Original Article

Functional results following surgical repair of post-traumatic hand tendon injuries

Mark Bugeja, Max Mifsud, Jason Zammit

Abstract

Introduction: The study aims to determine whether early physical therapy following hand tendon repair gives better results and to look at any possible limiting factors locally.

Methods: Twenty adults were selected from those admitted to Mater Dei Hospital, with traumatic tendon injuries to the wrist and hand during the year 2014. Their medical records were reviewed and details on surgical repair and postoperative rehabilitation noted. Participants completed *Q*uickDASH outcome measure questionnaires assessing their situation both on initial presentation to hand therapy and six months later. The range of motion in all joints of the injured digits, six months after commencement of therapy, was measured by manual hand goniometry and the Total Active Motion (TAM) score calculated.

Results: A negative correlation was found between delay in starting hand therapy and both TAM score (r=-0.650, N=20, p<0.001) and *Q*uickDASH score (r=-0.650, N=20, p<0.002). Comparison of the two outcome measures resulted in a strong negative correlation (r=-0.831, N=20, p<0.0005).

Conclusion: These findings support current literature confirming that a shorter delay in starting hand therapy following tendon repair is associated with a better outcome for the patient. Better documentation and interdisciplinary handover is required, and a new operation report template is being put forward.

Mark Bugeja MD(Melit.)*
Department of Trauma and Orthopaedics
Mater Dei Hospital
Malta
mark.a.bugeja@gov.mt

Max Mifsud MD(Melit.) MRCS(Edin.) MScRes(Melit.)
Department of Trauma and Orthopaedics
Mater Dei Hospital
Malta

Jason Zammit MD(Melit.) FRCS (Edin.) MSc Orth(Lond) FEBOT
Department of Trauma and Orthopaedics
Mater Dei Hospital
Malta

**Corresponding Author*

Keywords

tendon, repair, laceration, *Q*uickDASH, TAM, template

Introduction

The human hand is a sophisticated body part able of performing complex fine movements.[1] Injuries to the hand are common in young workers and lead to significant disability, hindering patients both at work and during social activities.[2] Despite the great advances in hand tendon surgery, successful tendon repair and rehabilitation still remains a difficult task, with poor functional outcomes after repair reported in up to 20% to 30% of cases.[3]

Aims

The primary aim of this retrospective study was to assess whether there is any correlation between a delay between surgical repair and instituting treatment, the range of movement at the joints of the finger at 6 months and the self-assessed perceived disability at 6 months.

