Management of digital tendon avulsion at the musculotendinous junction of the forearm: a systematic review

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Published online: 28 March 2012
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Abstract

Background Tendon avulsion at the musculotendinous junction caused by digit avulsion amputation or closed injury is a challenging problem, for which the literature lacks definitive recommendations regarding treatment. We have provided a systematic review and developed an algorithm to delineate optimal management of this injury.

Presented at the 62nd Annual Meeting of the Canadian Society of Plastic Surgeons, St. John's, Newfoundland, Canada, 24–28 June 2008.

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Methods Two independent reviewers undertook a systematic review of the literature to identify articles discussing management of forearm tendons avulsed at their musculotendinous junction. Patient demographics, injury mechanism, injury pattern, type of repair, and outcome were investigated. These data were analyzed to reveal tendencies in management, which were then organized into an algorithm.

Results Twenty articles fit our criteria for a total of 91 tendons. Cases were mostly males involved in work accidents. Treatment options were tendon resection, reattachment to muscle, tendon transfer, and side-to-side repair. When the digit was replanted, tendons avulsed through avulsion amputations were preferentially treated by reattachment in the case of the thumb, transfers for the index and long fingers, and resection for the ring and small fingers. Reattachment was favored for metacarpophalangeal level amputations, while transfer was selected for proximal phalanx levels. For closed avulsion injuries, flexors were preferentially treated with reattachment or transfer, while extensors underwent transfer or side-to-side repair.

Conclusions In the management of tendon avulsions at the musculotendinous junction, specific procedures are favored depending on the mechanism of injury, the type of tendon and digit involved, and the level of bone amputation. An algorithm is presented to facilitate optimal treatment based on these injury characteristics.

Keywords Tendon · Avulsion · Musculotendinous junction

Introduction

The avulsion of tendons at the musculotendinous junction in the forearm presents a challenging case for the hand

surgeon. Musculotendinous unit avulsion injuries can occur in five areas along its length: (1) the point of insertion of tendon into bone, (2) the tendon substance, (3) the musculotendinous junction, (4) the muscle belly, or (5) the muscle origin. In this article, only injuries at the musculotendinous junction of the forearm are discussed (seven charts were also obtained from Collins and Thoma, unpublished results) [8, 11, 13, 16–19, 21, 23–31, 33, 34].

Experimental work by McMaster [22] demonstrated that injury can occur either from direct trauma, in which the tendon is compressed between the bone and an outside force, or from indirect trauma, in which a longitudinal traction force is exerted along the entire musculotendinous unit. The latter often occurs through resisted wrist or finger flexion/extension [12, 31], with longitudinal forces acting in direct opposition to the muscular force [2, 11]. This mechanism of injury reveals the robustness of musculotendinous unit components, since the areas likely to rupture when exposed to indirect trauma are the insertion point, musculotendinous junction, muscle belly, or muscle origin [22]. Avulsion fractures at the insertion point or muscle origin can also occur. Boyes et al. [2] reported that the two weakest sections were the insertion point and the musculotendinous junction. Avulsions at the insertion point accounted for 62.8% of the studied cases, whereas avulsions at the musculotendinous junction only occurred in 5.1% of the cases, demonstrating that the insertion point was the most likely site of avulsion. However, if the mechanism of injury were to involve compression of the insertion point, which would prevent the separation of tendon from bone, avulsion at the musculotendinous junction would then be likely to occur instead. This could take place either through a closed injury or in concurrence with digit amputation, in which the tendon is avulsed with the digit. Depending on the type of injury, various tendons, digits, and levels of bone amputation could be involved.

Although uncommon, tendon avulsion injuries at the musculotendinous junction should not be overlooked. Failures in management could result in unrecognized compartment syndrome when tendons are avulsed from their muscle belly in the forearm or lumbricals in the hand in the short term, and significant disability in the long term [2]. Although the use of conservative management such as splinting and physiotherapy has been occasionally discussed [1, 27], surgical exploration and repair is favored throughout the literature. However, determining the optimal management of the tendon is challenging because many surgical approaches are described (resection of the tendon, reattachment of the tendon, tendon transfers, and side-to-side repair) but definitive recommendations, algorithms, or comprehensive reviews on this topic are hitherto unreported. In order to delineate the optimal management of the tendon involved in such injuries (based on whether the tendon was a flexor or

an extensor, which digit was involved, and at what level the digit amputation occurred), cases were gathered from our own experience (seven charts were obtained from Collins and Thoma, unpublished results) and through a thorough systematic review of the literature [8, 11, 13, 16–19, 21, 23–31, 33, 34]. Based on our findings, an algorithm was designed to state the most commonly performed operations for specific injury patterns.

