

# Flexor Zone 5 Cut Injuries: Emergency Management and Outcome

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## ABSTRACT

**Objective:** To determine the outcome and devise a protocol for emergency management of cut injuries in Flexor Zone 5 of hands.

**Study Design:** Descriptive study.

**Place and Duration of Study:** Department of Plastic Surgery and Burn Unit, Mayo Hospital, KEMU, Lahore, Pakistan, from January 2009 to March 2013.

**Methodology:** All patients above 12 years of age with single sharp cut injuries in Flexor Zone 5, with no skeletal injuries, presenting within 12 hours in emergency were included with follow-up of 6 months, with active range of motion evaluated by Strickland's adjusted formula. Power of opponens pollicis and adductor muscles was evaluated from P0-4. Nerve repair results were evaluated serially by advancing Tinnel's sign, electrophysiological studies and sensory perception scored from S0-4 compared to the normal opposite upper limb.

**Results:** The study group comprised of 31 patients (M : F = 2.4 : 1). Average age was 27 years ranging from 17 - 53 years. In 25 (80%) cases, injury was accidental, in 3 (10%) homicidal and in 3 (10%) injury was suicidal. Four most commonly involved structures included Flexor carpi ulnaris, ulnar artery, ulnar nerve and Flexor digitorum superficialis. Median nerve and radial artery were involved in 10 cases each, while ulnar artery and ulnar nerve were involved in 14 cases each. Long-tendons were involved in most cases with greater involvement of medial tendons. None of the patients required re-exploration for ischaemia of distal limb while doppler showed 22 out of 24 vascular anastomosis remained patent. Recovery of long-tendons was good and recovery after nerve repair was comparable in both median and ulnar nerves.

**Conclusion:** Early and technically proper evaluation, exploration and repair of Zone 5 Flexor tendon injuries results in good functional and technical outcome.

**Key Words:** Flexor zone 5. Spaghetti wrist. Median nerve. Ulnar nerve. Nerve injury.

## INTRODUCTION

Flexor Zone 5 extends from distal wrist crease to the flexor musculo-tendinous junction as described by Verdan in 1959.<sup>1</sup> This is the most exposed and so the most vulnerable zone for suicidal, homicidal as well as accidental cut injuries. Extensive injuries to flexor tendons and surrounding structures are sometimes referred to as spaghetti wrist.<sup>2</sup> The functional importance of the closely packed structures, blood vessels, nerves and flexor tendons, makes the injuries in this zone very hazardous and the immaculate management of paramount importance.<sup>3,4</sup> Most of these injuries land directly in A and E department of tertiary care hospitals or referred from peripheries. Since the patients are usually young so early evaluation and management in emergency is of utmost importance in the final functional outcome.<sup>5</sup>

The aim of this study was to determine the outcome and devise a protocol for emergency management of cut injuries in Flexor Zone 5 of hands.

## METHODOLOGY

All patients above 12 years of age with single sharp cut injuries in Flexor Zone 5, with no skeletal injuries, presenting within 12 hours in (A and E unit) of Mayo Hospital, Lahore, from January 2009 to March 2013, were included. Patients with all other kind of injuries were excluded from the study. Informed written consent was taken from all patients.

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 was 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 were identified and control of vessels was taken where indicated. In all cases, tendons were repaired first followed by nerves and finally vessels except in cases where both ulnar and radial arteries were severed, hand needed revascularization and time since injury was approaching 6 hours, in which case ulnar artery was repaired first followed by the above sequence.

All flexor tendons were repaired by modified Kessler repair with 4 core sutures with prolene 4/0 with knots in

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*Received: February 06, 2013; Accepted: January 17, 2014.*

the centre followed by paratenon running suture circumferentially with prolene 6/0, except in cases of flexor carpi ulnaris, which was repaired by Pulvertuft repair with prolene 4/0. Median and ulnar nerves were repaired with prolene 7/0. Ulnar and radial arteries were repaired with prolene 8/0. Postoperatively, hand was kept in a splintage and elevated.

Postoperative physiotherapy was started after 24 hours, 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 was allowed with progressively increasing resistance to flexion. After 6 weeks splint was worn only at night for another 2 weeks. Progressively increased activity was allowed from 8 weeks onwards.