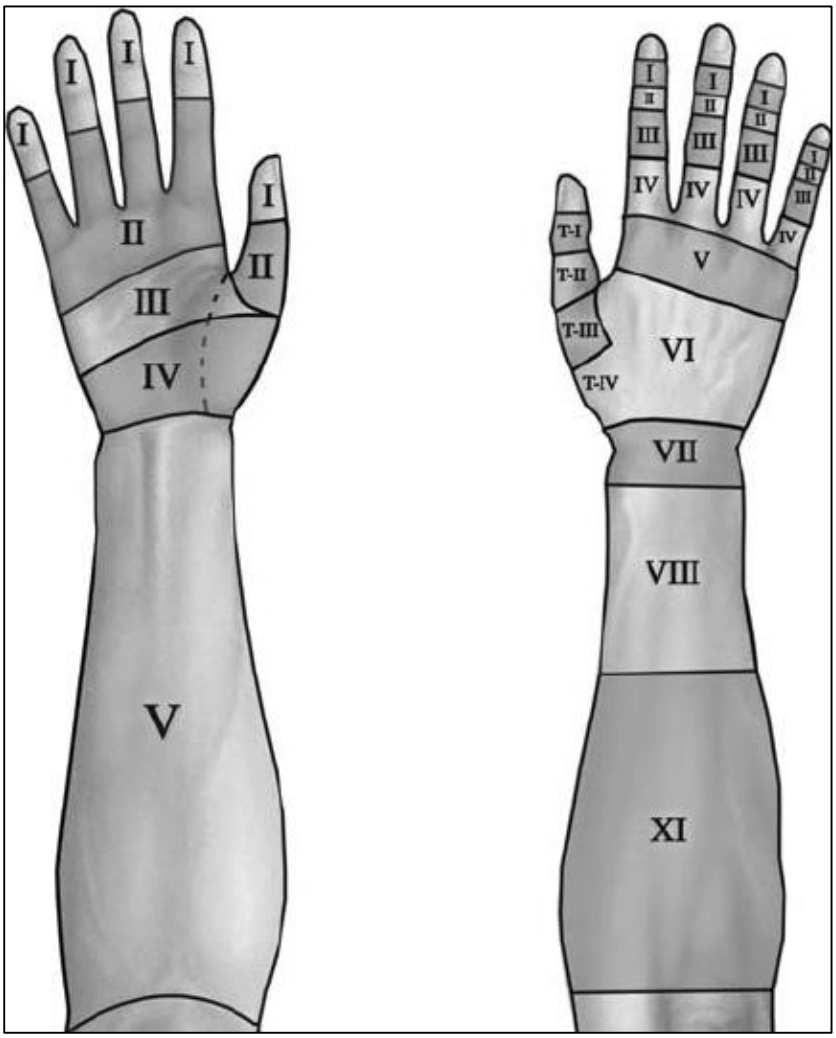
Methods

Approval was obtained from the University of Malta Research Ethics Committee, and the Data Protection Unit (Mater Dei Hospital, MDH). The list of patients with traumatic tendon injuries following lacerations to the wrist and hand in the year 2014 was obtained via the hospital's Clinical Performance Unit and the Occupational Therapy Department as the year progressed. Adult individuals were selected independently of their age, gender, injured tendon or zone injured.

Tendon injuries compounded by fractures (crush injuries) were excluded. Individuals with co-morbidities such as osteoarthritis, rheumatoid arthritis, neuropathy (peripheral and focal), and diabetes were also excluded. Individuals who were eligible, accepted to participate, and signed a consent form, were recruited in this study.

The medical records of the recruits were reviewed and data collected on gender, age, date of admission, hand injured, previous trauma, operation performed, documentation on surgical repair and rehabilitation, and date of commencement of physical therapy. Injury sustained was further classified by location (Figure 1).[4]

***Figure 1**: Classification of injuries for flexor (left hand side) and extensor (right hand side) hand tendon injuries. Image taken from Burnham et al.[4]*



The participants were asked to complete the *Q*uickDASH outcome measure questionnaire,[5] a standardised upper limb functional scoring tool, to assess their situation both on initial presentation to hand therapy department post-operatively and six months after surgery at outpatients follow-up. A paired student t-test was carried out on the *Q*uickDASH scores to check whether there was a statistically significant difference between the pre- and post-therapy results. Pearson correlation was used to assess the relationship between the delay in starting hand therapy and the *Q*uickDASH score six months after surgery.

Active range of motion in all joints of the injured digits, approximately six months after commencement of therapy, was measured by manual hand goniometry using a standard finger goniometer (Baseline®). These measurements

were performed by the same investigator. The technique used was adopted from the University of Scranton website.[6] The results were assessed using the Total Active Motion (TAM) clinical assessment score, as described by the American Society for Surgery of the Hand (ASSH).[7] TAM is the sum of the degrees of active flexion minus the sum of incomplete active extension in the metacarpophalangeal, proximal phalangeal and distal phalangeal joints of the affected fingers. The normal TAM of the thumb was considered to be 130 degrees while that of the digits to be 260 degrees. Pearson correlation was used to assess the relationship between the delay in starting hand therapy and the TAM score six months after surgery.

