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Hand

Prevention of Postoperative Peritendinous Adhesions with Bioresorbable Suprathel Barrier Membrane

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Summary: Postoperative adhesions can deteriorate clinical outcomes in tendon repair surgery significantly. Thus, the use of artificial membranes as a tendon sheath substitute has become popular and well studied in the last years. We performed a case series of three patients using a novel synthetic membrane (Suprathel) for complex reconstructive surgery and traumatic tendon repair surgery. All patients recovered well with no significant adverse effects and showed good clinical function afterward. Therefore, we concluded that Suprathel might be another potential candidate to prevent postoperative peritendinous adhesions. Further studies will be necessary to determine the effect of this bioresorbable barrier membrane.
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INTRODUCTION

The creation of a functional tendon slide bearing is a challenging task in complex reconstructive surgery. Especially, the reconstruction of traumatic or oncologic defects requires a feasible solution to prevent postoperative tendinous adhesions to conserve a functional hand or foot. Unfortunately, adhesions to the surrounding tissue are a major complication of any tendon surgery that can not only lead to limited range of motion (ROM) and thus reduced functionality but also bear the risk of a secondary tendon rupture due to forceful training or mobilization. Various techniques have been developed to prevent adhesions postoperatively like early postoperative motion of the affected joint (eg, passive mobilization as seen in Kleinert treatment or load free motion as found in early active motion protocols).[1,2] However, there are numerous additional surgical and nonsurgical techniques that have to be discussed: different suture techniques,[3] (if possible) closure of the existing tendon sheath,[4] medication with nonselective cyclooxygenase inhibitors,[5] or perioperative instillations of hyaluronic acid.[6] Most of these techniques did not show substantial benefit to the postoperative results, except early active motion and Kleinert treatment.

In this article, we demonstrate a new surgical approach to prevent adhesions after complex tendon repair in reconstructive surgery by the use of a biological degradable polymeric membrane.

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SUPRATHEL MEMBRANE

All of our patients were treated in our plastic surgery department at a maximum care hospital due to trauma or cancer surgery, and all underwent conventional surgical procedures. Additionally, they gave informed consent for compassionate use of Suprathel membrane to prevent postoperative adhesions. The copolymer-based Suprathel membrane is manufactured by Polymedics Innovations GmbH (Denkendorf, Germany) and consists of a combination of D,L-lactid, trimethylencarbonate and epsilon-caprolactone monomers. It is conformité européenne marked for the treatment of wounds and has become a standard for the treatment of burn wounds and split thickness skin graft donor sites. In this indication, it functions not only as a barrier material but also as a biodegradable matrix for dermal regeneration.[7–10] Therefore, we hypothesized that it is able to create a bioresorbable barrier to allow the body to form a tendon sheath substitute as it is wrapped around tendons and promotes a kind of serosal lining of the tendon before it is fully resorbed.

Case 1

A 43-year-old female patient underwent radical tumor resection due to a sarcoma of the right dorsal foot in 2017. Here, oncological resection included all dorsal connective tissues of the ankle from skin to periosteum. Thus, all extensor tendons and especially the extensor hallucis longus (EHL) tendon were resected. During the preoperative counseling, the patient asked for a reconstructive

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procedure that allowed sportive activities like hiking and walking. Therefore, we decided to reconstruct the defect with a free gracilis muscle that was anastomosed to the anterior tibial artery and allowed full coverage of the cutaneous defect. Moreover, the EHL tendon was reconstructed using the tendinous part of the gracilis muscle, and the distal extensor tendons of the remaining digits were tenodized to the intact forefoot. The patient recovered well and soon returned to daily activities. Although the overall result was very satisfying for the patient, she underwent tenolysis and tendon shortening by a suture technique 1 year after the initial surgery. By these means, dorsal extension could be improved but was still limited. Therefore, another surgery was performed 4 months later in May 2018, and the EHL tendon was rigorously freed from adhesions proximally up to the dorsal retinaculum. A tendon graft harvested from the plantaris muscle was interlaced with the proximal and distal stump of the EHL tendon. By these means, a threefold strand was created and could be sutured under adequate tension with a Kessler-Kirchmayer suture in maximal dorsal extension of the ankle. Finally, Suprathel was wrapped around the tendon, and the wound was closed with the remaining gracilis flap. After consequent rest and ongoing physiotherapy, the patient regained a good ROM of the metatarsophalangeal joint that was sufficient for the patient. In April 2020, we measured a ROM 0-0-30-degree angle regarding the metatarsophalangeal 1 joint. But more importantly, the patient could return to sportive activities that were only limited by early arthritis due to the osseous resections of the lower ankle (Fig. 1).

