TECHNICAL NOTE

Pulley Reconstruction Following Surgical Release of DC1 Pulley in De Quervain's Tenosynovitis: Surgical Technique and Case Series

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Abstract

De Quervain's disease (DQD) is tenosynovitis of the first dorsal compartment (DC1) of the wrist between the osteofibrous tunnel and the tendons involving the APL and EPB sheaths at the radial styloid. Surgical intervention is indicated when pain does not resolve despite 3 to 6 months of conservative management. Release of the first dorsal compartment is an effective treatment of DQD. In addition to surgical release, we performed pulley reconstruction using a new technique in the present series of 20 patients which has not been previously described with a followup of over 1 year. All patients showed a consistent improvement in VAS score at over one year followup with resolution of Finkelstein, Eichoff and WHAT test. Only one temporary neuropraxia was encountered due to stretching/scar entrapment of superficial branch of radial nerve. Our innovative technique of pulley reconstruction is not only easy to understand and perform but has shown consistent result in the 20 cases operated with this technique with a follow up of at least 1 year. The technique has the distinct advantage of having a quick learning curve and gives reliable, lasting results without complications or recurrence.

Level of evidence: IV

Keywords: De Quervain, Extensor tendon, First Extensor compartment, Pulley, Tendon subluxation, Tenosynovitis, Wide-awake hand surgery

Introduction

De Quervain's disease (DQD) is a stenosing tenosynovitis of the first dorsal compartment (DC1) of the wrist between the osteofibrous tunnel and the tendons (1). The disorder was described by Fritz de Quervain in 1895 as a disorder involving the Abductor Pollices Longus (APL) and Extensor Pollices Brevis' (EPB) sheaths at the radial styloid (2). Women are more commonly affected than men (3).

Histologically, DQD is intrinsic degenerative characterized by tendon sheath thickening with mucopolysaccharide accumulation, rather than inflammatory mechanisms making DQD more of tendinosis rather than tendinitis. The thickening causes impingement of the tendons at radial groove, causing impaired movement at wrist and thumb as well as pain. Primarily DQD is treated with orthoses to immobilize the wrist and thumb, anti-inflammatory medication and local steroids (4). Other modalities include acupuncture, ultrasound-guided percutaneous tenotomy, prolotherapy, platelet-rich plasma (PRP) and hyaluronic acid (HA) injections. Surgical intervention of DQD is indicated when symptoms fail to resolve despite 3 -6 months of conservative treatment (5).

Surgical release of the DC1 is both an effective and definitive treatment of DQD. Dissatisfaction following surgical release can be due to incomplete release of sub-compartments of the DC1, subluxation of tendons, iatrogenic trauma to the superficial branch of the radial sensory nerve which lies in the surgical approach (6). Subluxation is a preventable complication that can

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be avoided by the use of modifications to the surgical technique. Different techniques described to prevent complication are partial release (7), complete simple release with either longitudinal or transverse incision (4,5,8), excision of hypertrophied synovium (9), Z-plasty for pulley reconstruction (5), omega pulley plasty (10) incising the retinaculum dorsally leaving an intact volar flap (5).

The authors of the present study aim to describe one such innovative technique of pulley reconstruction that is not only easy to understand and perform but has shown consistent results in the 20 cases operated with this technique with a follow up of at least 1 year.

Materials and Methods

It was an observational study, where a total of 20 patients underwent Dequervains release and pulley reconstruction, done in the tertiary hospital from January 2018 to January 2021. This technique was used in patients with DQD with no or minimal response to non-operative management for 6 months including at least one injection of PRP or cortisol. The age for inclusion was over 18 years. Informed written consent was taken from all patients. All patients were followed up for at least 1 year when a final clinical assessment was carried out. In the clinical evaluation, outcome measures such as Visual Analogue Scale (VAS) score was recorded and the result of Finkelstein test, Eichhoff's test, wrist hyperflexion and abduction of the thumb (WHAT) test in preoperative period as well as at final followup were documented.

Clinical Evaluation for de Quervain's tenosynovitis

All patients operated for DQD had swelling and tenderness over anatomical snuffbox. Most of them tested positive for the Finkelstein test, Eichhoff's test and WHAT test. The Finkelstein test was carried out by grasping the thumb and ulnar deviation of the hand sharply. The Eichhoff's test was carried out by grasping and ulnar deviating the hand when a person had their thumb held within their fist. Similarly in the WHAT (Wrist Hyperextension Abduction of the Thumb) test, the wrist was hyperflexed and the thumb abducted in full MP and IP extension, resisted against the therapist's index finger. All three manoeuvres recreated similar pain located over the radial styloid. These tests were performed both preoperatively as well as at final follow up. Similarly a VAS scoring was carried out at final follow-up. All examinations and followups were carried out by a single author to decrease inter-observer bias.