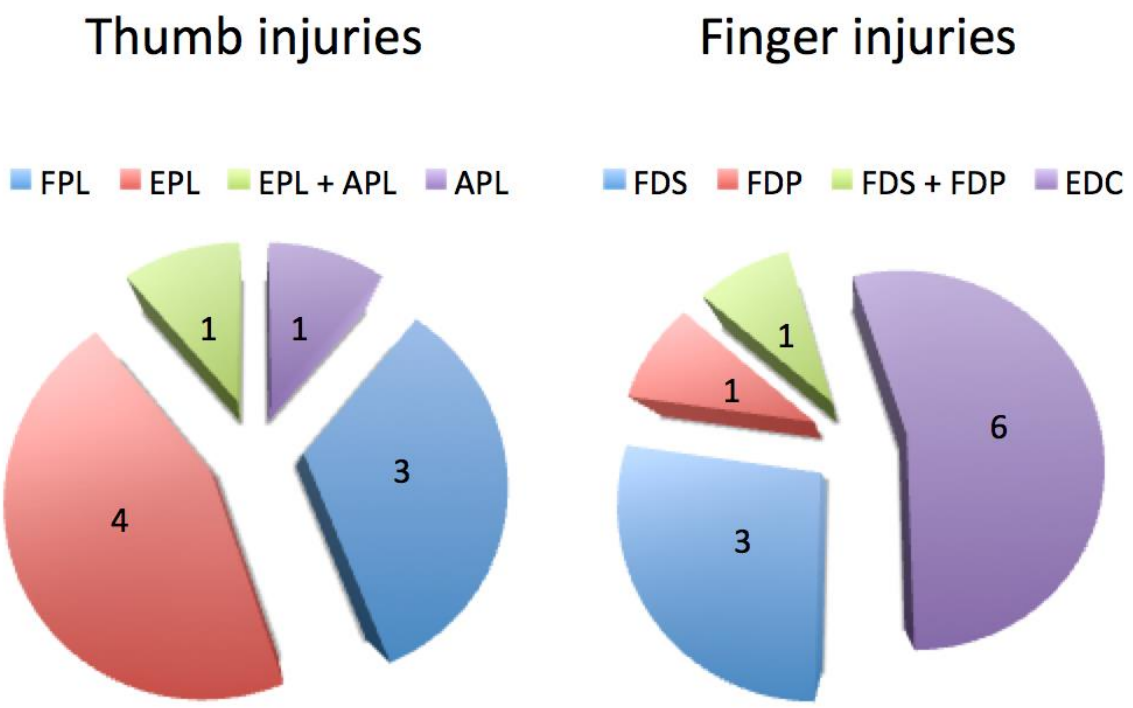
The data collected were analysed using the IBM Statistical Package for the Social Sciences (SPSS) Statistics version 22.

Results

The sample was made up of 20 people aged between 26 and 73 years with a mean age of 44.25 years (SD=12.63). The female to male ratio was 1:4. The dominant hand was injured in 40% (*n*=8) of cases, with right to left ratio of 9:11.

Figure 2 illustrates the distribution of tendon injuries. The thumb was injured in 45% (*n*=9) of cases. 15% (*n*=3) injured the flexor pollicis longus (FPL) in zone T2; the extensor pollicis longus (EPL) was injured in 20% (*n*=4), with half of them injuring zone T4, and the rest injuring zone T2 and T5; one case had injuries to the both the EPL and the abductor pollicis longus (APL) in zone T5, and another case injured the APL in zone T3. With regards to the digits, the flexor tendons were affected in 25% (*n*=5) of cases, with 3 cases injuring the flexor digitorum superficialis (FDS), two injuring the tendon in zone 2 and one in zone 3; flexor digitorum profundus (FDP) was injured in zone 2 in one case; another case injured both FDS and FDP in zone 3. Extensor digitorum communis (EDC) tendons of the digits were affected in 30% (*n*=6) of cases, with 4 cases injuring the tendon in zone 2 and the other 2 cases injuring it in zone 5.

***Figure 2**: Pie charts showing distribution of tendon injuries. See text for abbreviations.*



A Kessler suture technique was used in 35% (*n*=7) of cases, while the modified Kessler and interrupted sutures were used in 0.05% (*n*=1) of cases. In 55% (*n*=11), the suture technique was not mentioned in the operation notes. In 95% (*n*=19) of cases, the protocol of postoperative rehabilitation to

be used was not mentioned in the operation note.

The mean *Q*uickDASH score on initial assessment was 44.66 (*s*=8.35), which improved to 7.95 (*s*=10.75) after 6 months. The work module of the *Q*uickDASH score was 89.47 on initial assessment, improving to 28.94 after 6 months. Paired T-test showed a statistical significant (p=< 0.001) difference in means between *Q*uickDASH on initial assessment and at 6 months (Table 1). In 4 cases (20%), after 6 months, the perceived disability was severe enough for the person to quit their job or to have severe difficulty at the workplace. Patient satisfaction with outcome of surgery was seen in 75% (n=15). With regards to TAM score, 75% (n=15) had a good to excellent score, while a fair score and a poor score was achieved in 20% (n=4) and 5% (n=1) respectively.

