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Early Results after Repair of Cut Wrist Structures at Zone Five Volar Aspect of the Hand

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ABSTRACT
Background: Hand is one of the most active parts of the body, and its normal function is essential for daily activities. Function of the hand and fingers is related to normal integrity of the bones, tendons and neurovascular structures, and injuries in any parts of these organs can deteriorate the hand function.
Objective: This study aimed to evaluate the early results after repair of cut volar structures at zone five within 24 hours after injury in comparison with the cases which repaired after 24 hours of injury.
Patients and Methods: This was a cohort study that was performed in the period from 1/8/2017 to 1/8/2019 in Plastic & Reconstructive Surgery Department, Zagazig University Hospitals and Al-Ahrar Teaching Hospital Al-Sharqia Egypt. This study included sixty-four cases with sharp cut wounds in zone five of flexor tendons. They fulfilled the inclusion criteria during the study period.
Results: This study revealed that the early repair of cut wrist structures in the 1st 24 hours have more better results and good outcome than delayed repair after 24 hours. So we encourage the early repair of cut wrist structures as early as possible to avoid complications of delayed repair. **Conclusion:** Care of patients with acute hand injury begins with a focused history and physical examination. In most clinical scenarios, a diagnosis is achieved clinically. While most patients require straight forward treatment, the emergency clinician must rapidly identify limb-threatening injuries and obtain critical clinical information.
Keywords: Repair, Cut wrist, Structures, Zone five, Volar aspect.

INTRODUCTION

Hand is one of the most active parts of the body, and its normal function is essential for daily activities. Function of the hand and fingers is related to normal integrity of the bones, tendons and neurovascular structures. Injuries in any part of these organs can deteriorate the hand function [(1)]. The hand can give information about the position, size, and shape of an object by its highly developed sensory mechanism and described as third eye [(2)].

Flexor tendons of the hand are considered in five anatomic zones due to peculiarities of each area; Zone V extends from the proximal border of the transverse carpal ligament to the musculotendinous junction in the proximal part of the forearm. Flexor tendon lacerations in the forearm are frequently associated with laceration of the nerve and artery which further compromise the function of the hand [(3)].

Despite many surgical techniques and appropriate rehabilitation programs, cut wrist injuries may be associated with adhesion formation and loss of hand function [(4)]. Primary surgical repair with restoration of length, strength and gliding excursion of tendon cut is essential and primary repair would have the best outcome[(5)]. Results of flexor tendon cut after repair depends on many factors such as concomitant nerve injury, technique and type of repair, surgeon's experience, nature of the lesion, and post operative rehabilitation. Though this injury is frequently seen at our emergency department, there is little in the literature to indicate the best protocol of post operative rehabilitation after flexor tendon repair in zone five [(6)].

Cut wrist is one of the most common hand injuries, surgical repair of the injured structures requires an exact knowledge of anatomy, careful adherence to some basic surgical principles, sound clinical judgment, strict traumatic surgical technique and a well-planned post-operative program [(6)]. Injury of the wrist produces nonfunctioning or deforming hand. Deformity is more when tendon injury occurs in zone-v (especially when injury occurs in FDS and Flexor Digitorum Profundus (FDP) [(7)].

Deformed or nonfunctioning hand of a man produces burden not only to the family but also to the society, with the development of human civilization or the development of medical science day by day injured hand can be repaired. After repair of cut wrist structures by proper technique hand function can be normal or near to normal and patient becomes able to re-back his/her normal job [(8)].

The aim of the current study was to evaluate the early results after repair of cut volar structures at zone five within 24 hours after injury in comparison with the cases which repaired after 24 hours of injury.

PATIENTS AND METHODS

This study included 64 cases that were divided into two groups: Group I included 32 cases presented in the 1st 24 hours & repaired in the 1st 24 hours (primary repair) in comparison with group II that included 32 cases which were repaired after 24 hours of injury (delayed primary repair & secondary repair). Comparison includes motor, sensory & power of small muscles of the hand for 12 months after operation.

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Inclusion criteria: All ages above 5 years & below 60 years. Cut wrist of volar structures at zone 5 of the hand. Repair was done within the day of injury for the 1st group & after 24 hours for the 2nd group.

Exclusion criteria: All patients below 5 years. All patients above 60 years, any injury at the hand far of zone 5 volar aspect, patients presented with bony fractures at the wrist joint, and complete cut wrist with vascular inclusion of both radial & ulnar A.

Pre-operative:

All patients underwent comprehensive physical examination included motor, sensory and zone of injury. Plain x-ray for the affected hand for bone fractures. Preoperative investigation (CBC, KFT, LFT, PT, PTT, INR). Preoperative consultation: anesthesia consultation, orthopedic & any other consultation if needed. Preoperative consent and photography.

