Pulley Reconstruction for Symptomatic Instability of the Tendons of the First Extensor Compartment Following de Quervain's Release

Daan Renson, MD¹ Koen Mermuys, MD² Bert Vanmierlo, MD¹ Francis Bonte, MD¹
 Petrus Van Hoonacker, MD¹ Diederick Kerckhove, MD¹ Bart Berghs, MD¹ Jean F. Goubau, MD, PhD^{1,3}

¹ Department of Orthopaedics and Traumatology, Upper Limb Unit, Orthoclinic Brugge, AZ Sint-Jan AV Brugge–AZ Sint Lucas, Bruges, Belgium

² Department of Radiology, AZ Sint-Jan AV Brugge-Oostende, Campus Brugge, Bruges, Belgium

³ Department of Orthopaedics and Traumatology, University Hospital Brussels, Vrije Universiteit Brussel, Jette, Belgium

Address for correspondence Jean F. Goubau, MD, PhD, Department of Orthopaedics and Traumatology, Upper Limb Unit, Orthoclinic Brugge, AZ Sint-Jan AV Brugge-Oostende, Campus Brugge, Ruddershove 10, 8000 Bruges, Belgium
 (e-mail: jean.goubau@azsintjan.be; jean@goubau.eu).

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Abstract

Background Surgical management of de Quervain's tenosynovitis is based on decompression of the first extensor compartment. A simple release of the first compartment can cause instability of the extensor pollicis brevis (EPB) and abductor pollicis longus (APL) tendons in zone seven of the extensors. The WHAT test (wrist hyperflexion and abduction of the thumb) is very effective in diagnosing this instability.

Patients and Methods In this retrospective monocentric study, we analyzed a case series of 10 patients all of whom underwent a reconstruction of the first extensor compartment using a retinacular graft because of symptomatic instability after decompression surgery. The reconstruction was a modified technique of the sixth compartment. Functional outcome and characteristics of the newly reconstructed pulley were examined by physical examination with the aid of ultrasound and internationally validated questionnaires.

Results Four patients had a good-to-excellent functional outcome, all of those had a maximum of two surgical procedures performed on the first extensor compartment. Six patients presented poor functional outcome. In four of them, more than two surgical procedures were performed. Minor residual instability was noted in six cases, found in both the groups.

Conclusion The reconstruction procedures on the first compartment seemed to be satisfactory in treating instability of the EPB and APL tendons after primary surgical release for de Quervain's disease.

Level of Evidence Level IV, observational study without controls.

Keywords

- de Quervain
- tendon instability
- WHAT test
- pulley reconstruction
- retinaculum

Instability of the tendons of the first extensor compartment following a decompression procedure for de Quervain's tenosynovitis is rare but seems to be an underdiagnosed complication. Subluxation of the abductor pollicis longus

(APL) and extensor pollicis brevis (EPB) tendons may occur due to excessive release of the retinaculum or in the case of surgery in an early stage of the disease. Especially, volar subluxation of these tendons can cause a painful snapping.

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Alongside seldom cases of structural or posttraumatic instability, the largest cause of instability is the surgery of de Quervain's disease as reported in the literature.¹⁻⁴ The pathology of primary de Quervain's disease may vary from the absence of synovial hypertrophy to tendinosis. The WHAT (wrist hyperflexion and abduction of the thumb) test as physical examination and ultrasound analysis are useful for the diagnosis.⁵

A few surgical techniques for tendons subluxation have been described.⁶⁻⁸ To reconstruct the tendon pulley, Ramesh and Britton⁶ performed a sling procedure using a U-shaped extensor retinaculum graft and McMahon et al⁷ used a brachioradialis tendon flap. Littler et al⁸ described the reconstruction technique where only the APL tendon was embedded into the new pulley (consisting of the original retinaculum) to prevent subluxation of the APL tendon. At our institution, we modified the surgical procedure described by Eckhardt and Palmer⁹ for the treatment of extensor carpi ulnaris instability at the sixth compartment. In this study, we retrospectively examined 10 patients who underwent the reconstruction procedure of the first compartment for symptomatic instability of the APL and EPB tendons after the primary release of de Quervain's disease. The purpose of this study is to clinically evaluate the outcome of our technique using patient-related questionnaires. The dimensions (length and thickness) of the newly reconstructed pulley were examined by ultrasound simultaneously at a minimum of 2 years follow-up.

