Original Article

Comparison of the Results of Delayed Repair of Flexor Pollicis Longus (FPL) Tendon with Tendon Transfer or with Tendon Graft

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ABSTRACT

Background: In Flexor Pollicis Longus (FPL) injuries, primary repair with end-to-end suture is the treatment of choice. In cases where primary repair is not possible, tendon transfer or tendon grafting is used, each of which has its strengths and weaknesses. We aimed to investigate the effectiveness of each of the above two methods in patients.

Methods: Patients with FPL injury who referred to Hazrat Fatemeh Hospital, Tehran, Iran late in 2020 to 2021, if primary tendon repair was not possible, were randomly repaired with tendon transfer or tendon graft. After the appropriate time, the splint was opened and physiotherapy was performed for the patients. Then, at least three months after the repair, the range of motion of the IP and MP joints of the patients thumb was measured and compared in two groups.

Results: Ten patients in the tendon transfer group and 10 patients in the tendon graft group were studied. In the secondary repair of FPL with tendon grafting, the range of motion of both IP and MP joints of the thumb was not significantly different compared to repair with tendon transfer.

Conclusion: The findings of this research confirm controversies in this field. In order to obtain more accurate results, it is suggested to carry out a research with a larger number of patients and with strict control over the surgical technique and post-operative care, as well as taking into account the morbidities caused by donor tendon removal and examining the overall satisfaction of the patients.

KEYWORDS
Flexor pollicis longus; Hand injuries; Lacerations; Tendon injuries

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INTRODUCTION

Hand is a critical part of the body to supply human needs and environmental communications[1]. The first reports that early repair of injured flexor tendon is possible and recommended were published in the 1960s. Since then, many advances have been made to understand the anatomy, biology, injury response mechanism and repair of flexor tendons[2-5].

The final goal of the surgical treatment of a torn flexor tendon is correct

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matching of the two ends of the tendon in such a way as to allow the use of rehabilitation programs to increase the movement of the tendon, prevent the formation of adhesions around the tendon, maintain the movement bed of the tendon, provide the possibility of early repair of the injury site and finally maintain the normal range of motion (ROM) of the finger[6, 7].

Damage to the flexor tendons of the fingers, including the thumb, is one of the most common injuries. The flexor pollicis longus (FPL) tendon flexes the IP joint of the thumb. Although this movement is not necessary for thumb function, it is necessary for normal grasp and accurate finger pinch, and so most researchers recommend surgical reconstruction of FPL injuries[8].

The FPL tendon flexes the IP joint between 50 and 100 degrees and then flexes the MP joint with the help of thenar muscles[9]. In daily activities, only the first 30 degrees of active flexion of the IP joint is important[10]. This is the reason why sometimes- in cases where objective examinations show weak results, no significant disability is reported in the general function of the hand[11]. In other words, moderate rehabilitation and return of only 30 to 40 degrees of flexion of the IP joint will bring excellent thumb function, and for this reason, after the failure of initial FPL repair or in cases of old injuries, FPL repair is usually indicated[12].

In FPL injuries, primary or delayed primary repair of the tendon with end-to-end suture or with advancement is the treatment of choice[13-15].

In cases of FPL tendon injury following trauma, the interval between the injury and surgical intervention is important in determining the repair method. Direct tendon repair in the first 24 hours after the injury is called immediate primary repair. The repair that is done within 21 days after the injury is the delayed primary repair and the repairs after this time are the secondary repair. Despite the delay in the treatment, it is usually possible to bring the two ends of the tendon together and repair it directly, and is the repair of choice. Severe contamination, loss of soft tissue and patient delay in referring require delayed primary repair or secondary repair. However, even in this case, if the FPL muscle is still alive, according to its excursion of one to two centimeters, direct repair is sometimes possible. Tendon loss, scar formation in the tendon sheath, joint contracture, bone damage and non-viability of the FPL muscle are factors that require other methods of repair.