***Table 1**: Paired Student T-test between QuickDASH score when first seen by hand therapist and at 6 months (N = 20).*

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	*Q*uickDASH score at first seen by hand therapist - *Q*uickDASH score at 6 months	36.704	10.969	2.453	31.571	41.838	14.965	19	5.733×10^{-12}

Pearson's correlation was applied to the data. A negative correlation was seen between the delay (in days) to start physical therapy after surgery and the TAM score r=-0.650, N=20, p<0.001 (Figure 3). Another negative correlation between the delay before starting therapy and the self-assessed perceived disability 6 months after commencement of therapy was achieved r=-0.650, N=20, p<0.002 (Table 2). There was also a negative correlation between the percentage TAM and *Q*uickDASH score 6 months after commencement of therapy r=-0.831, N=20, p<0.000003 (Figure 4).

In summary, the results show that the shorter the delay in starting hand therapy following surgical hand tendon repair was associated with a higher TAM score and a lower *Q*uickDASH score.

***Figure 3**: Scatter Plot showing the correlation between %TAM score at 6 months and the delay (in days) in starting physical therapy after tendon repair (N = 20).*

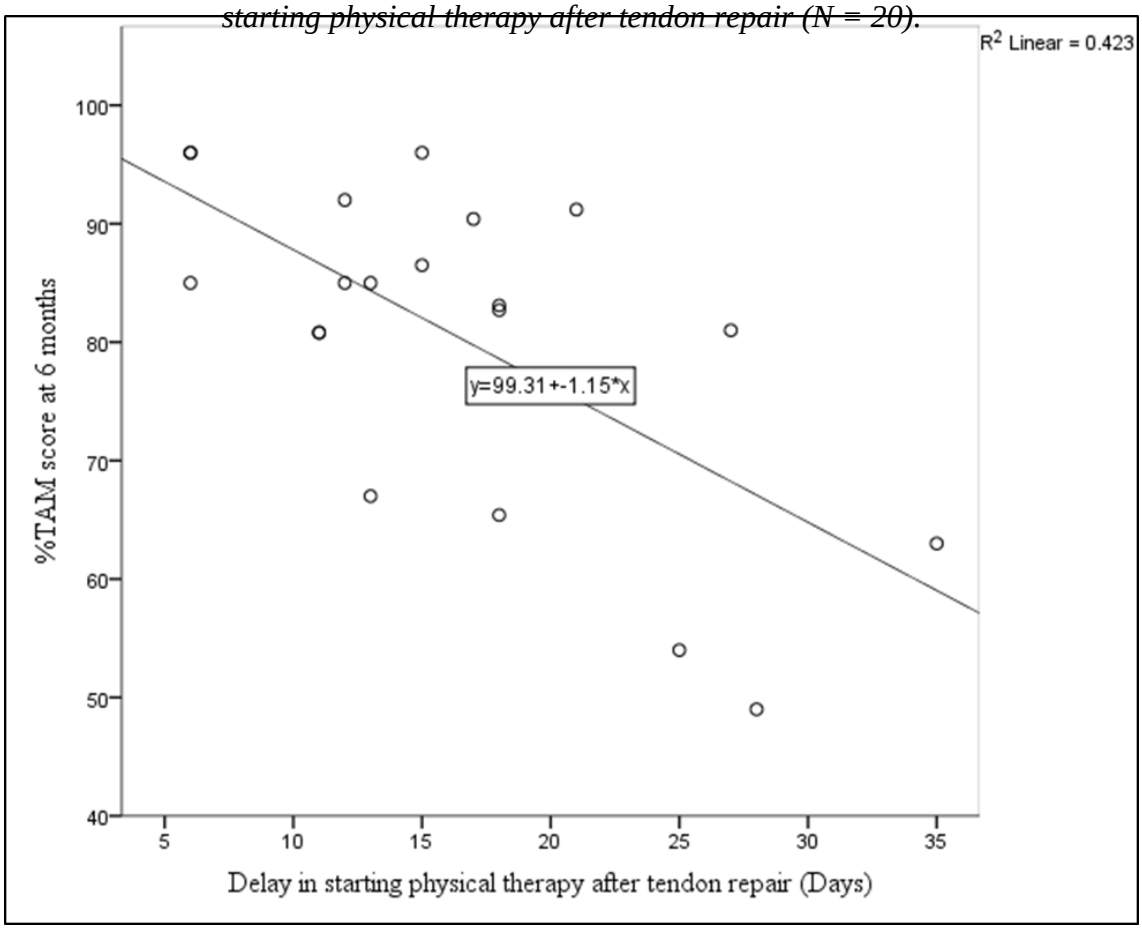
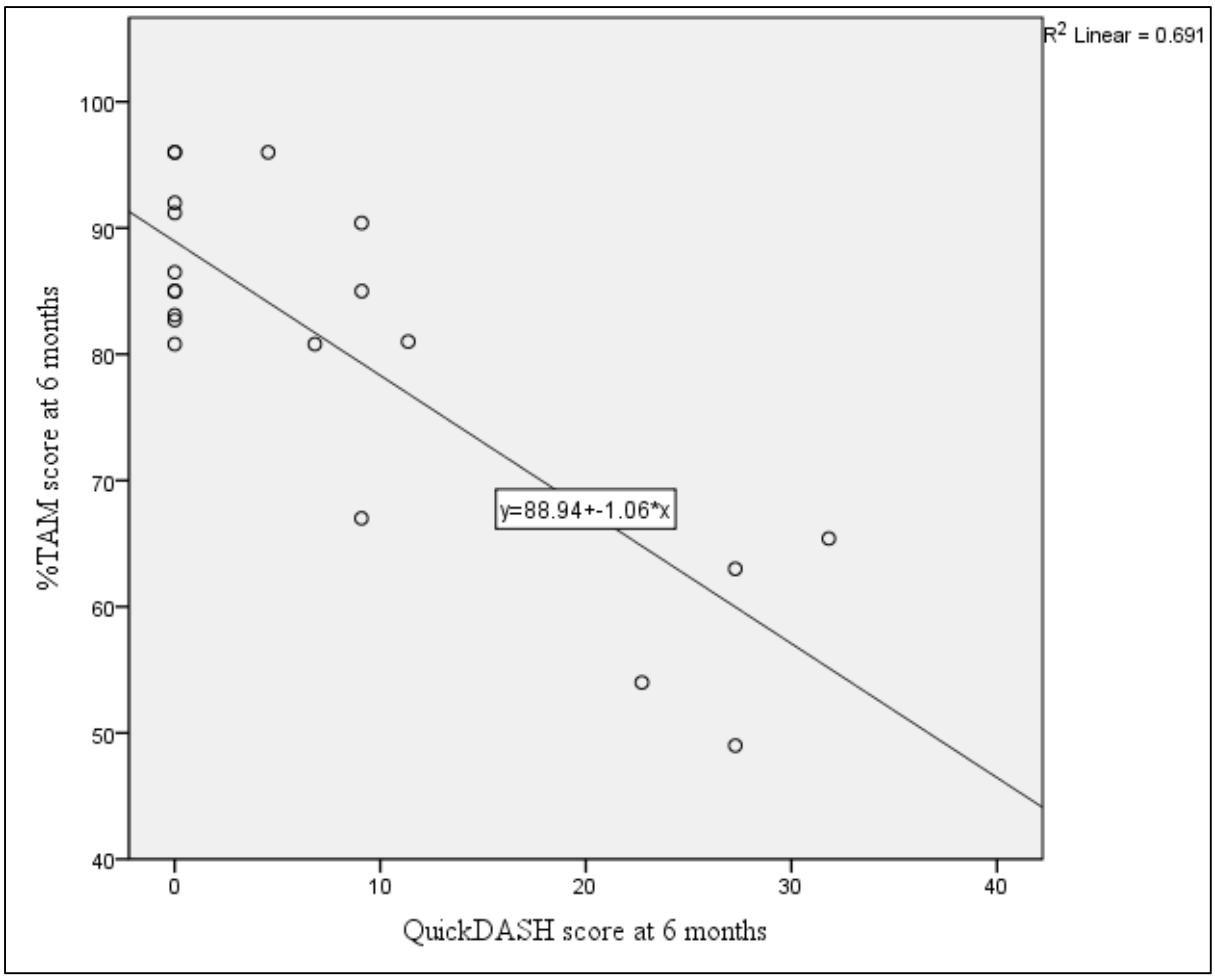


***Table 2**: Correlation between QuickDASH score at 6 months and the delay (in days) in starting physical therapy following tendon repair.*

		QuickDASH Score at 6 months	Delay in starting physical therapy following tendon repair
QuickDASH score at 6 months	Pearson Correlation	1	.627**
	Sig. (1-tailed)		.002
	N	20	20
Delay in starting physical therapy following tendon repair (Days)	Pearson Correlation	.627**	1
	Sig. (1-tailed)	.002	
	N	20	20

**. Correlation is significant at the 0.01 level (1-tailed).

***Figure 4**: Scatter plot showing the relationship between percentage TAM score at 6 months and QuickDASH score at 6 months (N=20).*



