

# Short-Term and Long-Term Therapeutic Results of Deep Flexor Tendon Repair in Zone II in Patients Referred to Imam Khomeini Hospital, Ahvaz, Southern Iran

Payam Mohammadhoseini<sup>1\*</sup>, Seyed Mohammad Mohammadi<sup>1</sup>, Narjes Mousavi Nia<sup>1</sup>

1. Department of Orthopedics, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

## ABSTRACT

**Background:** Hand injury as an important concern for the surgeon and the patient requires proper and timely treatment to prevent complications such as infection and adhesions, and with a proper rehabilitation program, the patient returns to maximum function as soon as possible. We aimed to investigate the short-term and long-term treatment results of deep flexor tendon repair in in zone II.

**Methods:** This retrospective study was performed on 34 patients with 45 injured fingers in the zone II referred to Ahvaz Imam Khomeini Hospital, Ahvaz, Iran during 2017-2019. The results of deep flexor tendons repair in two groups, immediate and delayed primary repair were assessed.

**Results:** The mean age of the patients was 27.76 years. There was no significant remarkable between male and female in the incidence of complications such as infection, tendon rupture and adhesions. 29.4% (n=10) had poor outcome, 8.8% (n=3) had fair outcome, 29.4% (n=10) had good outcome and 32.4% (n=11) had excellent outcomes. 26.5% had adhesion and infection rate was 11.8%.

**Conclusion:** Among surgeons, there is consensus for the primary repair of tendon injury, but there was no significant difference between the results of immediate and delayed primary repair. Although physiotherapy has been suggested as an effective factor in improving hand function, its positive effect on the range of motion of the fingers has not been proven.

## KEYWORDS

Hand Injury; Surgery; Tendon repair; Zone II flexor tendon

## Please cite this paper as:

Mohammadhoseini P, Mohammadi SM, Mousavi Nia N. Short-Term and Long-Term Therapeutic Results of Deep Flexor Tendon Repair in Zone II in Patients Referred to Imam Khomeini Hospital, Ahvaz, Southern Iran. *World J Plast Surg.* 2024;13(1):82-86.  
doi: 10.61186/wjps.13.1.82

## \*Corresponding Author:

Dr. Payam Mohammadhoseini

Department of Orthopedics,  
School of Medicine, Ahvaz  
Jundishapur University of Medical  
Sciences, Ahvaz, Iran

Email: [p13601467@gmail.com](mailto:p13601467@gmail.com)

Received: 12/22/2023

Accepted: 9/3/2024

## INTRODUCTION

Hand needs the correct confrontation of the flexor and extensor tendons for its proper functioning. It is divided into 5 anatomical regions. Tendon injury can occur in all 5 areas, but its complications are more serious and risky in zone II<sup>1-4</sup>.

Flexor tendon rupture is a common injury in hand trauma, most commonly seen in men in the 2nd and 3rd decades, and its prevalence

in industrialized countries is approximately 1 in 7,000. About 20 to 30% of all acute flexor tendon injuries occur in zone II<sup>5,6</sup>.

Symptoms of a person with flexor tendon injury include inability to flex the fingers, pain in active flexion and localized swelling<sup>7</sup>. Both superficial and deep flexor tendons of hand should be examined separately. When examining the superficial flexor tendons, the other fingers should be held so that interphalangeal joints are extended and patient flexes the corresponding proximal interphalangeal joint. On the other hand, if the proximal interphalangeal joint is extended and patient can flex distal interphalangeal joint, the deep flexor tendon is intact<sup>8,9</sup>.

Like all other hand injuries, age, sex, mechanism and nature of the injury are all important factors that influence the decision about the time and type of repair. The most important issue in repairing zone II tendon injuries is that non-surgical treatment has no place in this area. The mechanism of injury is crucial in determining the extent of contamination and deciding on pre- and post-surgical cares<sup>10</sup>. The fact that tendon repair in zone II has much poorer results than in other areas has been accepted by all surgeons<sup>11</sup>.

Surgical repair itself disrupts the biology of healing and cause further damage to the area, which can lead to scar formation and adhesions. Adhesion, as the most important complication of tendon repair, reduces tendon sliding and range of motion. Due to very small space and special anatomy of zone II, any scar formation or bulging of the repair site, causes adhesions and increased friction between tendon and the surrounding sheath<sup>12-15</sup>.