In general, in cases where less than 2 cm of tendon is lost, the repair can be done directly or with advancement of the remaining tendon. In cases where more than 2 cm of the tendon is missing, a tendon graft or tendon transfer should be used[8]. It is apparent that the success of other repair methods is less than primary and direct repair[16]. In addition, in chronic injuries, the initial repair may be difficult due to the contracture inside the FPL muscle, which limits the excursion. The creation of secondary muscle contracture following the rupture of FPL is much more common than the flexor tendons of other fingers. The FPL tendon that is torn inside its sheath is not held by any lumbrical muscle. It may retract to the proximal palmar carpal ligament[11]. In these cases, alternative surgical methods including free tendon graft or tendon transfer are used[17, 18]. Before proceeding with the secondary repair of the tendon, it is necessary to make sure that the passive movement of the IP joint is satisfactory[12]. In cases of irreparable instability of the IP joint or complete destruction of the joint, tenodesis or arthrodesis is used[11].

In repair with transfer tendon, FDS of the fourth finger is usually used as a donor[8]. This technique provides a viable tendon[19] and the transferred tendon has normal excursion and strength[11] and eliminates the need for surgery on another area of the body to obtain a tendon graft. The disadvantages of this method include the possibility of hyperextension of the PIP joint and a decrease in the flexion strength of the fourth finger[19]. In addition, it is difficult to achieve proper tension in this method[8].

Tendon grafting is done in one or two steps[20, 21]. If the fibro-osseous system has a slight destruction, it is done in one-step, and if the fibro-osseous system is completely destroyed, it is done in two steps and with Hunter insertion[8]. In this method, palmaris longus (PL) tendon[22, 23] or plantaris or extensor of toes is usually used as graft. The removal of the PL tendon or extensor tendon of the leg does not cause any specific functional disorder, and with good control, the desired tension can be created. The drawback of this method is making a surgical incision in another part of the body[12].

Many different methods have been reported to evaluate the results of tendon repair. In 1976, the American Association of the Hand Surgery introduced the amount of active flexion of the IP

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and MP joints of the finger as a measure to evaluate flexor tendon repair[24]. Strickland introduced a simpler method and stated that due to the fact that the MP joint is not only under the control of the flexor tendon, measuring the active flexion of the IP joint is sufficient[25].

All patients with FPL tendon injury who are unable to undergo primary and end-to-end tendon repair and need delayed FPL tendon repair should be treated with one of these two methods. Specific contraindications for these two methods are not mentioned in the literature. There are controversies about the effectiveness and side effects of these two methods and different results have been obtained in different articles. In such a way that the superiority of one method over another is not clearly stated. In addition, most of the articles are the results of researches that have been done in the distant past, and in the search for articles, similar researches were not found in recent years.

We aimed to compare these two methods and determine the more efficient method in FPL repair.

MATERIALS AND METHODS

Patients with FPL injury who were referred to Hazrat Fatemeh Hospital late in 2020 to 2021 and it was possible that primary repair was not possible for them were included in the study. Patients were discussed about the two available treatment methods in case of not being able to repair the tendon end to end, and informed consent was obtained from them. Then the patients underwent surgery and if primary tendon repair was not possible, if the pulley system of the tendon path was intact, they were included in the study and randomly underwent repair with tendon transfer from FDS of the fourth finger or tendon graft from PL or plantaris tendon. The tendons were repaired by Pulvertaft suture. After that, during weekly visits, patients were evaluated for acute complications such as infection, necrosis, etc. After the appropriate time (usually four weeks), the splint was opened and physiotherapy was performed for the patients, which continued with passive and then active movements. After that, at least four months after the repair, the range of motion of the IP and MP joints of the patients was measured using goniometry and compared in two groups.

Blinding the surgeon and the patient was not possible, but the staff who measured the range of motion of the joint did not know the surgical procedure performed for the patient.