Materials and Methods

Two independent reviewers (J.C. and Y.I.) undertook a systematic review of the literature using Cochrane, Medline, Embase, and CINAHL databases from 1966 to 2010 in any language, applying the following keywords: “tendon injuries,” “tendon avulsions,” “tendon rupture,” “avulsion amputation,” “musculotendinous junction,” “forearm,” “tendon repair,” and “tendon transfer.” Articles were selected using clear inclusion and exclusion criteria. References were then reviewed in order to acquire any outstanding articles not found in the initial literature search. A kappa coefficient was calculated as a measurement of agreement between the two independent reviewers, and disagreements with regards to article selection were resolved through discussion. Article quality could not be rated since a scale to evaluate retrospective case series and case reports does not yet exist. Additionally, patient charts from the senior author who fit the eligibility criteria were retrospectively reviewed.

Eligibility Criteria

Inclusion Criteria All patients with acute musculotendinous junction avulsion injuries in the forearm, resulting from digit avulsion amputation or closed traction and following any mechanism of injury were included in the study. This involved flexor or extensor tendons of any digit, with bone amputation levels anywhere between the wrist and the distal phalanx.

Exclusion Criteria (1) Avulsions at the insertion point; (2) rupture at any other level of the tendon or muscle; (3) musculotendinous junction injuries caused by lacerations; (4) delayed ruptures; and (5) patients with comorbidities that may have an effect on tendons (e.g., rheumatoid arthritis) were excluded from the study.

Data Extraction and Analysis

For each tendon, the following data were collected: patient demographics, cause of injury (work-, sports-, or trauma-related), mechanism of injury (digit avulsion amputation or closed avulsion), type of tendon involved (flexor or

extensor), digit involved, level of bone amputation, method of operative repair, primary outcomes, and duration of follow-up time. These data were grouped and depicted as five separate graphs: (1) management of flexors and extensors in tendons involved in avulsion amputations; (2) management of avulsion amputation tendons depending on which digit was involved; (3) management of avulsion amputation tendons depending on the level of bone amputation; (4) management of flexors and extensors in tendons involved in closed avulsions; and (5) management of closed avulsion tendons depending on which digit was involved. These findings were then combined to generate an algorithm.

Results

After applying the inclusion and exclusion criteria to the 130 titles and abstracts that were found, 20 clinically relevant articles (seven charts were obtained from Collins and Thoma, unpublished results) [8, 11, 13, 16–19, 21, 23–31, 33, 34] were identified in this systematic review (Fig. 1). The calculated kappa coefficient between the two independent reviewers was 0.943, with a 95% confidence interval of 0.87 to 1.00. The 20 articles accounted for 51 patients with a total of 91 injured tendons. The type and location of the identified tendons were classified as follows (see Table 1): 26 flexor pollicis longus (FPL), 9 flexor digitorum profundus, 7 flexor digitorum superficialis (FDS), 22 extensor pollicis longus (EPL), 17 extensor digitorum communis, 8 extensor indicis proprius, 1 extensor digiti minimi, and 1 extensor pollicis brevis. Cases were mostly males (46 males versus 5 females), and the mean age was 31 ± 4 years old. Work injuries ($n=37$) were more common than sports injuries ($n=7$) or nonwork-related trauma ($n=7$). Work injuries were most often caused by the patient's glove being caught and pulled into a machine, sport injuries arose from patients participating in gymnastics, judo, and baseball pitching exercises, and traumatic injuries were results of falls and

direct blunt trauma to the forearm. With regards to the mechanism of injury, avulsion amputations ($n=57$) were more common than closed avulsion injuries ($n=34$). When the digit was deemed replantable, options for tendon management included resection, reattachment to muscle, tendon transfer, and side-to-side repair; however, when the digit was considered to be nonreplantable, the only available option was revision amputation ($n=23$). All tendon injuries were classified into avulsion amputation injuries versus closed avulsions and flexors versus extensors, in order to detect trends in the preferred treatment of specific injury patterns. Various outcomes were studied, but the most common outcome was the patients' ability to return to their prior work. Follow-up times ranged from 7 weeks to 4 years.

