ORIGINAL ARTICLE

Upper extremity reconstruction and functional outcome assessment using Toronto Extremity Salvage Score (TESS)

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Abstract:
Objectives: To describe the demographics, reconstructive options for different area and defect sizes and the functional outcome of upper extremity reconstruction.
Study design: Descriptive study
Setting: Burns and Plastic Surgery Center, Hayatabad Medical Complex, Peshawar
Duration: 6-years
Material and Methods: This study was performed from 2018 to 2021 in the department of Burns and Plastic Surgery. All the patients with upper extremity defects, for which reconstruction was performed, were included in the study after informed consent. The data was collected from hospital record and functional outcome was assessed based on the Toronto Extremity Salvage Score (TESS) questionnaire after 6-months of reconstruction. All the data was organized and evaluated with the help of statistical software.
Results: A total of 67 patients were included in the study including 51(76.1%) male and 16(23.9%) female patients with age ranging from 5 weeks to 65 weeks (mean 30.27+14.9 SD). Right upper extremity was affected in 61.2 % (n=41). The main cause of injury was electric burns and machine injuries, accounting for 26.9% each. Hand was the mainly affected region. The most commonly performed flap in our series was retrograde posterior interosseous artery flap (n=14, 20.9). Insignificant partial flap necrosis was observed in 3 (4.5%). Post-operative TESS score ranged from 40% to 99% with a mean of 85.4+14.9SD.
Conclusion: There are multitude of options available for upper limb reconstruction. Functional outcome should be assessed using standardized tools like Toronto Extremity Salvage Score (TESS). This will lead to standardization of treatment modalities in such patients.

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Introduction:
A major share of plastic surgery out-patient department comprises of patients presenting for upper limb reconstruction. Some of the frequently seen patients are patients with upper limb trauma, burns, post-burn sequelae and tumors.[1-6] These cases have steadily increased over time due to increase in road congestion, urbanization and lack of proper safety equipment in the workshops and factories.[2]

Usually the working class male population is prone to upper limb injuries in road traffic accidents and in factories. These are usually the sole bread earners for their family. Hand injuries in these patients significantly adds to the financial strain on these families. The disability adjusted life years (DALY) are years of life lost due to hand injuries have been significant during the past few decades.[7]

Hand injuries if not treated in a timely manner, can cause complications for the patient in terms of protracted recovery and sub-optimal hand function.[8,9] It can also cause lead to loss of productivity in the industry and decrease in

Table 1: Mechanism of Injury

Mechanism of Injury	Frequency (n)	Percent (%)
Blast Injuries	13	19.4
RTA	4	6
Electric burns	18	26.9
Skin malignancy excision	2	3.0
Machine injuries	18	26.9
Avulsion injury	2	3.0
Contracture	7	10.4
Congenital	1	1.5
Infection	2	3.0
Total	67	100.0

Table 2: Anatomical site involved

Site	Frequency (n)	Percent (%)
Shoulder	1	1.5
Hand	2	3.0
1st Web Space	5	7.5
Web Creap	2	3.0
Forearm, Hand	4	6
Elbow	4	6
Forearm	9	13.4
Wrist	2	3.0
Dorsum of Hand	9	13.4
Palm	1	1.5
Thumb	16	23.9
Digits	12	17.9
Total	67	100.0

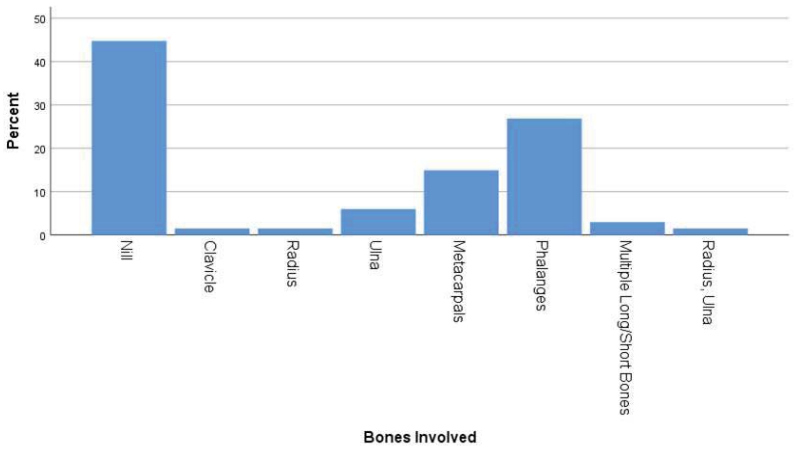

Figure 1: Distribution of fractures in the study population

cost-effectiveness. There is limited data available regarding the scale of this problem. As hand injuries are becoming increasingly common, we aim to describe the demographics, re-constructive options for different area and defect sizes and the functional outcome of upper extremity reconstruction