Inclusion criteria:

- All patients with FPL tendon injury in which primary tendon repair was not possible.

Exclusion criteria:

- Patients in whom primary repair of tendon was possible.
- Patients who needed pulley reconstruction and Hunter insertion due to the tendon bed damage.
- Patients who had severe destruction or untreatable stiffness of thumb joints.
- Patients who themselves preferred a certain surgical method.

Sampling was done in a simple random manner and according to the facilities of the research team and the time limit, 10 samples were taken for the tendon graft group and 10 samples were taken for the tendon transfer group in this research and the design is considered as a pilot study.

The study data were analyzed using SPSS version 25 software (IBM Corp., Armonk, NY, USA). In the descriptive analysis, qualitative variables were reported by frequency and ratio (percentage), and quantitative variables were reported as mean and standard deviation. In the analytical analysis, in the comparison of the quantitative variables in the two groups, after checking the normality, they were checked by *t*-test, and Pearson's correlation test was used to check the relationship between the variables. A significant level of 0.05 was considered.

Because in cases of delayed FPL tendon treatment, the preference between the two methods was not clearly stated, the procedure was explained to the patients and informed consent was obtained from the patients. Patients' information were used without disclosing their identity. No additional fees were charged to the patients, and the patients were free to exit from the study at any stage.

The study has been approved by the Ethics Committee of Iran University of Medical Sciences (Institutional Approval Code: IR.IUMS.FMD.REC.1400.650).

This clinical trial is registered in IRCT with register code of IRCT20211007052691N1.

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RESULTS

Thirty-eight patients with old FPL injury referred to our center. Among them 18 patients were excluded due to not meeting our criteria and 10 patients were treated with tendon graft and 10 patients with tendon transfer. The age of tendon graft group was from 19 to 52 years with average of 31.1 years and in tendon transfer, it was from 26 to 61 with average of 36.8 years.

Table 1: ROM of IP joint in patients

Group	Range of Motion	Frequency	Frequency percentage	Cumulative frequency percentage
Tendon graft	10	2	20.0	20.0
	15	1	10.0	30.0
	20	1	10.0	40.0
	45	1	10.0	50.0
	50	3	30.0	80.0
	80	1	10.0	90.0
	90	1	10.0	100.0
	total	10	100.0	
Tendon transfer	5	1	10.0	10.0
	10	1	10.0	20.0
	15	2	20.0	40.0
	40	1	10.0	50.0
	45	1	10.0	60.0
	70	1	10.0	70.0
	75	1	10.0	80.0
	80	2	20.0	100.0
	total	10	100.0	

Table 2: ROM of MP joint in patients

Group	Range of Motion	Frequency	Frequency percentage	Cumulative frequency percentage
Tendon graft	0	1	10.0	10.0
	10	1	10.0	20.0
	15	1	10.0	30.0
	30	1	10.0	40.0
	40	2	20.0	60.0
	45	1	10.0	70.0
	50	1	10.0	80.0
	70	1	10.0	90.0
	80	1	10.0	100.0
	Total	10	100.0	
Tendon transfer	30	2	20.0	20.0
	40	2	20.0	40.0
	45	1	10.0	50.0
	50	2	20.0	70.0
	60	1	10.0	80.0
	70	1	10.0	90.0
	80	1	10.0	100.0
	Total	10	100.0	

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Table 3: Descriptive statistics of IP movement in two groups

	Group	Frequency	Mean	Standard deviation	Mean deviation
IP movement	Tendon graft	10	42.00	28.304	8.950
	Tendon transfer	10	43.50	30.917	9.777

Table 4: Descriptive statistics of MP movement in two groups

	Group	Frequency	Mean	Standard deviation	Mean deviation
MP movement	Tendon graft	10	38.00	25.408	8.035
	Tendon transfer	10	49.50	16.406	5.188

The left hand of 6 patients, as well as the right hand of 4 patients of each groups were injured.