Case 2

A 26-year-old female patient suffered from a deep injury with a kitchen knife after preparation of an avocado in 2018. She had a 2-cm-long wound in zone 2 proximal to the proximal interphalangeal joint of the left middle finger, and clinical examination was highly suggestive for a deep flexor tendon injury. Therefore, early elective surgery was planned, and informed consent for the use of Suprathel was given. During wound exploration, we found a complete cut of the deep flexor tendon and also of the ulnar superficial flexor tendon. Repair was performed according to internal standards using a four-stranded Kirchmayr-Kessler suture. Afterward, Suprathel was wrapped around tendons instead of the injured A2 annular ligament. Postoperative training started during the first week postsurgery and was based on the Kleinert regime. Although wound healing was without any problems, the patient had limited ROM 3 months after surgery (proximal interphalangeal 0-0-60 and distal interphalangeal joint 0-0-30) and underwent prolonged ergo therapy. Two years later, the patient was very satisfied and had an almost complete ROM.

Takeaways

Question: Peritendinous postoperative adhesions occur regularly in tendon surgery and challenge clinical outcomes. Can bioresorbable barrier membranes used as artificial tendon sheaths prevent postoperative adhesions?

Findings: Three patients (complex reconstruction and trauma) were treated by Suprathel membranes and gained good clinical outcomes with no adverse side effects.

Meaning: Bioresorbable Suprathel membranes could become a new clinical tool to prevent peritendinous adhesions.

Case 3

The third patient was a 73-year-old man who suffered from a synovial sarcoma of the right wrist. He underwent chemotherapy and R0-resection in February 2018. The defect resulted in the entire loss of the dorsal soft tissues, including the extensor tendons and joint capsule.

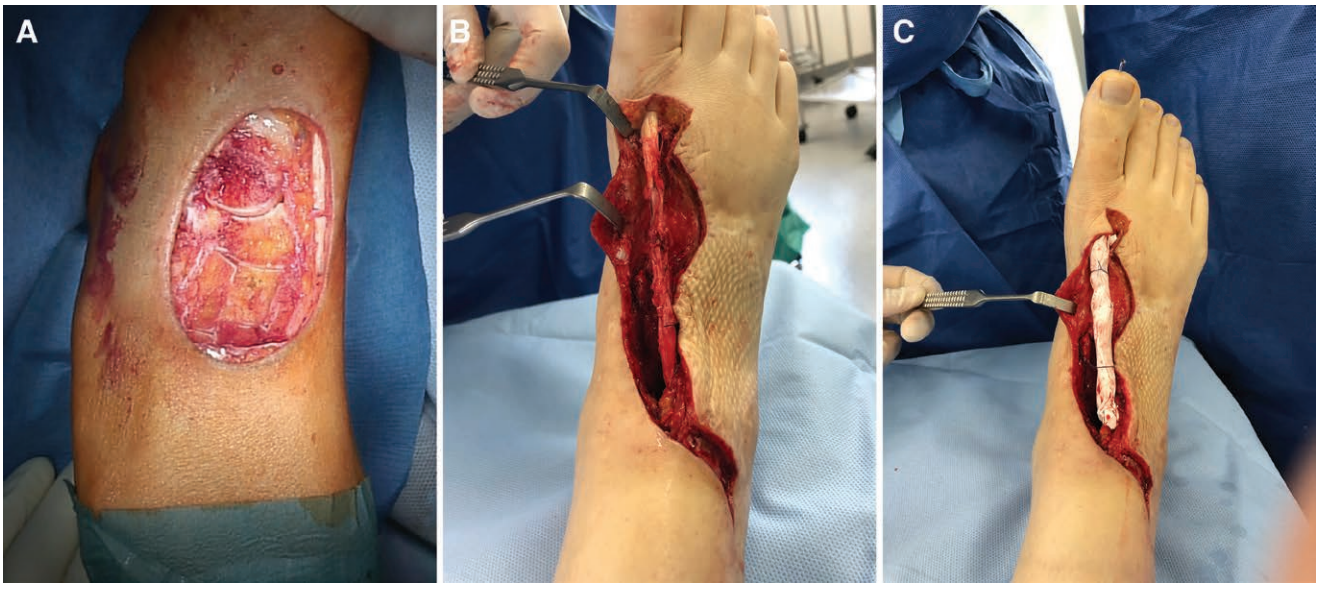

Fig. 1. Complex reconstruction after oncologic resection. A, The defect over the dorsal ankle. B, Reconstruction of the tendon. C, Suprathel wrapped around the tendon.

