Pulley Reconstruction As Part of the Surgical Treatment for de Quervain Disease: Surgical Technique with Medium-Term Results

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Abstract

Background Simple decompression of the first extensor compartment is commonly used for treating de Quervain disease, with the possible complication of subluxation of the tendons of the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) over the radial styloid. To prevent this painful subluxation of the tendons, several methods of reconstructing the pulley have been proposed.

Questions/Purposes The purpose of our study was to evaluate a new technique for reconstructing the first extensor compartment following a release for de Quervain disease.

Patients and Methods A retrospective study (mean length 40.4 months) was performed in 45 patients. The outcome assessment involved two different questionnaires and ultrasound evaluation of any tendon subluxation.

Results None of the patients required reoperation for tendon instability or incomplete decompression of the first extensor compartment. Two patients experienced clicking around the radial styloid after surgery. This was not related to the amount of volar migration of the tendons.

Conclusions We believe the reconstruction proposed here is an effective method of preventing painful subluxation of the APL and EPB following a release of the first extensor compartment.

Keywords

- de Quervain disease
- release tendons
- pulley plasty

As described by Fritz de Quervain¹ in 1895, treatment of de Quervain disease should initially be conservative. If conservative therapies fail to relieve pain, surgical decompression of the first extensor compartment is necessary.^{1,2} Simple incision of the pulley covering the tendons is the most frequently used surgical technique to decompress the compartment.³ An important complication following this type of surgery is painful subluxation of the tendons.^{4–8} This subluxation represents a painful snapping movement of the tendons of the abductor pollicis longus (APL) and extensor pollicis brevis

(EPB) over the palmar ridge of the bony gutter of the first extensor compartment at the radial styloid during wrist flexion and thumb abduction. To manage this complication further surgery is needed. To prevent this painful subluxation of the tendons, several methods of reconstructing the pulley have been proposed.^{9–14}

There are few studies of the results of these different techniques for pulley reconstruction with short follow-ups. We believe the pulley plays a major part in stabilization of the tendons, especially when flexing the wrist and abducting the

thumb, since this places maximum stress on the inflection point of the tendons within the first extensor compartment. At this specific movement the pulley prevents bowstringing of the tendons, and therefore its anatomic features should be respected.

The main purpose of our study was to evaluate tendon instability or relapsing/persistent disease (pain) after surgery. These two complications are both reason for reoperation and thereby considered most significant. Another research question was whether the distance of the tendons to the radius as visualized by ultrasound was actually correlated with clinically reported pain or a clicking sensation. Finally, we also investigated a possible correlation between age of the patient and outcomes.

Patients and Methods

Patients who were operated on between 2005 and 2011 were contacted. Criteria for exclusion that were applied on these initially selected 121 patients consisted of multiple previous operations on the affected hand, simultaneous procedures or other surgery for de Quervain disease on the affected hand, and patients with a follow-up period of less than 12 months.

Forty-five patients with a mean age of 55.2 years (range 20–83 years) agreed to take part in this study. The mean follow up time was 40.4 months (range 3–90 months). Of these participants, 7 were male and 38 were female. The dominant hand was affected in 27 patients. Eighteen patients performed daily manual work in their job. A total of 48 wrists were affected. With respect to patients who had been bilaterally operated, the site of the first operation was taken into account for determining whether the dominant hand was affected, because overuse of the other wrist to compensate for the operated wrist may have led to disease development.

Preoperatively, patients were identified as suffering from de Quervain disease based on a positive history regarding radial-sided wrist pain and tenderness located at the first dorsal compartment on physical examination. Also, a positive Eichhoff test was a requirement for inclusion in the study.^{15,16} With this test, often referred to as a Finkelstein test, the patient is asked to oppose the thumb into the palm and clench the fingers over the thumb. The examiner then ulnarly deviates the hand. Exacerbating pain over the first extensor compartment is a positive test. Possible symptoms of preoperative subluxating were not diagnosed preoperatively on clinical basis, since every patient was tested systematically for tendon displacement as will be described later.

Conservative treatment, consisting of steroid injections, temporary casting, and/or nonsteroidal anti-inflammatory drugs (NSAIDs), had been given to all patients, either by their general practitioner or by a specialist.

The presence of a subcompartment was also checked for in both the preoperative ultrasound report and in the operation report. Unfortunately, these data could not be reproduced reliably, since it was not always specifically mentioned in the relevant reports.