Inclusion criteria

Surgical intervention of de Quervain disease was carried out on failure of symptomatic relief despite 3 to 6 months of conservative management. All patients above 18 years who had a positive clinical test as described above and sharply localized pain and tenderness on exertion at DC1 region of the wrist were included in the study.

Exclusion criteria

Patients who had gout, rheumatoid arthritis, pregnant or nursing mothers, diabetes mellitus, chronic renal failure, pre-existing wrist deformities or those who were and patients who had previously undergone DQD release surgery were excluded from present study.

Surgical Technique

Surgery was carried out under wide-awake local anaesthesia and no tourniquet (WALANT) by a single surgeon with sufficient experience in hand surgery. The WALANT solution (11mL: 5mL of 2% lignocaine with 5mL of normal saline and 1mL of soda bicarbonate) was injected subcutaneously around the radial styloid. Surgery was started at least 20 minutes after the injection. All procedures were carried out under 4.2X loupe magnification. A 2 cm long, longitudinal skin incision was made over the first extensor compartment, 1 cm proximal to the radial styloid process. The superficial branch of the radial sensory nerve was identified and retracted. A longitudinal and central incision was made over the pulley [Figure 1a]. The APL and EPB tendons were identified and any septum between the APL and EPB

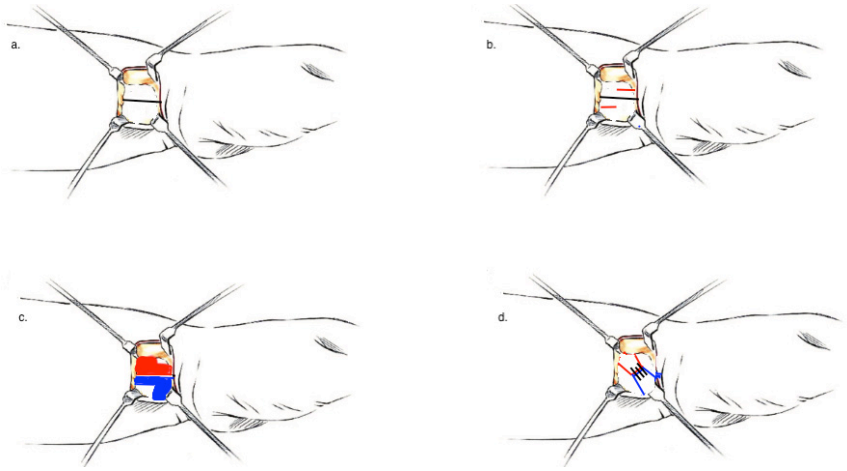

Figure 1. Schematic diagram showing the technique of pulley reconstruction described in the present study. 1A: Longitudinal incision along the pulley along the length of the forearm; 1B incision along the dorsal and volar flaps to create elongated longitudinal flaps; 1C and D Mobilization of elongated flaps and suturing to create pulley enlargement as well as prevent tendon subluxation.

tendons was divided along with identification of tendon indentation and multiple slips if present. Synovectomy was performed in the first extensor compartment.

The volar flap was divided longitudinally over half of its length in its proximal portion and the dorsal flap was similarly divided over its distal portion [Figure 1b]. The flaps created were mobilized transversely and were consequently sutured together [Figure 1c and d]. This lead to the enlargement of the pulley. The patency of the enlarged pulley was checked by passing the tip of the curved haemostat between the tendons and the reconstructed pulley. Surgical steps have been explained diagrammatically in Figure 1.

Patients were then asked to flex their wrist with simultaneous thumb abduction to confirm the stability of the tendons of the first extensor compartment. After the procedure, a palmar, below the elbow slab was given for 7 days.

Postoperative management

Complete movement of the thumb was encouraged immediately following suture removal which was about 7-10 days after surgery and patients were gradually allowed to resume most activities of daily living. Heavy manual work was allowed 4-6 weeks follwing surgery.

