Two-stage tendon sheath reconstruction using sublimis tendon and silicone Penrose drain after severe purulent flexor tenosynovitis: a case report

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Abstract Two-stage tendon sheath reconstruction, a method of pulley reconstruction using the sublimis tendon and a pseudosheath formed with a silicone Penrose drain wrapped around the profundus tendon, is a new technique for improving a poor functional prognosis after purulent flexor tenosynovitis.

Keywords Purulent flexor tenosynovitis · Tendon sheath · Penrose drain · Pulley reconstruction

Introduction

In case of purulent flexor tenosynovitis, early diagnosis followed by immediate surgical treatment with administration of antibiotics is widely recognized as a golden rule [7, 8, 15]. Without prompt treatment, infection within the sheath quickly worsens and consequently devitalizes the tendon sheath, the overlying skin, and occasionally, the tendon itself. In such cases, severe functional deficit remains, even after the infection has receded. Although many reports have focused on the initial stages of treatment, such as irrigation, debridement, and drainage [7, 14, 15], detailed discussions of secondary functional reconstruction are scarce. Poor prognosis due to total peritendon failure with partially survived flexor tendons and tendinous adhesions is possible in the progressive stage of flexor tenosynovitis (stage III in Michon classification [11] and stages III to IV in Loudon classification [8]). The basic strategy of functional reconstruction consists of pulley

reconstruction and tenolysis followed by postoperative motion exercises, but two particular points merit close attention. Early motion exercise after tenolysis is mandatory to achieve functional separation of the profundus and sublimis tendons. But a coapted surgical wound made on cicatricial skin and subcutaneous tissue is often too vulnerable to withstand aggressive early motion exercise. However, two-stage tendon sheath reconstruction may help mitigate the potential pitfalls encountered in the treatment of this complex condition.

Surgical Technique

Two-stage tendon sheath reconstruction should be planned after any signs of infections have not manifested for four consecutive weeks following cessation of any kinds of infection management including administration of prophylactic oral antibiotics. Since administration of antibiotics is usually continued for 2–4 weeks postoperatively, eventually it takes 6–8 weeks after the initial debridement and irrigation. The interval of 6–8 weeks is enough to judge as infection-free condition based on the general principle of two-stage reimplantation for artificial joint infection [10]. During the waiting period prior to reconstruction, range of motion (ROM) exercises should be conducted to prevent joint contracture. Since operation under axillary block has an advantage to avoid unfavorable and abrupt grasp of the operated hand which is seen during awakening from general anesthesia in some cases, both staged operations are performed under axillary regional block anesthesia with tourniquet control.

First Stage Operation

Radical tenolysis is administered to the surrounding subcutaneous tissue along the tendons and then between the sublimis and profundus tendons. The sublimis tendon is

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severed at the distal palm area and split into two slips. The distally based slips attached at the chiasma are used for pulley reconstruction. In case of total pulley deficiency due to necrosis and/or imperative radical debridement, one slip can be used for reconstruction of the proximal pulleys (such as A1, A2, and C1), and the other can be used for distal A4 and C3 reconstruction. The slip is sutured in a shoelace fashion to the fibrous tissue close to the bone or the remnants of the corresponding normal pulleys, if these exist. A widely used silicone Penrose drain (made by Fuji Systems Co., Ltd, Tokyo, Japan in our cases) is split longitudinally and used to prevent recurrent tendon adhesion by forming a pseudosheath. The profundus tendon on the proper digits is wrapped by the split Penrose drain inserted underneath the reconstructed pulleys. The tourniquet is deflated before wound closure in order to check for inadequate hemostasis. On the first postoperative day, gentle, active, and passive ROM exercise is initiated to prevent joint contracture.

Wound dehiscence caused by aggressive ROM must be avoided, so it is important that these exercises do not damage the overlying cicatricial skin. The presence of the silicone Penrose drain around the tendon obviates the need for active tendon gliding exercises to prevent tendon re-adhesion. Otherwise, a dorsal splint is applied at rest, with mild flexion of the wrist and intrinsic plus position of the digits. Although the splint is worn for 2 weeks postoperatively, active use of the affected digit should be prohibited until the second stage operation.

Second Stage Operation

The second stage operation is administered 6 weeks after the first stage. The silicone Penrose drain is removed through partial re-incision along the prior operative scar. Both active and passive ROM exercises commence at the day after the operation.

Fig. 1 **a** A 49-year-old-healthy man presented with subcutaneous abscess on the dorsal aspect of the DIP joint, circumferential swelling and redness of the entire digit, and all four Kanavel signs. **b, c** Proximal progression of the purulence was identified along the extensor tendon with necrosis of the terminal tendon. **d** Severe purulent flexor tenosynovitis caused by volar progression of the infection through the ruptured volar capsule of the DIP joint was also identified