Avulsion Amputations

In the case of avulsion amputations, the methods of management for flexor and extensor musculotendinous junctions showed similar distributions (Fig. 2). When the digit was replanted, reattachment of the tendon to its muscle was the most favored form of treatment, followed by tendon transfer. Analysis of digit-specific management indicated that the treatment of thumb flexor and extensor tendons also showed the same order of preference (Fig. 3). Index and long finger flexor tendons were preferentially treated with tendon transfers (FDS from intact adjacent digits), whereas ring and small fingers' avulsed flexor tendons were treated with resection. Literature data regarding extensor tendon amputations of the index, long, ring, and small fingers did not exist. Analysis of avulsion management sorted by the level of bone amputation revealed that, for metacarpophalangeal (MCP) joint level injuries, tendon reattachment was appreciably favored for both flexors and extensors (Fig. 4). For amputations at the proximal phalanx (PP) level, tendon transfer and reattachment were preferred for both flexors and extensors when the digit was replanted. In the literature, the majority of cases of digits with amputations at the proximal interphalangeal (PIP) joint and distal interphalangeal (DIP) joint, and the thumb interphalangeal (IP) joint, underwent revision amputation.

Closed Avulsions

For tendons injured as a result of closed avulsion injuries, flexors were managed with reattachment or tendon transfer, while extensors were repaired through tendon transfer or side-to-side repair (Fig. 5). Analysis of closed avulsion management by digit (Fig. 6) showed that thumb flexors underwent reattachment or tendon transfer (FDS [28, 30], palmaris longus [28]), while thumb extensors only received

Fig. 1 Flowchart of article selection process

Table 1 Patient demographics and details of tendon injuries

Patients	51
Male	46
Female	5
Mean age	31±4
Work injuries	37
Sports injuries	7
Trauma	7
Injured tendons	91
Avulsion amputations	57
Closed avulsions	34
Flexor pollicis longus	26
Flexor digitorum profundus	9
Flexor digitorum superficialis	7
Extensor pollicis longus	22
Extensor digitorum communis	17
Extensor indicis proprius	8
Extensor digiti minimi	1
Extensor pollicis brevis	1

tendon transfer (extensor indicis proprius [23, 25, 31, 33]). Index flexors were reattached, whereas index extensors were preferentially treated not only with side-to-side repair but also with tendon transfer (extensor digiti minimi [31], flexor carpi radialis [24]). Long, ring, and small fingers' extensors were managed with both side-to-side repair and tendon transfer (extensor carpi radialis [18, 31], flexor carpi radialis [24]). Flexor tendon data were not available for the long, ring, and small fingers.

Algorithm

All data were combined to generate an algorithm for simplicity of usage and visual clarity (Fig. 7). Once an injured

Fig. 2 The incidence of injury and treatment for tendons with musculotendinous avulsions secondary to avulsion amputations: **a** flexor ($n=23$) and **b** extensor ($n=11$) tendons

digit is deemed viable or replantable, this guideline can be used to determine which operative procedure is favored for a specific injury, after taking into account the mechanism of injury, the type of tendon involved, the digit affected, and the level of bone amputation.

Outcomes

Outcomes were not reported in a consistent fashion between studies. With follow-up times ranging from 7 weeks to 4 years, some reported the patients' descriptive and qualitative range of motion, while others displayed quantitative results by disclosing angles of maximal motion of the digit, as well as grip and/or pinch strength (Table 2). Moreover, some series described outcomes for each patient, while others summarized outcomes for the series as a whole, making it impossible to correlate a given procedure to a specific outcome.

Discussion

Since patients with tendon avulsions at the musculotendinous junction risk being significantly disabled, it is important to determine the surgical procedure that will optimize outcomes. There are several options available for the treatment of a tendon avulsion injury at the musculotendinous junction of the forearm. The preferred mode of treatment depends on the specifics of the injury, such as mechanism of injury, type of tendon affected, digit involved, and level of bone amputation, which should all be taken into account to devise a surgical plan specific to each patient. This decision may at times be difficult to make, and the literature currently lacks definitive recommendations. To this end, we have designed a pragmatic algorithm to delineate the preferred management of tendons ruptured at the musculotendinous junction, based on a compilation of case reports and case series (seven charts were also obtained from Collins and Thoma, unpublished results) [8, 11, 13, 16–19, 21, 23–31, 33, 34].

