

Chronic post-traumatic volar plate avulsions of the finger proximal interphalangeal joint: A literature review of different surgical techniques

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Abstract

Avulsions of the volar plate of the finger proximal interphalangeal joint (PIPJ) following sprains are often undiagnosed in the acute setting. Therefore, the chronic outcomes of this injury are most frequently the object of study and treatment. Different techniques for volar plate chronic avulsion repair are described in the literature. The most used among these are mainly two: the direct suturing with or without the use of bone anchors and the tenodesis techniques with flexor digitorum superficialis (FDS). The aim of this systematic review is to determine outcomes and complications associated with these surgical treatments of post-traumatic volar plate avulsions without phalangeal fractures. An electronic literature research was carried out and pertinent articles were selected. Surgical techniques details, outcomes and complications for direct sutures and tenodesis technique are discussed. Outcomes (Range of motion and pain) seem to be comparable, whereas authors that use the direct suture technique describe more frequently PIPJ flexion contracture complication. From this review of the literature, authors believe that both techniques are available for the repair of chronic injuries of the volar plate of the PIPJ, although direct suturing can be considered as less reproducible.

Introduction

The proximal interphalangeal joint (PIPJ) is a synovial joint, allowing flexion and extension of the middle phalanx (P2) (range = 0° to 100°-110°). The volar plate is a multilayered condensation of fibrocartilaginous tissue lying between the flexor tendons and the palmar PIPJ capsule, which maintains the stability of the PIPJ in the anteroposterior plane and prevents PIPJ

hyperextension. It originates from the proximal phalanx (P1) and inserts onto the P2.

A trauma in hyperextension of the PIPJ can cause the avulsion of the volar plate, eventually associated with a dorsal dislocation.¹⁻³ Most of these injuries are seen in athletes, especially ball-handling sports.^{1,4}

The proper treatment in the acute traumatic setting could be conservative, after reduction of any dislocation, by splinting the PIPJ for two-to-three weeks according to the clinical aspect, or operative, suturing the volar plate. However, many volar plate avulsions are not diagnosed immediately and degenerate into chronic conditions.⁵

The injury is usually tolerated until motion begins to be accompanied by a troublesome snapping, as the extensor lateral bands slide dorsally on the condyles of the P1 epiphysis. This chronic instability at its most severe can lead to remarkable pain and functional restriction.⁵ If not treated promptly, it may induce over the time cartilage wear and early arthritic degeneration.^{4,6-8}

Signs and symptoms include:^{1,3-6} significant swelling or deformity at the joint, pain when the finger is resting, inability to move the joint fully, severe pain at motion.

The surgical goals for correction of post-traumatic chronic injuries, include the restoration of joint stability, functional improvement, pain relief, and return to full sports or work. In this case, surgical options may include different methods as direct volar plate repair if still achievable,^{4,9} volar plate reconstruction with tendon or artificial graft,¹⁰⁻¹² collateral ligament advancement,^{2,13-15} lateral band translocation,¹⁶⁻¹⁹ and Flexor Digitorum Superficialis (FDS) tenodesis.²⁰⁻²⁴ Among these, the most common methods in clinical practice are direct repair or tenodesis.

This systematic review aims to determine outcomes and complications associated with different surgical treatments for post-traumatic chronic volar plate avulsions. We consider this investigation useful in consideration of the consequence of this injury on the global hand function. To our knowledge, this is the largest and only analysis in the literature for the treatment of this PIPJ instability.

Materials and methods

Study setting and design

The present study represents a systematic literature review reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

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Inclusion and exclusion criteria

In this review, we have considered the studies published as full-text articles in indexed journals, which investigated the finger PIPJ post-traumatic chronic volar plate avulsions, without phalangeal fracture. Only articles written in English with available abstracts were included. No publication date limits were set.

We excluded from the review: surgical technique reports, expert opinions, case report, letter to the editor, studies on animals, unpublished reports, cadaver or in vitro investigations, review of the literature, abstracts from scientific meetings, and book chapters.

Search strategy and study selection

Scopus, Cochrane Library MEDLINE via PubMed, and Embase were searched using the keywords: "Finger PIP Joint Volar Plate Chronic Avulsion" and their MeSH terms in any possible combination. The reference lists of relevant studies were screened to identify other studies of interest. The search was reiterated until May 30, 2020.

Data extraction and analysis

Two independent reviewers (G.C. and D.C.) collected the data from the included studies (Table 1). Any discordances were

solved by consensus with a third author (L.R.). For each study included in the present analysis, the following data were extracted: demographic features, number of patients, average follow-up, average age, average operation time after trauma, functional evaluation by range of motion (ROM), treatment performed, complications, outcomes (Disabilities of the Arm, Shoulder, and Hand questionnaire, pain, return to activity when available), and follow-up.

Results

Surgical techniques

The surgical techniques for the reconstruction of the volar plate, in the articles analyzed, can be divided into two groups: those that involve a direct suture and those that involve a reconstruction of the volar plate with the tenodesis of the FDS.