Patients and Methods

A total of 12 patients who underwent revision surgery for instability of the EPB and APL tendons after the release of the first compartment for de Quervain's tenosynovitis and were with a minimum follow-up of 2 years was found between 2000 and 2013. Ten patients underwent modified Eckhardt procedure done by the same consultant surgeon, and the other two patients underwent the sling procedure by a different surgeon. The latter were, therefore, excluded from the present study. Six of the 10 patients were referrals from other institutions. Patients were invited to a clinical examination which is detailed in the text below, an ultrasound investigation and had to fill out a questionnaire to assess their actual functional status at the minimum of 2 years after the reconstruction surgeries. All patients were active women with an average age at surgery of 35 years (range: 18–47 years).

Clinical examination consisted of five tests: palpation of the first extensor compartment (test 1, 0–2), the Finkelstein test¹⁰ (test 2, 0–2), the Eichhoff test¹¹ (test 3, 0–2), the WHAT test⁵ (test 4, 0–2), and an assessment of the status of the sensory branch of the radial nerve (test 5, 0–2). A positive/painful test or sensory deficit was scored as 0, a negative test, or intact sensory branch of the radial nerve was scored as 2. With this self-designed scoring system, we could obtain an overall clinical score calculated out of 10.

An ultrasound of the newly constructed pulley was performed by an experienced radiologist. He assessed the presence of synovitis, the thickness, and length of the extensor

retinaculum graft and a dynamic ultrasound analysis was done to determine the extent of volar migration of EPB and APL tendons from the radial styloid in the sagittal plane performing the WHAT test maneuver. The same ultrasound assessment was consequently done on the contralateral normal side as a control using the same anatomical landmarks as a reference.

Each patient had to fill out the visual analog scale (VAS), the Disabilities of the Arm, Shoulder and Hand Score (QuickDASH), the patient-rated wrist evaluation (PRWE), and the Michigan Hand Outcomes Questionnaire (MHOQ).

The MHOQ is the only score where the maximum score is a minimum disability. To have a correct functional global assessment with the obtained VAS, QuickDASH, and PRWE score, a total questionnaire score was calculated out of 10 by counting the arithmetic mean of each subtotal (VAS, PRWE, and QuickDASH were first converted to the interpretation of the MHOQ, because maximum score in these three scoring systems is maximum disability, wherein the MHOQ maximum score is minimal disability). As an example, patient 1:

$$\frac{((\text{VAS}(10-6.0) \times 10) + \text{PRWE}(100-32.5) + \text{QuickDASH}(100-52.77) + \text{MHOQ}(25))}{4} / 10 \approx 4.49 = 4.5$$

Outcome data were collected and statistically analyzed. Correlation testing was done with the Wilcoxon rank sum test. An overview of total functional outcome is given by comparing results of clinical and questionnaire scores and ultrasound findings.

Surgical Technique

A transverse incision of approximately 3 cm is made over the radial side of the wrist at the level of the radial styloid on first extensor compartment. Care is taken for the superficial branches of the radial nerve. A second transverse incision is made on the dorsal side of the wrist at the level of zone seven (extensor retinaculum). Subsequently, the extensor retinaculum is harvested to obtain a central graft of approximately 0.8 cm by 2 cm. The first fixation of the graft is made with an absorbable anchor (1.6 × 2.7 mm) on the volar edge of the APL and EPB tendon (MiniLok, Depuy-Synthes, Raynham, MA). The second anchor is placed dorsally, where the original second septal attachment was situated. Anchor positioning with final graft fixation is done in such a manner that subluxation is inhibited. The bone is revitalized and predrilled with a 1.3 mm drill bit before inserting anchors. To avoid overtightening the new pulley, dissection scissors are inserted into the first compartment not to overtighten the new pulley while tightening the knots. Finally, excursion of the APL and EPB tendons is tested in the wrist hyperflexion and the thumb in abduction (WHAT test). The patient is immobilized for 2 weeks with a removable forearm–thumb splint: instructions are given the day after the surgery to the patient to remove the splint from that moment every 2 hours to mobilize the tendons of the first extensor compartment during that period. Power grip and personal hygiene necessitating forceful flexion of the wrist is not allowed the first 3 months after the surgery. Steps are shown in **Figs. 1–4**.

