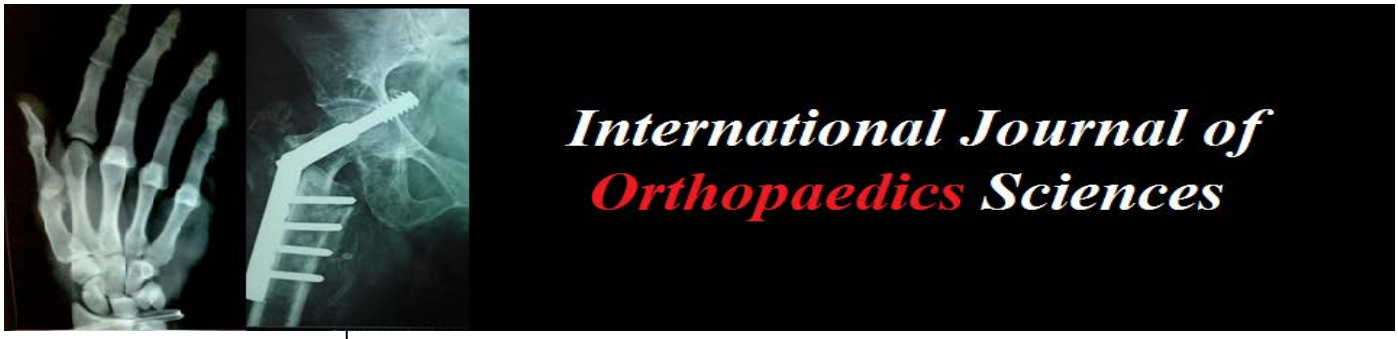

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Functional outcome of spaghetti wrist following surgery- our experience in 26 patients

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Abstract
Objective: To analyse the post-surgical functional outcome following spaghetti-wrist injury.
Background: Spaghetti wrist' may be described as laceration injury on the volar aspect of distal part of forearm, in which three or more structures (Tendon, nerve or vessel) were completely transected. Glass cut and knife injuries are the most common mechanism of injuries. Early operative repair followed by proper rehabilitation are needed for successful outcome of spaghetti wrist injury.
Materials and Methods: This study was carried in Orthopaedic surgery department, Bangabandhu Sheikh Mujib Medical University (BSMMU) and a private hospital in Dhaka, Bangladesh from January'17 to December'22. 26 patients were enrolled for the study. Post operatively patients were followed up at 2 weeks, 6 weeks, 12 weeks, 6 months, 12 months and 18 months. Final outcome was measured by tendon function, intrinsic, opposition, sensation, deformities, and grip strength. Statistical package for social sciences (SPSS-26) was used to analyse all the data statistically. $p<0.05$ were considered as the level of significance.
Results: Mean age was 29.30±9.1 years. Among the 26 patients, 12(46.2%) were glass factory worker. 18 (69.2%) patients had glass cut injury. Out of 26 patients 19 (73.1%) patients had associated nerve injury. 10 (38.5%) had both median and ulnar nerve injury and 9 (34.6%) had only ulnar nerve injury. 5 (19.2%) patients had associated ulnar artery injury. At final follow-up satisfactory (Excellent + Good) outcome was found in 22(84.6%) patients and unsatisfactory (Fair +Poor) outcome was found in 4 (15.4%) patients.
Conclusion: Early surgical repair and proper post-operative rehabilitation are the keys for successful outcome of spaghetti wrist injury.

Keywords: Spaghetti wrist, glass cut injury, tendon function

Introduction
'Spaghetti wrist' was first described originally by Meyer and Puckett (1984). They defined this as laceration injury involving the flexor aspect of distal forearm, in which three or more structures (Tendon, nerve or vessel) were completely transected [1]. Katz defined this as a laceration where ten or more structures were damaged. There are so many other definitions have been used in different literatures which creates some indistinctness in the literature. Jacquet *et al*. (2005) [2] used two definitions in their study. When flexor tendons along with median and ulnar nerves are simultaneously lacerated at the wrist and/or at least ten structures divided including the ulnar and / or median nerve [1]. The superficially placed anatomical structures on the volar surface of the distal forearm and wrist and the constant use of the hand to carry out activities of daily living make these structures susceptible to major injuries which ultimately results in lifelong disability, economic, social and psychological consequences [3]. The common mechanism of injuries is glass cut injuries, knife cut injuries, different occupational injuries and suicidal cut injuries. There is a lack of available data in the literature particularly focusing on injury followed by functional outcome [4]. Injuries of the anterior aspect of the wrist involving tendons, nerves and vessels frequently results in a non-functional or dysfunctional hand either because of severe soft tissue injury, or technical difficulties and faults during surgery.

