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Prospective Study on Effectiveness of Belfast Regime on Flexion Tendon Injury Zone V Using Tam Scoring

Maha Farhina[1*], Bushra Zulfiqar[1], Maryam Noor[1], Saba Kiran[1], Faisal Akhlaq Ali Khan[1], Shafa Atullah[2]

[1]Plastic Surgery Department, Civil Hospital Karachi, Karachi, Pakistan
[2]Baqui Medical University Karachi, Karachi, Pakistan
Email: *mahafarhina24@gmail.com

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Abstract

About 20% of injuries presented in the emergency room that require surgical repair involve the hand. Most of these injuries result from sharp objects such as glass and knives, and blades in case of suicide. In Pakistan, the most common injuries occur at the junction between the transverse distal crease on the wrist and the forearm muscles (zone 5). Wrist injuries are difficult to repair since they result in the tendon, ulnar and median nerve and arteries abrasion. In addition, an inadequate approach could damage abrasion and swelling of the flexor muscles, risking the functioning of the hand. A good outcome necessitates prioritizing the flexor muscles to avoid swelling and hand dysfunction. The objective of this study is to investigate the effectiveness of Belfast rehabilitation in the treatment of flexion tendon injury. The process of rehabilitation was carried out for a period of 2 years. Using the Belfast regime as a post-rehabilitation regime ensures no adhesion formation, swelling, or delayed healing.

Keywords

Rehabilitation, Flexor Injury, Zone V, Early Mobilization, Belfast Technique

1. Introduction

About 20% of injuries presented in the emergency room that require surgical repair involve the hand [1] [2]. Most of these injuries result from sharp objects such as glass and knives, and blades in case of suicide [3]. In Pakistan, the most common injuries occur at the junction between the transverse distal crease on

the wrist and the forearm muscles (zone 5). [4] A hand comprises five zones, as described by Kleinert and verdant, each with unique integrity and different surgical and rehabilitation approaches [2]. Wrist injuries are difficult to repair since they result in the tendon, ulnar and median nerve and arteries abrasion. [4] An inadequate approach could damage abrasion and swelling of the flexor muscles-a condition called "spaghetti wrist" where the exposed wrist laceration seems like spaghetti spread on a red tomato puree [5].

Previous studies have investigated flexor tendon injuries by improving surgical technique, finding the best operative procedure that is both easily understandable and approachable, and planning a perfect rehabilitation program [6]. In the early 90s, the repair of flexor tendon injury was treated as secondary, but it shows that primary repair gives a good outcome, but the result of a surgically repaired hand mainly depends upon the skills and knowledge of the hand therapist [7] and timing of referring the patient to therapist. A good outcome necessitates prioritizing the flexor muscles to avoid swelling and hand dysfunction. However, these approaches are effective sing the Belfast regime as a post-rehabilitation regime ensures no adhesion formation, swelling, or delayed healing.

Several research studies on rehabilitation of zone V flexor tendon injury to the wrist revealed that the volar site is the most common with injuries [8]. Notably, the volar site of the hand is the most common injury, and it requires proper rehabilitation. Studies show Belfast rehabilitation to be effective in nerve and tendon reconstruction if it begins from day 5 [9]. Other regimens, such as a triple Kessler, have been used to repair flexor tendon injury after treatment, which concluded that the triple Kessler method with rehabilitation showed satisfactory results [10]. Other methods have been used to rehabilitate the flexor tendon following injury. Quadbauer *et al*. stated that using the Zeichners technique on 115 tendon injuries and physiotherapy post-operatively showed significantly good results [11]. In 2014, Jason K.F Wang *et al*. studied rehabilitation in zone II injury. They established that knowledge of the tendon by altering the surgical approach could lead to new techniques for the rehabilitation of flexor injuries [12].

