Correction of Severe Contracture of Intrinsic Plus Hand with a Modified Ilizarov Mini-Fixator

Correction with an Ilizarov Mini-Fixator for Severe Hand Contracture

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Introduction

Complete flexion contracture of all digits, including the thumb, is rare. The presentation is similar to clenched fist syndrome and it is often associated with various non-psychiatric events such as trauma, malnutrition, and ischemia. It is also often associated with psychiatric pathology. Unlike clenched fist syndrome, its status can worsen over time and result in soft tissue contracture and joint malalignment. The most common type of severe post-traumatic finger contracture is intrinsic minus hand (claw hand) which is caused by an imbalance of traction forces between the extrinsics and intrinsics. In this condition, the former exceeds the latter. Intrinsic plus hand, on the other hand, in which the traction forces of

the intrinsics exceed the extrinsics, is rarely observed. Adduction contractures of all five digits are commonly observed in both conditions. Complete flexion contracture of the intrinsic plus hand is quite rare and its treatment is extremely difficult. While this deformity is often due to direct hand trauma, malnutrition, or ischemia, it can also occur without any obvious causes [1, 2]. The differential diagnosis includes the psychoflexed hand, a rare clinical condition with fixed finger contractures whose etiology is undetermined and it is often associated with psychiatric pathology [3–5].

Here we report a woman with severe contracture of the left hand who was treated with gradual distraction and coordinated correction of finger joints and web spaces. We used an Ilizarov mini-fixator (IM), developed by the Russian Ilizarov Scientific Center, with some modifications. We compare the IM method with conventional methods and discuss its limitations. In addition, we also discuss the background of intrinsic plus contracture without severe direct trauma of the hand.

Case Report

A very thin 54-year-old woman had been diagnosed with and treated for an eating disorder. She had contractures in both upper limbs (left more severe) of unknown etiology. The deformity had progressed gradually over the past 2.5 years and her left digits were completely flexed when she presented to us. She could not pinch with her left hand (Fig. 1a) and requested surgical intervention. Severe contracture was observed in all digits, including the thumb, and the condition was very similar to that of clenched fist syndrome. However, it differed from it in that the fingers were impossible to extend even under anesthesia. The range of motion (ROM), both active and passive, was very limited. The extrinsic and

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Fig. 1 Preoperative **a** photograph and **b** computed tomography (CT) image of the left hand shows complete contracture with dorsal dislocation of the proximal phalanx of the thumb and volar dislocation of the proximal phalanges of all fingers

Fig. 2 Postoperative therapy by Ilizarov mini-fixator at **a** 1 week, **b** 3 weeks, and **c** 6 weeks after surgery. *Arrows (1, 2, 3)* show the order of correction of the thumb. Reduction of the proximal phalanges of both the thumb and fingers was obtained after long axis traction

intrinsic tightness tests and the flexion contracture of the wrist indicated contractures of both the extrinsic and intrinsic muscles. Computed tomography (CT) of the left hand showed a collapsed thumb deformity and volar dislocation of the proximal phalanx of the fingers (Fig. 1b). A hyperextension/adduction deformity commonly occurs at the metacarpophalangeal (MP) joint of the thumb with advanced stages of carpometacarpal (CM) arthrosis. In this case, too, the deformity of the thumb MP joint seemed due to CM arthrosis. During surgery, we performed CM joint fusion of the thumb and proximal row carpectomy (PRC) to reduce the tension on the extrinsic muscles and to correct the malalignment of the hand. This procedure allowed the wrist to extend. After the CM joint fusion, we performed IM setting. The postoperative strategy for correction and maintenance of hand posture is important when the goals are a functionally formative hand and preventing recurrence of the deformity. After the operation, tension was applied by IM for 6 weeks. Soft tissues are somewhat vulnerable, but the IM can generate adequate direct traction from the bone. This traction stage was composed of a first stage (Fig. 2a, thumb: MP joint reposition under distraction, fingers: MP joint distraction) and a second stage (Fig. 2b, thumb: correction of first web contracture, fingers: MP joint reposition). The following

4 weeks constituted the stabilization period, holding fingers in the corrected position with an IM and rubber bands (Fig. 2c). Active exercise was started after removing the connecting rods, while each unit that held the phalanx was retained in this phase. We used rubber bands that were connected to each unit of the IM to maintain the corrected position by dynamic force. Finally, after removing all apparatus, splinting therapy was recommended for 6 months to maintain the intrinsic plus position, especially at night, to prevent the recurrence of deformity.

