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Flexor Digitorum Superficialis Excision for Trigger Finger – A Systematic Literature Review

Gareth CROUCH[*,†], Joshua XU[†,‡], David J. GRAHAM[§,¶,**,††], Brahman S. SIVAKUMAR[*,†,††,‡‡,§§]

[*]*Department of Hand and Peripheral Nerve Surgery, Royal North Shore Hospital, St Leonards, NSW, Australia*
[†]*Discipline of Surgery, Sydney Medical School, Faculty of Medicine and Health, The University of Sydney, Camperdown, NSW, Australia*
[‡]*Department of Orthopaedics and Trauma, Royal North Shore Hospital, St Leonards, NSW, Australia*
[§]*Department of Musculoskeletal Services Gold Coast University Hospital, Southport, QLD, Australia*
[¶]*Griffith University School of Medicine and Dentistry, Southport, QLD, Australia*
[**]*Department of Orthopaedic Surgery, Queensland Children's Hospital, South Brisbane, QLD, Australia*
[††]*Australian Research Collaboration on Hands (ARCH), Mudgeeraba, QLD, Australia*
[‡‡]*Department of Orthopaedic Surgery, Nepean Hospital, Kingswood, NSW, Australia*
[§§]*Department of Orthopaedic Surgery, Hornsby Ku-ring-gai Hospital, Hornsby, NSW, Australia*

Background: Division of one or more slips of the flexor digitorum superficialis (FDS) tendon has been posited as an effective surgical modality for advanced or recurrent trigger finger. This may be an effective approach among patients with diabetes or rheumatoid arthritis, or in those with fixed flexion deformities who have poor outcomes from A1 pulley release alone. However, there is limited evidence regarding the effectiveness of this procedure. The role of this study was to systematically review the evidence on functional outcomes and safety of partial or complete FDS resection in the management of trigger finger.

Methods: A systematic review was performed according to PRISMA guidelines. PubMed, Cochrane CENTRAL and Ovid Medline databases were electronically queried from their inception until February 2022. English language papers were included if they reported original data on postoperative outcomes and complications following resection of one or more slips of FDS for adult trigger finger.

Results: Seven articles were eligible for inclusion, encompassing 420 fingers in 290 patients. All included studies were retrospective. Isolated ulnar slip FDS resection was the most described surgery. Mean postoperative fixed flexion deformity at the proximal interphalangeal joint was 6.0° compared to 31.5° preoperatively, and the proportion of patients with fixed flexion deformity reduced by 58%. Mean postoperative total active motion was 228.7°. Recurrence was seen in 4.7% of digits, and complications occurred in 11.2% of cases. No post-surgical ulnar drift or swan neck deformities were observed.

Conclusions: FDS resection for long-standing trigger finger, or in diabetic or rheumatoid populations, is an effective and safe technique with low rates of recurrence. Prospective and comparative studies of this technique would be beneficial.

Level of Evidence: Level III (Therapeutic)

Keywords: *Trigger finger disorder, Orthopaedic procedure, Flexor tendon resection, Tendinopathy, Tendon entrapment*

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Correspondence to: Brahman S. Sivakumar
Royal North Shore Hospital
St Leonards
NSW 2065, Australia
Tel: +61-423-770-886
E-mail: brahman.sivakumar@gmail.com

INTRODUCTION

Adult trigger finger is a common disorder, characterised by catching of the flexor tendons during movement.[1] This may result in locking in flexion and require passive manipulation to overcome the obstruction. Green

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Table 1. Quinell's Classification of Trigger Finger[2]

Grade	Description
1	Tenderness over the A1 pulley; history of triggering not demonstrable on physical exam
2	Demonstrable triggering which can be actively overcome
3	Catching requiring passive extension or flexion to overcome
4	Fixed flexion deformity of PIP Joint

modified earlier attempts to classify triggering, when he described the pathology via four categories, ranging from tenderness over the A1 pulley to fixed flexion deformity (Table 1).[2] The pathophysiology is thought to be due to a mismatch in size between the flexor tendons and the fibrous retinacular pulleys within which they glide, in particular the proximal annular (A1) pulley. Pathologically, this results in impingement, hypertrophy and fibrosis of both pulley and tendon.[3–5] Long-standing disease results in formation of intratendinous nodules, flexion contracture of the tendon and fixed flexion deformity of the proximal interphalangeal joint (PIPJ).[5–7] Trigger finger is a common condition, affecting 2.6% of adults, and imparts a significant burden on individual patients and society as a whole.[8] Thus, optimal and evidence-based management in a timely fashion is key.