In avulsion amputation injuries, once the avulsed digit is deemed replantable, various options are available for the management of the severed tendon (Fig. 2). Although resection is considered to be the simplest form of treatment, this option is not favored in the literature because a major goal of the replantation is for the patient to regain function. When saving the tendon, reattaching it to the muscle is theoretically the simplest option because the procedure merely entails the reconnection of two ends of a broken structure, with no additional dissection needed to expose and use other tendons. Moreover, most injuries involving musculotendinous junction avulsions require fasciotomies to prevent or treat compartment syndrome, which results from the extensive soft tissue injury throughout the entire

Fig. 3 The incidence of injury and treatment for tendons of the thumb (D1), index (D2), long (D3), ring (D4), and small (D5) fingers with musculotendinous avulsions secondary to avulsion amputations: **a** flexor ($n=23$) and **b** extensor ($n=11$) tendons

length of the forearm. The fasciotomy incision itself can expose the proximal end of the injury, facilitating the repair due to the lack of need for further dissection. However, there are concerns regarding tendon reattachment in its strength and feasibility, since suturing through muscle does not allow

Fig. 4 The incidence of injury and treatment for tendons with respect to the level of bone amputation at the proximal phalanx (PP) or metacarpophalangeal joint (MCP) with musculotendinous avulsions secondary to avulsion amputations: **a** flexor ($n=21$) and **b** extensor ($n=10$) tendons. Of note, for the flexors, one reported case at the distal interphalangeal joint (DIP) was replanted with tendon resection and one reported case at the proximal interphalangeal joint (PIP) was replanted with tendon transfer. For the extensors, one reported case at the thumb interphalangeal joint (thumb IP) was replanted with reattachment

Fig. 5 The incidence of injury and treatment for tendons with closed musculotendinous avulsions: **a** flexor ($n=3$) and **b** extensor ($n=31$) tendons

for a strong repair. The incorporation of other techniques to fortify the repair, such as encapsulation of the tendon within the muscle substance, is also a surgical option [11]. However, most literature cases simply describe the reattachment of the tendon to the muscle and judge the results to be acceptable. This is likely because although this form of repair may not be robust initially, the subsequent scar is expected to maintain a strong repair if the extremity is splinted adequately for 4 weeks. Taking the above factors into consideration, it is reasonable that reattachment is the

Fig. 6 The incidence of injury and treatment for tendons of the thumb (D1), index (D2), long (D3), ring (D4), and small (D5) fingers with closed musculotendinous avulsions: **a** flexor ($n=3$) and **b** extensor ($n=31$) tendons

Fig. 7 Algorithm for the management of tendon avulsions at the musculotendinous junction, including the options of replant with resection of the tendon (*Rep.Res.*), tendon reattachment to muscle (*Reatt.*), tendon transfer (*T.T.*), and side-to-side repair (*S.S.*). *D1* thumb, *D2* index finger, *D3* long finger, *D4* ring finger, *D5* little finger, *DIP* distal interphalangeal

joint, *PIP* proximal interphalangeal joint, *thumb IP* thumb interphalangeal joint, *PP* proximal phalanx, *MCP* metacarpophalangeal joint. Any omissions in terms of fingers or amputation level are due to lack of available data

avored procedure for the repair of avulsion amputations. In our experience, we prefer to repair the tendon using a figure-of-eight or a modified Kessler technique if the amount of tendon substance remaining in the proximal muscle end is sufficient. If the tendon substance at the proximal muscle end is scarce, one can dissect within the muscle substance to find remnants of the tendon to be used in the repair. If this is not found, we simply lay the tendon in the corresponding muscle and splint the extremity for 4 weeks to allow for healing and scarring of the musculotendinous junction.

As an exception to the general inclination that tendon reattachment predominates in digit replantation, tendon transfer is occasionally preferred (Fig. 2). This exception is noted for index and long finger flexors in the digit-specific analysis (Fig. 3) and for both flexors and extensors involved in PP amputations (Fig. 4). This option might be preferred in the cases of index and long finger injuries due to the presence of intact adjacent tendons, sometimes in duplicate, which are dispensable and can be used in such repairs. Another exception, in which reattachment is not the most popular mode of treatment, is that resection is favored for flexor tendons of the ring and small fingers (Fig. 3). Although the anatomical reasons for this preference are unclear and since tendon transfers could also be used for these digits, this preference is perhaps due to potential partial active flexion retained at the DIP through tendinous interconnections between the ring and small fingers' flexor digitorum profundus tendons and lumbrical muscles [27].

