Turk J Phys Med Rehab 2019;65(4):318-326
DOI: 10.5606/tftrd.2019.2137

Original Article

Functional outcomes after flexor tendon repair of the hand

Taryn Spark[1], Lonwabo Godlwana[1], Veronica Ntsiea[1], Eileen Du Plooy[2], Charl Janse van Rensburg[3]

[1]Department of Physiotherapy, Faculty of Health Sciences, University of the Witwatersrand, South Africa
[2]Department of Occupational Therapy, Faculty of Health Sciences, University of the Witwatersrand, South Africa
[3]Department of Biostatistics, South African Medical Research Council, Pretoria, South Africa

Received: September 19, 2018 **Accepted:** September 30, 2018 **Published online:** November 22, 2019

ABSTRACT

Objectives: This study aims to evaluate the hand function after flexor tendon repair (FTR) and to investigate factors associated with functional outcomes.

Patients and methods: Between January 2013 and September 2015, a total of 126 patients (84 males, 42 females; mean age 31 years; range, 15 to 62 years) who underwent FTR due to flexor tendon injuries (FTIs) were included. The hand function was assessed using the Jebsen Hand Function Test (JHFT) and Quick Disabilities of the Arm, Shoulder and Hand (Quick DASH) at three and six months following FTR.

Results: Of the patients, 94 (75%) and 72 (56%) completed the three-month and six-month assessment visits, respectively. A total of 65 patients (51.1%) had both three and six-month follow-up data. The patients regained a fair amount of power grip strength and more than half of their pinch grip strength compared to the unaffected hand. The results of assessment of hand function at activity and participation levels (JHFT and Quick DASH) showed slightly higher levels of disability. Of 41 patients who were employed prior to injury, 29 (71%) returned to work at six months after surgery. Zone IV injury and language barrier were associated with poor functional outcomes at six months.

Conclusion: Our study results showed that the JHFT and Quick DASH scores of the patients were less than the established norms, although functional outcomes improved over time. Based on these results, we suggest that the presence of zone IV FTI and language barrier are associated with poor functional outcomes.

Keywords: Flexor tendon repair, functional outcomes, hand function.

Hand injuries are common and flexor tendon injuries (FTIs) are more common than extensor tendon injuries of the hand.[1,2] Despite this, optimal surgical and postoperative treatment for flexor tendon repair (FTR) has not been established, yet and there is a great variability in the with good outcomes being achieved in specialized hand units.[3] Based on the literature data, the possible factors which affect the outcomes of FTR include age, language barriers, smoking, mechanism of injury, zone of injury, extent of injury including the number of digits injured and associated injury, time elapsed from injury to surgery, surgical technique, postoperative rehabilitation protocol, and adherence to therapy.[2,4] Post-FTR outcomes are most frequently determined measuring the impairments in the body structure and functions, such as the range of motion (ROM) and strength. Most studies on FTR outcomes have been conducted in developed countries, and the number of such studies is very limited in developing countries.

The postoperative outcomes in patients undergoing FTR may differ between individuals, due to the lack of resources, higher postoperative infection rates, and lower levels of education.[4-6] Individuals with higher levels of education experience better health outcomes.[7] Postoperative functional outcomes may be also influenced by nosocomial infections which contribute to the high burden of infection and are

Corresponding author: Veronica Ntsiea, MD. Department of Physiotherapy, Faculty of Health Sciences, University of the Witwatersrand, 7 York Road, Parktown, 2193 South Africa. e-mail: veronica.Ntsiea@wits.ac.za

Cite this article as:
Spark T, Godlwana L, Ntsiea V, Du Plooy E, van Rensburg CJ. Functional outcomes after flexor tendon repair of the hand. Turk J Phys Med Rehab 2019;65(4):318-326.
Presented at the World Confederation for Physical Therapy Congress, Singapore, 1-4 May 2015

disproportionately high in clinical facilities with limited resources.[8,9]

Time elapsed between injury and surgery may also contribute to the functional outcomes. In specialized hand centers, patients are likely to undergo surgery sooner after the injury than those in lower-volume facilities.[10,11] Therefore, postoperative functional outcomes between specialized hand centers and lower-volume hospitals may differ. In the present study, we aimed to evaluate the hand function after FTR and to investigate factors associated with functional outcomes.[12]

PATIENTS AND METHODS

This longitudinal, observational, descriptive study was conducted at a tertiary state hospital in Johannesburg, South Africa between January 2013 and September 2015. Inclusion criteria were as follows: having a sustained FTI in any zone, in any finger, with any associated neurovascular and/or bony injury; and being over the age of 14 years. Those who had a previous injury to the affected or unaffected hand resulting in a ROM and/or strength deficit were excluded from the study.