High-quality evidence suggests that open or percutaneous release of the A1 pulley results in good outcomes in primary trigger finger, with minimal morbidity, high rates of symptom resolution (92%) and low rates of recurrence (7%).[1,9] Nonetheless, in patients with advanced disease and fixed flexion deformities, or in cohorts with high risk of recurrent and refractory disease (such as those with diabetes or rheumatoid arthritis), simple release does not convey similar outcomes, with up to 23% of patients experiencing persistent symptoms or recurrence.[9,10] Moreover, while triggering may improve, residual fixed flexion deformity of the PIPJ may remain, especially in long-standing disease.[10,11] The pathophysiological mechanism leading to treatment failure in these patients is yet to be determined, with surgical recourse in recalcitrant trigger finger being poorly described in the literature.[12]

Excessive tendon bulk beyond the A1 pulley has been proposed as a contributory factor to account for persistent triggering post A1 release.[13] Various approaches to reduce this mass have been described, including resection tenoplasty of the flexor digitorum profundus (FDP) tendon.[14] Ferlic first described the excision of some or all of the flexor digitorum superficialis (FDS) tendon to debulk the flexor tendon complex as it glides under the fibrous sheath.[15] FDS slip resection, originally used in cases of trigger finger with proliferative synovitis as seen with rheumatoid arthritis, has since become a surgical adjunct in disease not easily treated by A1 release alone.[13,16] However, outcome data for this operation is limited, and rates of postoperative recurrence, functional outcomes and complications unclear. Consequently, the role of FDS resection in the treatment of primary or recurrent trigger finger remains undefined. The role of this study was to systematically review the evidence on functional outcomes and safety of partial or complete FDS resection in the management of trigger finger.

METHODS

This literature review was registered in the PROSPERO database (ID CRD42022331646).

Subsequently, a literature search was performed in accordance with PRISMA guidelines, utilising the databases PubMed, Ovid Medline, Embase and the Cochrane Controlled Register of Trials (CENTRAL) from their dates of inception to February 2022. Various combinations of the terms 'trigger finger', 'stenosing tendinopathy', 'surgery' and 'orthopaedic procedure' were queried as keywords, MeSH terms or via wildcard inquiries. After exclusion of duplicates, abstracts were screened for relevance before undergoing full-text appraisal by two independent assessors (GC and JX). References were also evaluated to identify additional relevant studies. Studies were eligible for inclusion if they were published in the English language; reported original data following resection of one or more slips of FDS for treatment of trigger finger in patients greater than 18 years of age and commented on at least one postoperative measure of function or complication. When studies were identified where only a section of the cohort met inclusion criteria, results from that subgroup alone were included. Case reports, abstracts, conference presentations, editorials and expert opinions were excluded. The two assessors resolved any disagreements on inclusion or exclusion via consensus, and when this could not be achieved, the decision was escalated to the lead author (BSS). Data was extracted from the text, tables and figures of all included studies. Data collected when available included baseline demographic data; information regarding surgical technique and approach; outcomes (including postoperative motion described as either total active motion [TAM] or at individual joints) and complications. When multiple follow-up times were described for the same cohort, the longest follow-up interval was utilised. Studies were graded by level of evidence as per the Journal of Bone and Joint Surgery (JBJS) criteria.[17] TAM is defined by the American Society for Surgery of the Hand (ASSH) as the sum of active motion of the metacarpophalangeal and interphalangeal joints of a digit, and can be compared to a normal contralateral digit, or a norm of 260°.[18] All extracted data were displayed in tables, and simple summary statistics were used where appropriate.

RESULTS

The database search produced 571 results, with removal of duplicates leaving 499 articles. Following abstract and title screening, 30 articles remained for full-text review. Seven studies were eligible for inclusion (Fig. 1). The included articles were all retrospective cohort in nature and published between 1977 and 2014 (Table 2).

