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Superficial Inferior Epigastric Artery (SIEA) Flap is the Armamentarium for the Coverage of Large Complex Wounds on Dorsum of Hand in a Regional Medical College Hospital

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Abstract **Original Research Article**

As hand is a functional part of the body, dorsal surface of digits, hand and wrist is prone to injury causing complex wound. Thin, mobile and supple skin of the dorsal wrist and hand make significant for hand functions and aesthetic. Aims of the study were feasibility of the flap in terms of survivability of Superficial Inferior Epigastric artery (SIEA) flap, complications of flap and measurement of functional & aesthetic outcomes to achieve the reconstruction goal in hugely burden regional medical college hospital. 11 SIEA flaps were done in Rajshahi Medical College Hospital from August 2019 to July 2021 on both hands among both male and female patients. Only 2 (18.18%) flaps were lost partially. Almost all the wounds were covered successfully with good functional and aesthetic outcome. So, SIEA flap is the one of the best workhorses for extensive dorsal complex wound in overburdened regional medical hospital in Bangladesh.

Key words: SIEA flap; complex dorsal hand wound; complications; functional and aesthetic outcomes.

INTRODUCTION

Complex wound of hand is significant loss of skin, soft tissue with injury or exposed of bones, joints, tendons and neurovascular structures causing anatomical and functional instability [1, 2], and large wounds mean involving more than two contagious metacarpal dorsal surfaces where skin graft or direct closure is not amenable [3]. As hand is a functional part of the body, dorsal surface of digits, hand, and wrist is prone to machinery crush and degloving injuries and both hard and soft tissue are exposed [4]. Thin, mobile and supple skin of the dorsal wrist and hand make significant for hand functions and aesthetic [5, 6]. Dorsal hand complex large wounds require a good coverage option; So that, future reconstruction can be done to maintain optimum hand anatomy and functions [4]. There are many options like, regional flaps (Posterior interosseus artery flap, ulnar or radial artery perforator-based flaps); distant flaps (SIEA flap or groin flap) or free flaps. Free flap requires a unique facility and long operative time; whereas regional flaps are not suitable for large defect [3] and require inconspicuous skin graft on donor site in same limb which may create hurdle for future tendon reconstruction. Here, our choice was SIEA flap for coverage on large complex dorsal wounds. Though it takes two stages (first stage for flap harvesting and second stage for flap division & insetting) but it is simple, less time-consuming operation and requiring minimum facilities to achieve reconstructive goal. Aims of the study were feasibility of the flap in terms of survivability of flap, complications of flap and measurement of functional & aesthetic outcomes in hugely burden regional hospital.

PATIENTS AND METHODS

This prospective observational study was conducted by both Burn and Plastic surgery and Hand surgery department in Rajshahi Medical College Hospital from August 2019 to July 2021. We included all the patients with large complex dorsal hand injury

admitted in either department. But those who had life threatening co -morbidities or injuries and did not give consent for distant flap coverage were excluded. After fulfillment of criteria, we did SIEA flap among 11 patients for coverage of dorsum of hand with or without dorsum of digits and distal forearm. As SIEA is a two-stage surgery, after proper preoperative optimization and counseling, in first stage, under general anesthesia wound excision was done and we measured wound, designed flap and then SIEA flap (Fig.1) was harvested and wound closure were done. All the patients positioned in supine and/ or right/ left lateral side according to uninjured hand after first stage for 7 to 10 days. Then, mobilized the patient and passive movement of injured hand was done before second stage. At least after three weeks, in second stage, under regional or general anesthesia, flap division and in setting with passive stretching of shoulder and elbow joints were done. Same time donor site wounds were closed by direct repair or Split thickness skin graft (STSG). After checking both wounds in injured hand and in donor site at 3rd postoperative day in case of direct closure of donor wound or at 5th postoperative day in case of those who had STSG. All patients were given volar splint on injured limb for at least 2 weeks then passive movement was given. After 3 weeks patients were advised for both active and passive exercise and continuing intermittent splint for another 3/4weeks. After 6 months of first stage of operation patients in follow up session we measured functional outcome in terms of active movement in wrist, Metacarpophalngeal joint (MCPJ) and joint of digits. Those who had normal wrist movement, were in Excellent group and who had 10–20-degree flexion restriction was in good and who had >20 degree restriction of flexion were in poor group and incase of MCPJ and PIPJ & DIPJ, those had normal range of movement were in Excellent group and who had <30 degree flexion restriction were in good; and who had >30 degree restriction of flexion were in poor group (1 point). Five-point Likert grading scale (Fig. 2) [4] was used for measurement of colour and contour match of the flap with injured hand by 3 persons (patient, nurse, patient's attendance). Each flap scored average of points given by them. As average score of three persons was in fraction, we divided all the patients in five groups in qualitative data analysis eg. Excellent (>4 to 5), Good (>3 to 4), Satisfactory (>2 to 3), Poor (>1 to2); and Unacceptable (1).