Closed avulsion injuries are relatively rare and could be missed since they can be hidden by intact soft tissue coverage. Important clinical features that should raise suspicion for this injury include: ecchymosis, swelling and tenderness at the level of the injured musculotendinous junction(s) in the forearm, pain at this level at rest and with attempted range of motion of the affected digit(s), decreased or absent range of motion of the affected digit(s), and forearm compartment syndrome. An ultrasound could be obtained to visualize the rupture at the musculotendinous junction if the diagnosis is unclear after the physical exam. If the ultrasound is inconclusive, an MRI could further delineate the extent and nature of the injury.

For closed avulsion injuries, treatment options do not include resection (Fig. 5). Since the tendon is focally injured at the musculotendinous junction and not pulled out along its entire length, attempting to repair it seems reasonable; one would be more likely to resect a tendon that is already pulled out of the forearm (as in the case of avulsion amputation) because there is a higher likelihood of fraying and contamination. Another trend seen preferentially for closed avulsion injuries is side-to-side repair. This form of repair is effective for non-amputations, since the distal end of the affected tendon is intact in these injuries. Overall, reattachment and tendon transfer are favored for flexors in closed avulsion injuries and tendon transfer and side-to-side repair are favored for the repair of extensors (Fig. 5). These patterns are also observed in the corresponding digit-specific analysis. However, digit-specific preferences, such as the

Table 2 Range of follow-up times, summary of reported outcomes, and percentage of patients having returned to their preoperative activities (work, sports) for each treatment pathway of the algorithm in Fig. 7

Type of tendon	D	Level of amputation	Algorithm treatment	Range of follow-up	Summary of reported outcomes (ranging from best to worse)	RTA (%)
Avulsion amputations						
Flexor	D1	PP	Reatt.–T.T.	10–48 months	Normal extension with 45° flexion AROM—“restricted” AROM—equal after Reatt. or T.T. with strength (percent of contralateral): key 60, grip 70, all slightly stronger with T.T.	100
		MCP	(1) Reatt.; (2) T.T.	8–48 months	Normal extension with 35° flexion AROM—“restricted” AROM—equal after Reatt. or T.T. with strength (percent of contralateral): key 60, grip 70, all slightly stronger with T.T.	100
	D2	PP	T.T.	3.5 years	Tip to palm distance of 2.5 cm	100
	D3	PP	T.T.	3.5 years	Tip to palm distance of 1 cm	100
	D4	DIP/PIP/PP/MCP	Rep.Res.	4 years	“Acceptable” ROM for function	100
	D5	DIP/PIP/PP/MCP	Rep.Res.	7 weeks	DIP→ROM 50° PIP and 30° DIP	100
Extensor	D1	Thumb IP	Reatt.	10–48 months	“Acceptable” AROM with strength (percent of contralateral): key 60, grip 70	100
		PP	T.T.	10–48 months	“Acceptable” AROM with strength (percent of contralateral): key 60, grip 70	100
		MCP	(1) Reatt.; (2) T.T.	8 months	NAROM with normal thumb opposition	100
Closed avulsions						
Flexor	D1		Reatt.–T.T.	30 months	NAROM with strength (percent of contralateral): grip 93.7, key 81, pulp 97.7, tripod 90.2	100
	D2		Reatt.	10 months	FDS→DIP 95° flexion, –5° extension, normal strength	100
Extensor	D1		T.T.	12–36 months	No extension or flexion lag	100
	D2		(1) S.S.; (2) T.T.	12–36 months	S.S.: no extension or flexion lag—extension lag <15°, no flexion lag	100
					T.T.: no extension or flexion lag	
	D3		T.T.–S.S.	12–36 months	S.S.: no extension or flexion lag	100
	D4		T.T.–S.S.	12–36 months	S.S.: no extension or flexion lag	100
D5		T.T.	12–36 months	NAROM—extension lag >45° (1 case)	100	

AROM active range of motion, D digit (1 thumb, 2 index, 3 long, 4 ring, 5 small fingers), DIP distal interphalangeal joint, FDS flexor digitorum superficialis, MCP metacarpophalangeal joint, NAROM normal active range of movement, PIP proximal interphalangeal joint, PP proximal phalanx, RTA return to preoperative activities (percentage of patients in each group), Rep.Res. replant with resection of the tendon, S.S. side-to-side repair, thumb IP thumb interphalangeal joint, Reatt. tendon reattachment to muscle, T.T. tendon transfer

use of tendon transfer for thumb and small finger extensors, side-to-side repair for index extensors, and side-to-side repair or tendon transfers for the long and ring finger extensors, are of note (Fig. 6).