Statistical Analysis

Data was coded and recorded in the MS Excel spreadsheet program. SPSS v23 (IBM Corp.) was used for data analysis. Descriptive statistics was elaborated in the form of means/standard deviations and medians/IQRs for continuous variables, and frequencies and percentages for categorical variables. Data was presented graphically wherever appropriate for data visualization using histograms/box-and-whisker plots/column charts for continuous data and bar charts or pie charts for categorical data. Paired analysis for categorical variables was carried out using McNemar Test and for Continuous variables using Wilcoxin Signed Rank Test. Statistical significance was kept at $P < 0.05$.

Table 1. Summary of Clinical Details

Clinical Details	Mean ± SD Frequency (%)
Age (Years)	40.50 ± 10.59
Follow up (months)	17.85 ± 7.82
Gender	
Male	7 (35.0%)
Female	13 (65.0%)
Side	
Right	12 (60.0%)
Left	8 (40.0%)
Swelling over DC1 pulley (Positive)	16 (80.0%)
Tenderness over DC1 pulley (Positive)	20 (100.0%)

Results

Outcome evaluation

In this study, 20 patients underwent surgery with a mean age of patients, was 40.50 ± 10.59 years. Seven (35.0%) included patients were male while 13 (65.0%) were female. Sixteen (80.0%) of the patients had swelling over DC1 pulley and all patients had tenderness over DC1 pulley. All patients where checked for tendon subluxation following pulley reconstruction using WHAT test intra-operatively and none of the patients showed instability/subluxation. The follow-up ranged from 12 to 25 months with a mean follow up of 17.85 months. Clinical details of all patients are given in table 1. [Table 1] Surgical technique and case examples are depicted in Figures 2-5.

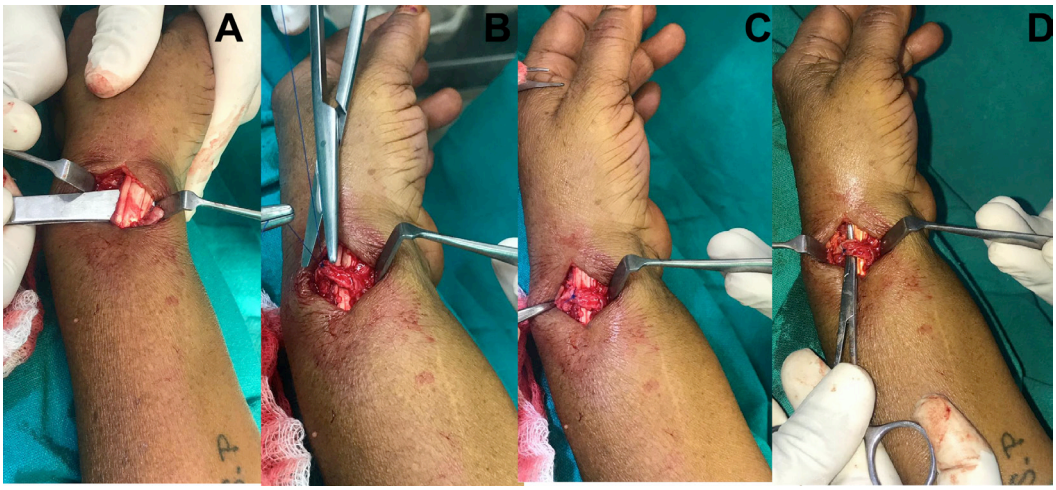

Figure 2. Case example of Dequervain's pulley release and pulley reconstruction. A: Showing released first dorsal compartment (DC1) with multiple tendon slips of APL and EPB indicating the pathology of DQD. B, C: Following pulley reconstruction of DC1 pulley; D: Showing adequate space following pulley reconstruction which allows passage of a haemostat but simultaneously prevents tendon subluxation.