Strongly disagree: 1 Disagree: 2Neither agree nor disagree: 3 Agree: 4Strongly agree: 5

Scoring:

Patient	**Nurse**	**Patient's attendant**	**Average**
Contour matching with normal hand tissue	**a**	**b**	**c**	**(a+b+c)/3**
Colour matching with normal hand tissue	**a**	**b**	**c**	**(a+b+c)/3**

Fig-2: 5- point Likert grading scale

All data analysis was done in Microsoft Excel 2010.

RESULTS

11 SIEA flaps were done on 6 left and 5 right side of the hand of same number of patients; among them 8 were male and age range was 18 - 66 years. Mostly (36.36%) soft tissue defect of dorsal hand was due to degloving injury by either heavy sharp weapon or machine. Demographic features of the study were shown Table 1. Distribution of wound was shown in Table 2. Largest size of complex wound was 30X10 cm^2 and largest dimension of the flap was 25X 12 cm^2. Mean operating time was 142.73 ±27.87 minutes and mean duration between two stages was 23.18 ± 2.18 days. 9 flaps were survived except 2 flaps required secondary procedure for wound closure. Complications of the flap were shown in Table3. 6 patients were required STSG for donor site closure.10 patients had normal wrist movement and three patients had restriction of flexion up to 30 degree at Metacarpophalngeal joint (MCPJ) and 10 patients had good functional outcome, shown Table 4. In aesthetical outcomes of the flap, excellent contour and colour matching were 27.27% and 54.54% respectively Figure 5.

Table-1: Distribution of variables of the study (n= 11)

Variables		
Age	Range	18-66 years
	Mean (SD)	37 ± 16.37 years
Sex	Male (%)	8 (72.72%)
	Female (%)	3 (27.27%)
Cause of wound	After wide local excision of Marjolin's ulcer	1 (9.09%)
	Machinery crush injury	2 (18.18%)
	Degloving injury	4 (36.36%)
	Release of PBSC	1 (9.09%)
	Electrical burn	3 (27.27%)
Injured side	Right	5 (45.45%)
	Left	6 (54.55%)
Wound dimension	Largest	300 cm^2
	Smallest	40 cm^2
	Mean (SD)	110.09(± 73.45) cm^2
Flap dimension	Largest	300 cm^2
	Smallest	66.5 cm^2
	Mean (SD)	137.77 (±69.44)cm^2
Operating time		
	Range	110- 205 min
	Mean (SD)	142.73 (±27.87) min
Interval between two stage		
	Range	21- 28 days
	Mean (SD)	23.18 (± 2.18) days
Hospital stay		
	Range	25- 66 days
	Mean (SD)	29.72 (±12.17) days
	Mean (SD)α	26.12 (±1.97)days

PBSC= Post burn scar contracture; α= excluding outlier (Case no 1)