Eleven factors which affect the post-FTR outcomes were identified through the literature search. For every factor considered to have a possibility of influencing the results of the study, at least 10 participants are required.[13] Thus, a total of 110 participants were required for this study. Considering 15% drop rate due to lost-to-follow-up, minimum 126 patients were required. Accordingly, a total of 126 patients (84 males, 42 females; mean age 31 years; range, 15 to 62 years) who underwent FTR due to FTIs were included in the study.

Outcome measures

Hand function was measured using the Jebson Hand Function Test (JHFT).[14] This measures the time it takes to complete seven functional tasks with both dominant and non-dominant hands: writing, turning over cards, picking up small common objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects. The longer the time taken to complete the tasks, the higher the level of function limitation.[15] The JHFT times were recorded in the format of min: sec: msec. The final value was converted into sec for ease of analysis.

The Quick Disabilities of the Arm, Shoulder and Hand outcome measure (Quick DASH) was also used.[16] It measures the upper limb function, up to participation level, using the optional work and sport modules. The Quick DASH was scored using this formula: ([sum of n responses/n] -1) ×25 for both the main disability and work components of the tool. The scores range from 0 to 100, with 0 indicating the least disability and 100 indicating most disability.[17]

Procedure

Every week day, the researcher obtained theatre lists from the hospital hand surgeons and identified the patients who were scheduled for FTR. Each patient, then, underwent surgery and was treated by an occupational therapist (OT) for four weeks after surgery. The OT protocols included passive motion, controlled active motion, and early active motion protocols. At four weeks of surgery, physiotherapy was initiated and the patients attended to a treatment session which included splint removal, scar management, place and hold hand exercises, active isolated joint movements, tendon-gliding exercises, and active wrist exercises. The patients were seen once every two weeks for 30 min. At eight weeks of surgery, passive extension exercises and strengthening exercises were introduced. At three months, all patients were informed that they could use their hand, without any restraint, for all activities of daily living.

At the first assessment which was carried out four weeks after surgery, a data collection form including details for demographics, injury, surgery, rehabilitation, and postoperative complications was completed. The sections regarding rehabilitation and postoperative complications were supplemented at three- and six-month assessment visits, where applicable.

The JHFT and the Quick DASH which were administered by the interviewer were used at three and six-month assessment visits. The optional work module of the Quick DASH was completed, if the participant was employed prior to sustaining their injury. A pilot study was conducted successfully.

A written informed consent was obtained from each patient. The study protocol was approved by the University of the Witwatersrand, Ethics Committee for Research on Human Subjects (No. M130748). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 25.0 (IBM Corp, Armonk, New York, USA). Descriptive statistics were expressed in mean

± standard deviation (SD), median (min-max), or number and frequency. A Wilcoxon signed-rank test was used to compare median scores of Quick DASH and JHFT times over the study period. A t-test was used to compare the JHFT times with established norms and to identify whether the outcome variables varied across two different categories of the predictor variable. A one-way analysis of variance (ANOVA) was used to compare more than two categories. Correlation analysis was performed among the variables using one-way ANOVA to determine factors which were significantly correlated with six-month Quick DASH scores. A p value of <0.05 was considered statistically significant.

RESULTS

Of all 126 patients, 94 (75%) and 72 (56%) completed the three-month and six-month assessment visits, respectively. Seven patients attended to their six-month assessment visit, but not to three-month assessment visit and finally 51.5% patients (n=65) had complete data. The demographic characteristics of the patients are shown in Table 1. Injury-related characteristics are summarized in Table 2. In most of the patients (61.5%, n=40), the dominant hand was injured with the main cause of injury being accidental (43%, n=28). The zone V (40%, n=26) was the most affected site and the ulnar nerve was the most commonly associated injury (21.5%, n=14).

