Variation in patient information and rehabilitation regimens after flexor tendon repair in the United Kingdom

Short title

Rehabilitation regimens after flexor tendon repair

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Abstract

Introduction

There is clinical uncertainty regarding the optimal method of rehabilitation following flexor tendon repair. Many splint designs and rehabilitation regimens are reported in the literature, however there is insufficient evidence to support the use of any one regimen. The aim of this study was to describe rehabilitation guidelines used in the United Kingdom (UK) following zone I/II flexor tendon repair.

Methods

Using a cross-sectional design, hand units in the UK were invited to complete a short survey and to upload their flexor tendon rehabilitation guidelines and patient information material. Approval was granted by the British Association of Hand Therapists. Data were extracted in duplicate, using a pre-piloted form, and analysed using descriptive statistics.

Results

Thirty-five hand units responded (21%), providing 52 treatment guidelines. Three splinting regimens were described, and all involved early active mobilisation: i) long dorsal-blocking splint (DBS); ii) short DBS; and iii) relative motion flexion splint. Duration of full-time splint wear ranged from 4-6 weeks. There were variations in splint design and composition of home exercise programmes, particularly for the long DBS. Where reported, recommended return to driving ranged from 8-12 weeks, and return to light work activities ranged from 5-10 weeks.

Discussion

Treatment guidelines varied across UK hand therapy departments, suggesting that patients receive differing advice about how to protect, move and use their hand after zone I/II flexor tendon repair. The disparity in splint wear duration, home exercise frequency and prescribed functional restrictions raises potential financial and social implications for patients. Future research should explore rehabilitation burden in addition to clinical outcomes.

Introduction

Flexor tendon injuries are common [1, 2] and usually require surgical repair followed by a period of rehabilitation. Clinical uncertainty surrounds many aspects of care including patient information, surgical repair method, splinting, rehabilitation, and outcome measurement [3–7]. Restoration of movement and function after flexor tendon repair remains a challenge, particularly for zone II injuries [8, 9]. Rehabilitation must find the balance of protecting the repair site from attenuation or rupture, while also enabling sufficient movement and tendon glide to prevent scar adhesions and joint contractures.

Historically, post-operative flexor tendon rehabilitation involved a long dorsal-blocking splint to immobilise the wrist in neutral or flexion, hold the metacarpophalangeal joints (MCPJs) in flexion and the interphalangeal joints (IPJs) in extension [10–12]. This was coupled with active finger extension and passive flexion, achieved with [10, 11] or without [12] elastic bands. As surgical techniques have progressed, early active mobilisation strategies have become popular [13]. These regimens allow both active and passive extension of the fingers within the splint and are considered to be associated with improved range of movement when compared with the previous passive regimens [8, 14, 15]. Initially these regimens also involved a long dorsal-blocking splint, but more recent advances include a hand-based dorsal-blocking splint [16, 17] and a finger-based relative motion flexion splint [18, 19].

Flexor tendon rehabilitation protocols have been published in peer reviewed journals [16, 20], but there is currently no robust evidence to support the use of any particular early active rehabilitation regimen [4], and anecdotally practice varies. The aim of this study was to describe rehabilitation guidelines being used in United Kington (UK) hand therapy departments for the management of adult patients following zone I and/or II flexor tendon repairs. Specifically, to review: the indications for treatment; when hand therapy begins; the type of splint and exercise programme; and recommendations for hand function and return to work and driving.

Methods

The steering group developed a protocol for this cross-sectional study, which was published a priori [21]. The study was exempt from formal ethics approval following guidance from the NHS Health Research Authority / Medical Research Council tool [22] (Supplementary file 1).

A short survey was developed by the steering group and refined following feedback from the British Association of Hand Therapists (BAHT) Clinical Evidence Committee as part of their peer review process, and two hand centres. The survey (Supplementary file 2) requested department name,

location, composition of the hand surgery and hand therapy teams, and the clinical disciplines responsible for developing departmental flexor tendon rehabilitation guidelines. Respondents were asked to upload relevant flexor tendon treatment guidelines and patient information sheets from their institution. Additional questions related to future research areas within flexor tendon rehabilitation and are not reported as part of this study. The study information explained that only one response was required per department, but that this could be completed by therapists at any level in discussion with their team.

