

# Characteristics of Neurovascular Injury Associated with Tendon Injury of Hand: A Retrospective Study

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## ABSTRACT

**Introduction:** Normal function of a hand depends much on the integrity of its anatomical structures. Musculotendinous injuries of the hand are frequently associated with neurovascular injury. Repair or reconstruction of all structures is important for optimal restoration of hand function.

**Aim:** To determine the characteristics of neurovascular injury associated with musculotendinous injuries of the hand.

**Materials and Methods:** The present study was a retrospective observational study conducted in the trauma care centre of a tertiary care teaching hospital from September 2020 to August 2021. Patients sustaining acute tendon injury of the hand of all age group and both sexes were included (n=38). Various epidemiological data like age, sex, occupation etc., and clinical and operative findings were collected and were analysed.

Descriptive statistics were used and results were expressed in terms of frequency and percentages.

**Results:** The mean age of the study population was 24 years, with 30 male patients and 8 female patients. As far as the side of involvement was concerned, 17 (44.7%) patients had a left-side injury, and 21 (55.3%) patients had a right-side injury. Majority of the patients, 27 (71.1%) sustained flexor Zone V injury. As to the neurovascular involvement, isolated median nerve, i.e., 10 (41.7%) and radial artery i.e., 8 (44.4%) injuries were more common.

**Conclusion:** Neurovascular injuries associated with tendon injury of the hand are a common finding. Prior knowledge of their presence and association with specific tendon injuries is beneficial for their identification and management, which ultimately leads to optimal restoration of hand function.

**Keywords:** Forearm, Nerve, Vessels

## INTRODUCTION

Our day-to-day activities depend heavily on the normal functions of our hands. Functions of the hand and fingers in turn are related to the normal integrity of the bones, tendons and neurovascular structures [1]. Derangement in any part of these structures owing to injuries or from any other causes can jeopardise the normal function of hand [2]. While the isolated tendon injury is a common finding in accident and emergency department of a hospital, association of neurovascular injury is also frequently encountered specially with flexor tendon injuries [3].

The clinical significance of this is that optimal outcome in such cases depends not only on meticulous repair or reconstruction of the injured tendons, but also on successful and timely addressing of such associated neurovascular injuries. Obviously, an associated nerve injury will have its effect on outcome, even after successful tendon repair, a vascular insufficiency may also lead to impairment of tendon healing [4]. Hence, knowledge of presence and character of such associated neurovascular injury is critical for planning and management of such multistructure hand injury.

There have been some studies done on this topic internationally [1,5,6]. There has been a study solely on the incidence of tendon injuries [7]. There is also dearth of such studies in our country particularly in the eastern part of India. At the trauma care centre of our institute, such cases of traumatic hand injuries are referred from all parts of our state and sometimes from the surrounding states also. So, present study was undertaken with the objectives to estimate the characteristics of neurovascular injury associated with musculotendinous injuries of the hand.

## MATERIALS AND METHODS

The present study was a retrospective descriptive study, conducted in the Department of Plastic and Reconstructive Surgery, IPGME&R/SSKM Hospital, a tertiary care hospital in Kolkata, West Bengal,

India, from September 2020 to August 2021 and data were analysed over the period of one month of data collection after the study commenced. Ethical clearance was obtained from Institutional Ethics Committee (IEC), before starting the study (IPGME&R/IEC/2022/289, Dt 30/06/2022).

The study population constituted all the patients who presented with acute hand tendon injuries to the trauma care centre of our institute during the study period.

**Inclusion criteria:** Patients sustaining acute tendon injury of the hand of all age group and both sexes were included in the study.

**Exclusion criteria:** Those who did not require surgical exploration and intervention such as those who were treated conservatively or patients with amputated upper limb injury were excluded from the study.

The sampling method was purposive sampling. From the hospital records, data of all patients who presented with acute flexor tendon injury during the study period were looked into. Among them, a total of 38 patients fulfilled all inclusion and exclusion criteria and were selected for the study. All the epidemiological data including age and sex, were recorded and compiled. Occupation and nature of work were especially important as they may be directly related to the cause of the injury. Employees of several occupations, like those who work with machines or sharp objects are more prone to this type of hand injury. Information about any pre-existing diseases including mental illness, history of any addiction, previous injury or intervention on the same hand was also collected if available.

Patients' presenting history like mode of injury- accidental, suicidal attempt or whether caused by others in conflict or in any act of violence were taken into consideration. From the clinical notes, findings such as functional loss, features of neurovascular injuries, nature of injury like whether the wound was a sharp cut, penetrating, crush injury, avulsion or degloving type, were recorded.

From Operation Theatre (OT) notes, details of musculotendinous injuries with mention of zone of tendon injuries were recorded. These zones of flexor tendon injury, described by Kleinert H et al., and Verdan CE divides the tendons into five Zones of clinical importance (Zone I/III/IV/V), starting from the musculotendinous junction of the long flexor to their insertion [8,9].