The final cohort included 420 fingers in 290 patients (206 women and 84 men). Mean patient age was 59.8 years (range 20–90 years), and the most common digit operated on was the middle finger, followed by the ring finger. A total of 37 operations were performed for recurrent trigger finger after previous A1 release (8.8%); the remainder were completed for primary disease. A total of 287 digits had a preoperative fixed flexion deformity of the PIPJ, with a mean deformity of 31.5° ($n = 286$). The surgical technique in most patients was A1 pulley release with ulnar slip FDS excision ($n = 252$), with variations including ulna slip resection alone ($n = 121$), resection of both slips ($n = 44$), radial slip excision ($n = 2$) and complete FDS resection with concomitant A1 pulley release ($n = 1$). Of the 118 patients in whom comorbidities were described, 25 patients reported a history of diabetes mellitus, and 36 had rheumatoid arthritis. Two studies were restricted to patients with rheumatoid arthritis, and one to those with diabetes mellitus.[11,13,15] Mean follow-up time per digit was 47.2 months (range 6–154 months).

There was significant heterogeneity in reporting of clinical outcomes (Table 3). Mean postoperative fixed flexion deformity at the PIP joint was 6.0° ($n = 310$), with a deformity present in 102 digits. This represented a 58.0% reduction in the number of people with fixed flexion deformity for whom data were available pre- and postoperatively. Residual locking was reported in 3 out of 128 patients (2.3%). Mean TAM was 228.7° ($n = 35$) and

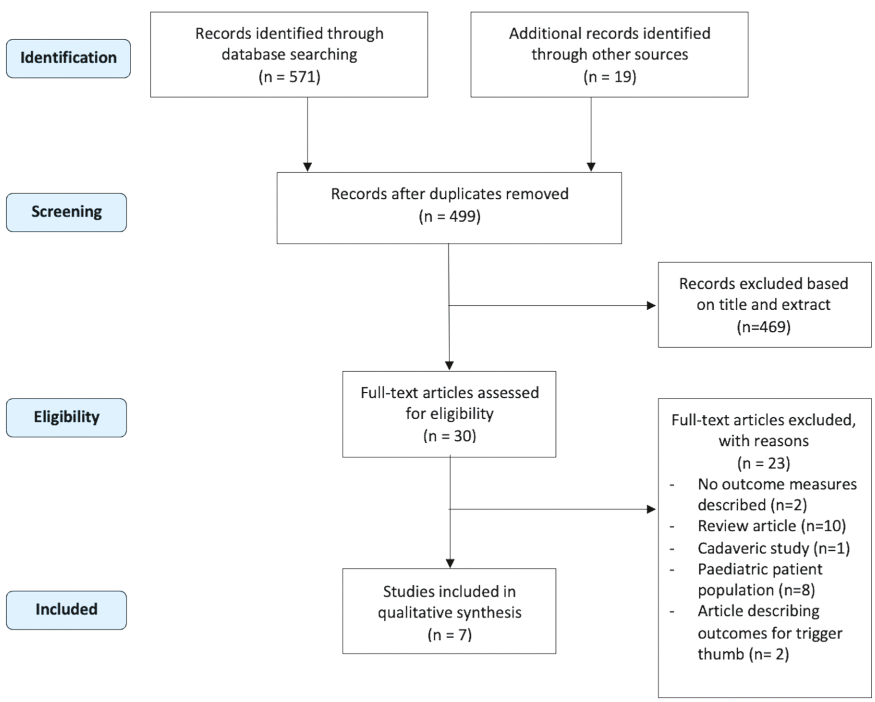

Fig. 1. Algorithm for systematic review, employing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Table 2. Patient Demographics and Surgical Technique

Study reference	Level of evidence	Number of patients [female gender]	Number of digits	Mean age [range]	Comorbidities	Operations performed			
						Ulnar slip resection	Radial slip resection	Total FDS division	FDS & A1 pulley division
Le Viet[19]	4	172 [134]	228	67.0 [24–87]	NR	228	0	0	0
Husain[20]	4	10 [6]	11	55.5 [29–80]	3 patients with diabetes 1 with rheumatoid arthritis 3 with hypothyroidism	4	5	2	0
Favre[15]	4	36 [31]	39	63.0 [49–90]	1 patient with diabetes	0	0	39	0
Marcus[11]	4	18 [8]	37	58.0 [31–72]	18 patients with diabetes	12	1	0	24
Degreef[21]	4	18 [14]	19	67.9 [46–85]	4 patients with diabetes	19	0	0	0
Wheen[14]	3	15 [13]	32	49.0 [20–69]	61 patients with rheumatoid arthritis	32	0	0	0
Ferlic[13]	4	21 [NR]	54	NR	54 patients with rheumatoid arthritis	54	0	0	0

NR: not reported; FDS: flexor digitorum superficialis.

