Asian J. Exp. Sci., Vol. 31, No. 1, 2017; 45-51

Online available on : www.ajesjournal.com, ISSSN : 0971-5444

Outcomes and Complications of Primary Repair of Extensor Tendons of Hand Injury in Emergency Department: Repair of 269 Tendons in Zone VI

[1]Seyed Mohammad Hosseini Kasnavieh[1], Seyed Hossein Shaker[1], Nader Tavakoli[2], [2]Mohammad Reza Yasinzadeh[1], Gholamreza Masoumi[1], Mohsen Abbasi[1], Simin Najafgholian[3]

[3]Department of Emergency medicine, Emergency Management Research Center, Iran University of Medical Sciences, Tehran, Iran[1]

[4]Department of Emergency Medicine, Emergency Medicine Management Research Center, Tehran University of Medical Sciences, Tehran, Iran[2]

Emergency Medicine, University of Medical Sciences, Tehran, Iran[3]

Email: d_snaj@hotmail.com

Abstract : Introduction: The surface position of the extensor tendons make them susceptible to damage and tear. Repair failure, infection, adhesions and tendon shortening are of the main problems of tendon repair. The aim of this study was to evaluate the results of primary repair of hand extensors tendons.

Methods: This cross-sectional study was done in patients that admitted for tendons repair in Sina hospital at April 2011 to September 2013. Inclusion criteria: age over 18 years, traumatic laceration, injured tendons in Zone VI and absence of severe damage in other organs. We followed patients for complication and outcome after surgery one week, one month and six month later after repair. Improving the performance of the repaired tendons was evaluated according to Miller Scale.

Results: 269 tendons in 163 patients (140 male, 23 female) were repaired. We use of Kessler method for repair all of tendons. Mean age of patients was 28.18 ± 11.29 years. The most common cause of tendon damage was workplace accident (31.3%) then cutting with knife, cutting with glass and traffic accidents were ranked next. According to Miller scale, the greatest measure of outcome relevant to the "good" group in one week, one month and 6 month follow up after repair.

Conclusion: The study findings showed that the tendon can be repaired as first-line therapy in the emergency department to acceleration for the next treatment. The treatment with regarding few complications and good outcomes for patients can be performed by an emergency medicine specialist.

Keywords -Tendon repair, hand extensor tendon, Miller Scale, modified Kessler.

Introduction

Tendons transmit forces from muscle to bone and provide the joint function (Sharma & Maffuli, 2005 & Khanna *et al.,* 2009). The hand cut cases are significant a significant proportion of patients admitted to the medical centers from emergency room. The patients when brought to emergency ward with primary repair of extensor tendons of hand, it is the prime function to evaluate the damage due to cut tendons. Saini *et al*., (2008) studied 26 cases of cut of extensor tendons injuries in Zone V to VIII according to the criteria of Dargan for six weeks and one year. The cut was due to agriculture instruments. The common site for injury was extensor zone VI (42%, n = 11). Majority of these patients, in addition to skin damages there was cut in nerves and tendons too. The injury of nerves and damage to tendon is because the skin of the posterior surface of the hand and forearm is thinner with little tissue (Green, 1998; Rockwell *et al*., 2000). Surface position of the extensor tendons of hand makes is prone to injury in the form of tear of the tendon at this area. The injury of these tendons appears as wounds as injury was caused by sharp objects such as glass or knives at their working place. The injury often cause fractures of the wrist, closed tear and rupture, which may be associated with complications such as decreased movement of fingers, adhesion and deformity of fingers (Newport and Tucher, 2005).

Explored zones in the back of the hand are divided into 8 different zones. The importance of this division is in terms of the occurrence of injuries and further complications to spread complications in other zones. Tendon injury in zones I and III can raise due to laceration with sharp objects and cause cut off the tendons and deformities such as *Boutonnière* or *Mallet*.