Table 1 shows the IP joint ROM in the two groups. The average IP movement of patients in tendon transfer group (43.5 degree) was not significantly different from the tendon graft group (42 degree).

Table 2 shows MP joint ROM in the two groups. The average movement of MP joint of patients in tendon transfer group (49.5 degree) was higher than the average movement of MP in tendon graft group (38 degree).

The significance level of the Kolmogorov-Smirnov test for the two variables of IP movement and MP movement was greater than 0.05, and parametric tests can be used for comparison.

Table 3 and 4 shows the number, mean, standard deviation and deviation from the mean of IP and MP movement of patients in two groups of tendon grafting and tendon transfer.

Using *t*-test showed that in the delayed repair of FPL with tendon graft, the range of motion of thumb IP and MP joint had no significant difference compared to repair with tendon transfer.

DISCUSSION

As mentioned above, there are controversies about the effectiveness and side effects of these two methods (tendon graft and tendon transfer) and different results have been obtained in different articles. Posner treated 23 patients with FPL injuries with FDS tendon transfer of the fourth finger. Eighteen patients were treated in one stage and five patients were treated in two stages (with Hunter insertion). He observed that only four patients had problems with full extension of the IP joint, and the rest of the patients had sufficient joint movement, and concluded that tendon transfer is considered as a suitable alternative to tendon grafting[11].

Lawrence Schneider and Wiltshire, in their 10-year study published in 1983, used one- or two-stage tendon grafts in 21 patients to repair FPL injuries that failed to repair primarily and in 14 patients; they used FDS transfer of the fourth finger. They observed that in 12 out of 14 patients, who were treated with tendon transfer, the thumb functioned well and only in two patients, the result was not favorable[19].

On the opposite side, Ebelin and his colleagues compared different FPL repair methods in a study they conducted between 1970 and 1982 at the Boucicaut Hospital in Paris on 43 patients. The patients were examined between four months and ten years after the operation. However, most of the patients were examined within six months after the operation. Seven patients were treated with one- or two-stage tendon graft with the palmaris longus tendon or toe extensor, eleven patients were treated with FDS tendon transfer of the fourth finger, and other patients were treated with other methods such as tenolysis, tenodesis, and tendon re-suture. At the end, they concluded that in cases where primary repair with tendon advancement is not possible, two-stage tendon graft is preferable to other techniques[10].

In our study, among the patients with FPL tendon injury whom needed secondary tendon repair, 10 patients were treated with tendon transfer and 10

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patients with tendon grafting. There were 7 men and 3 women in the tendon graft group, and 9 men and 1 woman in the tendon transfer group. The higher number of male patients in this study was justifiable and expected because most of these injuries are caused by accidents at work and due to physical conflicts. The average age of patients in the tendon transfer repair group (36.8) was higher than the average age of patients in the tendon graft repair group (31.1). The left hand of 6 of the patients in each group and the right hand of 4 of the patients in these groups were injured.

The results of the data analysis in this study showed that in the secondary repair of FPL with tendon graft, the range of motion of both IP and MP joints of the thumb is not significantly different compared to repair with tendon transfer. This actually confirms the controversies in this field.

Considering the time limit of this research, in order to obtain more accurate results, it is suggested to conduct a research with a larger number of patients and in the form of a long-term study with strict control over the surgical technique and post-operative care.

Both tendon transfer and tendon grafting involve morbidity from donor tendon harvesting. It is suggested additional research should be done by taking into account the complications caused by donor tendon removal and checking the overall satisfaction level of patients.

In addition, considering the lack of articles and researches in recent years, this topic seems to be a suitable field for various researches.

CONCLUSION

In the secondary repair of FPL with tendon graft, the range of motion of both IP and MP joints of the thumb is not significantly different compared to repair with tendon transfer. This actually confirms the controversies in this field.

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CONFLICT OF INTEREST

The authors declare no conflicting interests.

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