The mean time elapsed between injury and surgery was 11±15 days (n=65) with most of the patients (57%, n=37) undergoing FTR within a week of sustaining their injury. Almost half of the patients (48%, n=31)

Table 1. Demographics of study sample (n=65)

Descriptor	n	%	Range
Gender			
Male	41	63	
Female	24	37	
Age (year)			15-62
<20	5	7.5	
20-30	24	37	
3-40	20	31	
41-50	11	17	
>50	5	7.5	
Occupation			
Employed	41	63	
Unemployed	17	26	
Other*	7	11	
Type of work (n=41)†			
Sedentary	4	10	
Light	15	36.5	
Medium	15	36.5	
Heavy	7	17	
Hand dominance			
Right	59	91	
Left	6	9	
Smoker			
Yes	19	29	
No	46	71	
Language barrier			
Yes‡	8	12.5	
No	51	78.5	
Slight‡	6	9	

* Includes scholars, students, pensioners and prisoners; † See Appendix 15 for description of classification; ‡ "Yes" required a translator, "Slight" meant participant was not fluent in English, but a translator was not required.

Table 2. Characteristics of the injuries (n=65)

Descriptor	n	%
Hand injured		
Dominant	40	61.5
Non-dominant	25	38.5
Cause of injury		
Accidental*	28	43
Violence-related	24	37
Motor/pedestrian vehicle accident	2	3
Occupational	5	8
Self-inflicted**	6	9
Sharp/tearing†		
Sharp	60	92
Tearing	5	8
Zone		
I	1	1.5
II	19	29
III	9	14
IV	3	4.5
V	26	40
Thumb (zones I-III)	7	11
Number of digits injured		
1	25	38.5
2	18	28
3	11	17
4	8	12
5	3	4.5
Associated injury‡		
Isolated median nerve laceration	10	15
Isolated ulnar nerve laceration	14	21.5
Combined median and ulnar nerve laceration	4	6
Digital nerve laceration	11	17
Fracture/dislocation	5	7
Vascular injury	9	14
Extensor tendon/thenar muscle laceration	5	7
A2/A4 pulley injury	2	3
None	21	32

* Injuries caused by accidents (outside of work) such as falling onto glass or cutting oneself accidentally; ** Injuries sustained by punching windows and in one case a parasuicide; † Sharp: knives, broken bottles, glass, blade and windows; tearing: grinders/saws and a spanner in one case; ‡ Accounts for combined injuries i.e. more than one associated injury.

Table 3. Mean JHFT times (in seconds) for each domain at six months after FTR compared to established norms (females and males)