On the other hand, injury to zones II and IV may not completely cut off the tendon due its special anatomical position of tendon. If the laceration at these two zones has been simple and is the cause of injury, less than 50% patients are able to carry out full extension, conservative treatment is best (Newport, 1997, Matzon and Bozentka, 2010). Injury at zone V is usually caused by punching and the patient should be treated with antibiotics before repairing a tendon injury. Diagnosis of tendon injury in zone V requires careful examination. Yet, better medical treatments are obtained in repairing tendon injuries at these

zones compared to zones I-IV (Newport *et al*., 1995). Injury in zones VI and VII is caused by trauma of sharp objects, crush and severe abrasions. In most cases, injuries at this zone are along with other injuries in other organs such as skin and bone. Yet, no disturbance might cause in a single tendon injury at the extension. Tendon ruptures if in zone VII can cause special problems because tendon at this zone has synovial sheath (Chow *et al.,* 1985). Identifying the injured tendon is difficult on putting together the two edges of the cut tendon in zone VIII, especially if the injury is caused at muscle tendon junction. After repairing, the dynamic splint or static immobilization is used for immobilization in such a way that the wrist is in 45 ° of extension and metacarpophalangeal joint is in 20 ° flexion will have least pressure on the junction of the tendon to the muscle (Brzezienski and Schneider, 1995). Timely diagnosis and treatment of these lesions can be very influential in the final outcome, so that by the faster surgery on extensor tendons of hand injury, repair of tendon will be better and faster and after-repair complications such as fracture in healing, infection, tendon adhesions and shortening which are the main problems in repair of tendons will be less and result of surgery and after-surgery performance will be better (Minamikawa, et al., 1992; Mehdi and Sarafan, 2008).

On the other hand, most of these lesions occur in the workers and those who have not suitable conditions in terms of economic status, to whom fast return to work in addition to significance of reduction in medical cost is of great importance (Patillo and Rayan, 2012). To repair the tendons, four common methods are used to suture the tendon: a modified Kessler, modified Bunnell, matrix and Vestibular test. All of these methods in zone V due to adhesion shorten the tendons about 6 mm in length. Using these methods at zones I-IV causes less shortening and gains better result (Newport *et al*., 1995).

However gapping caused at the zone of tendon repair can cause Extensor Lag, the greatest and most serious complication was observed after repair of extensor tendons of hand injury by the Loss of flexion. This would be due to adhesion or shortening caused at the repair zone. Shortening of the tendon is caused more in the proximal portion of zone V (Saini, *et al.,* 2008). Results from repair of extensor tendons of hand are based on Miller classification including the loss of active extension (degrees) and the lack of flexion (degrees). Based on the degree of caused deformity, the patient will be in a group of excellent, good, unfavorable or poor (Miller, 1942) (Table - 1).

Primary repair of injured tendons can be more economical in terms of cost and can have better results in terms of return of performance. The injury caused in this zone and disability caused by dysfunction in the performance of hand followed by rupture in the extensor tendons of hand could have a huge impact on individual and social life of the community.

Study and a closer look at the age prevalence and the causes of tendon injuries in hand as well as the consequences of it seem to be necessary. This study was conducted aimed to evaluate the results of the initial repair of extensor tendons of hand in Zone IV by specialists in emergency medicine and emergency department.

Research method

Study was conducted via intervention method. Participants were selected among the patients admitted to Sina Hospital emergency in Tehran during the 18 months (April 2015 to September 2016). Inclusion criteria include:

Injury in zone IV of hand and the extensor surface, a traumatic origin, the lack of serious injury in other organs and a stable hemodynamic status. Patients were excluded from study if they do not wish to participate in the study and refer for follow-up treatment. The information given in the study included age, sex, injured hand, the number of torn tendons, mechanism of injury, the affected zone of hand, result of tendon repair and treatment complications. The information above was based on medical history, physical examination, observation and follow-up. Sampling was performed in a convenient and accessible way and all patients who met the inclusion criteria were selected.

