at the proximal phalanx. The third digit was replanted at the level of the proximal phalanx. The patient was initially lost to early follow-up and returned with a 95-degree flexion contracture of the PIP joint (Fig A).

Because the patient had already lost one digit, a decision was made to try to salvage the replanted third digit but place it in a more functional position. Splinting and casting were unsuccessful. Two attempts were made for surgical release of the PIP joint. Even minor manipulations of the joint rendered the digit ischemic.

A multiplanar distracter was placed on the third digit. Two pins were placed in the proximal phalanx and two were placed in the distal phalanx to hold the distracter in 95 degrees of flexion, equivalent to the flexion contracture (Fig B). The patient was instructed to change the angle of the distracter by increasing its angle approximately 5 degrees daily (decreasing the angle of the contracture). This was performed by simple rotation of a screw on the device. There was no neurovascular compromise after the gradual daily distraction.

After 2 weeks, the digit was extended to approximately 20 degrees of flexion (Fig C). The distracter was allowed to stay on the finger an additional 4 weeks. The distracter was then removed. After removal of the distracter there was an initial loss of extension of approximately 10 degrees. After 3 and 6 months, this has been stable (Figs D, E).

Discussion

The established, severe PIP joint contracture may be a difficult problem to correct. Conventional treatment of splinting and serial casting may be inadequate. Surgical release of the contracture may result in neurovascular compromise.

Distraction has been used successfully to lengthen bone and augment soft tissue. Several authors have used the principles of skeletal traction to release finger contraction in Dupuytren's disease, but these devices are cumbersome and may be difficult to apply.[12,13]

The PIP joint contracture may be corrected by the use of the multiplanar distracter. This is a simple technique that can be used to correct severe contractures of the PIP joint by gradual distraction without neurovascular compromise.

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Open Discussion

Armen Kasabian, MD

Kenneth A. Marshall, MD (Cambridge, MA): Dr Kasabian, have you used the distracter for congenital anomalies such as camptodactyly and

clinodactyly? If not, would you think there might be any difference between that and traumatic scarring?

Dr Kasabian: The answer to the first question is no. I have only used it on the 3 cases that I've shown. I don't know if it will be any difference, but you do need enough space to put the two pins in. So if it's a child, you may not have enough space on the bone. We did do one child. He's a 14-year-old. That was the burn scar. It just barely had enough bone to put the two pins in and the distracter on.