Discussion

Early mobilisation following tendon surgery dates back to World War I (1914-1918). Before this war, satisfactory hand tendon repair was rare.[8] In 1917, Harmer published a paper revealing a new tendon suture.[9] He wrote that a suture has to be strong enough to permit "very early use",[9] or else adhesions limit movement. He also recommended that "no splint is used",[9] with active movement commenced "as soon as the patient has recovered from the anaesthetic".[9] In 1918, Bunnell also agreed about early rehabilitation, but added that movement has to be applied "with care and judgement".[10] He discouraged very early movement in the first week, as it hindered healing of the incision and encouraged infection. As no antibiotics were available at that time, the practice was that tendons be repaired by delayed tendon grafting, and not by primary repair. Verdan, Young and Harman and Kleinert reversed this practice and improved postoperative rehabilitation, emphasising on the immediate mobilisation post-surgical repair.[11]

There is good evidence in the current literature that early tendon rehabilitation is associated with better results. Hsiao et al,[12] performed a retrospective study on 1,219 participants who underwent flexor or extensor tendon repair. They were divided into 3 groups: early rehabilitation (<1 week), intermediate rehabilitation (1 to 6 weeks), and late rehabilitation (>6 weeks) following surgical tendon repair.[12] Patients who underwent early rehabilitation had the lowest number of secondary surgical repairs and used less rehabilitation resources.[12]

With regards to flexor tendon injuries, the studies performed by Saini et al,[13] Quadlbauer et al,[14] and Nasab et al[15] focused on early rehabilitation following flexor tendon repairs. Saini et al[8] looked at flexor tendon repairs in zones 2 to 5 (25 patients), Quadlbauer et al[14] looked at all flexor tendon repairs (115 flexor tendons), whilst Nasab et

al[15] looked at flexor zone 5 tendon repairs (42 patients). They all showed overall good to excellent results with minimal complications.[13–15]

Hall et al[16] published a study comparing immobilisation, early passive motion and early active motion protocols following extensor tendon injuries to zones 5 and 6 in 27 patients. Those with the early active motion achieved a greater active range of motion, less active extension lag and better self-report function score.[16] Hirth et al,[17] compared relative motion splinting with immobilisation in the rehabilitation of extensor tendon repairs in zones 5 and 6. The modified relative motion splinting which enables early mobilisation, gave better range of movement and early return to the workplace.[17]

Magnani et al,[2] performed a study to assess correlation between DASH (disabilities of the arm, shoulder and hand) questionnaire and Total Active Motion (TAM) after flexor tendon repair. A sample of 24 patients was administered the early passive motion protocol following surgical flexor tendon repair. In this study a negative correlation was noted between TAM and DASH score (r=-0.3809 to -0.5815, P<0.0001).[2] Even though the tendons were mobilised early, after 12 weeks finger flexion did not equal the flexion of the contralateral finger.[2]

In this study traumatic tendon lacerations were most common in previously healthy young to middle aged people. The co-morbidities that were excluded were osteoarthritis, rheumatoid arthritis, neuropathy (peripheral or focal), and diabetes. The first three co-morbidities affect finger range of movement, while diabetes affects wound healing[18] and delays the onset of aggressive hand therapy.

Men had a fourfold increased incidence of tendon injuries as compared to women and this is likely due to the increased prevalence on men in jobs of a construction nature locally. Delay in starting physical therapy post tendon repair resulted in worse TAM score and higher *Q*uickDASH score, while a lower *Q*uickDASH resulted in better TAM score. This confirms all the hypotheses set forth at the beginning of the research. The results are comparable to studies mentioned in the introduction, making the current practice in Malta comparable with other developed countries.

Good communication and handover between the surgeon, therapist and the patient is of paramount importance. However this study found that documentation was very poor both in the operation notes and other entries in the medical records. Important information such as the suturing technique used, and the postoperative rehabilitation required was omitted in most cases, most likely due to a lack of familiarity by the surgeons on the rehabilitation programmes available. This makes the work of the hand therapist difficult, especially in choosing the right rehabilitation protocol for the patient. The outcome of the multidisciplinary team could also be improved if the hand therapist reviews and scores the patient before surgical repair, and ensures an inpatient post-operative review or an early outpatient appointment with a view to starting the rehabilitation early.