Fig. 1 Dorsoradial side of the wrist after obtaining the extensor retinaculum graft (*) and opening up the first extensor compartment (**).

Fig. 2 Placement of a volar suture anchor by discarding the APL tendon (*). APL, abductor pollicis longus.

Fig. 3 Attachment of the extensor retinaculum graft. Visualization of the APL (*) and EPB (**) tendon. APL, abductor pollicis longus; EPB, extensor pollicis brevis.

Fig. 4 New pulley embedding APL and EPB with enough room and no subluxation while performing the WHAT test. APL, abductor pollicis longus; EPB, extensor pollicis brevis; WHAT, wrist hyperflexion and abduction of the thumb.

Results

Four patients obtained good functional outcome with moderate clinical scores (mean: 6.0/10) and high scores on the questionnaires (mean: 8.3/10). There were no signs of synovitis on the ultrasound evaluation. Two patients had a minor residual migration of the tendons (1.4 and 3.6 mm, respectively) on ultrasound. There were no preexisting concomitant pathologies or postoperative complications in this group. These patients only applied for the presented reconstruction procedure on the first compartment.

Six patients had a poor functional outcome with low clinical scores (mean: 2.3/10) and low questionnaire scores (mean: 3.8/10). Two of them presented with signs of synovitis on the ultrasound examination. Four of them showed the minor residual migration of the tendons (1.1, 1.3, 1.7, and

2.0 mm, respectively). Three of them required one or multiple revision surgeries on the newly reconstructed pulley. One patient required tenolysis because of fibrosing stenosis. One patient required a release because of synovitis followed by a second revision procedure using the extensor retinaculum from the contralateral side. One patient had recurrent instability, therefore, a sling procedure was performed after this first revision instability remained, a revision then was performed with the extensor retinaculum of the contralateral side, a third revision was needed because of painful reaction on suture material, an open debridement with neurolysis was performed.

Three patients had already undergone multiple surgeries, such as tenolysis, before the construction of the pulley.

One patient had Ehlers–Danlos syndrome. One patient developed complex regional pain syndrome type 1

Table 1 Overview of clinical data, questionnaire scores, and findings on clinical examination

Data				Questionnaires				Clinical examination				
Age	Dominance	Affected side	Smoking	VAS	PRWE	MHOQ (100 = normal)	QuickDASH	Palpation	Finkelstein	Eichoff	WHAT	N. radialis, r. superficialis
47	Right	Right	No	6.0	32.5	25.00	52.77	Pos	Neg	Neg	Pos	Hypoesthesia
37	Left	Right	No	7.0	87.5	20.83	63.64	Pos	Pos	Pos	Pos	Hypoesthesia
46	Left	Left	Yes (33PY)	6.0	64.0	25.00	42.50	Pos	Pos	Pos	Pos	Normal
31	Right	Left	No	0.5	35.0	79.17	20.00	Pos	Neg	Pos	Neg	Normal
34	Right	Right	No	7.5	60.0	41.67	50.00	Pos	Pos	Pos	Pos	Normal
38	Right	Left	Yes (5PY)	1.0	22.5	70.83	22.50	Neg	Neg	Neg	Pos	Hypoesthesia
18	Right	Right	No	9.0	45.0	50.00	40.91	Pos	Neg	Pos	Pos	Hypoesthesia
44	Right	Left	Sporadic	9.0	66.0	25.00	29.55	Pos	Neg	Pos	Pos	Normal
22	Right	Right	No	1.5	19.5	66.67	15.91	Pos	Neg	Neg	Neg	Normal
32	Right	Left	Yes (4PY)	0.5	6.5	87.50	6.82	Pos	Neg	Pos	Pos	Normal