The effect of nerve injuries is more than the corresponding tendon injuries. However, ischemic contracture, necrosis or amputations following vascular damage are not reported yet. Post-operatively abnormal tendon gliding can occur usually by formation of scar, loss of soft tissues, and incorrect suturing between the injured tendons. So, it is necessary to inform the patient properly about the possibility of secondary surgeries to combat the aforesaid complications [4]. There are only a few articles which publish this combination of injury. Early surgical repair and proper post-operative rehabilitation are of great importance for successful outcome [5]. The objective of this study was to assess the functional outcome of spaghetti-wrist injury.

Materials and Methods

This study was carried out in the department of Orthopaedic surgery, BSMMU and a private hospital in Dhaka, Bangladesh from January'17 to December'22. Total 26 patients were enrolled for this study as per selection criteria. Post operatively follow up was given at 2 weeks, 6 weeks, 12 weeks, 6 months, 12 months and 18 months. Minimum follow up period was 12 months. Final outcome was measured by tendon function, intrinsic function, opposition, deformities, grip strength, and sensation. Tendon function was catagorized as excellent (85-100), good (70-84), fair (50-69), poor (Fixed contractures or adhesions) and to determine the final outcome of the study, excellent and good grades were considered as satisfactory outcome. The nerve repair outcome was evaluated serially by using advancing Tinel's sign, two-point discrimination and sensory perception score from S0-4, compared with normal contralateral upper limb. Muscle power was assessed by MRC grading (M0-M5) and the range of movement was also evaluated. Statistical package for social sciences (SPSS-26) was used to analyse all the data statistically. 95% CI and $p<0.05$ were considered as the level of significance.

Selection Criteria

Patient with more than three structures injury (Out of which at least one nerve/artery injury was there) was included in the study. Patients with age more than 5 years and psychologically fit to follow the post-operative rehabilitation protocol were selected. Duration of injury was 2 hours to 6 months. Patient having underlying bony injury and previously nonfunctioning wrist were excluded.

Results

A total number of 26 cases of spaghetti wrist were taken according to selection criteria. Demographic characteristics were shown in Table 1. Mean age was 29.30±9.1 years. Most of the patients (42.3%) belong to 16-25 years. The minimum and maximum age were of 16 and 44 years respectively. Out of 26 patient's males were 20 (76.9%) and females were 6(23.1%). There is male predominance and Male-female ratio was 3.3:1. Out of 26 patients 12(46.2%) were glass factory worker. Other patients were housewife (23.1%), driver (15.4%), service holder (7.7%) and student (7.7%). Out of 26 patients 20(76.9%) had right sided injury and 6 (23.1%) had left sided injury. Right sided injury is more common than left sided injury. 18 (69.2%) patients had glass cut injury, 6 (23.1%) had knife cut injury and 2 (7.7%) had road traffic accident. Among the study population, 5 (19.2%) patients were operated within 24 hours of injury, 15 (57.7%) were operated within 1 month and 6 (23.1%) were operated after 1 month (Figure 2). Out of 26 patients 19 (73.1%) patients had associated nerve injury. 10 (38.5%) had both median and ulnar nerve injury and 9 (34.6%) had only ulnar nerve injury (Figure 6). 5 (19.2%) patients had associated ulnar artery injury (Figure 3). Among the study population, 4(15.4%) had post-operative complications. 2 (7.7%) patients developed superficial surgical site infection, which was treated by antibiotic and regular dressing. 1(3.8%) had fixed flexion deformity and 1 (3.8%) had extension lag (Table 2). Table 3 demonstrates that, excellent tendon function was found in 10 (38.5%) patients and good in 12 (46.2%) patients. Opposition excellent in 7 (26.9%) patients and good in 13 (50%) patients. Intrinsic function excellent in 8 (30.8%) and good in 14 (53.8%) patients. Deformities excellent in 12(46.2%) and good in 14 (53.8%) patients. Sensation was excellent in 8(30.8%) patients and good in 14 (53.8%) patients. Grip strength excellent in 8 (30.8%) patients and good in 12 (46.2%) patients. According to Louisville system **(**Saini *et al*. 2010) [8] at final follow up excellent result was found in 8(30.8%) patients, good in 14 (53.8%), fair in 2 (7.7%) and poor in 2 (7.7%) patients (Figure 5). At final follow-up satisfactory (Excellent + Good) outcome was found in 22 (84.6%) patients and unsatisfactory (Fair +Poor) outcome was found in 4 (15.4%) patients (Figure 5). Early operation has better functional outcome as there is less adhesion and better delineation of the injured structures (Table 4).