Females	Dominant hand					Non-dominant hand				
	Current study	SA norms	P-value	JHFT norms	P-value	Current study	SA norms	P-value	JHFT norms	P-value
Hand writing	23.4±24.4	12.7±4.4	0.03*	11.7±2.1	0.02*	36.0±25.1	28.6±9.1	0.13	30.2±8.6	0.22
Page turning	5.1±5.3	4.9±1.2	0.08	4.3±1.4	0.41	5.4±3.4	5.6±1.3	0.81	4.8±1.1	0.33
Small objects	10.6±14.4	5.6±1.2	0.08	5.5±0.8	0.07	8.5±6.0	6.1±1.5	0.04*	6.0±1.0	0.04*
Feeding	6.6±2.3	6.3±1.1	0.49	6.7±1.1	0.80	7.7±2.1	7.6±1.4	0.79	8.0±1.6	0.39
Checkers	4.7±2.1	2.4±0.5	0.00*	3.3±0.6	0.00*	5.2±1.6	2.7±0.6	0.00*	3.8±0.7	0.00*
Light objects	3.4±2.0	3.7±0.7	0.58	3.1±0.5	0.37	3.3±0.8	4.0±0.8	0.00*	3.3±0.6	0.81
Heavy objects	4.0±3.6	3.8±0.7	0.77	3.2±0.5	0.24	3.7±1.2	4.1±0.9	0.08	3.3±0.5	0.06
Males	Dominant hand					Non-dominant hand				
	Current study	SA norms	P-value	JHFT norms	P-value	Current study	SA norms	P-value	JHFT norms	P-value
Hand writing	23.8±14.8	13.9±5.6	0.00*	12.2±3.5	0.00*	39.8±21.3	32.2±10.5	0.02*	32.3±11.8	0.02*
Page turning	5.2±3.2	4.7±1.2	0.31	4.0±0.9	0.01*	5.1±2.0	5.8±1.4	0.04*	4.5±0.9	0.04*
Small objects	11.7±12.1	5.5±0.9	0.00*	5.9±1.0	0.00*	9.2±6.6	6.2±1.2	0.00*	6.2±0.9	0.00*
Feeding	7.0±4.1	6.1±1.0	0.17	6.4±0.9	0.36	7.8±3.1	7.4±1.4	0.43	7.9±1.3	0.76
Checkers	7.1±17.5	2.4±0.6	0.08	3.3±0.7	0.16	4.8±2.1	2.7±0.7	0.00*	3.8±0.6	0.00*
Light objects	3.3±1.1	3.5±0.6	0.20	3.0±0.4	0.04*	3.3±0.7	3.7±0.7	0.00*	3.2±0.6	0.32
Heavy objects	4.91±10.7	3.6±0.6	0.43	3.0±0.5	0.24	3.6±1.4	3.9±0.8	0.12	3.1±0.4	0.02*

Data are given in mean±SD, unless otherwise stated; JHFT: Jebson Hand Function Test; FTR: Flexor tendon repair; * Indicates a significant difference between the means of this sample and the norms; ** SA norms: Govender[18]; JHFT norms: Jebsen et al.[14]

Table 4. Quick DASH and work module scores at three and six months after FTR

Quick DASH scores at three and six months post FTR (n=65)			
	Quick DASH 3 months	Quick DASH 6 months	*p*
Median	22.72	15.91	<0.001
25th percentile	12.5	9.09	
75th percentile	40.00	22.50	
Mean±SD	26.2±16.8	19.3±16.9	
Min-Max	0.00-70.45	0.00-77.27	

Quick DASH work module scores at three and six months post FTR (n=24)			
	Work module 3 months	Work module 6 months	*p*
Median	18.75%	12.50%	<0.001
25th percentile	12.50%	0.00%	
75th percentile	45.31%	12.50%	
Mean±SD	27.9±28.3	15.9±23.7	
Min-Max	0.00-100.00	0.00-100.00	

DASH: Disabilities of the arm, shoulder and hand; FTR: Flexor tendon repair; SD: Standard deviation; Min: Minimum; Max: Maximum.

had four-strand repair, and 68% of the patients (n=44) experienced one or more complications after FTR. The most common complication was tenodesis/adhesions (25%, n=16), followed by contracture (22%, n=14) and infection (9%, n=6). Of 65 patients, 2% (n=1) had an excellent outcome, 32% (n=21) had a good outcome, 32% (n=21) had a fair outcome, and 34% (n=22) had a poor outcome in terms of the ROM. At six months after FTR, the mean power grip was 60±25% (n=65) of the unaffected hand, while the mean pinch grip was 52±42% (n=65) of the unaffected hand.

The most commonly used protocol for postoperative rehabilitation was a passive motion protocol, which 88% (n=57) of the patients received. The majority of the patients (75%, n=49) were compliant with splinting. The mean adherence to therapy attendance was 91±13% (n=65) with 59% (n=38) of the patients having 100% attendance in the first 12 weeks after FTR. A total of 52% of the patients (n=34) completed treatment and 17% of the patients (n=11) were still receiving hand therapy at the time of completion of data collection.

The overall change in median JHFT time from three to six months was significant with an improvement of eight sec (p<0.001) and seven sec (p<0.001) in the non-dominant and dominant hand, respectively. The JHFT is measured according to dominant and non-dominant hands, rather than affected and unaffected hands. Times for individual domains of the JHFT and a comparison with the norms established by Jebsen et al.[14] and Govender[18] are shown in Table 3 for female and male patients. The mean time (as opposed to the median time) was used, as the established norms, with which these times were compared, are presented in a mean value. According to the Jebsen et al.'s[14] norms, the 20-59 age category was used, as the majority of the patients (97%, n=63) in the current study fell within this age range.