Table 3. Study Outcomes

Study	Mean follow-up (months)[number of digits, range]	Motion (degrees)	Mean preoperative PIPJ fixed flexion deformity (degrees) [range]	Mean postoperative fixed flexion deformity (degrees) [range]	Residual symptoms	recurrence	Other outcomes
Le Viet[19]	66 [228, 12–154]	NR	33 [20–60] in 228 fingers	7 [0–60] in 87 fingers	NR	-	NR
Husain[20]	8 [11, NR]	Mean [Range] TAM 252 [225–292], Mean active PIPJ range of motion [Range] 93 [80–110]	<30 [NR] in 5 fingers	NR	0/11 residual locking or catching	-	Mean (range) DASH 17 (0–45), Grip strength 112% of contralateral side, Tip Pinch strength 101% of contralateral side. Mean (range) Visual Analogue Pain Score 1.5 (0–5)
Favre[15]	30 [39,12–60]	NR	24 [15–30] in 29 fingers	4 [0–10] in 11 fingers	2/39 residual triggering	-	2 patients postoperative flexion deficits
Marcus[11]	48 [24, 11–101]	Mean TAM 218, Mean active PIPJ range of motion 76	NR [NR] in 12 fingers	5 [NR] in 3 fingers	1/24 residual triggering	0/24	19/24 fingers full FDS power, 9/14 patients completely satisfied, Mean return to work 39 days
Degreef[21]	32 [19, 6–59]	Mean [Range] active PIPJ range of motion 90 [45–130]	17.5 [10–30] in 13 fingers	0 [0–5] in 1 finger	NR	-	Mean Quick-DASH 9.1 (0–27.2), 89% Satisfaction, Median post-op stiffness and pain scores 0/3, 4/18 patients with mild pain on tasks with high tendon stress, 9/18 patients occasional stiffness
Wheen[14]	48 [32, NR]	NR	NR	NR	NR	3/32	NR
Ferlic[13]	16 [54, NR–84]	NR	NR	NR	1 residual stiffness, 0/54 residual triggering	1/54	Improved flexion to extent of passive range of motion in all fingers

TAM: total active motion; PIPJ: proximal interphalangeal joint; NR: not reported; DASH: Disabilities of the Arm, Shoulder and Hand.

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Table 4. Complications across Studies

Study	Hypersensitivity	Haematoma	Infection	Tendon rupture	New deformity	Other	Total complications/number of operated fingers (%)
Le Viet[19]	16	0	0	NR	0	2 patients intra-operative A2 pulley ruptures 9 CRPS, 11 with hard scars	38/228 (16.6)
Husain[20]	NR	NR	NR	NR	1 swan neck	NR	1/11 (9.1)
Favre[15]	2	1	0	NR	0	NR	3/39 (7.6)
Marcus[11]	NR	0	1	NR	0	3/11 patients reduced sensation, 1 small area skin flap necrosis	5/37 (13.5)
Degreef[21]	0	0	0	NR	0	0	0/19 (22.2)
Wheen[14]	NR	NR	0	0	0	NR	0/32 (0)
Ferlic[13]	NR	NR	NR	0	NR	0	0/54 (0)

NR: not reported.

average active PIPJ range of motion was 84.7° ($n = 52$). Recurrence of trigger finger was reported in four patients (3.6%). Differences in outcomes between patients treated for primary or recurrent trigger fingers were unable to be performed due to heterogeneity of data and small numbers.

Accurate description of complications was also limited by inconsistent reporting among studies (Table 4). Complications were rare; two intraoperative A2 pulley ruptures were reported requiring reconstruction, 18 patients reported postoperative hypersensitivity and three fingers reported loss of sensation. The pooled complication rate across the study was 11.2%.