Study data were collected and managed using REDCap electronic data capture tools hosted at the Kennedy Institute of Rheumatology [23, 24]. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing i) an intuitive interface for validated data capture; ii) audit trails for tracking data manipulation and export procedures; iii) automated export procedures for seamless data downloads to common statistical packages; and iv) procedures for data integration and interoperability with external sources.

With the required approvals, the survey was advertised by BAHT, the British Society for Surgery of the Hand and the Reconstructive Surgical Trials Network (RSTN) using e-bulletins, social media, and website posts. Data collection occurred between September 2020 and February 2021.

Data from the uploaded treatment guidelines were independently extracted in duplicate by LN and one of JL, DH and MG, using a pre-piloted form. Extracted data included: treatment timescales, splint type and duration of wear, indications for use, exercise programmes, and recommended timescales for return to driving and different functional or occupational activities. Piloting involved independent data extraction of the first three responses by LN, JL and DH followed by discussion and modification of the form to facilitate standardised use. In the case of any discrepancies, the documents were reassessed, and the final data entry agreed by two members of the study team. Data were summarised using descriptive statistics. Time periods were reported using the median and range, with the mode also reported if this differed from the median. Where an individual treatment guideline advised a range of time points, this was recorded using the mean, for example, 5-6 weeks was recorded as 5.5 weeks.

Results

Participants

Thirty-seven surveys were completed, including two duplicates and one response from Ireland, leaving 34 unique responses from the UK. The estimated response rate was 20.6% based on the

British Society for Surgery of the Hand (BSSH) and RSTN database of 165 UK hospitals with acute hand surgery services (personal communication R. Taha, RSTN, 15/10/21), and using the 34 UK guidelines as the numerator. The study steering group decided that the response from Ireland should also be included in the data analysis. It is our experience that the treatment of flexor tendon injuries is similar between the two countries, and it is our understanding that hand therapists and doctors undergo similar post-registration training. Data provided by the team from Ireland was within the parameters reported by the UK hand units and therefore did not expand the range of responses, but did provide additional context. These 35 responses yielded a total of 52 individual rehabilitation guidelines for flexor tendon repairs in zone I and/or II. Table 1 summarises characteristics of the participating hand therapy departments.

Table 1. Characteristics of participating hand therapy departments

	n (%)
Geographical Region (n=35)	
East of England	0
London	5 (14)
Midlands	7 (20)
North East and Yorkshire	3 (9)
North West	5 (14)
South East	4 (11)
South West	5 (14)
Northern Ireland	1 (3)
Scotland	2 (6)
Wales	2 (6)
Ireland	1 (3)
Hand therapy team composition (n=35)	
Occupational therapists only	3 (9)
Physiotherapists only	3 (9)
Mix of both disciplines	29 (83)
Hand surgery team composition (n=34)	
Orthopaedics	6 (17)
Plastics	13 (38)
Mix of both disciplines	15 (44)
Led development of flexor tendon rehabilitation guidelines (n=34)	
Therapy team	12 (35)
Surgical team	0
Mix of both teams	22 (65)
Number of zone I/II treatment guidelines per department (n=35)	
One	20 (57)
Two	13 (37)
More than two	2 (5.7)

Indications for treatment

Overall, 26 guidelines (50%) included information on indications, contraindications and considerations for use of the splint and rehabilitation regimen (Table 2). Most guidelines advised the treating therapist to contact a senior therapist or the operating surgeon to discuss individual cases, rather than providing blanket contraindications for use. There was one instance when 'tight or vulnerable repair' was reported as an indication for use of the long dorsal-blocking splint (DBS). This was specific to a rehabilitation regimen involving splinting in 0-20° wrist flexion and initial exercises involving passive digit flexion with active extension (modified Duran).

Table 2. Indications, considerations and contraindication for use of each splinting regimen

	Long dorsal-blocking splint n=37 guidelines	**Short dorsal-blocking splint** n=14 guidelines	**Relative motion flexion splint** n=1 guideline
Contraindications/consideration for use			
Children or those unable to comply with treatment	5	4	1
Concomitant fractures or significant trauma	2	3	1
>7-10 days between injury and surgery	2	-	-
Indications for use			
4-strand tendon repair (strong repair)	8	3	1
>40% laceration of the tendon	1	2	-
1-2 digits repaired		3	-
Surgeon specifies	1	-	-
Therapist has sufficient experience	1	-	-
Tight or vulnerable repair	1	-	-
Not reported	20	6	0

Rehabilitation timescales

Most guidelines outlined when hand therapy should commence after surgery (n=46, 88%). This information was frequently presented as a range of suitable timepoints. The earliest timepoint was a median of 3 days (range 1-5) and the latest was a median of 5 days (range 3-7).