Female patients were significantly slower stacking checkers with both dominant and non-dominant hands, picking up small objects with the non-dominant hand and writing with the dominant hand, but significantly faster at picking up light objects with the non-dominant hand. Male patients were significantly slower at writing, picking up small objects and were slower stacking checkers with the non-dominant hand, but significantly faster at page turning and picking up light objects with the non-dominant hand.

The Quick DASH and Work module scores at three and six months are shown in Table 4. The improvement rate in the Quick DASH and Quick DASH Work module scores from three to six months was 6.81% (p<0.001) and 6.25% (p<0.001), respectively.

The correlations between the Quick DASH and predictors are presented in Table 5. The patients who

Table 5. Correlation analysis

	Quick DASH	
	Mean±SD	*p*
Age category (year)		0.42
<20	17.2±5.4	
20-30	17.0±17.8	
31-40	16.9±13.3	
41-50	26.4±22.9	
>50	27.2±16.7	
Zone of injury		0.01*
I	54.6±0.0	
II	15.1±19.0	
III	17.8±16.8	
IV	45.2±17.2	
V	20.2±14.0	
Thumb	13.5±5.5	
Number of digits injured		0.11
1	17.0±14.0	
2	15.6±19.5	
3	26.1±19.3	
4	28.7±14.6	
5	12.1±8.6	
Associated injury		0.08
Ulnar nerve	19.3±15.9	
Median nerve	21.3±12.1	
Combined median and ulnar nerve	35.3±21.6	
Digital nerve	23.1±23.2	
Fracture/dislocation	13.6±9.6	
Pulley	0.0±0.0	
Nil	15.8±15.5	
Language barrier		0.00*
Yes	39.9±24.2	
No	16.4±13.4	
Slight	17.1±16.4	

SD: Standard deviation; Test used: ANOVA; * Significant

had an injury in zone IV or who were unable to speak English were more likely to score higher on the Quick DASH, indicating higher levels of disability. As the Quick DASH score is significantly associated with zone of injury and presence of a language barrier, the patients who had an injury in zone IV or who were unable to speak English were more likely to score higher on the Quick DASH. Although the zone I category has the highest Quick DASH score, there was only one patient in this category in our study and considering the SD and the fact that there were three patients in the zone IV category, it was concluded that the patients with zone IV injury had the higher mean scores on the Quick DASH.

DISCUSSION

In the present study, we evaluated the hand function after FTR and investigated factors associated with functional outcomes. Our study results showed that zones II (29%) and V (40%) were the most commonly affected zones. Similarly, de Jong et al.[1] and Hung et al.[19] found that zone II was the most commonly injured flexor tendon zone with a much lower rate of zone V injury (6.7% and 17%, respectively), compared to our study. In general, FTR studies do not include zone V injuries due to the higher likelihood of an associated peripheral nerve injury, which is often an exclusion criterion.[20] The lack of associated nerve injury as a part of the exclusion criteria in this study may explain the higher rates of zone V injuries in this patient population.

The most commonly adapted protocol for postoperative rehabilitation is a passive motion protocol. This is consistent with Venter[21] and Mncube and Puckree[22] who concluded that therapists working in the government settings in South Africa preferred passive motion protocols, as the patients were unable to attend therapy sessions regularly. In addition, the use of active motion protocols requires a four-strand repair and a patient who is fully able to understand the precautions and is motivated and compliant. In this study, the four-strand repair was not always done, which would lead therapists to lean toward a more conservative passive motion protocol. This is not consistent with the rest of the world's move toward more active protocols, which are considered the gold standard of FTR rehabilitation.[23,24] However, in our study, the patients still had improved functions.