Explored injured zone and exact tendon zone and number of injured tendons were specified via sterile equipment in the patients admitted to the emergency in outpatient surgery room. Further, associated injury including injury of soft tissue, nerve and artery was also examined. If there were evidences on tendon rupture in examinations, under patient's stable vital signs, an action had been made to repair injured tendons using Kessler method which was conducted under complete local anesthesia and immobilization. Patients were treated and followed up one week, one month and six months after the repair. In the follow up period, the patients were evaluated in terms of repair zone and movements of examined hand and performance of repaired tendon based on Miller's classification. To minimize the missing samples, it is explained to following up patients and also to their relatives to promote patients for checkups frequent visits.

Frequency and frequency percent were used to describe the qualitative data and mean and standard deviation were used to express quantitative data.

Further, to analyze difference on different qualitative and quantitative groups, Chi-Square test and Student T-Test were used at 95% confidence level. P value was considered less than 0.05.

Results/Observations

A total of 163 patients included in the study out of which 269 were of injured extensor tendons were repaired using a modified Kessler. All patients had clinically stable condition. 140 male patients (85.9%) and 23 female patients (14.1%) participated in the study. The average age

of patients participated in the study was 28.18 ± 11.29 years old (3-65 years). Most patients (38.7%) were in the age group 20-30 years. Characteristics of patients and the caused injury have been expressed in Table-1. The result of treatment after tendon repair was reviewed and evaluated one week, one month and six months based on Miller's classification. In all three cases, the most number related to group was good (table-2). Further, in table-3, the complications caused at various follow-up times have been displayed. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and injury to them at the first week after repair is given in table-4. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and injury to them in first month after repair is mentioned in table-5. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and injury to them at sixth month after repair table-6.

Table-1. Frequency and relative frequency distribution of patients' characteristics and injury to them

Patients' characteristics and injury to them		Numbers	%
Age groups	Under 20 years old	36	22.1
	20-30 years old	63	38.7
	30-40 years old	37	22.7
	40-50 years old	15	9.2
	50-60 years old	9	5.5
	Above 60 years old	3	1.8
	Sum	**163**	**100**
Injured hand	Right	112	68.7
	Left	50	30.7
	Both	1	0.6
	Sum	**163**	**100**
No. of injured tendons	1 case	79	48.5
	2 cases	67	41.1
	3 cases	12	7.4
	4 cases	5	4.1
	Sum	**163**	**100**
Trauma mechanism	Cut with a knife	34	20.9
	Cut with a glass	41	25.2
	Traffic accidents	30	18.4
	Workplace accidents	51	31.3
	Beat	7	4.3
	Sum	**163**	**100**
Injured zones	I	0	0
	II	0	0
	III	0	0
	IV	0	0
	V	0	0
	VI	163	100
	VII	0	0
	VIII	0	0
	Sum	**163**	**100**

Table-2. Relative frequency and frequency distribution of complications caused after repair of tendon one week, one month and six months after repair.

Repair complications		Numbers	%
One week after repair	Infection	10	1.8
	Break of repair	1	1.2
	secretion	9	3.1
	Sum	**20**	**100**
One month after repair	Fracture	2	20
	Chronic pain	5	50
	Sum	**10**	**100**
Six month after repair	Chronic pain	4	20
	Sum	**5**	**100**

Table- 3. Frequency distribution of therapeutic outcome after repair of tendon for one week, one month and six months after repair based on Miller's classification.

Therapeutic outcome	Outcome	Numbers	%
One week after repair	Excellent	34	20.9
	Good	108	66.3
	Unfavorable	17	10.4
	Poor	4	2.5
	Sum	**163**	**100**
One month after repair	Excellent	36	22.1
	Good	107	65.6
	Unfavorable	20	12.3
	Poor	0	0
	Sum	**163**	**100**
Six month after repair	Excellent	38	23.3
	Good	105	4
	Unfavorable	20	64
	Poor	0	0
	Sum	**163**	**100**