Recommended joint positions with different splint designs

Reported splint designs were described in three categories: long DBS (n=37), short DBS (n=14) and relative motion flexion (RMF) splint (n=1). Recommended wrist and metacarpophalangeal joint (MCPJ) positions within the splints were variable (Table 3). For both DBS designs, the interphalangeal joints (IPJs) were splinted in neutral; IPJs were not included within the RMF splint. Example splint designs are shown in Figure 1.

Figure 1. Examples of the three splint designs described in the flexor tendon rehabilitation guidelines

Table 3. Recommended wrist and metacarpophalangeal joint position within the splint

	Long dorsal-blocking splint n=37 guidelines (%)	**Short dorsal-blocking splint** n=14 guidelines (%)	**Relative motion flexion splint** n=1 guideline (%)
Wrist position			
Neutral	15 (41)	-	-
0-30° extension	16 (43)	-	1* (100)
0-30° flexion	2 (5)	-	-
Extension block 45°	-	9 (64)	-
Extension block 40°	-	3 (21)	-
Not reported	4 (11)	2 (14)	-
Metacarpophalangeal joint position			
30°	-	11 (79)	-
30-50°	24 (65)	-	-
50-90°	9 (24)	3 (21)	-
20° relative flexion	-	-	1 (100)
Not reported	4 (11)	-	-

* reported as 0-15 degrees

Duration of splint wear

For the long DBS, the median recommended duration of full-time splint wear was 5.75 weeks (range 4-6, mode 6), compared with 6 weeks (range 5-6) for the short DBS (n=14). The single RMF splint guideline advised 5-6 weeks of splinting, with the wrist component weaned from week four. Thirty-five patient information sheets (79.5% from a total of 44 provided) specifically stated that the patient should not remove their splint at all during the period of full-time splint wear.

Exercise programmes during full-time splint wear

All treatment guidelines included an exercise programme for the patient to perform at home which incorporated elements of passive and active finger flexion and active extension within the confines of the splint. Active flexion exercises were described in two forms, controlled active movement (flexion within a prescribed range that increased each week [n=25, 48%]) and flexion as able (n=27, 52%). Tenodesis (active wrist flexion with relaxed finger extension moving to active wrist extension with active finger flexion) was included in all exercise guidelines for the short DBS (n=14) from the first appointment. More than half of the long DBS guidelines also included tenodesis exercises (n=20, 54%); the median recommended time to start tenodesis was 3 weeks after surgery (range 1-6).

The recommended frequency and repetition of the home exercise programmes varied and were inconsistently reported. Where reported, exercises were described in terms of the number of

repetitions, rather than time spent exercising. To enable comparison, an estimated duration of exercise time per day was calculated for the first week of rehabilitation. The duration of prescribed exercises ranged from 7-90 minutes per day (Table 4).

Table 4. Daily hand and wrist exercise duration for the first week of rehabilitation

	Long dorsal-blocking splint n=37 guidelines	**Short dorsal-blocking splint** n=14 guidelines	**Relative motion flexion splint** n=1 guideline
Number of guidelines reporting data (%)	32 (86)	11 (79)	1 (100)
Median minutes of exercise per day*	30	40	60
Exercise duration range in minutes*	7-90	18-70	-

* Based on the assumption that a single exercise repetition takes 5 seconds with 12 hours of available exercise time per day. Where exercises were specified to be performed separately for each finger, this was calculated in total for 4 digits. Where a range of repetitions was provided, the mean was use for this calculation. Only hand/wrist exercises were included.

Hand function and return to work and driving

All but two long DBS guidelines advised that hand function was not permitted during the period of full-time splint wear (n=35, 95%). Hand function in the splint was not reported in the remaining two guidelines. Nine (64%) of the short DBS guidelines permitted hand function with the unaffected fingers only, while five (36%) advised against any hand function while using the splint. The RMF splint guideline advised hand function with the unaffected fingers only. Recommended timescales for return to work and driving are shown in Table 5.