Patients were followed-up with evaluation of patency of arterial repair by Hand Held Doppler. Active range of motion was evaluated by Strickland's Adjusted Formula  $[(DIP + PIP) \text{ flexion} - \text{extension deficit} \times 100/175 \text{ degrees} = \% \text{ normal}]$  with excellent being 75 - 100%, good 50 - 74%, fair 25 - 49% and poor < 25%. Power of Opponens pollicis and adductor muscles was evaluated from P0-4. Nerve repair results were evaluated serially by advancing Tinnel's sign, electrophysiological studies and sensory perception scored from S0-4 compared to normal opposite upper limb. Functional recovery was also evaluated by the duration to return to work.

Data was analyzed statistically after 6 months of follow-up with Statistical Package for Social Sciences (SPSS) version 10.

## RESULTS

Thirty one cases with sharp cut wounds in Zone 5 of Flexor Tendons fulfilled the inclusion criteria during the study period.

Average age was 27 years ranging from 17 - 53 years. Nine patients were females while 22 were males with male to female ratio of 2.4:1. The injury was accidental in 25 (80%) cases, homicidal in 3 (10%) and suicidal in

3 (10%). Amongst the accidental group, 21 were glass cut injuries, one was knife injury while 3 were sharp machine cut injuries. All injuries in the homicidal group were knife inflicted, while 2 in suicidal group were knife inflicted and one by sharp razor blade. In 21 cases, involved hand was the left one while in 10 cases right hand was involved.

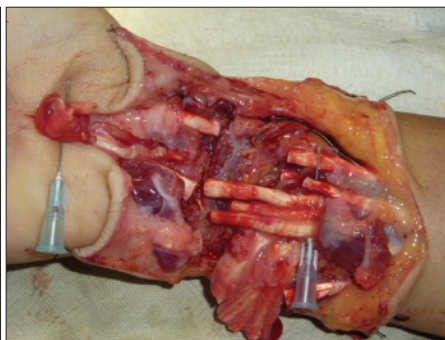
The four most commonly involved structures included flexor carpi ulnaris, ulnar artery, ulnar nerve and flexor digitorum superficialis. Medial aspect of the wrist had more propensity for involvement followed by central cuts of wrist. Ulnar artery alone was involved in 10 cases, radial artery alone in 6 cases while both ulnar and radial arteries were involved in 4 cases. Ulnar nerve alone was involved in 10 cases, median nerve in 6 cases while both median and ulnar nerves were involved in 4 cases. Superficial and deep flexor tendons of fingers were involved in 26 cases with a total of 159 tendons injured. Flexor carpi ulnaris alone was involved in 10 cases out of 14 flexor carpi ulnaris injuries. Flexor pollicis longus was involved in 7 cases. Flexor carpi radialis was involved in 10 cases while palmaris longus was involved in 15 cases.

None of the patients required re-exploration for ischaemia of distal limb. Doppler showed 22 out of the 24 vascular anastomoses remained patent over 6 months follow-up. One showed loss of anastomotic patency on the first postoperative day while another on second post-operative day, both in cases of isolated radial artery injury. Vascularity of hand was not found to be compromised in either case so re-exploration was not carried out. Wrist function became normal in all cases. In 97 out of the 159 long flexor tendons of fingers' excursion was found to be good to excellent at the end of 6 months, in 46, it was fair, while it was poor in case of 16 tendons. Joint stiffness was found in 12 cases. Flexor pollicis longus function was found good to excellent in 3 cases and fair in 4 cases. Poor excursion was not found in any of the repaired flexor pollicis longus.

Seven out of 14 repaired ulnar nerves showed S3-4 level sensory return, 6 had S3 while 1 had S1 levels of



**Figure 1:** Pre-operative picture of flexor zone 5 injury.



**Figure 2:** Per-operative picture.



**Figure 3:** Postoperative picture showing flexion of fingers.

**Table I:** Demography of injury (n = 31).

Parameters	n (%)
Motive of injury	
Suicidal	3 (9.67%)
Homicidal	3 (9.67%)
Accidental	25 (80.64%)
Mode of injury	
Glass cut	21 (67.74%)
Knife cut	6 (19.35%)
Machine cut	3 (9.67%)
Razor blade	1 (3.22%)