Abbreviations: MHOQ, Michigan Hand Outcomes Questionnaire; N. radialis, nervus radialis; Neg, negative; Pos, positive; PRWE, patient-rated wrist evaluation; PY, pack year; QuickDASH, Disabilities of the Arm, Shoulder and Hand Score; r. superficialis; ramus superficialis; VAS, visual analog scale; WHAT, wrist hyperflexion and abduction of the thumb.

Table 2 Overview of findings on ultrasound examination

Age	Ultrasound findings							
	Synovitis		Thickness (mm)		Length (mm)		Volar migration (mm)	
	Eckhardt	Contralateral	Eckhardt	Contralateral	Eckhardt	Contralateral	Eckhardt	Contralateral
47	No	No	0.7	0.6	6.6	9.9	1.3	0.0
37	Yes	No	0.9	0.3	8.3	14.0	1.7	0.0
46	No	No	1.1	0.5	7.8	9.6	0.0	0.0
31	No	No	0.8	0.3	8.6	12.4	0.0	0.0
34	No	No	0.9	0.6	7.4	11.5	1.1	0.0
38	No	No	1.6	0.5	8.3	12.5	1.4	0.0
18	No	No	0.9	0.4	7.2	10.7	2.0	0.0
44	Yes	No	1.6	0.4	10.6	12.2	0.0	0.0
22	No	No	0.9	0.7	7.0	11.8	0.0	0.0
32	No	No	0.7	0.5	7.0	11.6	3.6	0.0

postoperatively. Two patients showed minor signs of rhizarthrosis on radiographs.

There were no consistent findings between the clinical outcomes and questionnaire scores (►Table 1) and the presence of residual volar migration of the tendons (►Table 2). Patients without volar migration of the tendons did slightly better than those with the persistent residual migration of the EPB and APL tendons (►Table 3), although statistically not significant.

Patients who had a primary reconstruction of the pulley seemed to have better clinical and questionnaire scores, however, the results were not statistically significant.

The newly reconstructed pulley on the ultrasound evaluation showed the thickness of the reconstructed pulley was significantly thicker (mean + 0.5 mm) compared with the contralateral, normal side. The average length of the obtained extensor retinaculum graft is significantly smaller (mean: 3.7 mm) than the length of the first extensor lodge of the contralateral, normal side. Results are shown in ►Figs. 5 and 6.

Discussion

Some have proposed a primary reconstruction of the pulley of the first extensor compartment to avoid the subluxation of the EPB and APL tendons after the primary surgery of de Quervain's disease.¹²⁻¹⁶ Instability of the tendons of the first extensor compartment is more likely to occur following the simple release of the pulley of the first extensor compartment in early stages of the disease because the pulley is thinner. Chronic cases of de Quervain may have thickening of the pulley/retinaculum of the first extensor compartment up to more than 2 mm (measured by ultrasound). This may be a reason why the chronic case did not cause instability of the tendons.

In the present study, we obtained excellent-to-good clinical outcome with the reconstruction of the pulley using the extensor retinacular flap for instability of the EPB and APL tendons after the primary release of the first extensor

compartment in de Quervain's disease when there was no complication or without underlying systemic diseases. This emphasized the importance of a qualitative stabilization method for the first compartment that restores the stability of the tendons within the compartment. The reconstructed pulley was found thicker than the contralateral healthy pulley in ultrasound analysis. Harvesting the retinaculum more proximally may help to equalize the thickness of the reconstructed pulley since the extensor retinaculum has a fusiform appearance.¹⁷

In the modified Eckhardt procedure for the first compartment, 60% (6 out of 10 patients) of our patients had a poor functional outcome in the present study. Possibly this is due to the increased scarification and complication rate when more than two surgeries (primary release of the first compartment and reconstruction of the pulley) are done on the same site. Two patients who had a poor outcome, despite being operated only two times, one had synovitis, and mild trapeziometacarpal joint arthritis. The other patient had postoperative complex regional pain syndrome. This can explain why they have insufficient clinical- and questionnaire outcomes compared with the other patients who had satisfactory results after reconstruction of the pulley by retinacular graft (►Table 1).