Discussion

Single injuries in Extensor tendons of hand are caused by sharp objects. In cases where the injuries caused by crushing, extensive and severe rupture of organs, in addition to the tendon injury, it is presumed that injury will have effect in other tissues of the body. Usually the single tendon injury of hand especially in zone VI due to the continuity of extensor Digitorum tendon have not a large strain on the metacarpophalangeal (Miller, 1942). Tendon injuries at zone VII due to exposure to the synovial sheath are associated with particular complexities, because adhesion might cause after repair. Tendon in this zone has a more spherical state and it should be repaired with greater precision so that the central zone suture is made associated with epithelial suture (Evans and Burkhalter, 1986). In zones VI and VII, extension of extensor tendons is more than anywhere else, so patient should be provided with dynamic splinting which will provide more power and eventually prevent rupture of repaired tendon. Dynamic splinting is better then the static splints as suggested by the earlier workers (Ip and Chow, 1989; Evans and Burkhalter, 1986; Chow *et al.,* 1985).

In this investigation, all cases of tendon repair were made

Table-4. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and i njury to them at the first week after repair.

Variables		Treatment outcomes one week after repair									
		Poor		Fair		Good		Excellent		Sum	
		N	%	N	%	N	%	N	%	N	%
Age groups(year)	‹20	0	0	4	11	23	64	9	25	36	100
	20-30	2	3	6	10	41	65	14	22	63	100
	30-40	0	0	3	8	25	68	9	24	37	100
	40-50	0	0	2	13	12	80	1	7	15	100
	50-60	2	22	2	22	4	44	1	11	9	100
	›60	1	33	0	0	2	67	0	0	3	100
Sex	Man	5	4	15	11	92	66	28	20	140	100
	Woman	0	0	2	9	15	65	6	26	23	100
Injured hand	R	4	4	10	9	73	65	25	22	112	100
	Left	1	2	6	12	34	68	9	18	50	100
	Both	0	0	1	100	0	0	0	0	1	100
Number of injured tendons	One	0	0	6	8	51	64	22	28	79	100
	Two	2	4	5	7	47	70	12	18	67	100
	Three	2	17	4	33	6	50	0	0	12	100
	Four	0	0	2	40	3	60	0	0	5	100
Mechanism of injury	Cut with knife	0	0	2	6	23	68	9	26	34	100
	Cut with glass	2	5	6	15	28	68	5	12	41	100
	Car accident	1	3	4	13	18	60	7	23	30	100
	Workplace	2	4	4	8	35	69	10	20	51	100
	Violence	0	0	1	14	3	43	3	43	7	100
Injured zone	Zone 6	5	3	17	10	107	66	34	21	163	100

in zone VI only and were compared with treatment given in terms of the repair zone by the Parison treatment of repair of extensor tendons at zones VII and VIII (Chow *et al.,* 1985; Brzezienski and Schneider, 1995).It is found that Precision and skill of surgeon may also be consulted. Nasab and Sarafan (2008) suggested that the best treatment as proposed at zones V and III. A variety of studies have been conducted on treatment outcomes of tendon repair in which contributing factors in treatment outcomes have been examined.

The contributing factors include age, type of trauma, cause of trauma, injured zone, how to repair, maintenance after repair and different physiotherapy regimes (Chow *et al.,* 1985; Brzezienski and Schneider, 1995; Minamikawa *et al.,* 1992; Mahdi Nasab and Sarafan , 2008; Patillo and Rayan, 2012).

Cause of trauma is the effective cause in response and complications after tendon repair. Incidents such as traffic accidents, industrial injuries and deep burns can cause soft tissue injury associated with the extensor tendon injury. In these cases, in addition to the primary or delayed tendon repair, removing the flap from the abdomen or thighs may need. It has been shown that the flaps in severe injuries after primary repair of the tendon can provide satisfactory clinical outcomes (Quaba *et al.,* 1988). In the present study, over 80% of patients have been men and in age group under 40 years old are willingness to do risky behaviors. In 68%, dominant right hand is involved. In the present study, the causes is accidents at the workplace and is due to consistent improper use or lack of precision in the use of the used tools as suggested by Saini *et al.,* (2008).