Operational design:

After resuscitation, pain management and tetanus prophylaxis, complete examination of the limb was done including proximal and distal neurovascular evaluation and musculoskeletal examination as thoroughly as could be done without causing pain and discomfort to patient. Rest of examination was withheld till the patient anaesthetized. Investigations included baseline blood tests mainly complete blood count and radiological studies. All patients were operated under general anaesthesia, tourniquet control and loupe magnification. Tourniquet was released once all structures identified and control of vessels was taken where indicated. In all cases, tendons were repaired first followed by nerves. All flexor tendons were repaired by modified Kessler repair with 4 core sutures with prolene 4/0 with knots in the center followed by paratendon running suture circumferentially with prolene 6/0. Median and ulnar nerves were repaired with prolene 7/0. Postoperatively, hand was kept in a splint and elevated.

Post-operative

Postoperative physiotherapy started after one week, removing the splint during physiotherapy, initially with active extension and controlled passive flexion and passive range of motion exercises. After two weeks activity was progressed to placing but not holding and after 4 weeks holding objects but not exerting force. After 6 weeks holding and lifting light weights were allowed with progressively increasing resistance to flexion. After 6 weeks splint was worn only at night for another 2 weeks. Progressively increased activity allowed from 8 weeks onwards. Active range of motion was evaluated by Strickland's Adjusted Formula ((DIP + PIP) flexion - extension deficit x 100/175 degrees = % normal) with excellent being 75 - 100%, good 50 - 74%, fair 25 - 49% and poor < 25%. Power of Opponens pollicis and adductor muscles were evaluated from P0-4. Nerve repair results were evaluated serially by advancing Tinnel's sign, electrophysiological studies and sensory perception were scored from S0-4 compared to normal opposite upper limb. Functional recovery was also evaluated by the duration to return to work.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc., Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value ≤ 0.05 was considered significant.

RESULTS

There was no significant difference between groups as regards age and sex (Table 1).

Table (1): Age and sex distribution between studied groups

			1st 24 H (N=32)	After 24 H (N=32)	t/ X^2	P
Age			29.59±19.31	27.88±19.48	-0.709	0.48
Gender	Female	N	4	6	0.467	0.4945
		%	12.5%	18.8%		
	Male	N	28	26		
		%	87.5%	81.2%		
Total		N	32	32		
		%	100.0%	100.0%		

There was no significant difference between groups regarding follow up or hospital stay (Table 2**).**

Table (2): Hospital stay and follow up period distribution between groups

	1st 24 H (N=32)	After 24 H (N=32)	t	P
Follow up	9.00 ± 4.98	9.00 ± 4.98	--	--
Hospital staying	4.13 ± 3.20	4.00 ± 3.52	-0.297	0.7673

There was no significant difference between groups in mode of injury, but there was significance in tendons injured (Table 3).

Table (3): Mode of injury & no. of injured tendons in studied groups

			Group		Total	X^2	P
			First 24 H	After 24 H			
Mode of injury	Glass	N	11	10	21	0.310	0.8565
		%	34.4%	31.2 %	32.8 %		
	Knife	N	8	10	18		
		%	25.0 %	31.2 %	28.1 %		
	Machine	N	13	12	25		
		%	40.6 %	37.50 %	39.1 %		
Tendons	Single	N	0	4	4	4.20	0.0404*
		%	0.0 %	12.5 %	6.2 %		
	Multiple	N	32	28	60		
		%	100.0 %	87.5%	93.7 %		
Total		N	32	32	64		
		%	100.0%	100.0%	100.0%		

There was no significant difference between groups in nerve and vessels injured (Table 4).

Table (4): Nerve and vessels injured distribution between studied groups

			Group		Total	X^2	P
			First 24 H	After 24 H			
Nerves	Median	N	10	10	20	--	--
		%	31.2 %	31.2 %	31.2 %		
	Ulnar	N	20	20	40		
		%	62.5 %	62.5 %	62.5 %		
	Ulnar + Median	N	2	2	4		
		%	6.2 %	6.2 %	6.2 %		
Vessels	Radial	N	6	6	12	0.391	0.82
		%	18.8 %	18.8 %	18.8 %		
	Ulnar	N	20	18	38		
		%	62.5 %	56.2 %	59.4 %		
	Non	N	6	8	14		
		%	18.8 %	25.0 %	21.9 %		
Total		N	32	32	64		
		%	100.0%	100.0%	100.0%		

Postoperative complications were significantly higher in group managed after 24 H (Table 5).

Table (5): Post op complication distribution between studied groups

			Group		Total	X^2	P
			First 24 H	After 24 H			
Post Op	Adhesion	N	7	10	17	13.251	0.0101*
		%	21.9 %	31.2 %	26.6 %		
	Non	N	23	10	34		
		%	71.9 %	31.2 %	51.6 %		
	Scar	N	2	8	8		
		%	6.2 %	25.0 %	15.6 %		
	Hematoma	N	0	2	2		
		%	0 %	6.2 %	3.1 %		
	Neuroma	N	0	2	2		
		%	0 %	6.2 %	3.1 %		
Total		N	32	32	64		
		%	100.0%	100.0%	100.0%		

Both motor and sensory outcomes were significantly better in first 24 hours' group (Table 6).