DISCUSSION

Partial or complete excision of the FDS tendon reduces the mismatch in size between the flexor tendons and their encasing fibrous flexor sheath, theoretically reducing impingement. This has been shown to be true in cadaveric studies following FDP repair.[22] Despite this, outcomes of this technique remain sparse – isolated A1 pulley division remains the mainstay for primary trigger finger pathology, and the number of patients requiring more extensive dissection is low by comparison. FDS excision may play a role in the treatment of trigger finger in patients with residual symptoms or recurrence after prior A1 release, those at high risk of recurrence or those with pre-existing fixed flexion deformities due to flexor tendon shortening from neglected disease.[21] Small case series have previously reported the feasibility of this technique, but this review highlights the effectiveness of FDS resection in restoring functional outcomes while avoiding significant morbidity.

Multiple surgical techniques were used across this study. FDS ulnar slip resection alone was the most common operation (71%), though radial slip division and excision of both slips were also performed. Theoretically, ulnar slip division foregoes the risk of secondary destabilisation of the metacarpophalangeal joint and ulnar drift that may occur with radial slip resection.[23] This is of particular importance in patients with rheumatoid arthritis who are vulnerable to ulnar drift, but are also at risk of trigger recurrence.[24] Nonetheless, no ulna drift was reported in studies incorporating radial slip division, though numbers were low and the follow-ups short in these studies. Traditional teaching for trigger finger in rheumatoid arthritis is that violation of the A1 pulley leads to ulna drift of the MCPJs and should be avoided. Synovectomy with ulnar slip FDS resection, therefore, represents a viable alternative that maintains A1 integrity and avoids this risk. However, it should be noted that the importance of the A1 pulley in rheumatoid arthritis is increasingly being challenged.[20] Complete FDS division resulted in imbalance (?) and development of a swan neck deformity in only 1 of 42 patients, though pre-existing PIPJ contracture and short follow-up may have masked the propensity for FDS resection to lead to deformity.[19] In those with complete FDS resection, there was a trend towards reduced grip strength which did not reach statistical significance.

Incisions for FDS sectioning differed between studies (Fig. 2). Le Viet described an extensile approach with

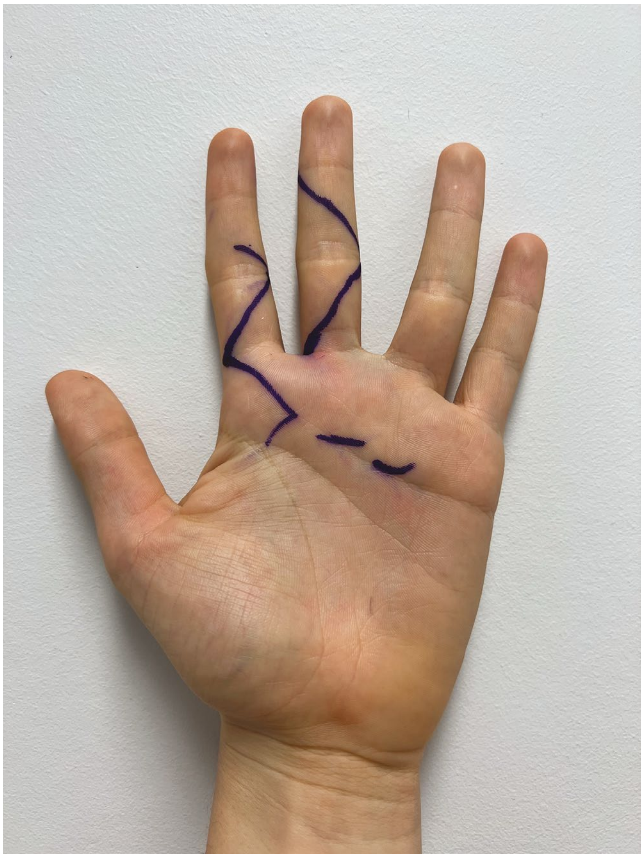

Fig. 2. Incisions for FDS resection as per Le Viet[25] (index finger), Wheen[13] (middle finger) and Polatsch[16] (ring finger).

complete visualisation of the FDS, followed by distal transection and proximal retrieval.[25] In contrast, Marcus and Wheen described discontinuous incisions from the palm into the digit.[11,13] Both of these techniques risk injury to the A2 pulley, or excessive postoperative scarring and contracture, due to the length of the incisions, even though only two A2 ruptures were reported across the whole cohort. Eighteen patients (6.2%) reported painful scarring. Improvements in technique have been described by Polatsch, whereby a single palmar incision allows access to the distal aspect of the ulnar slip with the finger hyperflexed, without need for a separate incision in the finger, theoretically reducing the risk of scar pain and contracture.[16] Outcomes and complications data have not been described for this technique to allow comparison.