Table-2: Characteristic of wound and flap dimension for coverage

Case no	**Side of injured hand**	**Site of wound**	**Wound dimension (cm^2)**	**Flap dimension (cm^2)**
1	Right	Mid dorsum of forearm to dorsum MPX of little ring middle and index fingers	300	300
2	Left	Dorsum of hand and PPX of index, ring, little and PPX & MPX of middle finger	140	186
3	Left	Dorsum of hand up to MCPJ of index, middle, ring & little fingers	80	110
4	Left	Dorsum of hand with PPX of little & ring fingers	99	126
5	Right	Dorsum of hand with PPX of index n middle fingers	80	99
6	Right	Dorsum of hand; distal forearm and PPX of index, middle& ring fingers	126	150
7	Left	Dorsum of hand	48	70
8	Right	Dorsum of hand and distal forearm	60	88
9	Right	Dorsum of hand; distal forearm and PPX of index, middle, ring & little	160	204
10	Left	Dorsum of hand, distal forearm and PPX of thumb, Index	78	116
11	Left	Dorsum of hand	40	66.5

MPX= Middle phalanx; PPX = Proximal phalanx; MCPJ= Metacarpophanlangeal joint

Table-3: Distribution of Flap complications and Donor site closure

Variable		
Survivability		
	No loss	5 (45.45%)
	Marginal loss (<1 cm)	4 (36.36%)
	Partial loss (>1 cm to 1/3rd of flap)	2 (18.18%)
Wound dehiscence+		
	Present	2 (18.18%)
	Absent	9 (81.82%)
Wound infection*		
	Present	2 (18.18%)
	Absent	9 (81.82%)
Donor site closure		
	STSG	6 (54.55%)
	Direct closure	5 (45.45%)

+= Wound dehiscence means Flap loss that warrants for further procedure

*=Infection means discharging pus

STSG= Split thickness Skin Graft

Table-4: Flap outcome

Outcome			
Functional outcome			
	Active Wrist movement		
		Excellent (Normal Range)	10(90.91%)
		Good (10-20 degree of flexion restriction)	1 (9.09%)
		Poor (>20 degree of flexion restriction)	0 (0.0%)
	Active MCPJ, PIPJ and DIPJ movement		
		Excellent (Normal Range)	7 (63.64%)
		Good (10-30 degree of flexion restriction)	3 (27.27%)
		Poor (>30 degree of flexion restriction)	1 (9.09%)
Aesthetic outcome			
	Contour matching	Excellent (>4 to 5 points)	3 (27.27%)
		Good (>3 to 4 points)	4(36.36%)
		Satisfactory (>2 to 3 points)	3(27.27%)
		Poor (>1 to 2 points)	1 (9.09%)
		Unacceptable (1 point)	0 (0.0%)
	Colour matching		
		Excellent (>4 to 5 points)	6 (54.55%)
		Good (>3 to 4 points)	2 (18.18%)
		Satisfactory (>2 to 3 points)	1 (9.09%)
		Poor (>1 to 2 points)	2 (18.18%)
		Unacceptable (1 point)	0 (0.0%)

MCPJ: Metacarpophalangeal joint; PIPJ: Proximal interphalangeal joint; DIPJ: Distal interphalangeal joint