In summing up the causes and the tendon injury in this study, it seems that the most accidents occurred in the dominant hand in male workers, which finally the injury has lasted a long time and may cause disability and even their retirement. This indicates special attention to the groups at risk and notifying them on one hand and providing the required safety equipment for these people. The most common cause of trauma in women has been everyday activities at home (60 percent), which can be avoided with proper training and more precision in performing the actions that are dealing with sharp objects. In this study, the highest short-term problem (one week) has been for superficial infection which around 6.1 percent of patients was infected despite.

It is suggested that in such cases of injury patients with

Table-5. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and injury to them in first month after repair.

Variables		Treatment outcomes one month after repair									
		Poor		Fair		Good		Excellent		Sum	
		N	%	N	%	N	%	N	%	N	%
Age groups(year)	‹20	1	3	4	11	22	61	9	25	36	100
	20-30	0	0	6	10	42	67	15	24	63	100
	30-40	0	0	3	8	25	68	9	24	37	100
	40-50	0	0	3	20	10	67	2	13	15	100
	50-60	0	0	3	33	5	56	1	11	9	100
	›60	0	0	1	33	2	67	0	0	3	100
Sex	Man	1	1	17	12	92	66	30	21	140	100
	Woman	0	0	3	13	14	61	6	26	23	100
Injured hand	R	1	1	13	12	71	63	27	24	112	100
	Left	0	0	6	12	35	70	9	18	50	100
	Both	0	0	1	100	0	0	0	0	1	100
Number of injured tendons	One	0	0	2	3	53	67	24	31	79	100
	Two	0	0	10	15	45	66	12	18	67	100
	Three	0	0	5	42	7	58	0	0	12	100
	Four	0	0	3	60	2	40	0	0	5	100
Mechanism of injury	Cut with knife	0	0	2	6	23	68	9	26	34	100
	Cut with glass	1	2	8	20	27	66	5	12	41	100
	Car accident	0	0	4	13	18	60	8	27	30	100
	Workplace	0	0	6	12	34	67	11	22	51	100
	Violence	0	0	0	0	4	57	3	43	7	100
Injured zone	Zone 6	1	5	20	125	106	65	36	22	163	100

severe pain should be put to antibiotics based on standard protocols, to avoid infection as suggested by Mahdi Nasab and and Sarafan (2008).

A chronic pain has been a major complication after six months follow-up in some patients (4 of 163 cases) that it still exists despite treatment with physiotherapy and occupational therapy. To sum up, over 80% of participants had proper outcomes which this is consistent with the results of study by Mahdi Nasab and Sarafan *et al.* (2008).

Table-6. Relative frequency and frequency of therapeutic outcome based on patients' characteristics and injury to them at sixth month after repair.

Variables		Treatment outcomes six month after repair									
		Poor		Fair		Good		Excellent		Sum	
		N	%	N	%	N	%	N	%	N	%
Age groups(year)	‹20	0	0	4	11	23	64	9	25	36	100
	20-30	0	0	6	10	41	65	16	25	63	100
	30-40	0	0	5	14	22	59	10	27	37	100
	40-50	0	0	3	20	10	67	2	13	15	100
	50-60	0	0	1	11	7	78	1	11	9	100
	›60	0	0	1	33	2	67	0	0	3	100
Sex	Man	0	0	17	12	91	65	32	23	140	100
	Woman	0	0	3	13	14	61	6	26	23	100
Injured hand	R	0	0	12	11	73	65	27	24	112	100
	Left	0	0	7	14	32	64	11	22	50	100
	Both	0	0	1	100	0	0	0	0	1	100
Number of injured tendons	One	0	0	5	6	50	63	24	31	79	100
	Two	0	0	6	9	48	72	13	19	67	100
	Three	0	0	6	50	5	42	1	8	12	100
	Four	0	0	3	60	2	40	0	0	5	100
Mechanism of injury	Cut with knife	0	0	3	9	22	65	9	26	34	100
	Cut with glass	0	0	6	15	30	73	5	12	41	100
	Car accident	0	0	5	17	15	50	10	33	30	100
	Workplace	0	0	6	12	34	67	11	22	51	100
	Violence	0	0	0	0	4	57	3	43	7	100
Injured zone	Zone 6	0	0	20	12	105	65	38	23	163	100

Conclusion

With regard to the findings of study, it can conclude that tendon repair in emergency by specialists in emergency medicine regarding few complications and suitable treatment outcomes for patients can be considered as the effective action in proliferating next treatment actions in emergency room.