Table 5. Recommended timescales for return to work and driving after zone I/II flexor tendon repair

	Long dorsal-blocking splint n=37 guidelines	**Short dorsal-blocking splint** n=14 guidelines	**Relative motion flexion splint** n=1 guideline
Return to driving			
Number of guidelines reporting data (%)	29 (78)	12 (86)	1 (100)
Median recommended time in weeks (range)	8 (7-10)	9.25 (8-10)*	10 (-)
Return to light/sedentary work			
Number of guidelines reporting data (%)	16 (43)	5 (36)	0
Median recommended time in weeks (range)	8 (5-12)	8 (8-12)	-
Return to heavy manual work			
Number of guidelines reporting data (%)	22 (59)	8 (57)	0
Median recommended time in weeks (range)	12 (10-14)	12 (12-12)	-

* mode 8 weeks

Discussion

We collected >50 different treatment guidelines for adults undergoing zone I/II flexor tendon repair from 35 hand therapy departments. The prevailing view in the literature is that early active mobilisation is associated with improved outcomes in comparison with passive mobilisation [4], and this was reflected in our data: all departments provided guidelines that followed early active mobilisation principles. In addition, one department included a 'modified Duran protocol' that advised passive finger flexion exercises for the first four weeks [12]. This was specifically indicated for use with tight or vulnerable repairs, and it is possible that other departments might also modify their rehabilitation approach in this situation, although this was not specifically reported.

The recommended timing of hand therapy after surgical repair was largely consistent across sites, and matched the BSSH standard of 3-5 days after surgery [25]. All sites used the traditional long DBS and more than a third of sites had also adopted the hand-based short DBS, first described as a case series in 2014 [17]. There is an ongoing randomised controlled trial comparing short and long DBS, but this has yet to be reported [26]. Only one site provided a treatment guideline for the relative motion flexion splint, which was reported as a case series in 2019 [18, 19]. This apparent gradual introduction of new treatment strategies follows the pattern described by the Adoption and Diffusion of Innovations Theory [27]. This theory highlights the importance of early adopters sharing and communicating the benefits of the innovation to facilitate widespread uptake, and it is anticipated that this process will lead to further adoption of the newer splint designs in future. However, caution is required to ensure that innovation is not introduced without proper evaluation [28].

Splint positions varied, particularly for the long DBS, which is consistent with the variation reported in the literature [20, 29]. Historically, splint designs have progressed from more flexed wrist and MCPJ positions to a more open posture. It has been demonstrated that the force required for IPJ flexion is reduced with wrist extension and MCPJ flexion, albeit in healthy volunteers and cadaver models [30, 31]. How well these biomechanical models translate to an injured hand remains unknown.

Splint designs for the short DBS largely followed the description provided by Peck *et al.* in their original summary [17]. However, three sites reduced the wrist extension block from 45 to 40° and increased MCPJ flexion from 30 to 50-90°. This modification may result in less tension through the repaired tendon(s) but could also lead to reduced differential glide between FDP and FDS. Again, whether this difference in splint design translates to any meaningful clinical difference is unknown.

The RMF splint design also differed from the published case series. Henry and Howell describe 30-40° relative flexion of the injured finger MCPJ [18], compared with 20° in the identified treatment guideline. RMF splinting uses the quadriga effect to offload the FDP tendon for the digits held in relatively more MCPJ flexion [32], but the optimal, and practically achievable, amount of relative flexion is unclear.

Future advances in flexor tendon rehabilitation may dispense with full-time splint use altogether. Henry *et al.* reported a retrospective case series of 51 flexor tendon patients when a splint was used 'as a defensive shield only in particularly dangerous environments' [33] p407. The splint was positioned in wrist extension and MCPJ flexion, although joint angles were not reported. Splints were included in all guidelines identified for the current study and the duration of full-time wear ranged from 4-6 weeks. Although full-time splint wear was recommended, this may not reflect actual practice. A survey of 80 patients who underwent flexor or extensor tendon repair in the UK found that 67% of patients reported removing their splints, most commonly for washing and dressing [34]. Reduction in splint use may benefit patients' return to work and activities of daily living and is a key area for future research.