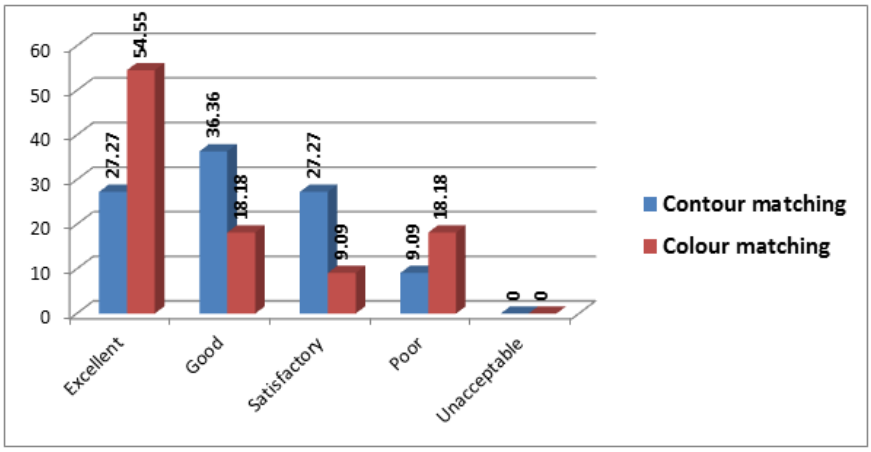

Fig-5: Colour and contour matching of the SIEA flap

DISCUSSION

SIEA fasciocutaneous flap is two staged surgery. Merits of this procedure are; good, robust and reliable flap based on known axial vessels; adequate coverage of the dorsal hand complex wound and even for wounds extending from forearm to digits; having enough tissue to design according to wound dimension that is not possible in Superficial circumflex iliac artery (SCIA) flap or regional flaps even pedicle may be injured; not demanding unique facilities regarding expert team, operating microscope or special instruments which are required in Free tissue transfer and having privilege further bony and tendon reconstruction [3]. Though regional flaps e.g. Posterior interosseus artery (PIA) flap or perforator-based forearm flaps do not require as much facilities as Free tissue transfer, but they are not suitable for extensive dorsal hand defect [3, 4] Acharya MA *et al*. [7] showed mean flap size was 51cm^2 whereas Fernández *et al*. [8] showed largest one was 45 cm^2 for dorsal wound coverage by PIA flap. Jang HS *et al*. [9] showed only 40cm^2 dorsal defect by ulnar artery perforator flaps, whereas, Medalie DA *et al.* [10] showed that largest dorsal hand defect measuring 56 cm^2 was covered by Radial artery perforator flaps.

In this study, most of the wound due to Machinery crush and degloving injury. Parrett BM, Bou-Merhi JS *et al*. [4] showed that most of their cases were dorsal hand and forearm due to same reasons.

SIEA flaps were done in the study period on either right or left hand of each patient. Complex wounds on dorsal hand with or without extending to dorsal forearm and fingers ranging from 300 cm^2 to 40 cm^2 and Mean wound size was 110.09 ± 73.45 cm^2 and mean flap dimension was 137.77 ± 69.44 cm^2 ranging from 300 – 66.5 cm^2. Though largest flap was harvested for coverage of the largest wound on dorsal mid forearm to PIPJ of index, middle, ring and little fingers, STSG were required for proximal wound on forearm.

Mean operating time was 142.73 ± 27.87 minutes; range for 10 cases 110 to 160 minutes; another one case which required 205 minutes because of large area for wound excision (case no 1). Mean interval between two stages was 23.18 ± 2.18 days, ranging from 21 to 28 days. Variation of gap was due to scheduling of operation day. Average hospital stay of 10 cases was 26.2 ± 1.97 days after first stage of surgery. Only case 1 stayed 66 days because of partial flap loss (4X 5 cm^2) with exposing proximal and middle phalanx of right index and middle fingers requiring groin flap for coverage causing prolong hospital stay. Another case had partial flap loss, wound was covered by STSG. Rest of 9 cases had neither wound dehiscence nor second procedure for coverage. 2 cases had wound infection and controlled by antibiotics according to wound swab culture sensitivity report. In 5 cases (45.45%) donor site repaired by direct closure and rest required STSG. Dhopte *et al*. [11] showed 1 (2.08%) flap had marginal loss and 1 partial flap loss after division among 47 SIEA flaps. Jabaiti *et al*. [12] showed 4 (11.8%) had partial loss and 1 was compete loss among 34 abdominal flaps for dorsal hand and forearm coverage.

Functional outcome was measured by restriction of movement of wrist joint, MCPJ; PIPJ and DIPJ after 6 months of second stage of surgery. 10 cases (90.90%) had normal wrist joint movement and only one case had 10 degree restriction of flexion. 7 patients (63.63%) achieved normal MCPJ movement; only 3 patients developed up to 20 degree flexion restriction at MCPJ movement and in one case (case 1), PIPJ flexion restriction was 30 degree and advised for further operative management.