Other studies have also examined the effectiveness of using the Kessler model in rehabilitating patients with lacerated flexor tendons. Though they registered better results with tendon injury recovery, there were poor outcomes with ulnar nerve repair [4]. Improvement in approaches aims to guard the healing, modify the tendonous adhesion, enhance tendon excursion as well as maintain joint movement [13]. Although timely mobilization has improved the healing of flexor tendons, lowered complications, and improved the outcomes, the intra-operation data from the surgical team to the rehabilitation therapist plays a crucial role in determining what type of splint can be used to minimize the rupture and gap force. Studies show that both Kleinert and Duran protocols decrease range of motion, but in active motion, the incidence of tendon rupture increases. Thus, new surgical techniques and rehabilitation can decrease the chances of rupture [14]. A modified Kleinert and Duran protocol for twenty months results in marked improvement in grip strength [15]. A disruptive study on "spaghetti wrist

management and outcome" on glass cut showed 50% involving commonly right hand; however, it showed promising results [16]. Overall results showed better results when early rehabilitation started on the first day of post-operation in cases of tendon rupture [6].

2. Methods

2.1. Subjects

The present study was conducted at Karachi's Civil Hospital, Plastic Surgery ward. A total of fifty subjects took part in the survey, and they included both males and females. The sampling technique included non-probability purposive sampling. A subjective research form was designed after an extensive literature review related to the study objectives. The form was screened through piloting to make it comprehensible. The patients were aged between 18 - 55 years, and the level of injury was the zone v of the hand caused by a sharp object. The population excluded patients with severe joint injury, those with skin loss needing coverage, and any fractures. The study also excludes those with a tendon transfer or graft procedure.

2.2. Procedures

Only cuts from sharp objects such as glass, mirrors, and knives were considered. All participants were emergency patients at the civil hospital's plastic surgery ward in Karachi. Tendons were repaired using 4-0 propylene and a modified two-strand Kessler's technique. A strong suture bond was required for the early rehabilitation program for tendon gliding to be possible and to avoid adhesion formation. Following surgery, the hand is placed on the slab, and a POP cast is applied to the hand. Thereafter a hand therapist took over for functional management.

The patient's rehabilitation begins on the first postoperative day with a modified Belfast protocol regimen. A dorsal splint was applied to the hand with 30 degrees of wrist flexion while the rest of the interphalangeal joint remained neutral, or zero degrees of flexion. For two weeks, passive flexion with active finger extension was recommended, as well as keeping the hand elevated to prevent edema from forming. To distinguish between FDP and FDS glide, isolated flexion of the distal and proximal interphalangeal joints was performed passively. Sutures were removed two weeks after patients were given a date for follow-up. Patients were given a follow-up date after 15 days. Thereafter doctors removed the sutures and they were advised to change dressings regularly.

After two weeks, the same protocol was followed, along with wrist flexion and passively flexing the finger with a hold/relax protocol for ten repetitions every two hours. These exercises were performed after the splint was removed and replaced. The therapist taught all exercises and included them in the home exercise program. In the fourth week, the splint was removed, an active movement was initiated, and the night splint was retained. The therapist taught all of the exer-

cises included in the home exercise program. In the fourth week, the splint was removed, an active movement was initiated, and the night splint was retained.

In the fifth week, patients were allowed to use their hands to perform ADLs such as hygiene, dressing, and feeding, but carrying any amount of weight was prohibited. Gradually increasing levels of resistance exercise were introduced at the start of the sixth week and remained a part of the rehabilitation program until the eighth week.

The emphasis was on relearning fine motor skills from the eighth to the twelfth week. At the beginning of the twelfth week, patients were allowed to return to their jobs. Patients were followed up once a week to assess the outcome prognosis. For peripheral injuries, the patient was kept on track for six months to document his or her recovery. For follow-up, the therapist recorded the fingers and wrist range of motion every week. The primary assessment of the Belfast regime was done on the last reading before the patient resumed his work activity.

A metallic hand goniometer was used to take the measurements. The American Society for Hand Surgery (ASSH) graded the range's result [17]. Aside from that, patients were examined before returning to work to check functional movements such as precision grip for writing, performing ADLs, use a lateral pinch, cylindrical, or spherical grip.

3. Statistical Analysis

The entirety of the statistical analyses was completed by means of SPSS version 23. A normal distribution of the difference between pairs was present; paired tests were performed. A change was deliberated when the reported value fell below 0.05.