Fig 1: Per-operative pictures of a spaghetti wrist injury patient.

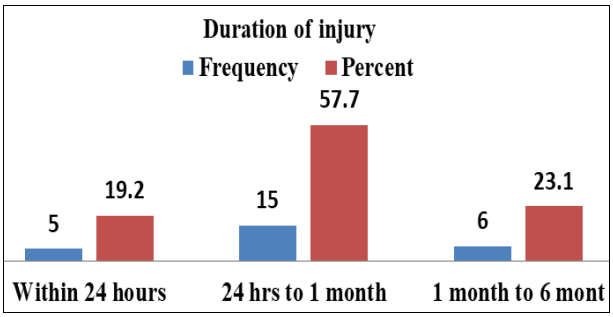

Fig 2: Distribution of the patients (n=26) according to duration of injury.

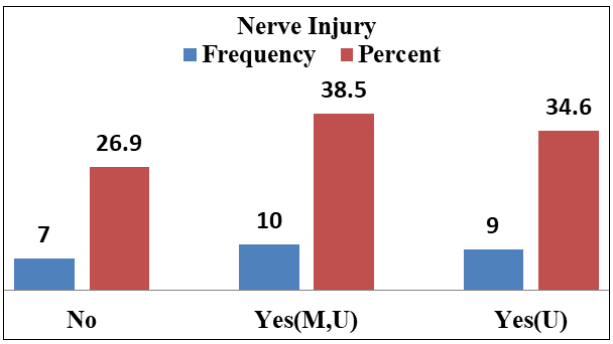

Fig 3: Distribution of the patients (n=26) according to associated nerve injury.

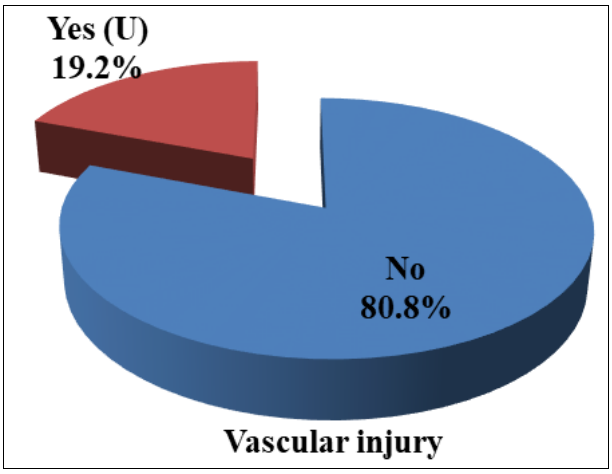

Fig 4: Distribution of the patients (n=26) according to associated vascular injury