In the present study, the mean adherence rate to therapy attendance was 91±13% (n=65). Most studies examined adherence to splint wear, rather than adherence to appointment attendance, making it difficult to compare attendance rate from this study with other researches.[25,26] The majority of the patients (75%) in our study were compliant with splint wear and did not remove their splints by themselves at home within the first four weeks of FTR. These adherence levels were much higher than those by Sanford et al.,[25] and Kaskutas and Powell[26] who found that patients removed their splints by themselves at a rate of 67.1% and 59%, respectively. In the Sanford, Barlow, and Lewis's[25] study, adherence was examined using an anonymous questionnaire, rather than by asking the patient directly whether they removed their splint at home, as in the current study. It is possible that participants are more likely to be truthful about their adherence to splint wear, when answering questions anonymously rather than face-to-face with a therapist, who they may desire to avoid any disappointment; therefore, the slightly lower

adherence in Sanford et al.,[25] study may be more accurate than the current study.

On the other hand, functional outcomes of patients in this study cannot be compared with those in the literature due to the differences in the interpretation of the results. Trumble et al.[27] used the JHFT as one of their outcome measures after FTR in their study comparing active and passive motion and found that the JHFT did not show a significant difference between the two groups, despite a significant difference in the ROM and patient satisfaction rates. The authors did not report the actual times taken by the participants to perform the JHFT, making it impossible to compare this study's results with theirs. Thus, it is more reasonable to compare our results with the established norms.

Writing and stacking checkers showed the most significant differences compared to the established norms across both dominant and non-dominant hands and male and female participants. One of the reasons for this could be that, as in many South Africans, hand writing might not be a commonly performed activity by the patients.[18] For the stacking checkers subtest, it has been acknowledged that this does not replicate any activity of daily living and was considered by Jebsen et al.[14] to be the least functional of all the subtests.[18] There was a difference between male and female participants' times in the performance of certain hand function-related tasks in this study. This finding is not unique, as Karantana et al.[28] (as cited in Govender[18]) found that women might be more cautious, leading to slower task completion and women tended to perform better in tasks requiring fine motor skills. However, Jebsen et al.[14] could not find any specific explanation for the variation in times between men and women.

In our study, we also found a statistically significant improvement ($p<0.001$) in the mean JHFT times from three to six months; however, the minimal clinically important difference (MCID) for the JHFT has not been established, yet and, therefore, there is no value with which to compare this improvement to ascertain whether this was a clinically important change. Using the Quick DASH scores, the improvement was also statistically significant ($p<0.001$); however, a change of 6.81% is less than the MCID of 8% points, indicating that the change is unlikely to be of clinical importance. Normative values have been established for the DASH questionnaire, but not for the Quick DASH. Hunsaker et al.,[29] in a large survey of the general American population, found that the general population would score a mean of 10.1±14.68 on the DASH. Aasheim and Finsen[30] also found the mean DASH score for the Norwegian population to be 13, suggesting that the mean Quick DASH scores were similar to the DASH scores. Considering the Aasheim and Finsen's[30] results that one could compare DASH and Quick DASH scores, a mean Quick DASH score of 19.34±16.89 in this sample was much higher than the previously mentioned norms, indicating a higher level of disability in this sample, compared to the general population.

Return to work (RTW) is another measure of participation. Most of the patients who were employed prior to their injury returned to work after surgery. There has been much research in RTW and the factors which affect RTW in hand-injured patients.[31-34] Bruyns et al.[31] examined the patients with median and ulnar nerve injuries and found that 59% of them had RTW within one year with a mean off-work time of 31.3 weeks. The RTW in this sample was higher at six months (71%) than the results of Bruyns et al.,[31] although this sample consisted of a fair number of participants with median and/or ulnar nerve injuries. The RTW can contribute to life satisfaction, wellbeing, self-worth, and social identity, at least partly through independence gained from income generation.[35]

The factors which had a significant correlation with functional outcome at six months of FTR were zone of injury and language barrier. Injury in zone IV was associated with worse scores on the Quick DASH, indicating a higher level of disability. Although zone IV injuries can be complicated due to their proximity to the carpal tunnel,[36] the fact that zone IV injuries had the worst outcome in this study was unexpected. One would assume that either zone II injuries, which are notorious for poor results,[37,38] or zone V injuries, in which there are more likely to be multiple digit injuries and associated peripheral nerve injury, would have the worst results. In our study, two of three patients who were injured in zone IV had associated peripheral nerve injury -one had a median nerve injury and the other had a combined median and ulnar nerve injury- and such an injury to the nerves affects the ROM, strength, sensibility, and hand function,[37] which could be a possible reason for the worse outcomes. However, associated injury was found to affect both the power and pinch grip strength at six months after FTR, consistent with the findings of Trumble et al.[27] and Starnes et al.,[37] who showed that, in the presence of an associated bony or neurovascular injury, poorer results could be achieved.