Details of neurovascular injury with special reference to their character are noted as below:

Associated neurovascular injury, if present, were noted with mention of specific vessels and nerve nature of injury like partial or complete, proximal or distal. Total discontinuity of nerve or vessels was considered complete injury whereas any degree of continuity of the cut ends was termed as partial or incomplete neurovascular injury. As per the classification of Kleinert H et al., Zone V injuries which occur proximal to distal wrist crease is termed proximal injury and Zone (I-IV) were considered distal musculotendinous injury [8].

## STATISTICAL ANALYSIS

All these data were analysed using MS Excel software (Version 2016). Descriptive statistics was used and results were expressed in terms of frequency and percentages.

## RESULTS

All the injured structures can be seen to have been identified. One of each type of structures is indicated with coloured arrows. Blue: tendon, yellow: nerve, vessel: white [Table/Fig-1].

In this picture [Table/Fig-2] all the injured structures are seen to repaired and it is before final skin closure.



[Table/Fig-1]: Case of hand injury multiple tendons, nerves and vessel injury.



[Table/Fig-2]: Same patients after repair of all structures.

Majority of the patients 20 (52.6%) were 21-40-year-old [Table/Fig-3]. The mean age of the study population was 24 years with male patients being 30 and female patients was eight.

Age in group (years)	Frequency	Percent
≤20	4	10.5
21-40	20	52.6
41-60	12	31.6
>60	2	5.3
Total	38	100

[Table/Fig-3]: Distribution of age group.

It was observed that 23 (60.5%) patients had accident injury [Table/Fig-4] and 15 (39.4%) patients had glass cut injury [Table/Fig-5].

Mode of injury	Frequency	Percent
Accidental	23	60.5
Violence	4	10.5
Self-inflicted	11	29.0
Total	38	100

[Table/Fig-4]: Showing distribution of mode of injury.

Cause of injury	Frequency	Percent
Glass cut injury	15	39.4
Machine injury	13	34.2
Other sharp object/weapon injury	10	26.4
Total	38	100

[Table/Fig-5]: Showing the distribution of causes of injury.

As far as side involvement was concerned, 17 (44.7%) patients had left-side of injury and 21 (55.3%) patients had right-side of injury.

Majority of the patients, 27 out of 38 (71.1%) sustained flexor Zone V injury as compared to distal injuries (Zone II-IV) [Table/Fig-6].

Type of flexor zone	Frequency	Percent
Zone II	2	5.2
Zone III	5	13.2
Zone IV	4	10.5
Zone V	27	71.1
Total	38	100

[Table/Fig-6]: Showing distribution of type of flexor zone involvement.

Maximum number of patients had Flexor Digitorum Superficialis (FDS) injury (63.1%), followed by Flexor Digitorum Profundus (FDP) injury which was 47.4% [Table/Fig-7].

Various tendons (in isolation or in combination)	Frequency	Percentage of total no. of patients (N=38)
Flexor Carpi Radialis (FCR)	8	21
Flexor Pollicis Longus (FPL)	3	7.8
Palmaris Longus (PL)	6	15.8
Flexor carpi Ulnaris (FCU)	5	13.1
Flexor Digitorum Superficialis (FDS)	24	63.1
Flexor Digitorum Profundus (FDP)	18	47.4

[Table/Fig-7]: Showing distribution of various tendon injury.

A total of 24 patients had associated nerve injury, either median or ulnar nerve or combined. Of these 24 patients, 10 had isolated median nerve injury (41.7%) while only eight patients (33.3%) had isolated ulnar nerve injury [Table/Fig-8].

Associated nerve injury	Frequency	Relative frequency of nerve injury (%)	Percentage of total patients (N=38)
Median nerve	10	41.7	26.3
Median nerve and ulnar nerve	6	25	15.8
Ulnar Nerve	8	33.3	21.0
Total	24	100	63.1

[Table/Fig-8]: Showing distribution of associated nerve injury.

In this study, 18 patients had associated vascular injury, either radial or ulnar artery or both, which is 47% of total 38 patient with tendon injury. Of these 18 patients, eight patients had isolated radial artery injury (44.4%) of the patients having vascular injury while seven patients (38.9%) had isolated ulnar artery injury [Table/Fig-9].

Associated artery injury	Frequency	Relative frequency of artery injury (%)	Percentage of total patient (N=38)
Radial artery	8	44.4	23.7
Radial artery and ulnar artery	3	16.7	5.2
Ulnar artery	7	38.9	15.9
Total	18	100	47.4

**[Table/Fig-9]:** Table showing distribution of associated vascular injury.

## DISCUSSION

Acute tendon injury though may happen at any age, young adult age group is more likely to sustain this type of injury. This corresponds to the most active age group of population. In present study, maximum incidence was in 21-40 years of age group with an incidence of 52.6%. Males were more commonly affected (79%) than females (21%) signifying it's more common association in men who are exposed to outdoor exposure like industrial injury or outdoor violence.

As far as reason or mode of injury in present study is concerned, 60.5% patients suffered accidental injury while 29% were self-inflicted injury. Kisch T et al., state that reason of injury, accidental or suicidal, also plays a role in the structures injured in wrist cut injury. In a retrospective study, they showed that suicidal injury more commonly caused injury to the median nerve, radial artery, Palmaris Longus (PL) and Flexor Carpi Radialis (FCR), especially on the non dominant hand, but were less likely to involve the ulnar artery and nerve on the dominant hand. They attributed this to the effect of the protective structures of PL/flexor carpi ulnaris on the median nerve/ulnar artery [5].