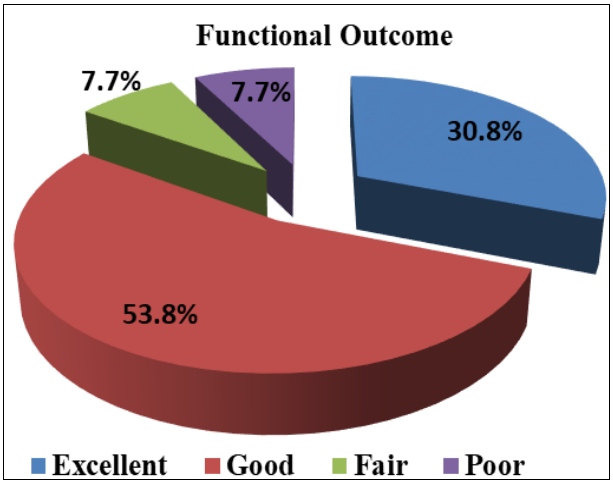

Fig 5: Distribution of the patients (n=26) according to Louisville system

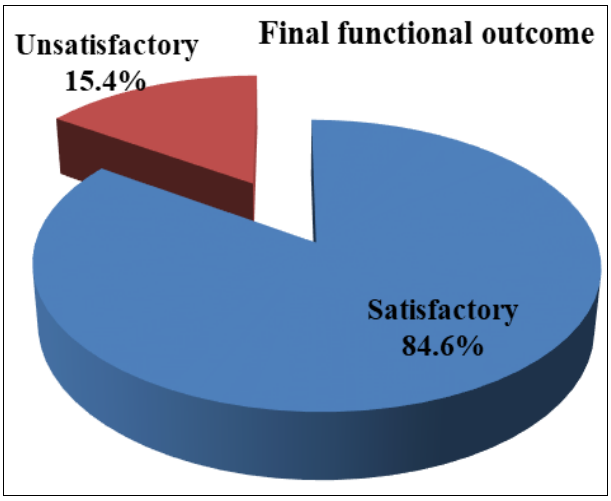

Fig 6: Distribution of the patients (n=26) according to final functional outcome.

Fig 7: Images of the same patient at 12 weeks post-operative follow-up showing hand function.

Table 1: Louisville system for evaluation of functional outcome.

Louisville system (Saini *et al*. 2010)		
Excellent	Flexion lag < 1 cm	extension lag < 15°
Good	Flexion lag 1–1.5 cm	extension lag 15°–30°
Fair	Flexion lag 1.5–3 cm	extension lag 30°–50°
Poor	Flexion lag >3 cm	extension lag > 50°

Table 2: Demographic characteristics of patients (n=26)

Patient characteristics	
Sex	
Male	20 (76.9%)
Female	6 (23.1%)
Age (Years)	29.30±9.1
Occupation	
Driver	4 (15.4%)
Service holder	2 (7.7%)
Student	2 (7.7%)
Housewife	6 (23.1%)
Glass factory worker	12 (46.2%)
Mechanism of injury	
Glass cut injury	18 (69.2%)
Knife cut injury	6 (23.15)
Road traffic injury	2 (7.7%)
Side of injury	
Right	20 (76.9%)
Left	6 (23.1%)

Table 3: Distribution of the patients (n=26) according to complication.

Complications	**Frequency**	**Percentage (%)**
Fixed flexion deformity	1	3.8
Extension lag	1	3.8
Wound infection	2	7.7
No	22	84.6
Total	26	100

Table 4: Overall functional outcome evaluation.

Functional Outcome	Tendon function	Opposition	Intrinsic function	Deformities	Sensation	Grip strength
Excellent	10(38.5%)	7(26.9%)	8(30.8%)	12(46.2%)	8(30.8%)	8(30.8%)
Good	12(46.2%)	13(50%)	14(53.8%)	14(53.8%)	14(53.8%)	12(46.2%)
Fair	2(7.7%)	4(15.4%)	2(7.7%)	-	2(7.7%)	4(15.4%)
Poor	2(7.7%)	2(7.7%)	2(7.7%)	-	2(7.7%)	2(7.7%)

Table 5: Correlation between duration of injury and functional outcome

Duration of injury	Excellent	Good	Fair	Poor	Total
Within 24 hrs	3	2	0	0	5
24 hrs to 1 month	5	10	0	0	15
1 month to 6 months	0	2	2	2	6
Total	8	14	2	2	26

Discussion

In the present study, mean age was 29.30±9.1 years. 42.3% patients belong to 16-25 years age group. Mean number of structures injured 8.62±1.65 (6-12). The minimum and maximum age of the patients were of 16 and 44 years respectively. Out of 26 patients' males were 20 (76.9%) and females were 6(23.1%). There is male predominance and Male-female ratio was 3.3:1. Occupational distribution shows, 12(46.2%) were Thai glass worker. Other patients were housewife (23.1%), driver (15.4%), service holder (7.7%) and student (7.7%). Boynuyogun *et al*. [4] found mean age of the study population was 32.7 years (range, 18-47 years). Mean follow-up was 21.9 months (range, 12-50 months).