Direct suture

The operation is usually performed under peripheral anesthesia with the aid of an operating table. Different skin incisions can be performed on the volar region of the PIPJ depending on the authors. The neurovascular bundles are identified and protected by retractors. The tendons sheath has

to be sectioned on one side and elevated to access the tendons. The FDS and Flexor Digitalis Profundus (FDP) are spread laterally and the articular aspect is exposed. At this point, the injury is checked. The volar plate can be sutured directly to itself^{1,9} or reattached to the bone using a mini-anchor.^{25,26} Melone *et al.*¹ use to exit the suture from the dorsal aspect of the P2 and to fix the PIPJ at approximately 15° to 25° of flexion with 0.35mm Kirschner wire for 3 weeks. Wollestein *et al.*⁹ prefer to suture the volar plate to itself with a single 5-0 suture of polyglycolic acid (Dexon). Lee *et al.*,²⁵ instead, predrilled a hole in the base of P2 to fix a 45-degree angle mini bone anchor, to suture the volar plate.

Flexor digitorum superficialis tenodesis

The approach is the same as for direct repair. The tenodesis technique was originally described by Littler²³ and subsequently used and modified by various authors.^{5,20,22,27-29}

The FDS ulnar slip is dissected as proximal as possible to obtain the maximum length. Surgical technique involves a mini-bone anchor, which is placed in the middle of the volar aspect of the P1. The tendon slip is passed deep to both the FDP tendon and the radial slip of the FDS tendon. It is therefore sutured to the anchor, tensioning it

so that the PIPJ is approximately 5° short of full physiological extension.^{5,20} Swanstrom *et al.*²⁰ pass a single 0.045-inch K-wire dorsally distal to proximal across the PIPJ in order to protect the repaired volar plate and applied a split. Rocchi *et al.*⁵ use a slight dressing, replaced between 4 and 7 days after surgery with an extension block thermoplastic splint, applied dorsally on the P1 and P2, leaving the flexion motion free. Other surgeons²² instead, use a variety of this technique which involves stabilizing the FDS at the proximal phalanx using an interference knot of tendon tissue and sutures.

Outcomes

Although there is a relative lack of evidence in the literature, optimistic results (Table 2) have been obtained with both techniques: volar plate suture and tenodesis.

Among the articles describing a suture of the volar plate, Wollstein's⁹ had the largest number of fingers treated: 54 in 52 patients. At a mean 10.5 months follow-up, patients had a mean 10° of PIP extension (versus 17.5° before surgery), no patients had pain at rest, and five presented activity pain. All the patients returned to work. In 2008, Lee *et al.*²⁵ described their suture technique used on 14 patients with acute volar plate avulsion and 6 chronic patients. Regarding chronic patients, the results at a

Table 1. Previous literature.

Article	N. of patients	Mean age of patients (years old)	Mean time between trauma and surgery	Mean follow-up (months)	Type of suture
Catalano ²² (2003)	12	41	143 months	35	FDS Tenodesis
Wollstein ⁹ (2006)	52 (54 cases)	39	10.5 months	10	Direct
Lee ²⁵ (2008)	6	30.8	52.5 days	25	Direct
Melone ¹ (2010)	25	42.7	8.2 months	96	Direct
Kaneshiro ²⁶ (2015)	7	34	21 months	28	Direct
Swanstrom ²⁰ (2016)	5	37	n.a.	66	FDS Tenodesis
Rocchi ⁵ (2019)	15	36	22 months	6	FDS Tenodesis

Table 2. Outcomes.

Article	Pip rom after surgery (flexion-extension in°)	Dash test results	Pain after surgery	Return to work
FDS Tenodesis				
Catalano ²² (2003)	100-0-12	5 excellent, 5 good, 2 fair	No pain	All patients returned to work
Swanstrom ²⁰ (2016)	n.a.-0-1	n.a.	n.a.	n.a.
Rocchi ⁵ (2019)	88-0-2	7 excellent, 6 good, 1 poor	Mean VAS 0.8	All patients returned to work (mean time 24 days)
Direct suture				
Wollstein ⁹ (2006)	n.a.-0-10	n.a.	5 patients with activity pain	All patients returned to work
Lee ²⁵ (2008)	92.5-0-30	n.a.	No pain	n.a.
Melone ¹ (2010)	92-0-6	23 excellent/ good, 2 fair	2 patients with mild pain	All patients returned to work
Kaneshiro ²⁶ (2015)	n.a.	2 excellent, 3 good, 2 fair	n.a.	n.a.

mean 25 months follow-up were: a PIPJ ROM of 92.5-0-30° (flexion-extension) and no pain after surgery. Melone¹ proposed a dorsal suture, presenting an 8 years follow-up with a mean improvement of PIPJ ROM from 93-0-24° to 92-0-6° in 25 patients, with DASH questionnaire resulting in 23 excellent/good results and 2 fair. Two patients reported mild pain, but all returned to work. In 2015 Kaneshiro *et al.*²⁶ published their results of 7 patients they treated with a suture with a pull-out or with an anchor, describing their extension results as “well corrected” with 2 excellent results, 3 good and 2 fair.