The basic principles that are always considered in tendon repair are high strength repair, post op physiotherapy protocol and improvement in healing mechanism with the use of various drugs. All primary repair procedures should be performed with minimal manipulation and the repair should be strong enough to allow early movement after surgery because after surgery, the joints should be immobile and this immobility can cause contracture of joints and exacerbate tendon adhesion if it is prolonged. Returning patient to previous functional level after repairing these injuries is an important orthopedic concern and there is an urgent need for patient's cooperation and awareness. Despite numerous advances in repair methods, the success

rate of treatment is still not entirely satisfactory<sup>10,16</sup>. Despite all the studies on flexor tendon repair, there are still several complications following repair. Complications that can occur shortly after repair include infection, tendon rupture and weak tendon sliding. The prevalence of infection is low and the use of prophylactic antibiotics can be effective in prevention. Tendon rupture with a prevalence of 3 to 9% is the worst complication after surgery because it requires immediate surgical intervention. Causes of rupture are swelling at the site of repair and improper hand use. Active movement of injured finger can be effective in preventing adhesions, but can increase risk of rupture. Delayed complications are adhesions, decreased muscle strength, scar formation and complex regional pain syndrome<sup>17</sup>. We aimed to investigate the short-term and long-term treatment results of deep flexor tendon repair in in zone II.

## MATERIALS AND METHODS

This retrospective study was done on patients referred to Imam Khomeini Hospital in Ahvaz during the beginning of 2017 to the end of 2019. Patients with following conditions could enter the study. The age range should be from 16 to 60 years old. Tendon damage in zone II should be sharp and patients with crushed injury were excluded. Tendon injury should be repaired immediately (24 to 48 hours after injury) or delayed (up to one week after injury), and patients who have repaired more than a week after injury, were excluded. Tendon damage must be repaired immediately or delayed in one-step, and patients who require a graft were excluded. Among 36 cases of flexor digitorum profundus tendon injury in zone II, one person was excluded due to re-repair and one due to age out of range, and finally 34 patients entered the study. Patients were examined by an orthopedist and they completed a Disabilities of the Arm, Shoulder and Hand Score (QUICK DASH). Sessions of Physiotherapy, possible underlying disease and medication were asked. Patients were divided into two groups of immediate and delayed primary repair. In immediate repair, repair is done no later than 24 to 48 hours after the injury. In delayed repair, after 48 hours from the time of injury to a maximum of one week after injury, repair is done.

The Ethical Committee of Ahvaz Jundishapur

University of Medical Sciences has approved this study (Ethics number: IR.AJUMS.HGOLESTAN.REC.1399.29).

**Statistical analysis**

Statistical analysis was done by SPSS software version 26 (IBM Corp., Armonk, NY, USA). Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test for the normality of data. Central and descriptive statistics were reported for quantitative. Analytical analyzes were performed using t-test or Mann-Whitney U test and chi square tests. P value<0.05 was considered statistically significant.

**RESULTS**

This retrospective study was performed on 34 patients referred to Imam Khomeini Hospital in Ahvaz between 2017 and 2019. All of them had a sharp ruptured tendon of the deep flexor muscle in zone II, repaired in one-step. A total of 45 injured fingers were examined. The mean age of patients was 27.76± 9.54 yr, of which 27 (79.4%) were male and 7 (20.6) were female. Nine (26.5%) were smokers and the rest were non-smokers. 15 patients (44.1%) had dominant hand injuries and 19 (55.9%) patients had non-dominant hand injuries. Based on the time of primary repair, 15 (44.1%) were immediate and 19 (55.9%) were delayed. After surgery, 4 patients (11.8%) had infection at the operation site and 30 patients (88.2%) had no infection. patients were asked about the number of physiotherapy sessions in which 50% had less than 10 sessions and 50% had 10 or more sessions. After orthopedic examination, 9 cases with adhesions (26.5%) were detected. Tendon rupture was in 3 cases (8.8%). The range of motion of the fingers was assessed based on the Strickland grading system: 10 (29.4%) were poor,

3 (8.8%) were fair, 10 (29.4%) were good and 11 (32.4%) were excellent. The rate of disability was calculated based on DASH score. The mean DASH score in immediate primary repair group was 17.88 ± 21.88% and in delayed primary repair group was 14.58 ± 17.55%. **Table 1** shows the comparison of treatment results between delayed and immediate repair groups.