Reported exercise programmes showed consistency in the main movement patterns (active and passive finger flexion and active finger extension), but the number of repetitions and frequency varied enormously. The available range of motion also differed depending on the splint position, as discussed above. None of the guidelines advocated full active composite extension of the MCPJs and IPJs within the first 4 weeks of surgery, as prescribed in the study by Henry *et al*. [33]. Across the identified guidelines, the greatest range of finger movement was available with the RMF splint and short DBS.

The short DBS guidelines all included tenodesis exercises (synergistic wrist and finger movement) from the first appointment, as recommended by Peck *et al* [17]. It was interesting that approximately half of the long DBS regimens also incorporated tenodesis exercises, as an apparent modification of the original long DBS early active mobilisation regimen [13]. A specific tenodesis splint has also been reported in the management of flexor tendon repairs [29], but this was not included in any identified guidelines. Tenodesis has been associated with increased tendon gliding in comparison with isolated movement [35] and may be beneficial in reducing tendon adhesion following flexor tendon repair [36]. The optimal timing and format of introducing tenodesis exercises is unknown.

Approximately half of the treatment guidelines described controlled active movement (active finger flexion within a prescribed range that increased each week during full-time splint wear), while the

remaining half advised active flexion to whatever the patient could achieve. The current BSSH guidelines advocate controlled active motion regimens [25], as does the original short DBS description [17]. The reasoning for controlled active movement exercises are that this reduces the tension at the repair site, while still achieving sufficient tendon glide, however there is no evidence that either exercise strategy is superior to the other in practice [4].

We took the approach of calculating exercise time as a measure of patient burden to enable comparison of the different exercise regimens. This did not include the time spent performing scar massage as this was very rarely quantified. We used the assumption that a single exercise repetition takes 5 seconds and that there were 12 hours of available exercise time per day. Given that this will vary, different patients may accumulate substantially different total rehabilitation times. Our assumptions were discussed with practising hand therapists for face validity, but we welcome further conversation on the assessment of the time burden of hand therapy home exercise programmes. The amount of time that patients were expected to engage in daily exercises ranged from several minutes to an hour and half. The ideal exercise dose for optimal clinical outcomes is unclear. A recent opinion piece by a prominent hand surgeon suggested that 40-80 cycles of active flexion were needed in each exercise session, with the number of consecutive repetitions more important than the number of sessions per day [20]. However, this recommendation was based on personal opinion, rather that robust research evidence. The duration of the exercise programme has obvious implications for the patient in terms of work and other activities that they also need to engage with during the day. It is also unclear whether the amount of exercise prescribed after flexor tendon repair, or the format of exercise delivery (paper, website, mobile phone application) affects adherence [37].

Advice regarding return to work and function was poorly reported in the guidelines. Two of the splint designs (RMF and short DBS) allowed hand function within the splint, advocating light function with the unaffected fingers only. This is similar to the advice reported in the literature [17–19]. Interestingly, more than a third of the short DBS guidelines did not permit any hand function, despite this being a key feature of the splint design [17].

Where reported, return to light work was recommended at a median (and mode) of 8 weeks after surgery and return to heavy manual work at 12 weeks, for all splint types. There is limited evidence to support these timescales [4]. We were surprised to find that the median recommended time for patients to return to driving was longer for the DBS and RMF flexion splints, as these regimens are purported to facilitate faster return to functional hand use [17, 18].

Limitations

Participants in this study were a self-selected sample of hand therapy departments and we acknowledge that our findings may not be representative of all settings. We took steps to capture a range of views by advertising the study though three relevant organisations (BAHT, BSSH and RSTN) and via social media and websites, in addition to email bulletins. We recruited 35 sites with widespread geographical representation and different combinations of surgical and therapy disciplines. Our estimation is that this represents 21% of UK hand units. We chose to include the response from Ireland, because although this is outside the UK, the organisation of hand surgery and hand therapy is similar. It is a limitation that we had not planned to specially include, or advertise the study with, the Irish Association of Hand Therapists.

We also acknowledge that treatment guidelines may not be a true reflection of the treatment provided in practice. Treatment may need to be modified to meet the needs of individual patients, or practice may have changed without the guidelines being updated. However, we believe this is a useful method of capturing 'routine' practice.