4. Results

Seventy-six males and 24 females participated, as shown in **Figure 1**. The occurrence of distributions is shown in **Table 1**. Most injuries happened at work in 29 and at home in 21 patients (**Figure 2**) (**Table 2**). According to data, most injuries were caused by the glass in 41 patients, knives in six types of machinery in 1, and others caused in 2 patients respectively (**Table 3** and **Figure 3**). The average age of subjects in this survey was 30.06 ± 8.05 years with a range of 37 (18 - 55) years (**Table 4** and **Figure 4**).

The age was stratified into five groups. 8% of patients were 18 years of age, 6% of patients were (18 - 20) years of age, 44% of patients were (21 - 30) years of age, 36% of patients were (31 - 40) 4% of patients were (41 - 50). 2% of patients were (51 - 60) (**Figure 5**). The mean age of patients was also calculated according to age group and gender. Mean age was 19.4 ± 0.54 years, 26.9 ± 2.33 years, 34.6 ± 2.90 years, and 48.3 ± 2.88 years for the patients belonged to 18 - 20 years, 21 - 30, 31 - 40, as well as 41 - 50 age group respectively.

The mean age of male patients was 30.3 ± 8.08, and that of female patients was 28.4 ± 5.01 years (**Table 5**). The Descriptive statistics of pre and post Assessment

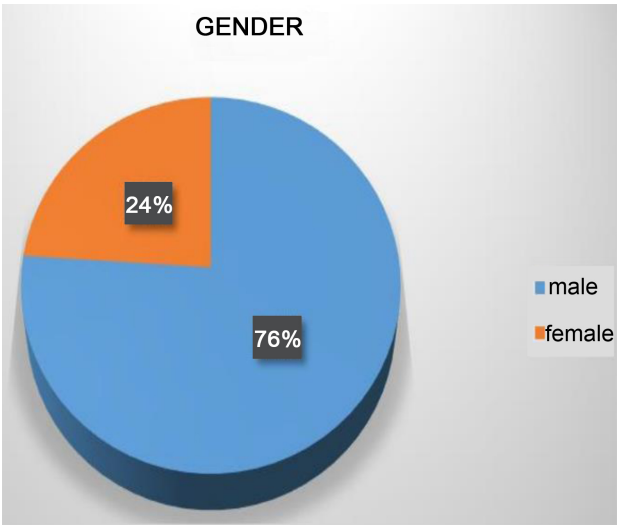

Figure 1. Percentage of gender distribution of subjects. Gender distribution of 50 the participants was 76 percent were male while 24% were female.

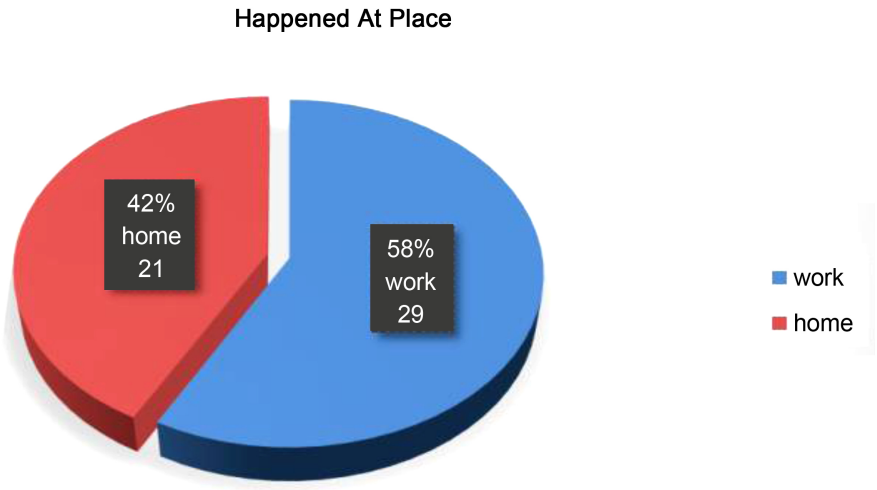

Figure 2. Most of the injuries occurred at work than at home. In the sample, 29 of the people has sustained injuries at work while 21 were injured at home.