**DISCUSSION**

Flexor tendon injuries are one of the most common hand injuries, especially in young men and at work, and are always a serious problem for hand surgeons. Treating this injury in zone II is far more serious and risky, and unacceptable results are more likely to occur<sup>13</sup>. The therapeutic results of flexor tendon repair are evaluated based on 3 important factors: the amount of active joint movement, the amount of rupture at repair site, the severity of defect caused by flexing and extending the fingers. Functional evaluation should be done after the rehabilitation is complete, and this may be delayed even up to 1 year after surgery<sup>16</sup>.

In a study, performed on 23 patients, the infection rate was 16% (3 patients)<sup>18</sup>, while in another study on 65 patients, the rate of infection was reported 9%<sup>19</sup>. The infection rate in this study was 11.8%.

Out of 15 patients with immediate primary repair, 20% and out of 19 patients of delayed primary repair, 5.3% (1 case) became infected, that was not statistically significant.

In a study conducted by Rigo et al. on 322 flexor tendons, smoking was mentioned as a negative predictor of tendon repair<sup>20</sup>. Previous studies have examined the effect of smoking on infection, slowing the healing process, and rupturing a repaired tendon, but this effect has never been proven<sup>20,21</sup>. In this study, 2 smokers (22.2%) and non-smokers

**Table 1:** Comparison of treatment results between delayed and immediate repair groups

Time of repair	Infection rate	Adhesion rate	Tendon tearing	Range of motion		DASH score
				Fair+poor	Good+excellent	
<b>Immediate</b> N=15	N=3 20%	N=3 20%	N=2 13.3%	N=4 30.8%	N=11 52.4%	Mean=17.573 SD=21.883
<b>Delayed</b> N=19	N=1 5.3%	N=6 31.6%	N=1 5.3%	N=9 69.2%	N=10 47.6%	Mean=14.589 SD=17.551
<b>P value</b>	0.299	0.697	0.571	0.217		0.806

N=number, SD: Standard deviation.

(8%) became infected, which was not statistically significant ( $P = 0.281$ ). Cigarettes on adhesion were also examined, in which 3 smokers (33.3%) and 6 non-smokers (24%) had adhesions, which was not statistically significant.

In a retrospective study of 149 patients with 194 fingers with a mean age of  $33.3 \pm 12.9$ , Siwan et al. reported an adhesion rate of 14.43% and no significant relationship was found between adhesion with the number of injured fingers and the sex of the patients<sup>22</sup>.

In the current study, the adhesion rate was 26.5% and no significant relationship was found between adhesion and patients' sex, which is in line with the Civan study<sup>22</sup>. The degree of adhesion was not significantly related to the time of repair. The main goal in repairing injured tendons is to obtain the maximum ability of patient to use hand to perform daily activities<sup>23</sup>.

In Tabriz, Iran, the range of motion was assessed by Strickland classification, and the results were as follows: 78.3% excellent, 10% good, 5% moderate and 6.7% bad, and there was no significant difference between the results in men and women and in immediate and delayed primary repair<sup>24</sup>. The range of motion was excellent and good in 71% of subjects, moderate in 34%, and bad in 15% of individuals<sup>25</sup>.

In the present study, there was no significant difference in range of motion between men and women. Range of motion between two methods of immediate and delayed primary repair were not significant, which is similar to the study of Navali et al.<sup>26</sup>. The rate of tendon rupture after repair was 6% in the study of Spark et al<sup>27</sup>.

In this study, the rate of rupture was 8.8%. In the study of Spark et al., the degree of disability after tendon repair surgery in zone II was evaluated and the mean DASH score was  $24.24 \pm 30.56\%$ <sup>18</sup>.

