Localized type Volkmann’s contracture treated with tendon transfer and tension-reduced early mobilization

A case report

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Abstract
Rationale: For localized type Volkmann’s contracture, in which degeneration of the flexor digitorum profundus (FDP) muscle to one or two fingers and restriction of finger extension occur, dissection or excision of the affected muscle is usually recommended. However, these surgical procedures need relatively wide exposure of the muscle, because the FDP muscle is in the deep portion of the forearm.

Patient concerns: In this report, the case of a 35-year-old woman with localized type Volkmann’s contracture is presented. Her left forearm had been compressed with an industrial roller 4 months earlier, and severe flexion contracture of the long finger and mild flexion contracture of the ring finger developed gradually.

Diagnoses: localized type Volkmann’s contracture.

Intervention: Five months after the injury, transaction of the FDP tendon to the long finger and transfer of the transected tendon to the FDP tendon to the index finger was performed after adjusting the tension of these two tendons using a skin incision. This procedure was followed by a tension-reduced early mobilization technique in which a tension-reduced position of the tendon suture site was maintained by taping the long finger to the volar side of the index finger, and then immediate active range of motion (ROM) exercise was started.

Outcomes: Within 9 weeks after surgery, full ROM had been regained.

Lessons: Using the treatment procedure presented in this case report, a good clinical result was obtained in a minimally invasive manner.

Abbreviations: FDP = flexor digitorum profundus, ROM = range of motion, FDS = flexor digitorum superficialis.

Keywords: tendon transfer, tension-reduced early mobilization, Volkmann’s contracture

1. Introduction

Up to now, a variety of therapeutic techniques for Volkmann’s contracture, such as splitting[1,2] excision of the affected muscle,[3,4] muscle sliding,[1,3-8] tendon lengthening,[2,9,10] and free muscle transplantation,[3,11,12] have been reported. Tsuge classified the disease into 3 groups according to severity, mild (localized), moderate, and severe type. He recommended that surgery be selected according to the severity of the disease, and for localized type Volkmann’s contracture, he recommended dissection or excision of the affected muscles.[11] However, these surgeries usually require a long incision and are rather invasive, since the affected flexor digitorum profundus (FDP) muscle is underneath the flexor digitorum superficialis (FDS) muscle. We believed that a less invasive procedure was needed.

Tension-reduced early mobilization is one of the rehabilitation methods usually applied following tendon rupture reconstruction.[13,14] In this method, the distal stump of the ruptured tendon is transferred to the tendon to the adjacent finger. Afterward, if the ruptured tendon is the flexor tendon, the tension-reduced position is maintained by taping the affected finger to the volar side of the adjacent finger, and the immediate active motion of the fingers is allowed. Using this method, active finger range of motion (ROM) exercise can be performed under a tension-reduced condition of the tendon suture site. Good clinical results have been reported using this method.[13,14]

A case of localized type (mild type) Volkmann’s contracture treated with tendon transfer and tension-reduced early mobilization is presented. In our view, by using this method, good clinical results will be obtained in a minimally invasive manner.

2. Case report

A 35-year-old woman presented to our hospital for subspecialty consultation for persistent flexion contracture of her left long and ring fingers. Her left forearm had been compressed with an
industrial roller 4 months earlier. The flexion contracture had
developed gradually after the injury, and she had received
rehabilitation to improve the contracture, but it failed.

On physical examination, the long finger of the left hand
demonstrated severe flexion contractures, and the ring finger
demonstrated a mild flexion contracture with the wrist in the
neutral position (Fig. 1 A and B). However, the flexion
contractures of these 2 fingers were reduced with the wrist in
the palmar flexion position (Fig. 1C). The ranges of motion of the
thumb, index, and little finger were normal. No cord-like
induration that suggested muscle degeneration was palpable on
the anterior side of the forearm, and there was no sensory
disturbance or paralysis of extrinsic or intrinsic muscles.
Roentgenograms of the left forearm showed no evidence of
fracture or deformity. In order to identify the area of muscle
degeneration, magnetic resonance imaging was performed, but
there were no intensity changes in the flexor muscle bellies. Thus,
the affected area could not be identified.