A Case Report

A 49-year-old healthy man complained of inability to flex his left middle finger with severe pain 1 month after popping a mucous cyst at the dorsal aspect of the distal interphalangeal joint (DIP) joint. He presented with a subcutaneous abscess on the dorsal aspect of the DIP joint, circumferential swelling and redness of the entire digit, and all four Kanavel signs (Fig. 1a). Intravenous administration of broad spectrum antibiotics was initiated preoperatively. Surgical exploration revealed proximal progression of the purulence not only of the extensor tendon with the necrotic terminal tendon, but also severe purulent flexor tenosynovitis with extensive necrosis of the tendon sheath on the volar side through the ruptured volar capsule of the DIP joint (Fig. 1b–d). Radical debridement of necrotic tissue and irrigation were administered on both the dorsal and volar sides. Since the necrotic terminal tendon was debrided and the articular cartilage of the DIP joint was

severely damaged, arthrodesis was aimed on the DIP joint in functional position with an external splint. All wounds were closed primarily. A bulky dressing was applied on the hand in the functional position postoperatively. After α -hemolytic *Streptococcus* was cultured from debrided tissue, sensitive antibiotics were then administered for a further 7 days in addition to precedent broad spectrum antibiotics. After an interval of 4 weeks without recurrence was achieved, staged flexor tendon sheath reconstruction was planned. The first stage began with meticulous tenolysis (Fig. 2a, b), and then the sublimis tendon at the distal palm was severed and split longitudinally in two slips. One slip of the distally based slips attached at the chiasma was used for substitution to A2 and C1 pulleys and sutured to the fibrous tissue close to the proximal phalanx from A2 to C1 level in a shoelace fashion (Fig. 2c). Since distal pulley reconstruction was unnecessary due to arthrodesis on the DIP joint in this case, the other slip was discarded. A longitudinally split silicone Penrose drain was

Fig. 2 **a** A dense scar was identified around the tendons in the first stage operation. **b** A scabrous tendon lacking a tendon sheath appeared after tenolysis. **c** The half-slip of sublimis tendon based at the chiasma was used for substitution to A2 and C1 pulleys. **d** A silicone Penrose drain was split longitudinally and inserted underneath the reconstructed pulleys, wrapping the profundus tendon

Fig. 3 **a, b** Three months after the operation, complete arthrodesis of the DIP joint was achieved. **c** Significant flexion failure before reconstruction of the tendon sheath. **d** Improvement of flexion after reconstruction

inserted underneath the reconstructed pulleys and used to wrap the profundus tendon (Fig. 2d). Six weeks later, the silicone Penrose drain was removed through a small incision. Three months after the operation, complete arthrodesis of the DIP joint was achieved in 45° of flexion (Fig. 3a, b). It was not ideal angle for arthrodesis of the DIP joint, but acceptable position in this case in which the DIP joint was fixed with only external splintage. Motions of both MP and PIP joints ranged from 0° to 90° , and pulp to distal palmar crease distance (PPD) was 2.5 cm (Fig. 3d). Evaluation with Buck–Gramcko score [5] improved to “good” from preoperative “poor” grade in which the total range of motion was 135° , and PPD was 6.5 cm (Fig. 3c).

Discussion

The purpose of two-stage flexor tendon reconstruction is to form a smooth tendon gliding surface (a pseudosheath), with

temporary use of an artificial rod or tube prior to tendon graft in cases of severe flexor tendon injury. The original technique, using a celloidin tube, was first described by Mayer [13] in 1936. A modified version of this technique, using a silicone rod was later reported by Bassett and Carroll [3] with successful results. Around the same time, coverage of a primarily repaired or grafted tendon with a slip of fascia lata [6] and its modification using an artificial sheet [1, 2, 16] substituted for the tendon sheath was used as a solution for the same condition. Although artificial materials were used in both techniques, the former technique has been more than the latter. The latter technique eventually became obsolete, in part because the artificial tendon sheath obstructed extrinsic blood supply. In contrast, the technique described in this paper allows tissue fluids through the split portion of the Penrose drain between the two stages of surgery, assuring a continuous intrinsic blood supply and maintaining tendon viability.

Different from two-stage flexor tendon reconstruction using silicone rods in which the waiting interval between two stages is typically maintained 2 to 6 months for maturation of the tendon bed to the point where it can nourish and lubricate the gliding tendon graft [9], the purpose of an interval between two stages of this tendon sheath reconstruction is to wait for maturation of the cicatricial skin and subcutaneous tissue to enable aggressive ROM exercise. Furthermore, since histological observation over time revealed formation of pseudosheath surrounding a silicone rod in 4 weeks [20], 6 weeks is a plausible interval for this tendon sheath reconstruction.

In the severe stage of purulent flexor tenosynovitis, in which the digit is near amputation, it is likely that the flexor tendons will survive but accompanied by tendon sheath necrosis. In such cases, poor functional prognosis due to nearly complete deficiency of the tendon sheath with strong tendinous adhesion can be expected. Flexor pulley injury is frequently seen in rock climbers, and pulley reconstruction is indicated in cases of multiple pulley injuries [17]. Although reconstruction of robust pulleys followed by aggressive early motion exercise is recommended for functional recovery in these cases, functional reconstruction to prevent deficiency of the tendon sheath after severe purulent flexor tenosynovitis requires a different approach. Since the subcutaneous scar surrounding the neurovascular bundle is usually dense and broad, accidental injury to the neurovascular bundle may occur due to blinded circumferential undermining around the phalanx in robust pulley reconstruction such as Bunnell's loop technique [19]. Furthermore, a coapted surgical wound made on cicatricial skin and subcutaneous tissue is too vulnerable to withstand aggressive early motion exercise. Two-stage tendon sheath reconstruction using a silicone Penrose drain is a useful option in this particular circumstance.

In comparison to other anti-adherent agents, a Penrose drain is inexpensive and compassable everywhere. Recently, hyaluronic acid gel has been proven to be effective in reducing adhesion in animal models [12, 18]. Because of no need of removal, using hyaluronic acid instead of a Penrose drain will make this tendon sheath reconstruction simpler in the near future. Blanco's success using a silicone rod for two-stage flexor tendon grafting in an infectious trauma case [4] suggests that temporary usage of the silicone Penrose drain after purulent flexor tenosynovitis presents a low risk of recurrent infection.

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Conflict of Interest The authors declare that they have no conflict of interest.

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