Three patients scored 4 point in contour matching and one patient scored 5 point in colour matching in 5-point Liket grading scale. Excellent and good contour matching was in 3 and 4 patients respectively. Among three, two female patients were not satisfied their contour due to bulky abdomen resulting in bulky flap. 6 patients had Excellent and 2

patients had good colour matching. Similar data showed by Dhopte *et al*. [11] showed satisfactory contour matching. And Parrett *et al*. [4] showed in their study that 42 fasciocutaneous free flaps average score was 1.95 point in contour matching and 2.52 in clour matching and 88% requiring debulking surgery. In our study, average score were 3.48 and 3.79 in contour and colour matching respectively.

CONCLUSION

SIEA flap is simple and non-time-consuming surgery and is not required special facilities. But it gives durable coverage of dorsal hand reconstruction for good outcomes both in functional and aesthetic aspect. So, SIEA flap is the one of the best workhorses for extensive dorsal complex wound in overburdened regional medical hospital in Bangladesh.

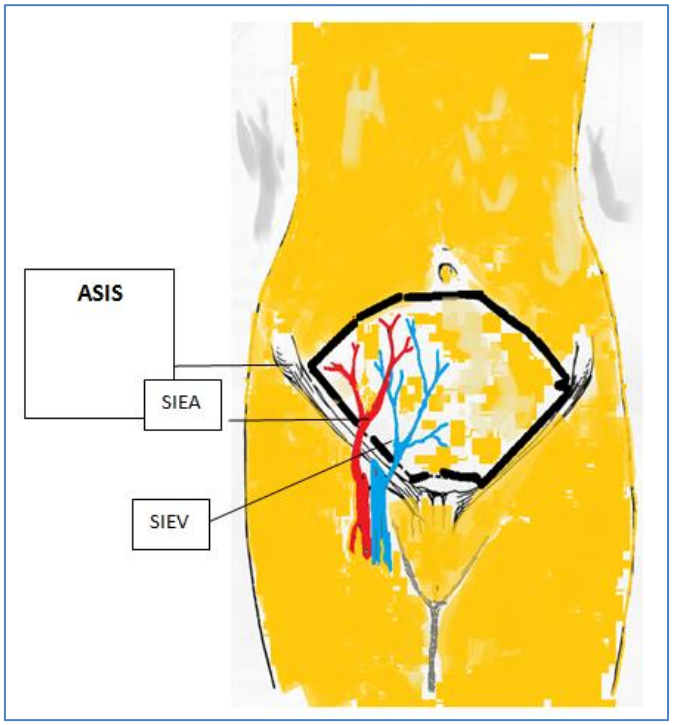

Fig-1: Area Superficial Inferior Epigastric Artery Flap. ASIS: Anterior Superior Iliac Spine. SIEA: Superficial Inferior Epigastric Artery. SIEV: Superficial Inferior Epigastric Vein

Fig-3: Case1: a.Machinery crush injury on right dorsal forearm, hand , index,middle,ring and little fingers;b. after excision of wound c. 25 X12 cm2 flap inset; d. partial flap loss exposing PPX of index and middle fingers and managed by groin flap (e)

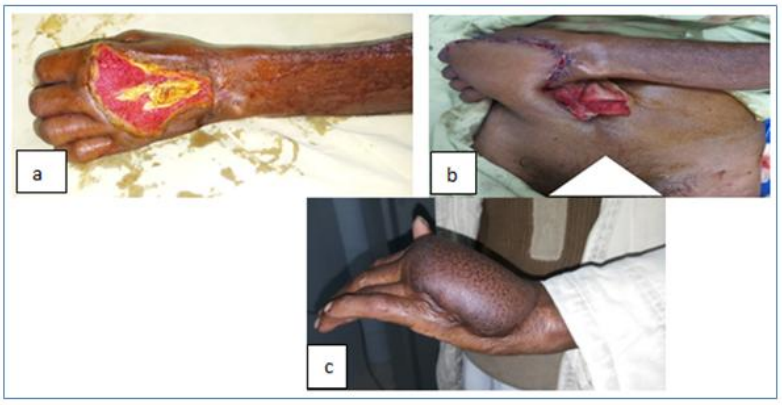

Fig-4. a) Dosal hand (left) injury due to havey sharp weapon (b) after flap inset (c) after 6 months of flap division; colour matching near to normal hand tissue but bulky

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