Five months after the injury, the patient underwent surgery.
The FDP tendons to the long and ring fingers were explored via a
4-cm longitudinal skin incision, and the FDP tendon to the long
finger was found to have lost its mobility because of muscle
contracture (Fig. 2A). The mobility of the FDP tendon to the ring
finger was only slightly decreased, and mobilities of the FDS
tendons to both the long and ring fingers were normal. Thus, it
was decided to transect only the FDP tendon to the long finger
just distal to the tenomuscular junction. By doing this procedure,
the flexion contracture of the long finger was reduced (Fig. 2B).
Then, the distal stump of the transected tendon was transferred to
the FDP tendon to the index finger using end-to-side interlacing
suture after adjusting the tonus of these 2 tendons (Fig. 2C). For
the FDP tendon to the ring finger, no surgical intervention was
performed because the contracture was mild. After the surgery,
the tension-reduced position was maintained by taping the long
finger to the volar side of the index finger, and then immediate

![Figure 1](image1.png)

**Figure 1.** Preoperative findings of the left hand. (A, B) The long finger shows severe flexion contracture, and the ring finger shows a mild flexion contracture with the wrist in the neutral position. (C) The flexion contractures of these 2 fingers are reduced with the wrist in the palmar flexion position.

![Figure 2](image2.png)

**Figure 2.** Intraoperative findings. (A) The FDP tendon to the long finger has lost its mobility because of muscle contracture. (B) By transecting the FDP tendon to the long finger, the flexion contracture of the long finger is reduced. (C) The distal stump of the transected tendon has been transferred to the FDP tendon to the index finger. FDP = flexor digitorum profundus.
The active ROM exercise was started. During the day, the wrist was fixed in the neutral position with a dorsal plastic splint to prevent excessive extension stress to the flexor tendons (Fig. 3). The patient was allowed to do active ROM exercise without the splint only in the rehabilitation room in the presence of a hand therapist. At night, the wrist and MP joints were fixed at 20 degrees of palmar flexion, and the PIP and DIP joints were fixed at 0 degrees with a night splint to prevent recurrence of flexion contractures of the fingers (Fig. 4). The application of the splint was continued for 3 weeks after surgery, and taping was continued for 5 weeks. Full extension of the long finger was maintained from the day of surgery to the day of final observation. Within 9 weeks after the surgery, full flexion of the long finger had been regained. The flexion contracture of the ring finger had also improved, even though no surgical intervention was performed for the FDP tendon to the ring finger (Fig. 5). The grip strength of the left hand at the final observation (12 months) was 21.7 kg, compared to 22.8 kg for the unaffected right hand. Written, informed consent was obtained from the patient for publication of this case report and accompanying images.

3. Discussion

Among the stages of Tsuge’s classification (mild, moderate, and severe types),[1] the mild type is also called the localized type, and in this type, there is degeneration of part of the FDP muscle, causing contracture in only 2 or 3 fingers. Tsuge also classified localized type into 3 groups according to the injured portion of the forearm (common, proximal, and distal types); the common type, in which the middle one-third of the forearm is affected, is the most common. He reported that, in this type, there is contracture of the long or ring finger, or both, if the muscle degeneration is limited to part of the FDP, and half of the cases were due to contusion and crush injury of the forearm.[1] In the present patient, the flexion contracture was observed only in the long and ring fingers following a roller injury affecting the middle one-third of the left forearm. These facts suggest that her Volkmann’s contracture belonged to the common localized type.

For the localized type Volkmann’s contracture that develops within 1 month, a combination of dynamic splint, physical therapy, and functional training is considered effective.[1] On the other hand, for older Volkmann’s contractures, surgical treatment is needed. Tsuge and Ishida reported that, when the...
contracture involves only 1 or 2 fingers and the extent of muscle degeneration is comparatively limited, dissection or excision of the affected muscle will suffice, or if that is insufficient, lengthening of the flexor tendons may be performed. Conversely, Gulgonen recommended tenolysis and tendon lengthening with Z-plasties after removing the related area of the deep flexors, whereas Stevanovic and Sharpe recommended a muscle sliding operation.

However, to perform dissection or excision of degenerated portions of the FDP muscles, which are in the deep part of forearm, or to perform a muscle sliding operation, a long skin incision and wide exposure of the muscles are required, and a long surgical scar cannot be ignored, especially in female patients. Furthermore, in the present patient, since the flexion contracture of the long finger was severe, the development of flexion lag after excision of degenerated muscle or tendon lengthening was a concern. Gulgonen also reported that a disadvantage of tenolysis and tendon lengthening was the additional weakening of the already impaired muscles. The tendon transfer used in the present patient was performed with a small skin incision, which is advantageous for a young woman. Moreover, by using this method, secure improvement of the flexion contracture is expected, and the development of flexion lag can be avoided. Furthermore, with this method, since the FDP tendon to the long finger was transected, decreased grip strength was a concern; however, grip strength was maintained at almost the normal level in the present patient.

The advantage of tension-reduced early mobilization is that the patients can start finger active ROM exercises immediately after surgery without loading stress to the tendon suture site. Better tendon gliding is expected with this active finger motion compared with other exercises, such as Kleinert’s method, in which the fingers are flexed passively by a rubber band. This advantage decreases the risk of tendon adhesion. In the present case, it was thought that the patient regained good ROM of her fingers because of this. Concerning grip strength, Ishida et al. reported that the average postoperative grip strength of the affected hand was 74% of the unaffected hand after dissection or excision of the affected muscle or lengthening of the flexor tendons. In the present patient, the grip strength of the affected hand at the final observation was 95% that of the unaffected hand. This result is fairly good compared with their report. Furthermore, the preservation of grip strength indicates that the effect of transsection of a single FDP tendon on grip strength is minimal.