TAM Scores are presented in **Table 6**. TAM Score was also evaluated according to gender and age groups. Pre-assessment observed that in male patients, the mean TAM score was 10.6 ± 28.3 and in female patients mean TAM score was not calculated because of the 0 scores. The mean TAM score was 33.3 ± 57.7, 10.68 ± 2.81, and 3.88 ± 16.4 in the 18 - 20, 21 - 30, and 31 - 40 years groups, respectively (**Table 7**). Post-Assessment, it was observed that the mean TAM score in male patients was 81.2 ± 27.4 and in female patients means TAM score was 95.28 ± 7.33. Mean TAM score was 85 ± 21.2, 94.0 ± 83.7, 83.08 ± 32.22, 86.80 ± 17.07, and 67.33 ± 26.1 in 18, 18 - 20, 21 - 30, 31 - 40, and 41 - 50 categories respectively (**Table 8**).

The treatment outcome was also assessed according to grade, *i.e.*, poor, fair,

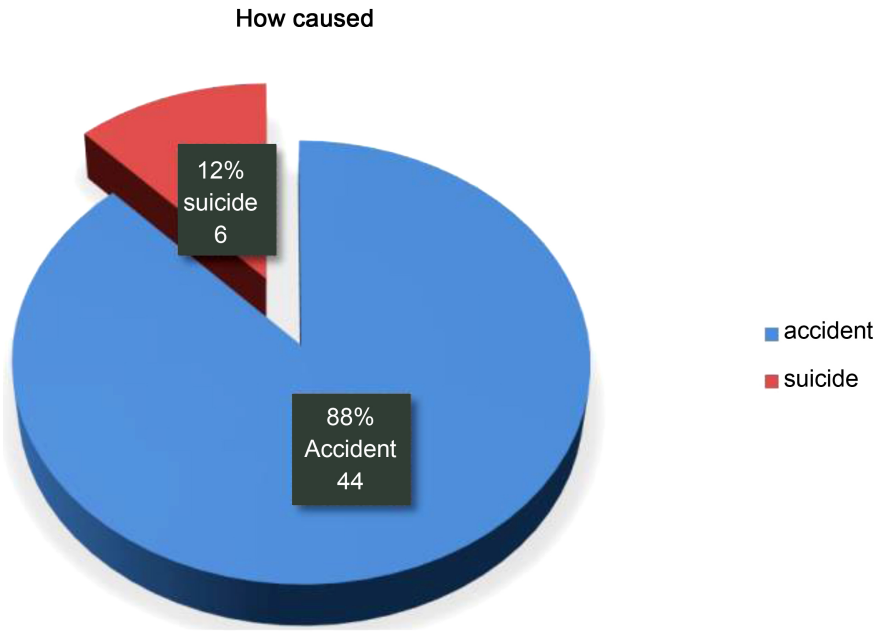

Figure 3. Many flexion tendon injuries were sustained due to accidents at 88%. Other injuries were sustained during attempted suicide.