Conclusions

Treatment guidelines varied across UK hand therapy departments. The short DBS regimen does not appear to be universally adopted and there was only one guideline submitted for a RMF splint regimen. The optimal rehabilitation programme following zone I/II flexor tendon repairs is unclear and this study both highlights the need for consensus and provides a starting point for this discussion. The disparity in splint wear duration, home exercise frequency and prescribed functional restrictions raises potential financial and social implications for patients, particularly in relation to return to work and driving. Future research should explore rehabilitation burden in addition to clinical outcomes.

References

1. Manninen M, Karjalainen T, Määttä J, Flinkkilä T. Epidemiology of flexor tendon injuries of the hand in a Northern Finnish population. Scand J Surg. 2017;106:278–82.

2. de Jong JP, Nguyen JT, Sonnema AJM, Nguyen EC, Amadio PC, Moran SL. The incidence of acute traumatic tendon injuries in the hand and wrist: A 10-year population-based study. Clin Orthop Surg. 2014;6:196–202.

3. Tang JB. Recent evolutions in flexor tendon repairs and rehabilitation. J Hand Surg [Eur].

2018;43:469–73.

4. Peters SE, Jha B, Ross M. Rehabilitation following surgery for flexor tendon injuries of the hand. Cochrane Database Syst Rev. 2021;1:CD012479.

5. Shaw A V, Holmes DG, Rodrigues JN, Lane JC, Gardiner MD, Wormald JC. Outcome measurement in adult flexor tendon injury: A systematic review. J Plast Reconstr Aesthetic Surg. 2021. doi:10.1016/j.bjps.2021.08.033. (In press).

6. Ishak A, Rajangam A, Khajuria A. The evidence-base for the management of flexor tendon injuries of the hand: Review. Ann Med Surg. 2019;48:1–6.

7. Neiduski RL, Powell RK. Flexor tendon rehabilitation in the 21st century: A systematic review. J Hand Ther. 2019;32:165–74.

8. Chesney A, Chauhan A, Kattan A, Farrokhyar F, Thoma A. Systematic review of flexor tendon rehabilitation protocols in zone II of the hand. Plast Reconstr Surg. 2011;127:1583–92.

9. Natal-Albelo EJ, Olivella G, Paraliticci-Márquez GU, Rivera L, Echegaray G, Ramírez N, et al. Functional and disability assessment among Hispanics with zone 2 flexor tendon injuries: Comparative study between flexor digitorum superficialis repair and flexor digitorum superficialis excision. JAAOS Glob Res Rev. 2020;4:e20.00081.

10. Kleinert H, Kutz J, Atasoy E, Stormo A. Primary repair of flexor tendons. Orthop Clin North Am. 1973;4:865–76.

11. Lister G, Kleinert H, Kutz J, Atasoy E. Primary flexor tendon repair followed by immediate controlled mobilization. J Hand Surg [Am]. 1977;2:441–51.

12. Duran R, Coleman C, Nappi J. Management of flexor tendon lacerations in zone 2 using controlled motion postoperatively. In: Hunter J, Schneider L, Mackin E, editors. Rehabilitation of the Hand: Surgery and Therapy. St Louis: CV Mosby Company; 1990. p. 410–3.

13. Gratton P. Early active mobilization after flexor tendon repairs. J Hand Ther. 1993;6:285–9.

14. Starr HM, Snoddy M, Hammond KE, Seiler JG. Flexor tendon repair rehabilitation protocols: A systematic review. J Hand Surg Am. 2013;38:1712–7.

15. Ayhan E, Tuna Z, Oksuz C. Getting better results in flexor tendon surgery and therapy. Plast Reconstr Surg - Glob Open. 2021;9:1–6.

16. Higgins A, Lalonde DH. Flexor tendon repair postoperative rehabilitation: The Saint John

protocol. Plast Reconstr Surg - Glob Open. 2016;4:1–3.

17. Peck FH, Roe AE, Ng CY, Duff C, McGrouther DA, Lees VC. The Manchester short splint: A change to splinting practice in the rehabilitation of zone II flexor tendon repairs. Hand Ther. 2014;19:47–53.

18. Henry SL, Howell JW. Use of a relative motion flexion orthosis for postoperative management of zone I/II flexor digitorum profundus repair: A retrospective consecutive case series. J Hand Ther. 2020;33:296–304.