In patients with generalised ligamentous laxity, the authors' preference is single FDS slip resection to reduce the risk of secondary PIPJ hyperextension, with tenodesis of the divided FDS slip to the proximal phalanx or A2 pulley via sutures for those at high risk of developing swan neck deformity. Both slips of FDS are excised in patients without generalised laxity. Our preferred approach is a transverse incision over the A1 pulley, and a second Brunner's incision over the PIPJ. If only one slip of FDS is to be excised, it can be mobilised and split proximally and distally to facilitate retrieval. If complete FDS excision is to be performed, both FDS slips are identified and divided at their insertion through the distal wound, followed by A1 pulley and FDS tendon excision through the proximal wound (Fig. 3). For patients with grade II–IV recurrent trigger finger, we perform surgery wide awake under local anaesthesia to confirm resolution of dynamic pathology (catching, clicking or locking) on table. However, this benefit is not seen in grade I trigger finger where pain is the primary symptom; we have no preferred anaesthetic technique in this patient population.

One of the principal proposed advantages of FDS resection is resolution of fixed flexion deformity in long-standing trigger finger. This was possible in most cases, with a postoperative reduction of 58% in the number of fingers with fixed flexion deformity. The effect size was clinically significant, with mean deformity at the PIPJ decreasing from 31.5° to 6.0°. This improvement is inversely proportional to preoperative deformity, with Le Viet reporting lower correction in those with more severe fixed flexion deformity.[25] Digits with a preoperative fixed flexion deformity of 30° or more had an average postoperative deformity of 12°, with only 40 out of 127 digits achieving full range of motion postoperatively. This contrasts with the 101 fingers within the same study with a preoperative deformity of less than 30°, all of which achieved full range of motion. Similarly, Favre found only 72% of patients with deformity greater than 30° recovered full range of motion.[14] This is likely related to contractures of the volar plate and other soft tissues rather than bony factors. Le Viet performed preoperative radiographs to screen for intra-articular bony pathology and did not find any osseous pathology responsible for persistent deformity.[25]

Another proposed advantage of FDS resection is a reduction in postoperative recurrence or residual triggering, particularly in high-risk patients with rheumatoid disease and diabetes. Across this study, rates of recurrence and residual disease were low, with only four patients reporting recurrence and three reporting ongoing triggering (4.7%). Among those with rheumatoid arthritis, recurrent and recalcitrant disease occurred in 4 of 115 patients (3.5%), and among diabetics, 1 of 26 patients (3.8%). This compares favourably to primary treatment of diabetic patients with A1 release (13.3% treatment failure) and is similar to success rates in primary trigger

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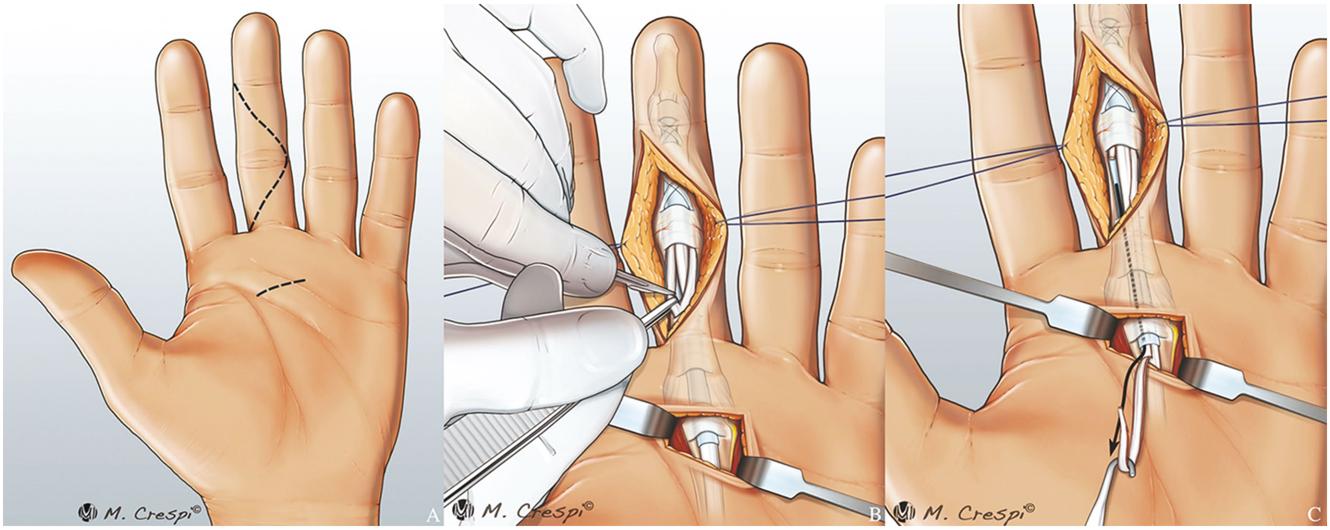