This study has a number of limitations. One of the limitations is that the sample size was small (*N*=20), and this makes quantitative studies of specific tendon injuries difficult. Also, this study only recruited eligible individuals who signed a consent form, thus somewhat giving rise to selection bias. Another limitation is that this study included injuries in all hand tendons and was not specific to a particular rehabilitation protocol.

Conclusion

Early rehabilitation was associated with higher TAM score and lower QuickDASH score. This emphasizes the benefit of early rehabilitation following tendon repair. Good communication and handover between surgeon, hand therapist and patient needs to be improved.

To this end, we propose the introduction of a standardised operation report template (Figure 5) for all tendon injuries. A copy of this operation report can be attached to the referral note to the occupational therapy, providing the occupational therapist all the necessary information. The aim is to re-audit these introductions to assess their impact and outcomes. Furthermore, more local studies are needed to compare the types of rehabilitation protocols (especially early active motion with early passive motion), for different types of hand tendons and zones.

***Figure 5**: Proposed standardised operation report template for all tendon injuries to be used at Mater Dei Hospital*

SPTAR MATER DEI

Operation note template
Upper extremity tendon surgery

Bugeja M., Mifsud M., Zammit J

Patient name		**Age**	
ID number		**Ward**	
Date of surgery		**Theatre number**	
Procedure			
Lead surgeon		**Anaesthetic team**	
Assistants			
Scrub nurse			

SURGICAL PROCEDURE

Routine P+D. on hand table. Antibiotics given at induction / in ward *(delete as applicable)*.
Exploration of wound with extension to find distal and proximal ends of tendons, and repair of tendons in zones as follows:

Flexor zones

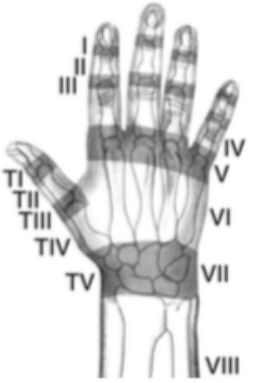
Finger flexors
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

Thumb flexors
- ☐ T1
- ☐ T2
- ☐ T3
- ☐ T4
- ☐ T5

Finger extensors
- ☐ 1 ☐ 5
- ☐ 2 ☐ 6
- ☐ 3 ☐ 7
- ☐ 4 ☐ 8

Thumb extensors
- ☐ T1
- ☐ T2
- ☐ T3
- ☐ T4
- ☐ T5

Extensor zones



Suture type and size used for tendon repair was
- ☐ Ethibond _____ *(write suture size)*
- ☐ Prolene _____ *(write suture size)*
- ☐ Other_____ *(write suture name and size)*

Number of suture strands used in repair
- ☐ 4
- ☐ 6
- ☐ 2 _____ *(2 strands should be used if justifiable. Write justification here)*

Tendons repaired and percentage required
1.
2.
3.
4.
5.

Other structures damaged and repaired
1.
2.
3.
4.

Skin suture and splint:

POST-OP INSTRUCTIONS

Signature

References

1. Soucacos P. Anatomy and biomechanics of the finger joints. In: Bruiser P, Gilbert A, editors. Finger Bone and Joint Injuries. First Edit. Martin Dunitz Ltd; 1991. p. 151.
2. Magnani PE, Ferreira AM, da Silva Rodrigues EK, Barbosa RI, Mazzer N, Elui VMC, et al. Is there a correlation between patient-reported outcome assessed by the Disabilities of the Arm, Shoulder and Hand Questionnaire and total active motion after flexor tendon repair? Hand Ther [Internet]. 2012 May 18 [cited 2015 Jul 4];17(2):37–41. Available from: http://www.researchgate.net/publication/258139486_Is_there_a_correlation_between_patient-reported_outcome_assessed_by_the_Disabilities_of_the_Arm_Shoulder_and_Hand_Questionnaire_and_total_active_motion_after_flexor_tendon_repair.
3. Amadio PC. Tendon injuries and tendinopathies. In: Terri M. Skirven, Lee Osterman, Jane Fedorczyk PCA, editor. Rehabilitation of the Hand and upper Extremity. sixth edit. St Louis: Mosby; 2011. p. 439–44.
4. Burnham JM, Hollister AM, Rush DA, Avallone TJ, Shi R, Jordan JC. Technique for and an anatomic guide to forearm tendon repair. Tech Hand Up Extrem Surg [Internet]. 2011 Jun 1 [cited 2016 Mar 14];15(2):125–32. Available from: https://www.researchgate.net/publication/51160237_Technique_for_and_an_Anatomic_Guide_to_Forearm_Tendon_Repair.
5. Institue for Work and Health. The QuickDASH Outcome Measure - Disabilities of the Arm, Shoulder and Hand. [Internet]. 2006 [cited 2015 Jul 1]. Available from: http://dash.iwh.on.ca/system/files/quickdash_questionnaire_2010.pdf
6. Kosmahi E. Goniometry [Internet]. The University of Scranton. Available from: http://www.scranton.edu/faculty/kosmahl/courses/gonio/index.shtml.
7. ASSH. The Hand, Examination and Diagmosis. Third Edit. Churchill Livingstone; 1990.
8. Young RE, Harmon JM. Repair of tendon injuries of the hand. Ann Surg [Internet]. 1960 Apr [cited 2015 Dec 30];151:562–6. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1613583&tool=pmcentrez&rendertype=abstract
9. Harmer TW. Tendon Suture. Bost Med Surg J [Internet]. 1917 Dec 6;177(23):808–10. Available from: http://www.nejm.org/doi/abs/10.1056/NEJM191712061772303.
10. Bunnell S. Repair of tendons in the fingers and description of two new instruments. Surg Gynecol Obs. 1918;(126):103–10.
11. Elliot D, Giesen T. Avoidance of unfavourable results following primary flexor tendon surgery. Indian J Plast Surg [Internet]. 2013 May [cited 2015 Dec 30];46(2):312–24. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3901913&tool=pmcentrez&rendertype=abstract.
12. Hsiao P-C, Yang S-Y, Ho C-H, Chou W, Lu S-R. The benefit of early rehabilitation following tendon repair of the hand: A population-based claims database analysis. J Hand Ther [Internet]. 2015 Jan [cited 2015 Jun 25];28(1):20–5; quiz 26. Available from: http://www.sciencedirect.com/science/article/pii/S0894113014001434.
13. Saini N, Kundnani V, Patni P, Gupta S. Outcome of early active mobilization after flexor tendons repair in zones II-V in hand. Indian J Orthop [Internet]. 2010 Jul [cited 2015 Dec 30];44(3):314–21. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2911933&tool=pmcentrez&rendertype=abstract.
14. Quadlbauer S, Pezzei C, Jurkowitsch J, Reb P, Beer T, Leixnering M. Early Passive Movement in flexor tendon injuries of the hand. Arch Orthop Trauma Surg [Internet]. 2015 Dec 11 [cited 2015 Dec 30]; Available from: http://www.ncbi.nlm.nih.gov/pubmed/26659831.
15. Mehdi Nasab SA, Sarrafan N, Saeidian SR, Emami H. Functional outcome of flexor tendon repair of the hand at Zone 5 and post operative early mobilization of the fingers. Pakistan J Med Sci [Internet]. 2013 Jan [cited 2015 Dec 30];29(1):43–6. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3809199&tool=pmcentrez&rendertype=abstract.
16. Hall Barbara, Lee Hoe, Page Rohan, Rosenwax Lorna LHA. Comparing Three Postoperative Treatment Protocols for Extensor Tendon Repair in Zones V and VI of the Hand [Internet]. The American Journal of Occupational Therapy. 2010 [cited 2016 Jan 6]. Available from: http://search.proquest.com.ejournals.um.edu.mt/docview/758663831/fulltextPDF?accountid=27934.
17. Hirth MJ, Bennett K, Mah E, Farrow HC, Cavallo A V., Ritz M, et al. Early return to work and improved range of motion with modified relative motion splinting: a retrospective comparison with immobilization splinting for zones V and VI extensor tendon repairs. Hand Ther [Internet]. 2011 Oct 21 [cited 2016 Jan 6];16(4):86–94. Available from: https://www.researchgate.net/publication/258139480_Early_return_to_work_and_improved_range_of_motion_with_modified_relative_motion_splinting_a_retrospective_comparison_with_immobilization_splinting_for_zones_V_and_VI_extensor_tendon_repairs.
18. Ahmed AS, Schizas N, Li J, Ahmed M, Östenson C-G, Salo P, et al. Type 2 diabetes impairs tendon repair after injury in a rat model. J Appl Physiol [Internet]. 2012 Dec 1 [cited 2016 Mar 11];113(11):1784–91. Available from: http://jap.physiology.org/content/113/11/1784.long.