Lee CH et al., in their study found that more than five structures occurred more frequently in stab or penetrating wound caused by a sharp instrument during a conflict or violent event involving another person [6]. In present study, glass cut injury was 39.4%

as compared to machine injury 34.2%. According to Weinzweig N et al., injuries occurring between the distal wrist crease and the flexor musculotendinous junctions involved atleast three completely transected structures, including at least one nerve and often a vessel [10]. In a study on flexor tendon injuries of hand, Mehdi Nasab SA et al., found that flexor tendon lacerations in the forearm are often related with laceration of the nerve and artery which compromise the function of the hand [1].

In present study, 27 out of 38 patients had zone V injury (71.1%), explaining high association of neurovascular injury. This high incidence of zone V injury was echoed in their studies by Ranjan V et al., who reported as high as 60% of the patients had zone V injury [11]. Cho J and Choi Y too stated about role of FCR, PL and Flexor carpi Ulnaris Ulnaris (FCU) on neurovascular structures [12]. Lee CH et al., found that palmaris longus tendon associated with median nerve injury were more common in self-inflicted injuries [6]. In present study, all six cases of combined median and ulnar nerve injury palmaris longus was found to be injured, possibly because of its central location, rather than associated only with isolated median nerve injury. Also, in all cases of isolated radial artery injury (eight cases) FCR was found to be injured (nine cases).

As to the specific nerve involvement it was found that in 41.1% of cases, median nerve was injured. This was in contrast to Noaman HH who found in 88% of cases median nerve was involved [13]. However, combined median and ulnar nerve injury constituted only 15.8%. Though Rogers GD et al., opined that simultaneous laceration of both major nerves with flexor tendons at the wrist is a combination injury familiar to any hand surgeon [14]. These two findings may be attributed to relatively lesser number of cases in the current study. On the other hand, vascular injury was found in 18 patients. Amador EV and Hernandez Solano MA in their series of 22 paediatric cases found vascular injury only in seven cases (31.8%), mostly ulnar artery [15]. [Table/Fig-10] shows comparison of various studies with present study [1,5,10,13-15].

Study, place, publication year	Epidemiological data	Mode of injury	Zone of injury and its association with neurovascular injury	Association of specific tendon injury with specific nerve injury	Incidence of occurrence of specific nerves injury with musculotendinous injuries	Incidence of occurrence of specific vessels injury with musculotendinous injuries
Current study Kolkata, India 2023	Age group involved mostly 21-40 years. (52.6%). Sex: Male most common (79%)	Accidental most common (60.5%) followed by self-inflicted injury (29%)	63% of all musculotendinous injury cases had neurovascular injury. This value shoots up to 88% of Zone V injury alone	100% cases of palmaris longus injured patient had combined median and ulnar nerve injury. 89% patients with FCR injury had isolated radial artery injury	Of 24 patients (out of the total of 38 patients of musculotendinous injury. with nerve injury 41.7% had isolated median nerve, 33.3% had isolated ulnar nerve and 25% had combined nerve injury	Present study found 47.4% of all flexor tendon injury cases having vascular injury. Isolated radial artery incidence was 23.7%, ulnar artery 15.9% and 5.2% cases had both arteries injured
Weinzweig N et al., [10] Chicago, USA 1998			Zone V injury cases at least three completely transected structures, including atleast one nerve and often a vessel			
Mehdi Nasab SA et al., [1] Ahvaz, Iran, 2016			Flexor Zone V injury cases had frequent association of neurovascular injury of forearm			
Noaman HH, [13] 2007					88% patients had sustained median nerve injury and 15.8% had combined median and ulnar nerve injury	
Rogers GD et al., [14] Adelaide, Australia, 1990					Simultaneous injury of both major nerve is a common finding	
Kisch T et al., [5] Lübeck, Germany 2019						Suicidal attempt injury or self-inflicted injury was more likely to cause radial artery injury rather than ulnar artery



Amador EV and Hernandez Solano MA [15] Barranquilla, Columbia 2018						31.8% of all paediatric group cases had vascular injury, most commonly ulnar artery
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**[Table/Fig-10]:** Comparison of findings of the current study and previously published studies [1,5,10,13-15].

## Limitation(s)

Small sample size, retrospective nature and the results are restricted to a single centre, hence its results/findings cannot be generalised.

## CONCLUSION(S)

Tendon injury especially that of hand is a very common occurrence in any accident and emergency department of any large hospital. Varying degree of neurovascular injury are associated with musculotendinous injury. Certain locations of tendon injury, like zone V injury are more commonly associated with neurovascular injury. Certain specific tendons confer protection. So injury of certain tendons can predict specific neurovascular injury. This is important from clinical point of view as neurovascular injury not only has its deleterious clinical effect, but also affects results of tendon repair and overall restoration of the hand functions.

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