In this study, the mean DASH score was  $19.32 \pm 15.9\%$ . The mean DASH score was 17.57% in patients with immediate repair and 14.58% in the delayed group, but no significant difference was observed. According to statistical results, immediate or delayed primary repair has no effect on hand complications. In general, the results did not differ between men and women. In previous studies<sup>20,28</sup>, the effect of immediate primary repair, smoking, infection and physiotherapy on adhesion formation as an important complication in the injury of zone II were investigated. In this study, the effect of these

factors on forming adhesion was not proven, but the small number of people in the study can cause these results.

Patients' proper follow up plays an important role in results especially the effect of physiotherapy on range of motion and adhesion. The mean age of the subjects in this study was 27.76 years. Due to the age of the patients and the absence of underlying disease, it was not possible to evaluate the effect of drugs and various diseases in this study, but according to previous studies, it seems that these factors can be influential in the results.

In this study, a questionnaire was used to assess the degree of disability after tendon repair, but it is possible that in all patients, the questionnaire was not filled with the same amount of accuracy, which can change the results.

## CONCLUSION

Among surgeons, there is consensus for the primary repair of tendon injury, but there was no significant difference between the results of immediate and delayed primary repair. Although physiotherapy has been suggested as an effective factor in improving hand function, its positive effect on the range of motion of the fingers has not been proven. For better results in future studies, it is recommended to increase the sample size and follow patients closely, and the best way to achieve this, is to use a clinical trial instead of retrospective studies.

## FUNDING

This research was supported by grant number U-99114 from Ahvaz Jundishapur University of Medical Sciences.

## CONFLICT OF INTERESTS

There is no conflict of interests.

## REFERENCES

1. Rrecaj S, Martinaj M, Murtezani A, Ibrahim-Kaçuri D, Haxhiu B, Zatriqi V. Physical therapy and splinting after flexor tendon repair in zone II. *Med Arch* 2014;**68**(2):128-31. doi: 10.5455/medarh.2014.68.128-131.
2. Elhassan B, Moran SL, Bravo C, Amadio P. Factors that influence the outcome of zone I and zone II flexor