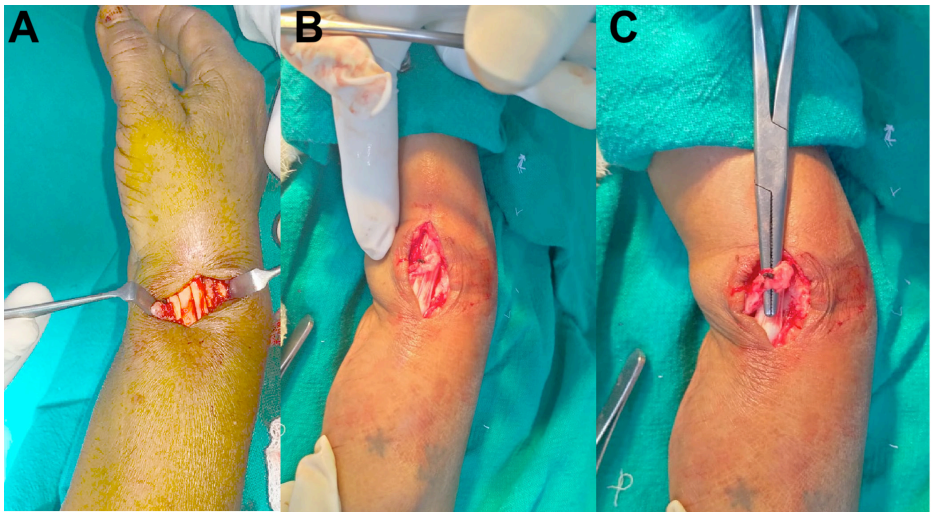

Figure 3. Case example of Dequervain's pulley release and pulley reconstruction. A: Showing released first dorsal compartment (DC1); B, C: Following pulley reconstruction and assessing adequacy of space beneath the reconstructed pulley.

[Figure 2, 3, 4, 5]

After confirming normality of data, McNemar's test was used to assess the change in Finkelstein, Eichoff's and WHAT Test between the two-time points. A significant result denotes that the distribution of patients in terms of the clinical Test changed significantly over time. The overall change in all three tests were statistically significant (Finkelstein test: McNemar's test: $\chi 2 = 19.000$, *P=<0.001*; Eichoff's test: McNemar's test: $\chi 2 = 20.000$, *P=<0.001*; WHAT test: McNemar's test: $\chi 2 = 20.000$, *P=<0.001*). [Table 2]

Non-parametric tests were used to make a statistical inference as data were not normally distributed. Paired

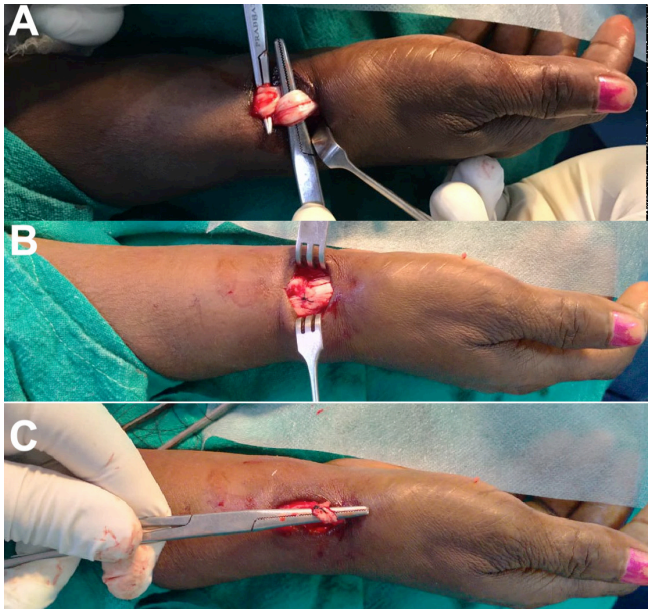

Figure 4. Case example showing adequately released APL and EPB tendons with degenerated /pathological tendons (4 A). Pulley reconstruction was subsequently carried out (4 B and C).

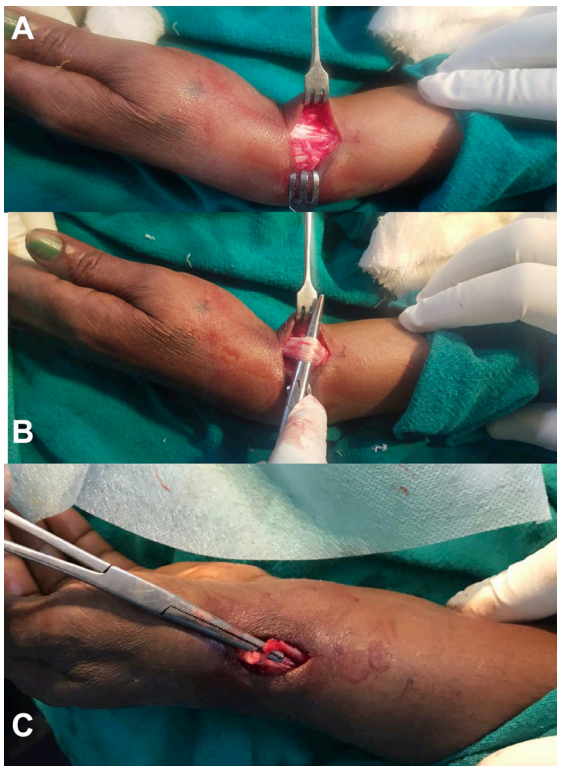

Figure 5. Case example of DC1 release (5 A) and pulley reconstruction (5 B and C) using the authors described technique.