The presence of a language barrier was also found to affect the outcome after FTR. A possible reason for that in this study is that the therapists were able to speak English which was not the language spoken by the patients. This may limit communication of strict instructions and the importance of rehabilitation after FTR. If the patient understands both of them, they would be less likely to unintentionally be non-adherent with splint wear and the home-based exercise programme, all of which are important to the post-FTR functional outcomes.[23] However, it is difficult to compare this result with other studies due to a lack of research regarding language barriers in FTR. This lack of research is likely due to the fact that most FTR researches have conducted in developed countries where the medical staff speaks the same language as patients and, therefore, so language barriers are not often a concern for post-FTR.

The small sample size of our study precludes the generalization of the results, which can be considered a limitation. In addition, the final functional outcomes might have been more accurately assessed in the long-term (i.e., at 12 months).

In conclusion, our study results showed that the JHFT and Quick DASH scores of the patients were less than the established norms, although functional outcomes improved over time. Based on these results, we suggest that the presence of zone IV FTI and language barrier are associated with poor functional outcomes. In addition, the rate of RTW among the employed patients prior to injury was good.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. de Jong JP, Nguyen JT, Sonnema AJ, 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.
2. 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 2010;44:314-21.
3. Kotwal PP, Ansari MT. Zone 2 flexor tendon injuries: Venturing into the no man's land. Indian J Orthop 2012;46:608-15.
4. Tang JB. Tendon injuries across the world: treatment. Injury 2006;37:1036-42.
5. Allegranzi B, Pittet D. Healthcare-associated infection in developing countries: simple solutions to meet complex challenges. Infect Control Hosp Epidemiol 2007;28:1323-7.
6. Chung KC, Kotsis SV, Kim HM. Predictors of functional outcomes after surgical treatment of distal radius fractures. J Hand Surg Am 2007;32:76-83.
7. Trojanowska A, Brodowicz-Król M, Trojanowska P. Knowledge of young women concerning the impact of natural feeding on the growth and state of health of a baby. Ann Agric Environ Med 2017;24:484-8.
8. Rothe C, Schlaich C, Thompson S. Healthcare-associated infections in sub-Saharan Africa. J Hosp Infect 2013;85:257-67.
9. Brown S, Kurtsikashvili G, Alonso-Echanove J, Ghadua M, Ahmeteli L, Bochoidze T, et al. Prevalence and predictors of surgical site infection in Tbilisi, Republic of Georgia. J Hosp Infect 2007;66:160-6.
10. Farzad M, Layeghi F, Asgari A, Ring DC, Karimlou M, Hosseini SA. A prospective randomized controlled trial of controlled passive mobilization vs. place and active hold exercises after zone 2 flexor tendon repair. Hand Surg 2014;19:53-9.
11. Moriya K, Yoshizu T, Maki Y, Tsubokawa N, Narisawa H, Endo N. Clinical outcomes of early active mobilization following flexor tendon repair using the six-strand technique: short- and long-term evaluations. J Hand Surg Eur Vol 2015;40:250-8.
12. Kasashima T, Kato H, Minami A. Factors influencing prognosis after direct repair of the flexor pollicis longus tendon: multivariate regression model analysis. Hand Surg 2002;7:171-6.
13. Nunnaly JC. Psychometric theory. 2nd ed. New York: McGraw-Hill; 1978. p. 230-45.
14. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. Arch Phys Med Rehabil 1969;50:311-9.
15. Poole JL. Measures of hand function: Arthritis Hand Function Test (AHFT), Australian Canadian Osteoarthritis Hand Index (AUSCAN), Cochin Hand Function Scale, Functional Index for Hand Osteoarthritis (FIHOA), Grip Ability Test (GAT), Jebsen Hand Function Test (JHFT), and Michigan Hand Outcomes Questionnaire (MHQ). Arthritis Care Res (Hoboken) 2011;63:189-99.
16. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. J Bone Joint Surg [Am] 2005;87:1038-46.
17. IWH. The DASH Outcome Measure 2006; Retrieved October 15, 2015, from DASH: Available at: http://www.dash.iwh.on.ca
18. Govender P. To establish normative data using the Jebsen Taylor Hand Function Test (JHFT) for normal, ethinically diverse South Africans aged between 20 and 59 years. MSc Occupational Therapy 2008; University of the Witwatersrand, Johannesburg. Available at: http://wiredspace.wits.ac.za/handle/10539/6931