Fig. 3. The authors' preferred technique for FDS slip excision showing preferred incisions. (A) Division of an FDS slip at its insertion on the middle phalanx and (B) proximal retrieval of the cut FDS slip, followed by A1 pulley and FDS tendon excision through the proximal wound (C).

finger release.[10] However, follow-up durations of the studies in this review were short, which may result in underestimation of true recurrence. Direct comparison with isolated A1 pulley release was only performed in one non-randomised study, but showed decreased recurrence rates with FDS resection in those with rheumatoid arthritis.[13] Given the recurrence rate using FDS resection was lower than that seen for isolated A1 pulley release, with high levels of symptom resolution and infrequent complications, the authors suggest that primary FDS resection may be an appropriate modality for treatment of trigger finger in high-risk groups.

Conjecture remains whether FDS resection is appropriate in recurrent or ongoing triggering after A1 release. No guidelines exist for this clinical scenario, and unfortunately the low numbers and heterogenous reporting in the included studies did not allow for direct comparison of outcomes for primary compared to revision surgery. Pathological findings in recurrent trigger finger following A1 release are variable, with Husain reporting degenerative partial ruptures of FDS and histological changes in only a portion of their cohort of patients with recurrent disease.[19] Anatomical variations in flexor tendon morphology may also result in recurrence following trigger finger release.[30] These findings suggest that the pathophysiology, and, therefore, optimal treatment, in recurrent trigger finger may not obey a 'one-size fits all' approach, or that some trigger fingers initially treated with A1 release may be incorrectly diagnosed. Numerous differentials for trigger finger exist, including Dupuytren contracture, sagittal band injury, joint contracture or arthritis, and excluding alternate pathology and identifying the cause of treatment failure is important before embarking on revision surgery specific for trigger finger. Other treatments proposed for recurrent trigger finger include A2 pulley venting, which has shown promise in small case series, though concerns remain about the potential for bowstringing.[26,27] Similarly, reduction flexor tenoplasty has been proposed as an alternative or adjunct to FDS resection.[28,29] The value of these procedures compared to FDS resection alone remains unexamined.

It is important to consider the limitations of this study. Firstly, there was high clinical heterogeneity in the studies that were included, from the operation performed to the patient population (which had variable representation of comorbidities). The follow-up period of the included studies also ranged extensively from 12 to 154 months, with some studies not reporting on this metric. Shorter follow-up times may reduce detection of recurrence, resulting in an underestimation of this complication. The included studies were all observational in nature and primarily retrospective, limiting the interpretation of cause and effect.

This study provides a systematic review of the literature regarding FDS resection for trigger finger. It finds the technique is effective at decreasing fixed flexion deformity in long-standing trigger finger, and results in lower recurrence rates among diabetic or rheumatoid populations when compared to isolated A1 pulley release. It is a safe technique with acceptable complication rates. Our conclusion is, therefore, that primary FDS excision should be performed alongside A1 pulley release in patients with ongoing triggering on table after A1 pulley release alone and can be considered in patients at high risk of disease recurrence (those with insulin dependent diabetes or rheumatoid arthritis) or with preoperative fixed flexion deformity at the PIP joint without after informed patient discussion. In the setting of recurrent trigger finger, we also advocate for FDS excision as an adjunct to A1 pulley rerelease provided other pathologies have been excluded. Prospective and comparative studies of this technique would be beneficial.

DECLARATIONS

Conflict of Interest: The authors do NOT have any potential conflicts of interest with respect to this manuscript.

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