Material and Methods:

This study was performed from 2018 to 2021 in the department of Plastic & Re-constructive Surgery. All the patients presented with soft tissue defects, irrespective of the etiology, were included in the study population. Patients with systemic co-morbidities and those requiring re-implantation were excluded. After informed consent, all the data regarding the demographics, mechanism, time since injury and reconstruction, flap type and post-operative complications. Defect size was classified into small (<5cm), medium (5cm to 10 cm) and large (>10cm) defects. Post-operative necrosis was divided into insignificant partial (does not required secondary reconstructive procedure), significant partial (required a secondary reconstructive procedure) and complete necrosis. The patients functional evaluation was performed with the help of Toronto Extremity Salvage System (TESS) proforma for upper extremity, six months post-operatively. All the data was organized and analyzed with the help of statistical package for social sciences (SPSS).

Results:

A total of 67 patients were included in the study including 51(76.1%) male and 16(23.9%) female patients with age ranging from 5 weeks to 65 weeks (mean 30.27+14.9 SD). Right upper extremity was affected in 61.2% (n=41). The main cause of injury was electric burns and machine injuries, accounting for 26.9% each as shown in table 1. Most of the defects were small size (35.8%) followed by large and medium size defects, accounting for 32.8% and 31.3% cases respectively. Different regions of the hand were affected by 76.2% of the defects as shown in table 2. Out of the total study population, 55.2% (n=37) patients presented with fractures of the associated bones (Figure 1). The time of presentation to our department for reconstruction

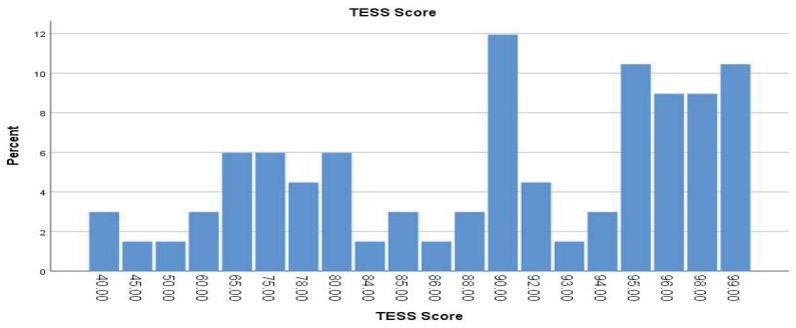

Figure 2: Six monthly post-operative TESS score of the study population

Table 3: Types of flaps performed in the study population

Types of flaps	Frequency (n)	Percent (%)
Pedicled LD	1	1.5
Cross Finger Flap	3	4.5
Litteral's Flap	2	3.0
FDMA	11	16.4
V-Y Flap	2	3.0
Bilateral V-Y Flap	1	1.5
Abdominal Flap	10	14.9
Groin Flap	1	1.5
Free ALTF	4	6.0
Free LD	1	1.5
Dorsal Index Finger Transposition Flap	4	6.0
V-M Plasties	2	3.0
Venkatswami Flap	2	3.0
Qwaba Flap	1	1.5
Moberg Flap	1	1.5
Retrograde Lateral Arm Flap	2	3.0
Antigrade Radial Forearm Flap	1	1.5
Antigrade PIA	1	1.5
Retrograde PIA	14	20.9
Dorsal Ulnar Artery Perforator Flap	2	3.0
Dorsal Hand Flap	1	1.5
Total	67	100.0

Figure 3: a. Patient had high voltage electrical burns to right distal forearm endangering vascular supply to the hand. Fasciotomy and debridement of necrotic tissue done previously. Radial artery is thrombosed. Patient suffered from blow back of ulnar artery B. After Ulnar artery blow back, Anterolateral thigh flow through free flap was planned. Markings for ALTF are shown. C. Follow-up after 6 months

ranged from 1 week to 12 weeks with a mean of 1.98+1.75SD. The time of re-construction after the injury ranged from 1 week to 13 weeks (mean 2.85+1.97SD). The most commonly performed flap in our series was retrograde (reverse) posterior interosseous artery flap (n=14, 20.9%) followed by first dorsal metacarpal artery (FDMA) flap and abdominal flap, each accounting 16.4% (n=11) and 14.9% (n=10) cases respectively (Table 3). In 80.6% (n=54) cases, re-construction was performed in single stage, while in the remaining cases, reconstruction was completed in two stages. In-significant partial and complete flap necrosis was observed in 3(4.5%) and 2(3%) cases respectively. The second most common complication observes was infection (n=2, 3%). Post-operative TESS score ranged from 40% to 99% with a mean of 85.4+14.9 SD as shown in figure-2.