Surgical Technique

The patient was placed in the supine position with the affected arm supported by a hand table. Surgery was performed using radial wrist block under tourniquet control. A transverse incision over the first extensor compartment was made, taking the Langer lines into account. Careful subcutaneous dissection, with identification of the superficial radial nerve, was performed. Consecutively the tendon sheath was dissected and incised proximally and distally to the pulley (→ Fig. 1). A diagonal incision of the pulley was made from

Fig. 1 Anatomic drawing of the first extensor compartment of the right wrist. Peroperative view bottom right.

Fig. 2 Orientation of the incision of the pulley and consequent opening of the first extensor compartment. Peroperative view bottom right.

proximal dorsal to distal palmar, and the tendons were checked for possible intertendinous septa, which were excised if present (**►Fig. 2**). Synovectomy was performed when possible. To enlarge the pulley, the bases of the flaps were incised up to half their size (**►Fig. 3**). To avoid translation of the inflection point, the palmar flap was mobilized over half of its length in its proximal portion and the dorsal flap in the same fashion over its distal portion (**►Fig. 4**). The

transversely mobilized sides of the pulley were consequently sutured together, thereby enlarging the pulley. The volar flap was sutured in a layered fashion, taking care to put it under the dorsal flap, using Vicryl 3.0 (Ethicon, Somerville, NJ, USA) for u-shaped sutures (**►Fig. 5**). The enlarged pulley was checked for patency by passing the tip of the scissors between the new pulley and the tendons. Patients were then asked to flex their wrist while abducting their thumb actively to verify

Fig. 3 Mobilization of the flaps. Arrows refer to side of incision of the flaps. Peroperative view bottom right.

Fig. 4 The incisions at the bases of the flaps are made, and the transverse sides will be sutured together. Peroperative view bottom right.

stability of the tendons of the first extensor compartment. Finally, extensive irrigation was applied, followed by intracutaneous suturing of the skin with Ethilon 5.0 (Ethicon, Somerville, NJ, USA). Standard wound care with a paraffin-impregnated dressing and a wet and dry bandage was given and a protective palmar splint applied.

Postoperative Management

The first day after surgery, a postoperative wound check was combined with the application of a tailor-made remov-

able dorsal cast with inclusion of the thumb. Patients were advised to wear the cast for 2 weeks, systematically removing it every 2 hours for a period of 5 minutes to mobilize the wrist and to prevent adhesions following the reconstruction. After that period of time, unlimited mobilization was allowed. Patients were told not to carry out heavy manual work or lifting for at least 3 months to allow the reconstruction to heal. At the beginning of the third month, progressive loading of the operated side was encouraged.

Fig. 5 Suturing of the transverse sides of the flaps using Vicryl 3.0. Peroperative view on the right.

Assessment

Postoperative outcomes were evaluated on four different aspects:

1. Patients were asked to complete the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) and Patient Rated Wrist Evaluation (PRWE) questionnaires.^{17–19} These two questionnaires were used because the authors thought the PRWE to be more specific regarding wrist disease. The QuickDASH, however, is used more commonly. The QuickDASH questionnaire consists of 11 questions regarding both functional and pain scores experienced the week before completing the form. With the PRWE, five questions to the level of pain experienced and 10 questions on functional loss, both in the last week, result in two separate scores and a total score when summed. Both questionnaires are based on a score system scaled 0–100, with 0 being the most satisfying result and 100 being the least.
2. Patients were examined clinically at the department. An accurate examination for possible complications was conducted, addressing incomplete relief of symptoms, persistent dysesthesia to the sensitive branch of the radial nerve, a painful or insightful scar, and snapping or clicking of the tendons as a symptom of subluxation of the tendons. Patients were also asked for any other serious complaints of the affected upper extremity, since these may have influenced the answers given in the questionnaires.
3. Ultrasound was used to check the postoperative anatomical reconstruction of the region as well as any possible subluxation of the tendons. The thickness of the extensor retinaculum as well as the presence of a possible sub-compartment can be measured with transverse scans. Since the surgical technique enlarges the diameter but, on the other hand, shortens the pulley, we were interested in verifying its length and its dynamic biomechanical features. To detect any displacement of the tendons, patients were asked to flex their wrist actively while abducting their thumb, this being the point of maximum possible bowstringing. This test is known as the wrist hyperflexion and abduction of the thumb (WHAT) test.²⁰ The peak palmar movement of the tendons was measured in millimeters of motion of the tip of the radial styloid. Both sides were compared. Thickness and length of the pulley were also measured in millimeters and compared with the nonaffected side to identify the new anatomic

characteristics of the pulley. All ultrasound checks were executed by the same specialized radiologist.