19. Hung LK, Pang KW, Yeung PL, Cheung L, Wong JM, Chan P. Active mobilisation after flexor tendon repair: comparison of results following injuries in zone 2 and other zones. J Orthop Surg (Hong Kong) 2005;13:158-63.
20. 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.
21. Venter J. An investigation to establish the flexor tendon rehabilitation protocol use amongst Occupational Therapists in South Africa. MSc Hand Rehabilitation 2012, University of the Witwatersrand, Johannesburg. Available at: https://pdfs.semanticscholar.org/ddfe/ec0e044294141f194e47903bed4b8e5d45f2.pdf
22. Mncube NM, Puckree T. Rehabilitation of repaired flexor tendons of the hand: Therapists' perspective. SAJ Physio 2014;70:33-8.
23. Torie PAG, Atwal N, Sheriff D, Cowey A. Flexor tendon injuries. Orthopaedics and Trauma 2010;24:217-22.
24. Dy CJ, Daluiski A. Update on Zone II Flexor Tendon Injuries. J Am Acad Orthop Surg 2014;22:791-9.
25. 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.
26. Kaskutas V, Powell R. The impact of flexor tendon rehabilitation restrictions on individuals' independence with daily activities: implications for hand therapists. J Hand Ther 2013;26:22-8.
27. Trumble TE, Vedder NB, Seiler JG, Hanel DP, Diao E, Pettrone S. Zone-II flexor tendon repair: a randomized prospective trial of active place-and-hold therapy compared with passive motion therapy. J Bone Joint Surg [Am] 2010;92:1381-9.
28. Karantana A, Downs-Wheeler MJ, Webb K, Pearce CA, Johnson A, Bannister GC. The effects of Scaphoid and Colles casts on hand function. J Hand Surg Br 2006;31:436-8.
29. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American academy of orthopaedic surgeons outcomes instruments: normative values from the general population. J Bone Joint Surg [Am] 2002;84:208-15.
30. Aasheim T, Finsen V. The DASH and the QuickDASH instruments. Normative values in the general population in Norway. J Hand Surg Eur Vol 2014;39:140-4.
31. Bruyns CN, Jaquet JB, Schreuders TA, Kalmijn S, Kuypers PD, Hovius SE. Predictors for return to work in patients with median and ulnar nerve injuries. J Hand Surg Am 2003;28:28-34.
32. Gustafsson M, Ahlström G. Problems experienced during the first year of an acute traumatic hand injury - a prospective study. J Clin Nurs 2004;13:986-95.
33. Wong JY. Time off work in hand injury patients. J Hand Surg Am 2008;33:718-25.
34. Opsteegh L, Reinders-Messelink HA, Schollier D, Groothoff JW, Postema K, Dijkstra PU, et al. Determinants of return to work in patients with hand disorders and hand injuries. J Occup Rehabil 2009;19:245-55.
35. Medin J, Barajas J, Ekberg K. Stroke patients' experiences of return to work. Disabil Rehabil 2006;28:1051-60.
36. Griffin M, Hindocha S, Jordan D, Saleh M, Khan W. An overview of the management of flexor tendon injuries. Open Orthop J 2012;6:28-35.
37. Starnes T, Saunders RJ, Means KR Jr. Clinical outcomes of zone II flexor tendon repair depending on mechanism of injury. J Hand Surg Am 2012;37:2532-40.
38. Polatkan S. Principles of Rehabilitation in Tendon Injuries of Hand. Turk J Phys Med Rehab 2007:53(Suppl 2);23-6.