Discussion:

Most of our patient population were adult males. Several other studies show that upper limb injuries are more common in males.[2,10,11] Young adults are the most common demographic that sustains the hand injuries.[12] In some countries, the pediatric population is more prone to hand injuries as compared to adults. This could be because of good occupational and road safety in those regions.[2]

Most of our patients presented to our out-patient department after a delay of a few weeks. Most likely cause was that patients from remote rural areas get their initial treatment locally and getting to a major center for treatment can be a costly journey for them. Another reason is lack of infra-structure in remote areas and lack of proper referral system.

In most of the cases reconstruction was done in a single stage. Those were the patients who had already undergone initial emergency treatment in the ER and were ready for re-construction. Functional outcome in our cases was assessed using TESS scoring system and was good. Functional outcome usually depends on the types of injuries and involvement of neuro-vascular elements in hand injury.[13] Hoftiezer et al. also

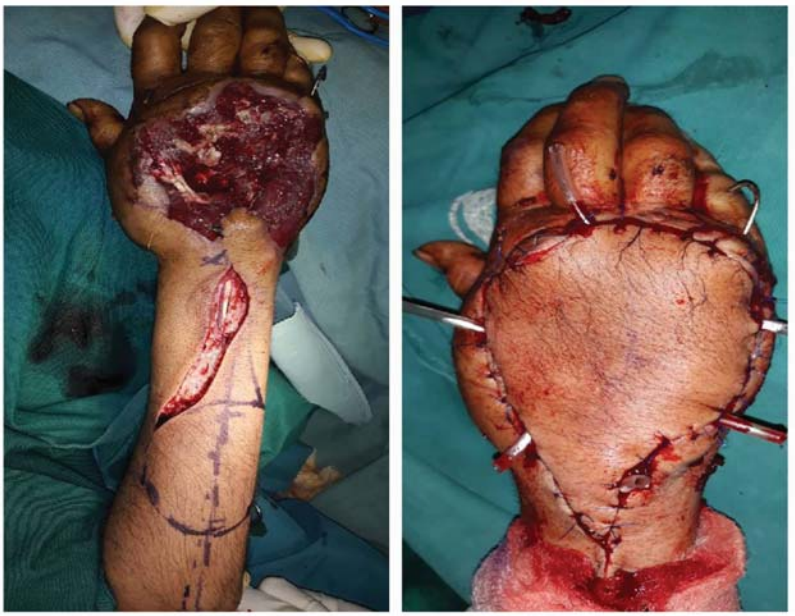

Figure 4: A. Bomb blast injury to the dorsum of the hand. Posterior interosseus artery (PIA) flap designed as shown. B. Wound was debrided and PIA flap inset. Drains placed to prevent hematoma formation

Figure 5: A. Wound over elbow joint after road traffic accident. B. Pedicled radial forearm flap done for wound coverage.

reported similar TESS scores in their cases of upper limb reconstruction.[14] Injury or exposure of neuro-vascular structures can prolong the treatment for such cases.[15] Mangled injuries usually required aggressive debridement before re-construction. Georgescu et al. also showed prolonged recovery time in these patients.[16] The outcome in these patients depends upon the complexity of the injury.[16]

Our limitations are the retrospective nature of this study. Many variables that we wanted to study could not be included because of the retrospective nature of this study. However tis study provides valuable insight into the field of upper limb reconstruction.

Not many articles are present which assess the functional outcome of hand after re-construction. Further large studies need to be done and standardized tools for assessing functional outcome should be developed.

Conclusion:
There are multitude of options available for upper limb reconstruction. Functional outcome should be assessed using standardized tools like Toronto Extremity Salvage Score (TESS). This will lead to standardization of treatment modalities in such patients.

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Role and contribution of authors:
Mansoor Khan, collected the data, references and wrote the article.

Waqas Hayat, collected the data and helped in introduction writing.

Hidayat Ullah, collected the data and helped in interpretation of the data.

Rashid Khan, collected the references and helped in discussion writing.

Nasir Hayat Khan, collected the data, and helped in result writing.

Qazi Amjad Ali, critically review the article and made final changes.

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