19. Newington L, Ross R, Howell JW. Relative motion flexion splinting for the rehabilitation of flexor tendon repairs: A systematic review. Hand Ther. 2021;26:102–12.

20. Tang JB. Rehabilitation after flexor tendon repair and others: a safe and efficient protocol. J Hand Surg Eur Vol. 2021;46:813–7.

21. Lane JC, Newington L, Holmes DG, Gardiner MD. Evaluation of rehabilitation guidelines and patient information for upper limb flexor tendon injury in the UK. Open Science Framework. 2020. https://osf.io/6knef/?view_only=4abdf3467fff420ab16fbe00d7a0533d. Accessed 12 Oct 2021.

22. NHS Health Research Authority. HRA Decision tool. 2020. http://www.hra-decisiontools.org.uk/research/. Accessed 30 Nov 2020.

23. Harris P, Taylor R, Thielke R, Payne J, Gonzalez N, Conde J. Research electronic data capture (REDCap) – A metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42:377–81.

24. Harris P, Taylor R, Minor B, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: Building an international community of software partners. J Biomed Inform. 2019;95:103208.

25. British Society for Surgery of the Hand. Lacerations with flexor tendon involvement. 2014. https://www.bssh.ac.uk/_userfiles/pages/files/professionals/Trauma standards/3 Flexor tendon final.pdf. Accessed 12 Oct 2021.

26. Lees V, O'Brien D, Redvers-Chubb K. Efficacy of the Manchester Short Splint versus traditional dorsal splint for rehabilitation of Zone II flexor tendon repairs: study protocol for a randomized controlled trial. Research Square Preprint. 2020. https://www.researchsquare.com/article/rs-21059/v1. Accessed 12 Oct 2021.

27. Dedehayir O, Ortt RJ, Riverola C, Miralles F. Innovators and early adopters in the diffusion of innovations: A literature review. Int J Innov Manag. 2017;21:1740010.

28. Haskell H. Cumberlege review exposes stubborn and dangerous flaws in healthcare. BMJ.

2020;370:1–2.

29. Clancy SP, Mass DP. Current Flexor and Extensor Tendon Motion Regimens. A Summary. Hand Clin. 2013;29:295–309.

30. Savage R. The influence of wrist position on the minimum force required for active movement of the interphalangeal joints. J Hand Surg [Eur]. 1988;13:262–8.

31. Tanaka T, Amadio P, Zhao C, Zobitz M, An K. Flexor digitorum profundus tendon tension during finger manipulation. J Hand Ther. 2005;18:330–8.

32. Hirth MJ, Howell JW, O'Brien L. Relative motion orthoses in the management of various hand conditions: A scoping review. J Hand Ther. 2016;29:405–32.

33. Henry M, Lundy FH. Flexor subzone II A-D range of motion progression during healing on a no-splint, no-tenodesis protection, immediate full composite extension regimen. J Hand Sugery [Asian-Pacific]. 2019;24:405–11.

34. Sandford F, Barlow N, Lewis J. A study to examine patient adherence to wearing 24-hour forearm thermoplastic splints after tendon repairs. J Hand Ther. 2008;21:44–52.

35. Cooney WP, Lin GT, An KN. Improved tendon excursion following flexor tendon repair. J Hand Ther. 1989;2:102–6.

36. Horsfall G. Pilot study comparing two early active motion (EAM) regimens for surgically repaired flexor tendons, zone I–IV, wrist synergistic EAM vs. modified Belfast static wrist EAM. J Hand Ther. 2016;29:362–3.

37. Argent R, Daly A, Caulfield B. Patient involvement with home-based exercise programs: Can connected health interventions influence adherence? JMIR MHealth UHealth. 2018;6:e47.

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Informed consent

The purpose of the survey and links to the protocol were provided at the start of the survey. Respondents were asked to opt in to participate.

Ethical approval

The study was exempt from formal ethics approval following guidance from the NHS Health Research Authority / Medical Research Council tool (Supplementary file 1).

Guarantor

LN.

Contributorship

All authors conceived the study and developed the protocol and survey. LN extracted all data with duplicate data entry by one of JL, MG and DH. LN, JL and DH analysed the data with review by all authors. LN wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version.

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