- tendon repairs in children. *J Hand Surg Am* 2006 Dec;**31**(10):1661-6. doi: 10.1016/j.jhsa.2006.09.003.
3. 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 Dec;**37**(12):2532-40. doi: 10.1016/j.jhsa.2012.09.021.
  4. Rosskopf AB, Taljanovic MS, Sconfienza LM, Gitto S, Martinoli C, Picasso R, Klauser A. Pulley, Flexor, and Extensor Tendon Injuries of the Hand. *Semin Musculoskelet Radiol* 2021 Apr;**25**(2):203-215. doi: 10.1055/s-0041-1727196.
  5. Akbari H, Rahimi AA, Ghavami Y, Mousavi SJ, Fatemi MJ. Effect of Heparin on Post-Operative Adhesion in Flexor Tendon Surgery of the Hand. *J Hand Microsurg* 2015 Dec;**7**(2):244-9. doi: 10.1007/s12593-015-0192-4.
  6. Dickson K, Mantelakis A, Reed AJM, Izadi D, Wade RG, Wormald J, Furniss D. The management of partial extensor tendon lacerations of the hand and forearm: A systematic review. *J Plast Reconstr Aesthet Surg* 2023 Oct;**85**:34-43. doi: 10.1016/j.bjps.2023.06.004.
  7. 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. doi: 10.2174/1874325001206010028.
  8. Lalonde DH, Martin AL. Wide-awake flexor tendon repair and early tendon mobilization in zones 1 and 2. *Hand Clin* 2013 May;**29**(2):207-13. doi: 10.1016/j.hcl.2013.02.009.
  9. Tang JB, Lalonde D, Harhaus L, Sadek AF, Moriya K, Pan ZJ. Flexor tendon repair: recent changes and current methods. *J Hand Surg Eur Vol* 2022 Jan;**47**(1):31-39. doi: 10.1177/17531934211053757.
  10. Ozturk MB, Basat SO, Kayadibi T, Karahangil M, Akan IM. Atraumatic Flexor tendon retrieval- a simple method. *Ann Surg Innov Res* 2013 Sep **16**;7(1):11. doi: 10.1186/1750-1164-7-11.
  11. Tang JB. Flexor Tendon Injuries. *Clin Plast Surg* 2019 Jul;**46**(3):295-306. doi: 10.1016/j.cps.2019.02.003.
  12. Dowd MB, Figus A, Harris SB, Southgate CM, Foster AJ, Elliot D. The results of immediate re-repair of zone 1 and 2 primary flexor tendon repairs which rupture. *J Hand Surg Br* 2006 Oct;**31**(5):507-13. doi: 10.1016/j.jhsb.2006.06.006.
  13. Venkatramani H, Varadharajan V, Bhardwaj P, Vallurupalli A, Sabapathy SR. Flexor tendon injuries. *J Clin Orthop Trauma* 2019 Sep-Oct;**10**(5):853-861. doi: 10.1016/j.jcot.2019.08.005.
  14. Rouhani A, Tabrizi A, Ghavidel E. Effects of non-steroidal anti-inflammatory drugs on flexor tendon rehabilitation after repair. *Arch Bone Jt Surg* 2013 Sep;**1**(1):28-30.
  15. Chauhan A, Palmer BA, Merrell GA. Flexor tendon repairs: techniques, eponyms, and evidence. *J Hand Surg Am* 2014 Sep;**39**(9):1846-53. doi: 10.1016/j.jhsa.2014.06.025.
  16. Dy CJ, Hernandez-Soria A, Ma Y, Roberts TR, Daluiski A. Complications after flexor tendon repair: a systematic review and meta-analysis. *J Hand Surg Am* 2012 Mar;**37**(3):543-551.e1. doi: 10.1016/j.jhsa.2011.11.006.
  17. Ishak A, Rajangam A, Khajuria A. The evidence-base for the management of flexor tendon injuries of the hand: Review. *Ann Med Surg (Lond)* 2019 Oct **15**;48:1-6. doi: 10.1016/j.amsu.2019.10.006.
  18. 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 Rehabil* 2019 Nov **22**;65(4):318-326. doi: 10.5606/tftrd.2019.2137.
  19. Spark T. The impairments and functional outcomes of patients post flexor tendon repair of the hand. *Hand 11*(1 Suppl) 2016 Sep; **11** (2):141-146. doi:1.1177/1558944716660555jv.
  20. Rigo IZ, Røkkum M. Predictors of outcome after primary flexor tendon repair in zone 1, 2 and 3. *J Hand Surg Eur* 2016 Oct;**41**(8):793-801. doi: 10.1177/1753193416657758
  21. Hurley CM, Reilly F, Callaghan S, Baig MN. Negative Predictors of Outcomes of Flexor Tendon Repairs. *Cureus* 2019 Mar **23**;11(3):e4303. doi: 10.7759/cureus.4303.
  22. Civan O, Gürsoy MK, Cavit A, Özcanlı H, Karalezli MN. Tenolysis rate after zone 2 flexor tendon repairs. *Jt Dis Relat Surg* 2020;**31**(2):281-285. doi: 10.5606/ehc.2020.71752.
  23. Deniz E, Ayse K, Sehim K, Mehmet D, Aysun S, Süreyya E. Postoperative management of flexor tendon repair in zone 2. *J Phys Ther Sci* 2000;**12**(1):63-6. DOI:10.5812/traumamon.85800
  24. Kannan N. Prognostic indicators affecting functional outcome in Zone II flexor tendon repairs. *Int Surg J* 2018 Oct. **5**(11):361-368. doi: 10.18203/2349-2902.isj20184632.
  25. Vögelin E. IFSSH Scientific committee on flexor tendon repair. *Ezine IFSSH* 2015;**5**(4):21-34.
  26. Navali AM, Rouhani A. Zone 2 flexor tendon repair in young children: a comparative study of four-strand versus two-strand repair. *J Hand Surg Eur Vol* 2008 Aug;**33**(4):424-9. doi: 10.1177/1753193408090761.
  27. 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 Rehabil* 2019 Nov **22**;65(4):318-326. doi: 10.5606/tftrd.2019.2137.
  28. Dy CJ, Hernandez-Soria A, Ma Y, Roberts TR, Daluiski A. Complications after flexor tendon repair: a systematic review and meta-analysis. *J Hand Surg Am* 2012 Mar;**37**(3):543-551.e1. doi: 10.1016/j.jhsa.2011.11.006.