Stefanou *et al*. (2021) [3] conducted a retrospective study where 61 patients (where 49 were males and 12 were females with an average age of 34.7 years) treated for spaghetti wrist lacerations and followed up for 2 years. They found on an average, 8.86 structures were injured in each patient including 6.83 tendons, 1.24 nerves, and 0.79 arteries. 28 patients out of 61 had more than ten structures injured (45.9%). It is similar to our study. Spaghetti wrist injury is common among male glass worker in active age group [2, 4, 6].

Out of 26 patients 20 (76.9%) had right sided injury and 6 (23.1%) had left sided injury. Right sided injury is more common than left sided injury. 18 (69.2%) patients had glass cut injury, 6 (23.1%) had knife cut injury and 2 (7.7%) had road traffic accident. Yazdanshenas *et al*. 2016 [6] found that, the commonest mechanism of injury was glass window panes and bottles. Quite similar result was also found by Stefanou *et al*. (2021) and Boynuyogun *et al*. 2021 [3, 4].

Out of 26 patients 19 (73.1%) patients had associated nerve injury. 10 (38.5%) had both median and ulnar nerve injury and 9 (34.6%) had only ulnar nerve injury. 5 (19.2%) patients had associated ulnar artery injury. Among the study population, 5 (19.2%) patients were operated within 24 hours of injury, 15 (57.7%) were operated within 1 month and 6 (23.1%) were operated after 1 month. Stefanou *et al*. (2021) in their study found that, on an average 8.86 structures were injured in each patient, including 1.24 nerves, 6.83 tendons, and 0.79 arteries. Hassan (2007) [7] found an average of 9.16 structures was injured, including 6.95 tendons, 1.4 nerves, and 0.8 arteries.

Yazdanshenas *et al*. [6] in their study found excellent tendon functionality in 78% patients, excellent opposition in 75.1% and intrinsic function in 40.5% patients. 'Fair' sensation of the hand in 49.1% patients, "good" in 30%, and "excellent" 18.3% patients.

Jaquet *et al*. [2] found the mean Functional Symptom Score 15.1 with a mean follow-up of 10.0 years (SD, 4.4; range, 2 to 18). 34.7 weeks were mean time off work and 45.2% patients could not return to work within 1 year of injury. Compared with the unaffected hand, grip and pinch strength were decreased with means of 23.5% and 33.9% respectively. Regarding sensory recovery, 27.9% had no protective sensation.

Among the study population, 4(15.4%) had post-operative complications. 2 (7.7%) patients developed superficial surgical site infection, which was treated by antibiotic and regular dressing. 1 (3.8%) had extension lag and 1 (3.8%) had fixed flexion deformity.

At final follow up, 10 (38.5%) patients have excellent tendon function and good in 12 (46.2%) patients. Excellent opposition in 7 (26.9%) patients and good in 13 (50%) patients. Intrinsic function was excellent in 8 (30.8%) and good in 14 (53.8%) patients. Deformities excellent in 12 (46.2%) and good in 14 (53.8%) patients. Sensation excellent in 8(30.8%) patients and good in 14 (53.8%) patients. Grip strength was excellent in 8(30.8%) patients and good in 12 (46.2%) patients. Yazdanshenas *et al*. [6] in their study found excellent tendon functionality in 78% patients, excellent opposition in 75.1% and intrinsic function in 40.5% patients. 'Fair' sensation of the hand in 49.1% patients, "good" in 30%, and "excellent" 18.3% patients. The average return time to activities of daily living was 10 months. Comparable result also found in other study [3, 6].

According to Louisville system **[8]** at final follow up excellent result was found in 8(30.8%) patients, good in 14(53.8%), fair in 2(7.7%) and poor in 2(7.7%) patients. Satisfactory (Excellent + Good) outcome was found in 22(84.6%) patients and unsatisfactory (Fair +Poor) outcome was found in 4 (15.4%) patients. It is comparable to other studies [3, 4, 5]. Early operation has better functional outcome as there is less adhesion and better delineation of the injured structures.

Conclusion

Spaghetti wrist injuries are a multifaceted and severe soft tissue injury of the volar aspect of the wrist which involve damage of various structures like nerves, tendons and vessels that lead to a dysfunctional hand. But early surgical repair and proper post-operative rehabilitation can lead to a fruitful outcome.

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Conflicts of interest: No

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