Concerning the timing of surgery, Seddon recommended waiting for at least 3 months for evidence of spontaneous recovery in the forearm muscles before surgical treatment. Tsuge recommended waiting for more than 5 or 6 months as function of the hand and fingers was gradually restored with the recovery of the degenerated muscles. However, Chuang advocated exploration within 3 weeks of injury, since debride ment of infarcted muscles can prevent the fibro tic compression responsible for further nerve damage. In this case, surgery was performed 5 months after the injury. Since there were no neurological signs in the present patient, it was possible to wait for a sufficient duration, and 5 months was considered enough to verify the recovery of degenerated muscles.

In this case, the flexion contracture of the ring finger recovered fully without surgical intervention. We thought that the muscle degeneration was very limited in the FDP muscle to the ring finger, and the flexion contracture was mainly at the synovial communication between the FDP tendon to the ring and long fingers. Just after the surgery, 64° flexion contracture of the ring finger persisted, but it gradually improved. This fact suggested that the degeneration and contracture were actually present in the FDP muscle to the ring finger, but they were mild enough to recover with rehabilitation.

Tendon transfer and tension-reduced early mobilization presented in this report were very useful for a localized type Volkmann’s contracture. The advantages of this method were that it was minimally invasive, and, furthermore, early mobilization minimized the risk of postoperative tendon adhesion. In our view, this method could be a useful treatment for localized type Volkmann’s contracture involving 1 or 2 fingers.

References

[1] Tsuge K. Treatment of established Volkmann’s contracture. J Bone Joint Surg Am 1975;57:925-9.
[2] Sundararaj GD, Mani K. Management of Volkmann’s ischaemic contracture of the upper limb. J Hand Surg Br 1985;10:401-3.
[3] Hovius SE, Ultee J. Volkmann’s ischemic contracture. Prevention and treatment. Hand Clin 2000;16:647-57.
[4] Seddon HJ. Volkmann’s contracture: treatment by excision of the infarct. J Bone Joint Surg Br 1956;38:152-74.
[5] Page CM. operation for the relief of flexion-contracture in the forearm. J Bone Joint Surg Am 1923;5:233-4.
[6] Sharma P, Swamy MKS. Results of the Max Page muscle sliding operation for the treatment of Volkmann’s contracture of the forearm. J Orthop Traumatol 2012;13:189-96.
[7] Nisbet NW. Volkmann’s ischaemic contracture benefited by muscle slide operation. J Bone Joint Surg Br 1952;34:245-7.
[8] Stevanovic M, Sharpe F. Management of established Volkmann’s contracture of the forearm in children. Hand Clin 2006;22:99-111.
[9] Hardwicke J, Srivastava S. Volkmann’s contracture of the forearm owing to an insect bite: a case report and review of the literature. Ann R Coll Surg Engl 2013;95:e36-7.
[10] Tsuge K. Green’s Operative Hand Surgery, Vol. 1. 3rd ed.1993,Churchill Livingstone, Philadelphia, PA:593-605.
[11] Ikuta Y, Yoshio K, Tsuge K. Free muscle transfer. Aust N Z J Surg 1980;50:401-5.
[12] Zuker RM, Beuzhly M, Mantelkow RT. Selective fascicular coaptation of free functioning gracilis transfer for restoration of independent thumb and finger flexion following Volkmann ischemic contracture. J Reconstr Microsurg 2011;27:439-44.
[13] Ikegami H. Experimental study on the effects of tension-reduced early mobilization on extensor tendon healing. Nihon Seikeigeka Gakkai Zasshi 1995;69:493-505. [Japanese].
[14] Suzuki T, Iwamoto T, Ikegami H, et al. Comparison of surgical treatments for triple extensor tendon ruptures in rheumatoid hands: a retrospective study of 48 cases. Mod Rheumatol 2016;26:206–10.
[15] Ishida O, Suzuki O, Sunagawa T, et al. Treatment of established Volkmann’s contracture. J Jpn Ped Orthop Ass 2005;14:170–3.
[16] Gulgonen A. Green’s Operative Hand Surgery, Vol. 2. 5th ed.2005; Churchill Livingstone, Philadelphia, PA:1985-2006.
[17] Chuang DC, Carver N, Wei FC. A new strategy to prevent the sequelae of severe Volkmann’s ischemia. Plast Reconstr Surg 1996;98:1023-31.