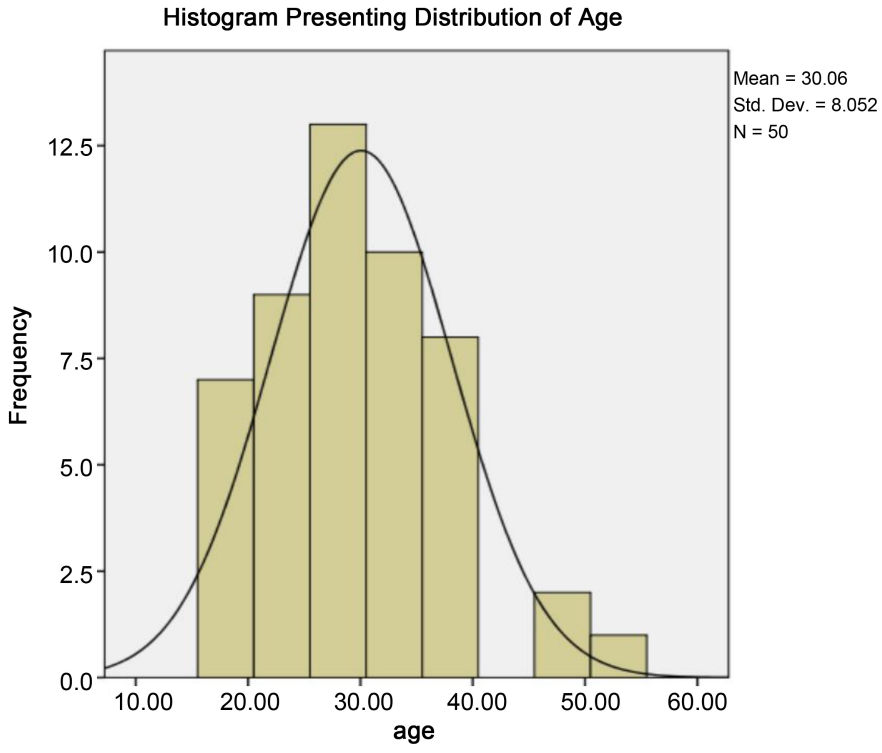

Figure 4. The most frequent age for injuries was 25 - 35 years. People above forty years were less likely to sustain injuries.

good, and excellent (**Figure 6**). It was observed that a post-treatment total of 22 patients had excellent outcomes (Score 100), 19 patients had good outcomes (Score 75-99), 4 patients had fair outcomes (score 50-74), and 5 patients had

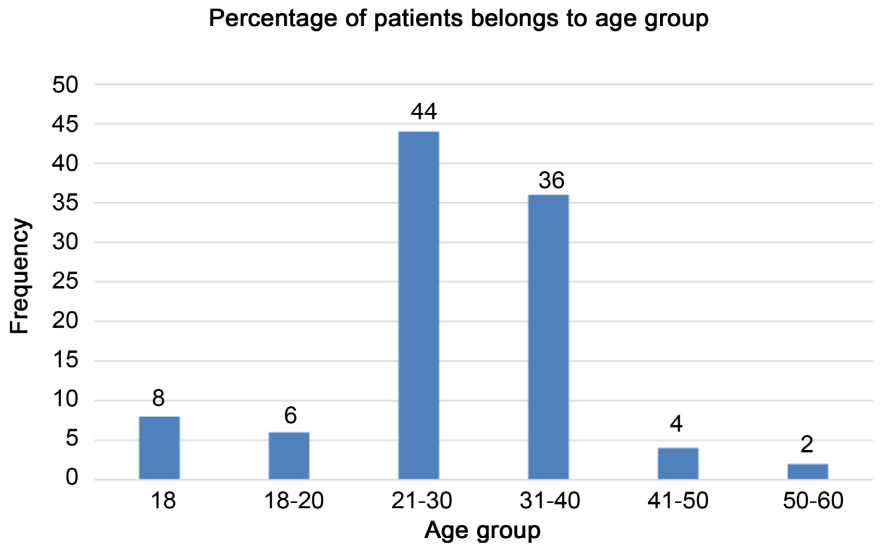

Figure 5. Patient rates were higher among the 21 - 30 age group (at 44%); 18 - 20 had fewer patient rates (6%) while 50 - 60 age group had the least percentage of patients (2%).