4. In 36 patients a biopsy of the tendon sheaths was performed. Materials obtained with synovectomy were sent for histopathology in formalin.

A possible correlation between subjectively experienced symptoms as assessed by both questionnaires, age of the patient, thickness of the pulley, or volar migration in wrist flexion when actively abducting the thumb, was analyzed statistically using the nonparametric Spearman rho test.

Analysis of ultrasonic data for distance to the radial styloid and volar migration of the first extensor compartment tendons on the operated versus the contralateral side was performed using the Wilcoxon matched-pairs signed-ranks test. Significance was accepted at the level $P < 0.05$.

Results

Total average score outcome of the QuickDASH questionnaire and the PRWE were respectively 9.1 (range 0.0–59.0) and 10.5 (range 0.0–75.5). At consultation, eight patients complained of minor tenderness over the first extensor compartment. Of these eight, two patients had other conditions associated with the affected extremity, such as carpal tunnel syndrome and arthrosis. One patient experienced increased pain during emotional distress. Two patients experienced tenderness after repetitive motion or heavy work. Clicking or snapping had occurred in two patients, with one patient experiencing a one-off painful snap while gardening and the other experiencing several uncomfortable clicking sensations during heavy lifting while working as a restaurant employee. One patient who complained of numbness in the sensory area of the superficial radial nerve, suffered from an increase in this sensory deficit when executing repetitive movements. Two-point discrimination at the fingertip was also abnormal in this patient.

The second question was whether the distance of the tendons to the radius as visualized by ultrasound was actually correlated with clinically reported pain or a clicking sensation. Results of measurements on ultrasound are summarized in ► **Table 1**. When compared statistically using the Wilcoxon matched-pairs signed-ranks test a significant difference in thickness of the pulley on the operated versus the contralateral side ($p < 0.0001$) and length of the pulley on the operated versus the contralateral side ($p < 0.0010$) was found, as

Table 1 Ultrasonographic measurements

	Operated side	Contralateral side
Thickness of pulley in mm	Mean 1.27 (SD 0.26)	Median 0.40 (range 0.20–0.90)
Length of pulley in mm	Median 9.80 (range 5.70–15.20)	Mean 12.17 (SD 2.02)
Distance to styloid radii in mm	Median 0.80 (range 0.0–2.30)	0.0
Volar migration of EPB and APL tendons in WHAT test, in mm (mean)	Mean 1.79 (SD 1.11)	0.0

was to be expected. The same test was used for comparing distance to the radial styloid and volar migration of the EPB and APL tendons during the WHAT test on the operated versus the contralateral side, thereby representing the movement of maximal possible bowstringing of the tendons.²⁰ A significant difference was found in both tests ($p < 0.0001$). Outcomes of both questionnaires were not significantly correlated to thickness of the pulley or volar migration in wrist flexion when actively abducting the thumb (Spearman rho test, $P > 0.05$).

For the final question, whether or not the age of the patient was correlated with outcomes on the questionnaires, the Spearman rho test was also used. No correlation was found ($P > 0.05$).

Discussion

Patients suffering from de Quervain disease and not responding to conservative therapy will need surgical decompression of the first extensor compartment. Release of the compartment by simple incision is a commonly used procedure. Complications include sensory deficit due to damage of the superficial radial nerve, a painful scar or adherence of the scar to underlying tendons, incomplete decompression of the compartment, and the rare but troublesome complication of volar subluxation of the tendons.^{3,5,21} We believe that this complication is especially present in surgical treatment of early stage de Quervain disease, where the reactive thickening of the pulley is moderate. Even though exact incidence numbers are not known, several case reports describe this complication. Most recently, Collins reported a single-center study of six patients suffering from painful subluxation of the tendons.²³ In our experience of a secondary referral center, we also encounter this complication on a yearly basis. Because of the highly difficult revision surgery of these cases, several surgical techniques to prevent this complication have been proposed. The reconstruction as proposed by Codega consisted of resecting a longitudinal part of the pulley and using this part to make two separate "bridges" at the most distal and most proximal parts of the pulley. Releasing the most distal volar part of the pulley weakens the pulley at its most crucial functional part; the inflection point of the tendons.¹⁰ Bakhach described the "omega omega" pulley plasty. This plasty consists of a subperiosteal release of the pulley, leaving the pulley itself intact. In this approach the remaining part of the pulley does not have to be incised, so this technique was hypothesized thereby to be more stable than other reconstructions. However, only 10 of these plasties were included in this study, of which two already needed an additional strengthening of the pulley using fibers of the pronator quadratus muscle. Time of follow up was only 15 days, and several complications were reported after the resumption of normal (professional) activity.⁹ In 1992 Le Viet described a pulley plasty fixating the pulley to the palmar skin. The results of this technique seem promising.¹² However, we believe that since anatomy is changed drastically, the operated area could be predisposed to friction with branches of the superficial radial nerve. Moreover, this creates the so-called tenodermodesis of skin and pulley, which can hinder in