References

Brzezienski, M.A., Schneider, L.H. (1995): Extensor tendon at the distal interphalangeal joint. Hand clin; 3:373-86.

Chow, J.A., Dovelle, S., Thomes, L.J., Ho, P.K., Saldana, J. A. (1989): Comparison of results of extensor tendon repair followed by early controlled mobilization versus static immobilization Hand Surg; 14B: 18–20.

Evans, R.B., Burkhalter, W.E. (1986): A study of the dynamic anatomy of extensor tendons and implications for treatment. J. Hand Surg., 11A:774–779.

Green, D. (1998): Operative hand surgery. 4th ed. New York :Churchilk Livingstone.

Ip, W.Y., Chow, S.P. (1997): Results of dynamic splintage following extensor tendon repair. J Hand Surg 1997;22B: 283–287.

Kerr, C.D., Burczak, J.R. (1989): Dynamic traction after extensor tendon repair in zones 6, 7, and 8: a retrospective study. J. Hand Surg. ;14 B: 21–2.

Khanna, A., Friel, M., Gougoulias, N., Longo, U.G., Maffulli, N. (2009): Prevention of adhesions in surgery of the flexor tendons of the hand: what is the evidence ? Br Med Bull 90:85-109.

Matzon, J. L., Bozentka, D.J. (2010): Extensor tendon injuries. J. Hand Surg.;35 A:854-61.

Mehdi Nasab, S.A., Sarafan, N. (2008): Primary extensor tendon repair of the hand. Iranian J of Orthop Surg. 3(11):130-134.

Miller, H. (1942): Repair of severed tendons of the hand and wrist. Surg Gynecol Obstet. ;75:693–8.

Minamikawa, Y., Peimer, C.A., Yamaguchi, T., (1992): Wrist position and extensor tendon amplitude following repair. J Hand Surg [Am]. 17:268–271.

Newport, M.L. (1997): Extensor Tendon Injuries in the Hand. J Am Acad. Orthop. Surg.;5:59-66.

Newport, M.L., Pollack, G.R., and Williams, C.D. (1995): Biomechanical characteristics of suture techniques in extensor zone IV. J. Hand Surg.;20A, 650-656.

Newport, M.L., Tucher, R.L. (2005): New perspectives on extensor tendon repair and implications for rehabilitation. J hand Ther. 18(2):175-181.

Patillo, D, and Rayan, G.M. (2012): Open Extensor Tendon Injuries: An Epidemiologic Study. Hand Surg. ;17 (1):37-42.

Quaba, A.A., Elliot, D. and Sommerlad, B.C. (1988): Long term hand function without long finger extensors: a clinical study. J Hand Surg; 13 B:66–71.

Rockwell, W.B., Butler, P.N., and Byrne, B.A. (2000): Extensor tendon: anatomy, injury, and reconstruction. Plast. Reconstr. Surg.; 106:1592-603.

Sharma, P., Maffulli, N. (2005): Tendon injury and tendinopathy: healing and repair. J Bone Joint Surg Am., 87, 187–202.

Saini, N., Sharma, M., Sharma, V.D. (2008): Outcome of early active mobilization after extensor tendon repair. Indian J. Orthop. Jul; 42(3):336-41.

Woo, S.H., Tsai, T.M., Kleinert, H.E., (2005): A biomechanical comparison of four extensor tendon repair techniques in zone IV. Plast. Reconstr. Surg. 115 (6):1674-81.