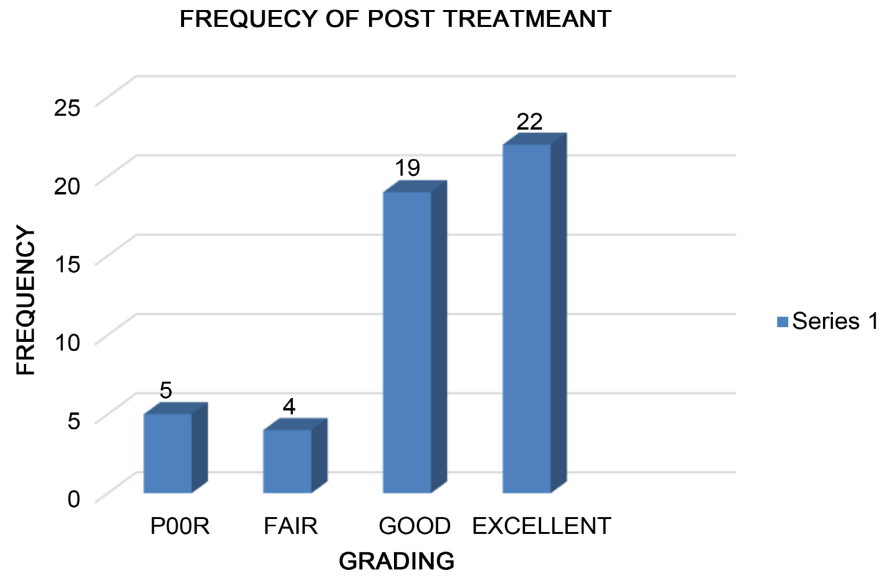

Figure 6. The treatment outcome was excellent among 22 percent of the patients. 19% reported "good", 4% rated as fair, while 5% stated a "poor" outcome.

Table 1. Frequency distribution of gender.

	Frequency	Percentage %
Male	38	76
Female	12	24
Total	50	100

poor outcomes (Score < 50). (Figure 7, Table 9) The treatment was also analysed to determine its effectiveness. The treatment was effective among 45 patients because their TAM Score was >50, and in only five patients, the treatment

Table 2. Frequency distribution of where it happened.

	Frequency	Percentage %
Home	21	42
Work	29	58
Total	50	

Table 3. Frequency distribution of how it was caused.

	Frequency	Percentage %
Accident	44	88
Suicide	6	12
Total	50	

Table 4. Descriptive statistics of age.

	Age (Years)
Mean ± SD	29.9 ± 7.46
95% CI (LB – UB)	27.77 - 32.02
Median (IQR)	30 (8.25)
Min-Max	18 - 50
Range	32

Table 5. Descriptive statistics of AGE (years) according to AGE groups and gender.

		Mean ±SD	95% CI (LB - UB)	Median (IQR)	Min - Max	Range
AGE GROUPS (Years)	**18 - 20**	19.4 ± 0.54 19	18.71 - 20.08	19 (1)	19 - 20	1
	21 - 30	26.9 ± 2.33	25.91 - 27.99	28 (3.8)	22 - 30	8
	31 - 40	34.6 ± 2.90	33.20 - 36.12	33.5 (6)	32 - 40	8
	41 - 50	48.3 ± 2.88	41.65 - 55.50	50	45 - 50	5
GENDER	**Male**	30.3 ± 8.08	27.70 - 33.02	30 (11)	18 - 50	32
	Female	28.4 ± 5.01	25.22 - 31.60	28 (7)	18 - 30	20

Table 6. Descriptive statistics of TAM score.

	Pre assessment TAM Score	Post assessment TAM Score
Mean ± SD	8.1 ± 25.0	84.65 ± 24.8
95% CI (LB - UB)	0.981 - 15.21	77.5 - 91.71
Median (IQR)	0 (0)	92.4 (19.83)
Min - Max	0 - 100	0 - 100
Range	100	100

Table 7. Descriptive statistics of TAM score (pre-assessment) according to AGE groups and gender.

		Mean ± SD	95% CI (LB - UB)	Median (IQR)	Min - Max	Range
Age Group (Years)	18 - 20	33.3 ± 57.7	−110 - 176.7	0 - 50	0 - 100	100
	21 - 30	10.68 ± 28.1	−1.789 - 23.15	0	0 - 100	100
	31 - 40	3.88 ± 16.4	−4.31 - 12.09	0	0 - 70	70
Gender	Male	10.65 ± 28.33	1.341 - 19.97	0	0 - 100	0
	Female	-	-	-	-	-

Table 8. Descriptive statistics of TAM score (post-assessment) according to AGE groups and gender.

		Mean ± SD	95% CI (LB - UB)	Median (IQR)	Min - Max	Range
Age Group (Years)	18	85 ± 21.2	105.5 - 275.57	85	70 - 100	30
	18 - 20	94.0 ± 83.7	83.79 - 104.20	100 (15)	85 - 100	15
	21 - 30	83.08 ± 32.22	68.79 - 97.36	98.1 (15)	0 - 100	100
	31 - 40	86.80 ± 17.07	78.31 - 95.29	42 (22.4)	40 - 100	59.30
	41 - 50	67.33 ± 26.1	2.491 - 132.1	70	40 - 92	52
Gender	Male	81.2 ± 27.4	72.26 - 90.32	92 (23.75)	77 - 100	100
	Female	95.28 ± 7.33	90.59 - 99.9	100 (23.75)	77 - 100	**23.3**

Table 9. Frequency distribution of post treatment outcome.

