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International Journal of Surgery (2005) 3, 113–116

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INTERNATIONAL JOURNAL OF SURGERY

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Use of vein graft as a tendon sheath substitute following tendon repair: An innovative technique in tendon surgery☆

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KEYWORDS
Tendon sheath;
Tendon repair;
Saphenous vein;
Venous patch

Abstract *Objectives:* This is a new technique for managing tendon repair that may improve the results of existing methods.
Methods: In a prospective randomized clinical trial, 210 patients were divided into two groups of test and control. All patients had flexor tendon injuries, involving zone 2. They were new or old tendon injuries or complications of previous repairs. In the test group (105 patients), a modified Kessler repairing of tendons with 3-0 prolene was used, followed by a core suture of running 6-0 nylon or prolene epitendinous suture. After the tendon repair, a segment of vein through which the tendon had been passed before or a patch of vein, as a tendon sheath substitute, was used to repair the sheath defects. The results in a span of six months of follow-up were compared with those of the control group whereon 105 patients were operated under the conventional technique – the modified Kessler method.
Results: We assessed the results by measuring the range of motion of the MCP joint in the follow-up period and we graded them as excellent, good, fair and poor. In the test group we had 86% excellent, 11% good, 3% fair and 0% poor results, and in the control group, 0% excellent, 12% good, 38% fair and 50% poor results. The differences were significant ($p < 0.005$).
Conclusions: Our preliminary results appeared encouraging when compared with the outcomes achieved by the conventional tendon repair technique. As this technique reduces the adhesion formation, improves tendon nourishment, and decreases the need of intensive physiotherapy, it may substitute the conventional one and become a standard technique in the future.
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☆ Presented in the 5th European Congress of Trauma and Emergency Surgery, October 2002, Istambul, Turkey.

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doi:10.1016/j.ijsu.2005.06.007

Introduction

In the past, most surgeons performing zones 1 and 2 flexor tendon repair in the fingers and thumb, routinely removed some portion of the tendon sheath.[1,2] Theoretically, it was believed that such a removal would prevent the development of adhesion between the tendon and its covering sheath and would thus, allow unrestricted motion of repaired tendon without any interference from the sheath or pulley systems. Recently, concepts of tendon nutrition and healing have changed, instead emphasis has been placed on the diffusion of nutrients via the synovial fluid as one of the major mechanisms of flexor tendon nourishment.[3,4] Another hypothesis states that flexor tendons within the digital sheath have an intrinsic capacity for healing.[5,6] It, therefore, seems logical to re-establish the continuity of the tendon sheath to improve tendon nourishment and prevent restricting adhesion formation that may occur between the repaired tendon and surrounding tissues. In this study a segment of a vein, the saphenous vein, was used as the tendon sheath substitute.

Material and methods

We planned a prospective randomized clinical trial with 210 patients who suffered from zone 2 flexor tendon injury and were, from May 1996 to October 2001, referred to the Department of General, Trauma and Vascular Surgery at the Shohada Medical Center, affiliated to the Shahid Beheshti University of Medical Science, Tehran. All patients were informed about the study and had signed the related forms. We divided them into two equal groups (test and control) at random alternatively, but we don't aware them about their position in the test or control groups (single blind study). All of the patients were operated by the same operation team including an attendant surgeon and two residents.

Patients with fresh tendon injuries underwent early primary repairing within 18—24 h, unless the wound was grossly contaminated, dirty or infected. If the injury was a clean sharp wound, or could be converted to one by proper debridement, and if the skin coverage was in good condition, direct end to end repair was carried out; otherwise, a delayed repair was performed.

In all of the patients, first, we repaired the tendon by the modified Kessler technique (Fig. 1) with 3-0 prolene or ethibond as the core suture. Afterwards, we applied a running 6-0 nylon or prolene epitendinous suture to protect the repair site. In the test group (105 patients) after direct end to end repair of the tendon, a segment of vein through which the tendon had been passed prior to the repair, or a vein patch, was used as a tendon sheath substitute. We used 6-0 nylon or prolene monofilament sutures for anastamosing the proximal and distal ends of the sheath defect and the interposed segment of autogenous vein or vein patch (Figs. 2—4). All the patients received antibiotics just before incision and postoperatively. For immobilization, two to three weeks of splinting by a dynamic splint was used. In the control group we performed the same but without repair of tendon sheath defects (as the conventional method). All patients underwent serial outpatient visits in the surgical clinic weekly in the first month, every two week in the second month and monthly thereafter, until the sixth month and the range of motion of the metacarpo-phalangeal (MCP) joint of