Table (6): Motor and sensory outcome distribution between studied groups

			Group		Total	X^2	P
			First 24 H	After 24 H			
Motor	Fair	N	4	10	14	15.519	0.0004*
		%	12.5 %	31.25 %	21.88 %		
	Good	N	16	22	38		
		%	50 %	68.75 %	59.37 %		
	Excellent	N	12	0	12		
		%	37.5 %	0 %	18.75		
Sensory	S2	N	4	10	14	15.519	0.0004*
		%	12.5 %	31.25 %	21.88 %		
	S3	N	16	22	38		
		%	50 %	68.75 %	59.37 %		
	S4	N	12	0	12		
		%	37.5 %	0 %	18.75 %		
Total		N	32	32	64		
		%	100.0%	100.0%	100.0%		

DISCUSSION

Injuries to the volar wrist surface have the potential to be severely debilitating, mainly due to the superficial location and high density of tendons, nerves and arteries in that area [9]. Extensive injuries to flexor tendons and surrounding structures are sometimes referred to as spaghetti wrist [10, 11]. The tendons have pretty less inherent tendency of healing. The functional integrity of hand requires intact neurovascular units and a stable platform in the form of a normal wrist joint [12]. Per-operatively, close proximity of structures poses a great challenge in identification of structures. Repair of structures is highly demanding especially in combined neural and tendon injuries [13].

Postoperatively, inter-structural adhesions are a major problem. Prolonged rest postoperatively increases the propensity for adhesions, while early mobility impairs healing of nerves [13]. It was found that Zone five Flexor tendon injury is much more common in younger and manually working people. **Tuncali *et al.*** [14] studied a total of 228 patients with various types of upper extremity structures injuries. They concluded that tendon and nerve repair are far superior in the younger age group people. This further supports the findings of **Nietosvaara *et al.*** [15] who studied the tendon repair in pediatric age group in 28 patients with 45 injured structures in upper extremity. Accidental injuries are far more common than suicidal and homicidal cases. So most of these patients are co-operative and motivated and have a high intent of recovery and return to work [16, 17]. This further stresses on the need for early repair in these patients.

This study showed that primary repair of flexor tendons has superior results as far as postoperative functional recovery as compared to results of studies with delayed repairs. **Chan *et al.*** [16] came to same conclusion in their study of 31 zone 2 flexor tendon injuries. **Strickland** also agreed on an early primary repair of flexor tendons. Primary repair of nerves also has a superior outcome [17].

In the present study the results of primary repair of ulnar and median nerves are comparable. This is shown by the improvement in sensation, which is comparable in patients' post-ulnar and median nerve repairs. Motor return in both groups of nerve repairs was shown by recovery of Opponens pollicis and adductors. This is in accordance with the **Karaberg *et al.*** [18] who compared ulnar and median nerve repairs, in which they studied 55 patients post-ulnar and/or median nerve repair.

This study also concluded that electrophysiological studies do not always corelate accurately with clinical assessment and so they should only be considered in conjunction with clinical evaluation rather than alone as a diagnostic tool as shown by **Dutelli *et al.*** [19] in their study as well. This study also implied that the increasing number of core sutures is directly proportional to the strength of repair and it does not hamper the healing or gliding of tendons. It did not have an impact on the adhesion formation as well, which is in accordance with a number of other studies [17-19]. An additional advantage of multiple core sutures, four in this study showed that early mobilization and physiotherapy can be carried out, which had beneficial effects in both promotion of healing and prevention of adhesion formation, as stated by **Morya *et al.*** [20] in their study of various suture techniques for flexor tendon repair.

There had been a debate on early versus late mobilization post-tendon repair. Some believe in commencement of early physiotherapy while others believe in prolonged rest post-tendon repair. In this study it was seen that with proper technique of repair, early mobilization and therapy was safe and indeed beneficial. It has been proposed as the stress theory that controlled early stress promotes the healing process of tendons. Prolonged rest post-tendon repair may be responsible for adhesion formation, which is an important limiting factor in the final recovery and return of function after tendon repair. This is also

shown in an elaborate study by **Hung *et al.*** [(21)].

Some of these studies were characterized by the variation of settings in which the injuries occurred including domestic neat blade cuts to industrial machine injuries with grossly contaminated wounds. Also some patients were more motivated in rehabilitation therapy than others. It is beyond the scope of this study to achieve all these standardizations.

CONCLUSION

Care of patients with acute hand injury begins with a focused history and physical examination. In most clinical scenarios, a diagnosis is achieved clinically. While most patients require straight forward treatment, the emergency clinician must rapidly identify limb-threatening injuries and obtain critical clinical information. From all results reported in the present study, it can be said that, multidisciplinary team can evaluate and manage acute volar wrist injuries saving time and decreasing post-operative functional disability with short time to return to patient's daily activity due to accurate repair of injured structures, early movement and appropriate rehabilitation program which need patient co-operation.

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