In 2003, Catalano *et al.*²² were the first authors to expose their results for the treatment of volar plate chronic avulsion with FDS tenodesis. Patients improved from a mean range of motion of the PIPJ before surgery of 92-0-31° to 100-0-12° at a mean 35 months follow-up. At the DASH questionnaire, among 12 patients, they obtained 5 excellent, 5 good, and 2 fair results. None of the patients had pain after surgery and they all returned to work. Swanstrom *et al.*²⁰ also presented their results using a tenodesis technique on 5 patients with a mean 5 years follow-up. The patient’s mean extension of the PIP joint was 59° before surgery and of 1° after surgery. Last, in 2019 Rocchi *et al.*⁵ published their series of 15 patients treated with tenodesis and anchor presenting their result at a short-term follow-up. Patients were treated at an average 22 months after traumatic avulsion of the volar plate and they improved from a mean ROM of 88-0-43° to 88-0-2° post-operatively. DASH results were excellent in 7 cases, good in 6, poor in 1 case. One patient was lost at follow-up. Among those patients, means VAS score was 0.8 after surgery, and the average return to work time was equal to 24 days.

Complications

Although most of the patients were satisfied with the surgery of the PIPJ volar

plate, regardless of the technique, those procedures may present some complications (Table 3).

Among the authors who performed a tenodesis with the FDS, Swanstrom *et al.*²⁰ described no complications in their cases. Catalano²² referred 2 patients out of 12 with significant postoperative flexion contractures of the PIPJ. In Rocchi’s article,⁵ the authors described only minor complications with no flexion contracture: they present a case with superficial skin infection observed at two weeks after surgery, two cases of temporary dysesthesia, and one case with a painful scar. Conversely, three out of four authors who performed the direct suture technique, experienced PIPJ flexion contracture as the main complication. Wollstein⁹ reported 4 patients with limited function postoperatively, that required a second operation for the release of proximal interphalangeal joint contracture. Lee²⁵ reported one patient which developed flexion contracture because of poor compliance, which made it necessary two open release surgeries. Kaneshiro²⁶ observed in one patient a postoperative degenerative change of the PIPJ, although pain and functional disability were not observed. Melone¹ doesn’t describe any complication but he considered “a *minor residual flexion contracture of the PIP joint*” as a “*surgically created check rein to dorsal instability*” and he considered that it “*should not be considered a complication of the procedure*”.

Discussion and conclusions

Chronic volar plate avulsion is a condition often linked to sports activities⁴ and therefore affects young patients. The mean age among the 124 patients analyzed in the seven articles included in this review is equal to 38,8 years old. Therefore, the authors feel important to identify a surgical

technique that allows to restore PIPJ ROM and stability, without pain, allowing patients to return to work as soon as possible, possibly avoiding complications.

In the selected articles, variability of including factors such as time between trauma and surgery (ranging from 2 to 123 months) or length of follow-up (ranging from 6 months to 5 years), and the non-uniformity of data considered in the results, didn’t permit the authors to analyze statistically those results.

The only data presented by all authors is post-operative ROM: the restoration of active PIPJ flexion is comparable in all articles. However, some residual hyperextension seems to be present particularly in the patients treated with direct suture. Apart from Kaneshiro and Swanstrom who don’t report about pain, the most of authors describe their surgery as pain-free, except Wollstein⁹ that describes 5 cases out of 54 (9,25%) with pain at follow-up during activities. DASH score, when used, is not presented in a homogenous manner. It seems anyway comparable in both techniques, direct suture and FDS tenodesis, with mainly excellent and good results. The last presented result is the return to work that seems to happen in all cases. In summary, functional results seem comparable in the series of direct suture and FDS tenodesis, but the first method can be considered less reproducible, because it depends on the variable residual tissue of the volar plate, unlike tenodesis, which is a more standardized technique. Regarding complications, authors using FSD tenodesis describe mainly minor complications, while all authors using direct suture present cases of PIPJ flexion contracture, even severe.

Despite the small number of articles published on this topic, we can conclude that both techniques may be considered as option to treat the chronic avulsion of the PIPJ volar plate, however tenodesis seems more advisable due to the fewer complications and its greater reproducibility.

Table 3. Complications.

Article	N. of patients with flexion contracture		Other complications
	FDS Tenodesis		
Catalano ²² (2003)	2		None
Swanstrom ²⁰ (2016)	0		None
Rocchi ⁵ (2019)	0		1 skin infection, 2 temporary dysesthesia, 1 painful scar
Direct suture			
Wollstein ⁹ (2006)	4		None
Lee ²⁵ (2008)	1		None
Melone ¹ (2010)	n.a.		None
Kaneshiro ²⁶ (2015)	1		None

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