**Table II:** Frequency of injury to different structures (n = 31).

Structures	Total	Involved n (%)	Structures/ patient
Median nerve	31	10 (32)	0.3
Flexor digitorum superficialis	124	86 (69)	2.7
Ulnar nerve	31	14 (45)	0.4
Palmaris longus	31	15 (48)	0.5
Ulnar arteries	31	14 (45)	0.4
Flexor digitorum profundus	124	73 (59)	2.3
Flexor carpi radialis	31	10 (32)	0.3
Radial arteries	31	10 (32)	0.3
Flexor carpi ulnaris	31	14 (45)	0.4
Flexor pollicis longus	31	7 (22)	0.2
Radial structures	31	10 (32)	-
Ulnar structures	31	14 (45)	-
Miscellaneous	31	7 (22)	-

**Table III:** Ulnar and median nerve (motor and sensory) recovery.

Nerve motor	Total n	P=3-4 n (%)	P=2-3 n (%)	P=1 n (%)
Median nerve				
Opponens pollicis	10	3 (29)	6 (57)	1(14)
Ulnar nerve				
Adductors (palmar interossei + adductor pollicis)	70	24 (34)	35 (50)	11 (16)
Nerve sensory recovery	Total	S=3-4 n (%)	S=2-3 n (%)	S=1 n (%)
Median nerve	10	4 (40)	4 (40)	2 (20)
Ulnar nerve	14	7 (50)	6 (43)	1 (7)

sensory recovery. On the other hand, 4 out of 10 median nerves repaired showed S3-4 level of sensory return, 4 showed S2 level of sensory return and 2 had S1 level of sensory return. Three Opponens pollicis had P3-4 after 6 months, 6 showed P2-3 while 1 showed P1, out of 10 cases of median nerve repair. On the other hand, 24 out of 70 adductors showed P3-4, 35 showed P2-3 and 11 showed P1 in 14 cases of ulnar nerve repair. Nerve conduction studies showed regenerative changes in 13 out of 24 repaired nerves but the results of these studies did not always co-relate exactly with clinical findings.

### DISCUSSION

Lacerations 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.<sup>6</sup> Extensive injuries to flexor tendons and surrounding structures are sometimes referred to as spaghetti wrist.<sup>2-4</sup> 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.<sup>7</sup> 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.<sup>8</sup> Postoperatively, inter-structural adhesions are a major problem. Prolonged rest postoperatively increases the propensity for adhesions while early mobility impairs healing of nerves.<sup>8</sup>

It was found that Zone 5 Flexor tendon injury is much more common in younger and manually working people which is in accordance with Tuncali *et al.* study where they studied a total of 228 patients with various types of upper extremity structures.<sup>9</sup> Results of tendon and nerve repair are far superior in the younger age group people so it is a viable option taking the pain of exploring and repairing such cases in emergency. This further supports the findings of Yrjana *et al.* who studied the tendon repair in paediatric age group in 28 patients with 45 injured structures in upper extremity.<sup>5</sup> 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. This further stresses on the need for early repair in these patients.

This study shows that primary repair of flexor tendons has superior results as far as postoperative functional recovery is concerned compared to delayed repairs. The rate of rupture is very low while healing and adhesion formation is also comparable to other studies. Chan *et al.* came to same conclusion in their study of 31 zone 2 flexor tendon injuries.<sup>10</sup> Strickland also agreed on an early primary repair of flexor tendons.<sup>11</sup>

Primary repair of nerves also has a superior outcome.<sup>12</sup> 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, shown by recovery of Opponens pollicis and adductors, is also comparable. This is in accordance with the Karaberg *et al.* comparison of Ulnar and Median nerve repairs, in which they studied 55 patients post-ulnar and/or median nerve repair.<sup>13</sup> This study also concludes that electrophysiological studies do not always co-relate 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.* in their study as well.<sup>14</sup>



This study also implies 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. They do not have an impact on the adhesion formation as well which is in accord with a number of other studies. An additional advantage of multiple core sutures, four in case of this study is that early mobilization and physiotherapy can be carried out which has beneficial effects in both promotion of healing and prevention of adhesion formation, as stated by Morya *et al.* in their study of various suture techniques for flexor tendon repair.<sup>15</sup>

There has always 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 is 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 was also shown in an elaborate study by Hung *et al.*<sup>16</sup>

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

An early and technically proper evaluation, exploration and repair of Zone 5 Flexor Tendon injuries results in good functional and technical outcome.

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