	Frequency (n)	Percentage %
Excellent	22	44.0
Good	19	38.0
Fair	4	8.0
Poor	5	10
Total	50	

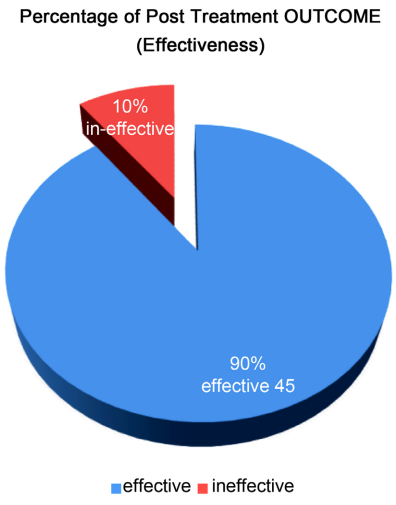

Figure 7. Post treatment outcomes measured effectiveness of the treatment procedure. 45 out of the 50 in the sample were effective, while 10% were reported as ineffective.

was ineffective because their TAM Score was <50 (Table 8 and Table 10). The study evaluated the effectiveness of treatment based on the mean difference of post- and pre-TAM score by using t-test, as well as a p-value ≤ 0.05. The mean in TAM between before and after treatment was important. The paired difference mean was −81.46 (Table 11). In each outcome category, that is, excellent, fair, good, and poor, the mean of TAM score between post and pre-treatment is important with $p < 0.01$. (Table 12).

Table 10. Frequency distribution of post treatment effectiveness.

	Frequency (n)	Percentage (%)
Effective	45	95.0
Ineffective	10	5.0
TOTAL	50	

Table 11. Paired sample t-test mean difference of TAM score according to pre and post treatment (n = 50).

	Paired Difference		t	df	p-value
	Mean	SD			
Pair pre & post TAM Score	−81.46	24.0	−24	49	0.000*

Table 12. Paired sample t-test mean difference of pre and post treatment TAM score according to outcome categories.

	Paired Difference		T	df	p-value
	Mean	SD			
Excellent (Score 100) n = 22	−77.5	35.5	−10.23	21	0.000*
Good (Score 75 - 99) n = 19	−84.7	6.10	−60.5	18	0.000*
Fair (score 50 - 75) n = 4	65.2	8.38	−15.5	3	0.001*
Poor (score < 50) N = 5	−18.3	19.5	−2.095	4	0.104

5. Discussion

This study investigated response to rehabilitation protocols following Flexor tendon injury. This injury is complicated to evaluate because the result of the treatment depends upon many things like dominancy of the hand, nerve injuries, vascular damage, surgical techniques, culture difference, patients' understanding of rehabilitation protocols, and the chances of human error. In Pakistan, zone v injuries result from handheld labor; using the Belfast regime was favorable since patients can quickly follow it as a home regimen. Most hand injuries involve nerve involvements, and the main goal of the treatment is to make patients functionally independent so they are evaluated at least for six months because, in six months, the patient could achieve a range of movements and can perform ADLS.

Several limitations and strengths may be enumerated in this study. Because of its prospective nature, treating traumatic tendon injuries was only observed in a government setup with limited sources and benefits to patients. Nonetheless, further study should be done in both private and government setups to evaluate the effectiveness of the Belfast regime. In addition, another evaluation questionnaire can be used to examine other factors, including the DASH or MULLIGAN questionnaire, apart from TAM scoring. The patient should be evaluated for at least one year to evaluate the strength of a handheld dynamometer that can be used, but mechanical can give an error reading.

6. Conclusion

We concluded that the Belfast regime (early passive and active fingers motion), the tendon adhesion, and the rupture rate were deficient and gave a good result. Most commonly, at 70%, men were affected by the injury, and injuries mostly happened at work by accident. The injuries were common between 20 to 40 years of age and showed a good prognosis. There is no regular protocol, and the Physical Therapist should talk with the surgeon as well as patients before selecting an appropriate therapy program.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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