Table 2. Change in Finkelstein, Eichoff's and WHAT Test Over Time (n = 20)

Finkelstein Test		Pre-Operative			McNemar's test	
		Positive	**Negative**	**Total**	**χ2**	***P Value***
	Positive	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Post-Operative	Negative	19 (95.0%)	1 (5.0%)	20 (100.0%)	19.000	<0.001
	Total	19 (95.0%)	1 (5.0%)	20 (100.0%)		
Post-Operative	Eichoff's Test	Pre-Operative			McNemar's test	
		Positive	**Negative**	**Total**	**χ2**	***P Value***
	Positive	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Post-Operative	Negative	20 (100.0%)	0 (0.0%)	20 (100.0%)	20.000	<0.001
	Total	20 (100.0%)	0 (0.0%)	20 (100.0%)		
	WHAT Test	Pre-Operative			McNemar's test	
		Positive	**Negative**	**Total**	**χ2**	***P Value***
	Positive	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Post-Operative	Negative	20 (100.0%)	0 (0.0%)	20 (100.0%)	20.000	<0.001
	Total	20 (100.0%)	0 (0.0%)	20 (100.0%)		

*The uncolored cells on the diagonal represent patients whose category did not change. The red shaded cells represent patients who moved to a lower category. The green shaded cells represent patients who moved to a higher category.

Table 3. Assessment of change in VAS Score over time (n = 20)

Timepoint	VAS Score			Wilcoxon Test	
	Mean (SD)	**Median (IQR)**	**Range**	**V**	***P Value***
Pre-Operative	7.00 (1.52)	7.00 (2.25)	5.00 - 9.00	210.0	<0.001
Final Followup	1.45 (1.15)	1.00 (1.00)	0.00 - 4.00		
Absolute Change	-5.55 (1.67)	-5.50 (3.00)	-8.00 - -3.00		
Percent Change	-79.2% (16.0)	-80.0% (18.7)	-100% - -50%		

Wilcoxon test was used to explore the difference in VAS Score at the two-time points. The mean VAS Score decreased from a maximum of 7.00 Pre-Operatively to a minimum of 1.45 at the final follow up. This change was statistically significant (Wilcoxon Test: V = 210.0, *P=<0.001*). [Table 3]

Complication

One of the 20 patients reported radial sensory nerve entrapment in a scar that needed prolonged medical management with pregabalin which resulted in a loss of paraesthesia and hypoaesthesia. None of the patients reported tendon subluxation clinically and on performing WHAT test on examination at final follow up.

Discussion

DQD is a common condition affecting the first dorsal compartment of the wrist causing significant pain and discomfort. The aetiology and pathology of this condition are unclear (11). DQD can cause severe disability and absence from manual work due to painful movements of the hand and wrist (7). The condition is initially managed by nonoperative management in the form of local and systemic anti-inflammatory medication (12,13). If the relief is inadequate the patient can be given a local cortisol shot in the tendon sheath. The injection is associated with potential subcutaneous tissue atrophy of the subcutaneous tissue or rarely tendon rupture (11). Additionally, anatomical variation in the first dorsal compartment leads to poor response to conservative treatment in a few patients (14,15).

In cases where conservative management does not provide desired results surgical intervention in the form of DC1 pulley release is considered may be performed. Surgical treatment of DQD is considered to be highly effective with over 90% cure rate (7). Surgical intervention is, however, associated with other complications like the involvement of superficial branch of radial sensory nerve (injury or scar entrapment), reflex sympathetic dystrophy, inadequate pulley release, and tendon subluxation (11,16,17).