The algorithm presented herein allows for the integration of all the injury characteristics and repair decisions encountered in this study (Fig. 7). It puts forth all the relevant information in a clinically oriented fashion that is straightforward to use when faced with a case of musculotendinous junction avulsion in a viable or replantable digit. Since it is based on data from the literature, it presents the cumulative experience of several different surgeons. However, it must be forewarned that the relatively small number of reported cases may cast some doubt on the level of confidence of this algorithm for certain digits or levels of amputation. As well, data

were insufficient to complete the algorithm for all possible digits or level of injuries.

The case of a 33-year-old male treated by the senior author (A.T.) is shown below to illustrate the application of the presented algorithm (seven charts were obtained from Collins and Thoma, unpublished results). This patient had his glove pulled into a drilling press while at work. As a result, he suffered an avulsion amputation of his left thumb at the MCP level. Tendinous injury included avulsion of the FPL at its musculotendinous junction and laceration of the EPL at the level of amputation (Fig. 8). With regard to the management of the avulsed tendon, one can simply follow the algorithm: avulsion amputation → flexor tendon → thumb (D1) → MCP. This leads to the conclusion that reattachment is the favored operative procedure in the literature for an injury bearing these characteristics.

Fig. 8 **a** Avulsion amputation of the left thumb at the MCP joint level; **b** amputated thumb showing the FPL avulsed from the musculotendinous junction

Retrospectively, this is what was executed for this tendon, along with an MCP joint fusion and digit replant with direct EPL repair. A follow-up after 8 months showed that the patient had an active range of motion at the interphalangeal joint of 22° of extension and 46° of flexion with good thumb apposition (Fig. 9). The patient had also fully returned to his pre-injury occupation as a heavy machinery operator.

The scarcity of data regarding this topic was an impetus for the embarkation of this study but ultimately became its inherent weakness. High-level studies (RCT, prospective studies, etc.) have yet to be reported and would be difficult

to execute for this type of injury. Current articles consist only of case reports and case series. However, by combining these isolated cases, we have discovered trends that could lead to more specific management for such injuries. As further case series accumulate in the future, one may readjust this algorithm. In order to strengthen the evidence on the ideal management of this injury, such future studies should ensure that they follow rigorous methodology, as suggested by Coroneos et al. [7]

Finally, an important issue surfaced when trying to evaluate the degree of success of the procedures employed: a lack of common outcome measures between articles (Table 2). Consequently, attempting to objectively correlate the chosen procedure to its degree of success was fruitless. However, all articles uniformly reported that their patients were able to fully return to the occupations they held prior to injury. Thus, it can be inferred that all the selected procedures are generally successful with regard to long-term outcomes. Nevertheless, as surgical fields become increasingly aware of the methods and use of evidence-based practice [32], reporting outcomes should become more systematic. This would not only facilitate comparison and analysis of one's own data, but would also optimize communication within the surgical community via a common unit of measure. A complete evaluation protocol should include both surgeon- [14, 20] and patient-reported outcomes. Surgeon-reported outcomes should document quantitative data through complete preoperative and postoperative physical exams, including (1) quantitative degrees of flexion and extension for the DIP, PIP, and MCP joints of the affected digits and their uninjured contralateral counterparts, as well as those of the other digits on the injured hand, in order to assess the impact of a specific repair on the hand's function as a whole and (2) quantitative power assessment of key pinch and/or grip strength depending on the digits affected. Patient-reported outcomes should be assessed using validated quality of life instruments such as the Disabilities of the Arm, Shoulder and Hand (DASH), Neck and Upper Limb

Fig. 9 Eight-month follow-up, with the patient having returned to work. The repair involved replant of the amputated thumb, with metacarpophalangeal joint fusion, reattachment of the FPL to its muscle belly, and direct repair of the EPL laceration at the level of the amputation

Index (NULI), or Michigan Hand Outcomes Questionnaire (MHQ) [3–6, 9, 10, 15].

In the management of tendon avulsions at the musculo-tendinous junction, some operative procedures are favored over others. This preference is dictated by the mechanism of injury, the type of tendon involved, the digit affected, and the level of bone amputation. The algorithm presented herein can be used in the event of such injuries to determine the optimal operative management.

Acknowledgments The authors thank Leslie McKnight for editorial assistance.

Conflicts of Interest The authors declare no conflicts of interest, commercial associations, or intent of financial gain regarding this research.

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