Fig. 3 Schematic drawings of the correction method. **a** As the principle of correction of multiple joints in the same finger went from the distal joint to the proximal joint, IP (PIP and DIP) joints were kept in extension by rubber bands while **b** MP joints were stretched with long axis (volar) traction. *Arrow* shows the volar traction. **c** After opening of the joint space by 3 mm or more, the volar traction was changed in the distal direction to obtain a supple MP joint. *Arrow* shows the distal traction. **d** Once distraction rods were removed, the stiffness of fingers and the reduction of MP joints were checked manually before setting up a new frame. **e** After obtaining MP joint reduction, distraction rods were applied to induce direct extension force with a new frame. *Arrow* shows the extension force. **f** The extension rod for rubber bands was exchanged to keep or correct the flexed MP joint by dynamic force in a stabilization period, which permitted active exercise of atrophic muscles

Fig. 4 At 3-year follow-up, **a** photograph and **b** X-ray of the left hand demonstrated mild recurrence of dorsal subluxation of the proximal phalanx of thumb

Strategy of Surgical Rehabilitation With IM

Figure 3 demonstrates our surgical strategy with the modified IM to correct the fingers. The correction of finger joint contracture in the direction of extension at the MP joint was initiated after achieving sufficient opening of the joint space with long axis traction. After the reduction, we treated the MP joints with rubber bands instead of distraction rods to apply dynamic forces to the MP joint, permitting active exercise as shown in Fig. 2b and c. The aim of this stage using the rubber bands is to induce active contraction of atrophic muscles as well as to prevent the recurrence of contractures.

For the thumb, reduction of the proximal phalanx was obtained after long axis traction as shown in Fig. 2a. Correction of the first web contracture was initiated after reducing the dorsal dislocation of the proximal phalanx at the MP joint by using a newly assembled perpendicular frame (Fig. 2b).

Three years after the surgery, the patient was satisfied with the results and had only mild recurrence of the deformity (Fig. 4). Active and passive ROMs of all post-surgical PIP joints were maintained to 30° or more and 90° or more, respectively. Loss of active ROMs of all post-surgical PIP joints were observed. All MP joints were stiff at the functional position. She was still able to perform a pulp-to-pulp pinch and grip.

Discussion

It is rare to encounter complete contractures of intrinsic plus hand, in which the intrinsic muscles exceed extrinsic muscles in traction. Usually, conservative treatment with a splint is not effective. In the most severe cases, flap coverage is necessary for the surgical release of the stiff joint and atrophic muscle [6, 7]. We have previously treated several cases with intrinsic plus hand contracture in a conventional manner by surgically releasing the MP joints and volar plates, resecting the lateral tendons of interossei from a volar approach, and covering the open wounds with

ulnar parametacarpal flaps or Spinner flaps with skin grafts [8, 9]. However, the present case was too severe to perform this surgical joint reduction with soft tissue coverage. Extensive soft tissue surgery is technically demanding and the results are often discouraging, especially when the patient has poor healing potential. Other options to reduce the MP joint are oblique metacarpal shortening osteotomy or resection of the metacarpal head. Lengthening or tenotomy of the flexor muscles at the distal forearm is also a candidate for reducing the tightness of the flexor muscles. For the thumb, we preferred the IM system so as to obtain CM joint fusion in the corrected position and MP joint correction because it seemed difficult to correct the CM joint without excising the trapezium after the PRC procedure.

Clenched fist syndrome, a condition similar to intrinsic plus hand, is treated with amputation, wet dressing on the wound surface after fixation in the functional position with Kirschner wire, and botulinum toxin [10–12]. Like those of clenched fist syndrome, patients with intrinsic plus hand often have episodes of psychiatric diseases, such as eating disorder or alcoholism as in our cases. However, intrinsic plus hand as seen in our cases differed from clenched fist syndrome in that the fingers were impossible to extend under anesthesia. How to differentiate such cases of intrinsic plus hand from psychoflexed hand syndrome as well what causes the deformity remains to be elucidated.

Correction with an external fixator leaves atrophic muscles and other soft tissues intact. We recommend this technique for severe or neglected hand contractures and deformities because it is safe and less invasive. The IM system has promising results in functional and cosmetic formative correction, and the present case demonstrates the IM system can dramatically increase the indication range. However, we do not strongly recommend this method, considering the time and effort we spent on postoperative management. The success of this procedure depends largely on postoperative management and careful evaluation of the hand disorder.

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