In the present study, patients who underwent pulley reconstruction with the described technique were evaluated with regard to three criteria. The first of these

was intra-operative assessments of pulley subluxation; the second, evaluation of treatment results in the form of VAS score at final follow up and a final evaluation of DC1 pulley compression clinical signs were used. A simple release increases the risk of painful volar subluxation which is a preventable and avoidable complication (5). Several surgical techniques are described to prevent this complication which includes leaving a volar flap intact by modifying the incision to release of DC1 pulley, allowing post-operative immobilization following pulley release as well as pulley reconstruction (18–21). Several methods of pulley reconstruction have been described including creating a U shaped sling with the retinaculum to prevent subluxation (22), Omega pulley plasty (10), and pulley lengthening using oblique incision and step-cut lengthening (21). The techniaue described in present study is relatively simple and easy to perform with a fast learning curve and the authors could replicate their results in all 20 of their cases without any sigificant long term sequelae.

In addition to pulley reconstruction cognizance was given to anatomical variations in tendon structures. Incomplete release of a sheath can cause persistent and recurrent pain. In our technique sheaths of both EPB and APL were released followed by reconstruction of the common DC1 pulley. A follow up of over 12 months ensured that neither incomplete release nor re-adhesion was observed in any of the cases. Our results confirmed that pulley reconstruction is not associated with re-adhesion in any of the 20 cases where the present reconstruction technique was used.

The only complication that the authors faced in this series were scar entrapment or stretching of the superficial branch of radial sensory nerve in one case. The approach used was longitudinal skin incision which was cosmetically more acceptable as the scar gets easily hidden in distal forearm creases than a transverse incision over the DC1 pulley which has been associated with the higher number of scar complications based on a recent comparative study on the south asian population (8). Moreover a surgeons understanding of the anatomical relationship of the superficial branch of radial sensory nerve in the first dorsal compartment helps prevent superficial branch of radial nerve damage as a complication. Stretch and neuropraxia as a complication of this procedure is common because terminal divisions of superficial branch of radial sensory nerve lie immediately superficial to the first dorsal compartment compartment in the surgical approach to the DC1 pulley.

A recent study by Acar et al has reported hypertrophic scar with transverse incision (23) [Figure 6]. This is consistent with our findings where none of the 20 patients in our series developed hypertrophic scar with longitudinal incision. Also, Salim et al who have carried out 40 longitudinal incisions and only one patient developing hypertrophic scar which needed local triamcinolone injection.

The authors of the present study believe in immobilisation of the thumb initially for a week. This protocol is similar to a few other authors as well who suggest that initial short immobilization helps in wound

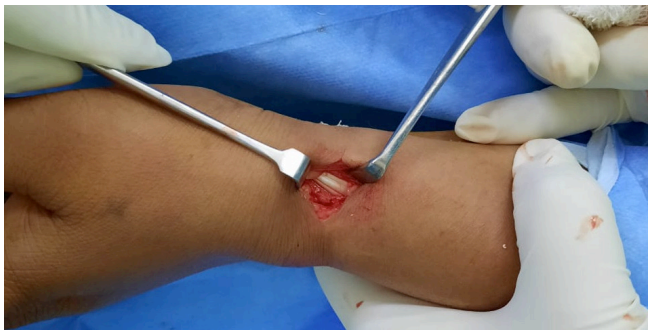

Figure 6. Use of transverse incision to release DC1 pulley.

healing and allows good pain control (7,11,24,25). A few others however use immobilization for a longer period to prevent tendon subluxation which would improve long term clinical outcomes (18,22). Kim et al in their analysis has found that long term immobilization has no bearing on long term outcome especially tendon subluxation (5). The authors go on to conclude further that tendon subluxation is associated with complete excision of the pulley and its fibrous roof and also tendon subluxation does not affect the overall clinical outcome.

The present study was limited by relatively small sample size, its retrospective and non-comparative nature, and the lack of ultrasonographic evaluation to look for tendon subluxation. The mean follow up was nearly 18 months which shows the midterm results to be favourable which may improve or deteriorate further on further and longer follow-up. In the present study, all patients showed clinically subjective as well as objective improvement following DC1 pulley release and pulley reconstruction technique that has been described, as measured.

In conclusion, the described technique of pulley reconstruction following release provides a good outcome with a resolution of symptoms of DQD with no tendon subluxation in immediate intra-operative assessment as well as up to final follow-up. This technique gives reliable, lasting results without any significant or lasting complications or risk of recurrence. Further, the authors propose to conduct a prospective, randomized comparative study with larger populations are needed to confirm these results and compare the outcomes with existing described techniques of pulley reconstruction.

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