selected cases. More recently, Littler proposed a reconstruction removing the EPB tendon from the compartment. This study, again, consisted only of a study group of 10 patients, thereby limiting its statistical value.¹³ Anatomically one could expect the released EPB tendon to give complaints of friction, since it now moves independently of its original compartment.

One of the main reasons to develop this technique of reconstruction was that it offered the possibility to enlarge the pulley sufficiently. The technique used by Kapandji¹¹ to restore the compartment forms the basis of the technique used in this study. Using a diagonal incision of the pulley and a small incision at the bases of the two flaps, Kapandji's technique shifts the diagonal sides of the two flaps on each other, thereby enlarging the pulley. We modified this technique on two levels. First we make the diagonal incision in the opposite direction. Consequently the incision of the bases of the flaps is also reversed. This ensures preservation of the most important part of the pulley: the most distal volar part. Since this is the point of inflection, no weakening should be present at this point. Also, we did not shift the two flaps on each other but rather sutured the transverse sides to each other, thus avoiding recurrence of the disease due to recreating a pulley with too small a diameter.

A significant limitation of the study is that it was not a controlled trial. In our department we conduct the proposed pulley reconstruction only in patients requiring surgical decompression of the first extensor compartment; thus, we could not include a control group treated by regular simple decompression without pulley reconstruction. Further research is needed in which a control group is also included. Another limitation is the fact that part of the study is retrospective in nature. In future research the evaluations and questionnaires should also be executed preoperatively to verify the score changes. One of the possible drawbacks of this surgical technique is the inherent term of healing of a reconstructed anatomic structure, which has to be respected before loading for heavy duty can be resumed. Pulley healing takes time to evolve to mature repaired tissue with higher stiffness and enough tensile strength.²² Our results focus on the medium-term outcomes of this modified reconstruction with a mean time of follow up of 40.4 months. In addition to both the qualitative results as evaluated by questionnaires and objective results as evaluated upon physical examination, the anatomic relations were also visualized by ultrasound. Both these features distinguish this study from previous studies. On evaluation, 8 out of 45 patients complained of minor pain or tenderness within the operated area. Interestingly, the two patients complaining of a clicking or snapping sensation had a volar migration of the tendons as revealed by ultrasound of respectively 2.0 and 2.2 mm, with mean volar migration of all patients being 1.79 mm (SD $\pm$ 1.11). The patient with the greatest volar migration (3.8 mm) had no complaints of pain, clicking, or snapping even though she was performing heavy manual work as a chambermaid. We therefore hypothesize that the tendons need to flick completely over the palmar rim of the bony gutter at the styloid of the radius to cause a painful snapping. The second question we investigated was whether the subjectively

experienced pain and discomfort as reported by both questionnaires was correlated with the distance of the tendons to the radius. As we expected, the pulley of the operated wrists was significantly thicker and shorter compared with that of the nonoperated wrists. The tendons moved slightly volar when abducting the thumb while flexing the wrist, and the distance to the styloid radii had increased. Indeed, this feature is to be expected, since the purpose of the operation is to expand the diameter of the gutter in which the tendons move, which is formed by the bony gutter at the radial side of the styloid of the radius and the pulley, to prevent a recurrence of the disease. Surprisingly, none of these characteristics were correlated to pain and loss of function as determined by both questionnaires. Finally, we hypothesized prior to the study that the age of the patient would be significantly correlated to outcomes on the questionnaires, since younger patients are likely to be more demanding on their wrist function. No statistical correlation was found, however.

In conclusion, we believe that, since complications of tendon instability after simple decompression surgery are very hard to treat, the technique to reconstruct the compartment as we propose in this study gives satisfactory medium-term results and should be considered as part of the surgical treatment for de Quervain tenosynovitis.

Conflict of Interest

None

Note

This study received the approval of the Leading Ethics Committee OG 065 of the AZ Sint-Jan AV Brugge-Oostende, campus Brugge, Brugge, Belgium, September 21, 2012, and received the approval number BUN B049201214473 (internal reference number 1599).

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