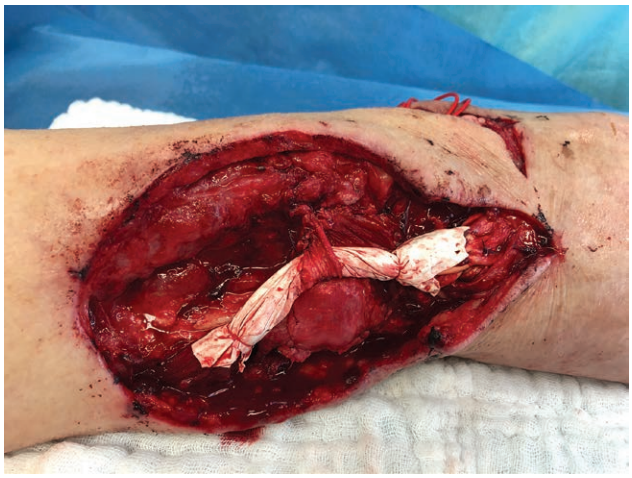

Fig. 2. Defect at dorsal wrist reconstructed with tendon transfer wrapped with Suprathel and a sling used as a pulley for the extensor tendon.

Therefore, he underwent a 7-hour long reconstructive surgery. Here, the joint capsule was enforced using a fascia lata graft, and multiple tendon transfers were performed for functional reasons. In particular, the palmaris longus tendon was transferred to the extensor pollicis longus (EPL) tendon, and the flexor carpi ulnaris muscle was transferred to the extensor digitorum communis tendons. Suprathel was wrapped around tendon transfer sutures and tendons themselves to create a new tendon sheath. Finally, the defect was closed using a free M. gracilis flap with a split skin graft. Recovery went well, and the patient left the clinic with closed wounds. We were able to make a telephone interview with the patient in April 2020. Additionally, we were able to assess the ROM of the hand using a short video clip. The patient reported to us that he was in good health and that he was very satisfied with the functional result after surgery. He was limited but able to do all necessary daily activities. For example, he managed to eat with knife and fork both handed and was able to write (Fig. 2).

DISCUSSION

Reviewing the literature, we found that clinical studies have been performed since the 1980s. There have been several materials tested for use in flexor tendon repair with variable results. Most studies did not find a significant benefit with the use of biomaterials to prevent adhesions. Only Eiken et al[11] found very good results with autologous tissue transplants.

We found one study that investigated the safety of Seprafilm.[12] The author reported no significant adverse effects. Patients recovered well and had good function. These promising results by Kohanzadeh et al[12] are very similar to our observations. We believe that the operative approach and the similar biological function of sodium hyaluronate with carboxymethylcellulose can explain our findings. Additionally, Chen et al[13,14] conducted several in vitro studies with polycaprolactone (PCL)-based membranes. Here, they found very promising results with reduced peritendinous adhesion from histology, joint flexion angle, gliding excursion, and biomechanical evaluation. Moreover, they have shown that these PCL-based membranes have similar efficacy to commercially available Seprafilm. As the Suprathel polymer also contains PCL, we might conclude that it has similar efficacy to prevent postoperative adhesions and similar safety as that seen in the Seprafilm study and the membranes studies by Chen et al.[15]

CONCLUSIONS

Suprathel can be regarded as a potential new candidate for clinical investigations. It has several advantages: clinical approval for other indications, good safety results, and good clinical results in our patients. Therefore, we recommend further clinical investigations in a placebo-controlled prospective clinical trial to determine the effect of bioresorbable Suprathel barrier membranes.

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The investigation was performed according to the Declaration of Helsinki. There was no clinical trial registered as this study was a retrospective case analysis.

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