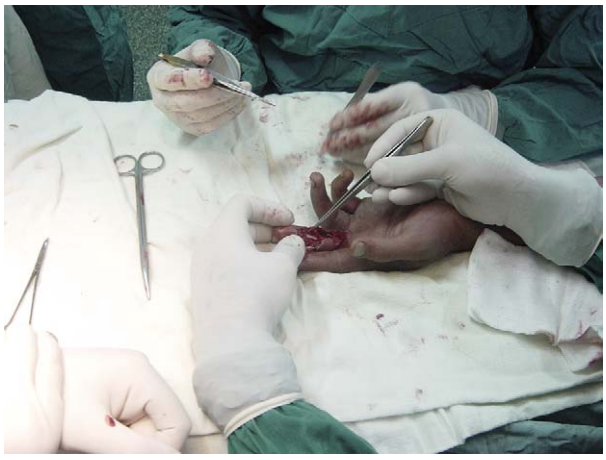

Figure 1

Figure 2

Figure 3

the repaired tendon was measured and the results were recorded in special charts.

The results were graded according to the return of the range of motion in the MCP joints as follows: excellent, 175-130°; good, 129-87.5°; fair, 87.4-43.75°; and poor, 43.74-0°. At the end of the follow-up period the results were compared and then analysed by the *t*-test, grade by grade and *P*-values were calculated.

Results

The average hospital stay was 1.5 days for two groups. Two patients in the flexor tendon repair (vein graft group) felt mild pain, and other patients had no compliant. After 2—3 weeks, the splint was removed from the patients, and they were followed up for 6 months. In the control group there were four ruptures and no excellent results, 13 (12%) being rated as good, 40 (38%) as fair, and 50 (50%) as poor. In the test group there were 90 (86%) as excellent, 12 (11%) as good, 3 (3%) as fair, and no poor results and rupture (Table 1). There were significant differences between the two groups grade by grade ($p < 0.005$).

Figure 4

Table 1 Results of the test and control groups

Group/ROM	Control	Test
Excellent	0 (0%)	90 (86%)
Good	13 (12%)	12 (11%)
Fair	40 (38%)	3 (3%)
Poor	52 (50%)	0 (0%)
Sum	105 (100%)	105 (100%)

Discussion

In the past, for zone 1, and zone 2 injuries, most surgeons used to remove a portion of the flexor tendon sheath around the repaired site in the fingers and thumb for a flexor tendon repair.[1,2] They believed this would allow the development of some motion of the repaired tendon without interfering by the sheath and pulley system. As already mentioned, the concepts of tendon nutrition and healing have changed, and emphasis is now placed on the role of diffusion of nutrients from the synovial fluid in the nourishment of flexor tendons. Theoretically and experimentally, since the synovial sheath and fluid are maintained, nutrition of the tendons is improved and there is fewer tendencies for adhesion formation.[3—6] Some investigators noting the tenuous blood supply to the tendons within the sheath postulated that tendons were nourished not only by vascular perfusion, but also by diffusion from the synovial fluid. According to Manske and Lesker[7] this controversy, beginning at the turn of the century, still remains unsettled.[8] Some authors[5,9,10] have done much to help our understanding about the relative importance of diffusion from the synovial fluid to the flexor tendons. Most of these studies indicate that diffusion is more important than perfusion in flexor tendons of the fingers. Creating a new sheath once again establishes an environment in which diffusion and tendon nutrition can take place and adhesion formation between the newly repaired tendon and adjacent tissues is prevented because the repaired site is no longer exposed.

Any un-repaired window or laceration in the sheath also leaves an edge against which a tendon suture line can catch, and produce posttraumatic triggering and possibly attenuation and rupture. The free edges of an un-repaired sheath scars down,

and adhesions may form, leading to contracture. For this reason, if the defect of the tendon sheath is wide, we use a segment of vein for repairing it. As our results show the patients whose tendon sheaths were repaired had significantly ($p < 0.005$) better function of their related digits comparing with the others. In clinical series, reported so far, there has been no report concerning the use of vein for repairing of the tendon sheath defect. In one study in Japan by Inoue and Suzuki, one stage repair of skin and tendon using an arteriolized venous flap with palmaris longus has been reported,[11] but our technique is much simpler and can be used in all cases of primary and secondary repair, especially in delayed flexor tendon repairs. Early post-operative mobilization and early exercise after tendon repair is encouraged.[12–15]

Due to the disastrous effects that adhesion formation leaves on the gliding mechanism of flexor tendons, a number of techniques have been devised to permit early movement and to prevent adhesion formation. Both clinically and experimentally, it has been shown that early mobilization techniques following flexor tendon repair within the digital sheath have improved tendon healing and promised a better final result.

As our technique reduces the adhesion formation, improves tendon nourishment, allows early mobilization decreases the need for intensive physiotherapy, and improves significantly the function of the operated hand comparing with other methods ($p < 0.005$), it may substitute the conventional one and become a standard technique in the future.

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