We can differentiate two subgroups: those with a good-to-excellent outcome ($\geq 7.9/10$) and those with a poor, inadequate outcome ($\leq 4.5/10$). There was no patient with an intermediate score. Young active women in our study may have high expectations of treatment outcome.

Study limitations in our case series are the monocentric model, the small sample size, and a large amount of variables. No intra- and interrater reliability analysis of the ultrasound assessment preoperatively was done.

In conclusion, the reconstruction procedures on the first compartment seemed to be satisfactory in treating instability of the EPB and APL tendons after primary surgical release for de Quervain's disease. The multiple reconstruction surgeries do not warrant good-to-excellent results.

Table 3 General overview

Data			Questionnaires			Clinical examination		Technical examination					
Age	CP	de Quervain release	Interval	ME	Post	TS	Total score (/10)	Total score (/10)	Synovitis	Thickness (0.3–0.7 mm) ^a	Length (9.6–14 mm) ^b	Residual migration (1.1–3.6 mm)	X-ray ^c
47		2007	11 mo	2008	1x revision	3	4.5	4	No	+0.1	−3.3	Yes	CMCI arthritis
37	Ehlers–Danlos	2000, 2006	6 y 7 mo	2007	3x revision	6	2.5	0	Yes	+0.6	−5.7	Yes	Styloid radii
46		1997, 2002	8 y 4 mo	2010		3	4.0	2	No	+0.6	−1.8	No	Styloid radii
31		2004	6 y 2 mo	2010		2	8.0	6	No	+0.5	−3.8	No	Styloid radii
34		2012	3 mo	2013	Sudeck	2	3.9	2	No	+0.3	−4.1	Yes	NI
38		1991	21 y	2013		2	8.0	6	No	+1.1	−4.2	Yes	Styloid radii
18		2009, 2009	1 y 1 mo	2010	2x revision	5	4.4	2	No	+0.5	−3.5	Yes	NI
44	CMCI arthritis	2008	2 y 8 mo	2011		2	3.5	4	Yes	+1.2	−1.6	No	CMCI arthritis + styloid radii
22		2006	9 mo	2007		2	7.9	8	No	+0.2	−4.8	No	NI
32		2009	7 mo	2009		2	9.2	4	No	+0.2	−4.6	Yes	NI

Abbreviations: age, age when modified Eckhardt procedure performed; CMCI, trapeziometacarpal joint; CP, preexisting concomitant pathologies; de Quervain release, year of initial de Quervain release, if there is a second date it means there was a redo; interval, interval between last procedure and modified Eckhardt; ME, year when modified Eckhardt procedure performed; post, postoperative period (revision surgery, e.g., tenolysis, redo, and complications); TS, total surgeries.

^aThickness, difference with contralateral side (ranges contralateral side).

^bLength, difference with contralateral side (ranges contralateral side).

^cX-ray, styloid radii or subtle alterations due to anchor sequelae.

Fig. 5 The Wilcoxon rank sum test ($W = 1$, p value < 0.001) indicates that the contralateral side has a significantly lower thickness (median = 0.5, Q25 = 0.4, Q75 = 0.575) than the Eckhardt side (median = 0.9, Q25 = 0.825, Q75 = 1.050).

Fig. 6 The Wilcoxon rank sum test ($W = 98$, p value < 0.001) indicates that the contralateral side has a significantly higher length (median = 11.7, Q25 = 10.90, Q75 = 12.35) than the Eckhardt side (median = 7.6, Q25 = 7.050, Q75 = 8.30).

Ethical Approval

This study received the approval of the Leading Ethics Committee number B049201629348, of the AZ Sint-Jan AV Brugge–Oostende, Campus Brugge, Brugge, Belgium.

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None.

Conflict of Interest

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