Evaluation of Full-Thickness Skin Grafting with De-Epithelialization of the Wound Margin for Finger Defects with Exposed Tendon

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ABSTRACT:

BACKGROUND:

Full-thickness skin grafts are generally considered unreliable for coverage of full-thickness finger defects with exposed tendons, but there are some clinical reports of its use in this context. In this study, covering the exposed tendon with FTSG with de-epithelialization of wound edges was chosen.

OBJECTIVE:

To evaluate the reliability of FTSG survival on an exposed tendon in full thickness finger defects.

PATIENTS AND METHODS:

From January 2017 to May 2018, nine patients (5 males, 4 females), with tendon-exposed defects of 12 fingers managed with FTSGs.This included marginal de-epithelialization of the normal skin surrounding the defect, and preservation of the subdermal plexus of the central graft, and partial excision of the dermis along the graft margin. The donor site was from mastoid, wrist or groin region.

RESULTS:

Most of grafts (10 of 12 fingers) survived without significant surgical complications and achieved satisfactory functional and aesthetic results.

CONCLUSION:

In this study graft survival was good, with no additional surgical injury of the normal fingers, and satisfactory functional and aesthetic outcomes. However, few disadvantages like depression and graft hyperpigmentation were recorded. Therefore, FTSG is an option for treatment of full-thickness finger defects with the exposed tendon.

KEYWORDS: Skin graft, exposed tendon.

INTRODUCTION:

One of the most frequently injured part of the body is the hand[1].successful management of traumatic soft tissue loss of hand usually depends on adequate tissue coverage that provides an adequate function to the hand with acceptable appearance[2].The skin of the hand had great disparity in character, where the dorsal skin is thin, pliable with vulnerable to avulsion injury[3].in contrast glabrous palmar skin is thick, immobile and firmly attached to the underlying tissue by multiple septa[4].

When repairing soft tissue defects of the hand, reconstructive ladder should be respected and the goals of reconstruction is to restore sensate functional hand with acceptable appearance[5].

There are multiple options including healing by secondary intention, primary closure, skin graft and flaps whether local, distant or free flaps. using these flaps depends on size, location, and characteristic of tissue loss.[6] There are various flaps including: Hueston flap, laterodigital flap, vascular island flap based on the palmar digital artery, cross-finger flap and kite flap.[7]

Provided the area of the defect is small, many studies concluded that skin graft could survive over bare bone, tendon and cartilage. In these studies, skin graft survival was dependent on bridging phenomenon, where the skin graft vascularization provided from its periphery rather than from its bed as in the classical way.[8]

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As the avascularized tissue is freely transferred, the SG take largely depends on rapid revascularizations. The recipient site should be clear of necrotic, infective, or avascular elements to maximize skin graft take.[9] lee et al. study, is used in this study.

PATIENTS AND METHODS:

Between January 2017 and May 2018, nine patients (5 males and 4 females), with twelve fingers were included in this study, their ages ranged between 5 and 70 years. Six of them were presented to the emergency department with soft tissue loss associated with exposed tendon due to trauma, and three patients had exposed tendons as a result of elective release of post-burn contracture. All cases were operated upon at teaching hospitals (Al-Wasity hospital and Ghazi Alhariry hospital).

In this study the FTSG (Full Thickness Skin Graft) with de-epithelization of wound edges were used for finger defects with exposed tendon, the mean defect size was 2.5*2 cm², the exposed area of tendon was up to 10 mm wide.

No tendon injury or bone fracture was included in our series; patients' data are shown in table (1).

History was taken from patients including age, dominant hand, time of injury and mechanism of injury. Physical examination was done focusing on assessment of site and size of defect, associated injury, degree of contamination of the wound, and evaluation of vascular and neurological status of involved digit. X-ray was taken for all of the patients included in this study both in AP and lateral view to exclude any fracture, dislocation or foreign bodies. Photographs and Informed consent was taken from all of our patients preoperatively.

The intervention was made within five days of traumatic finger injuries, and mature scar of post burn contracted fingers were selected (not less than 6 months after trauma). Those patients with severe crushed finger injury and mutilated hand were excluded from this study, any bone fracture or open joint injury was also excluded from the study.

Table 1: Patients' data

Patient No.	sex	age	Type of injury	Site of defect	Size of defect in Cm^2	Donor site	Graft survival	Follow up	Secondary deformities
1	m	57	acute electrical burn	volar in Rt. little &Rt.Ring	ring=3*2.5 little=2*2.6	groin	complete partial loss	8 months	Depression hyperpigmen tation
2	f	70	degloving injury by sharp object	volar in Lt.middle & Lt.ring	index=3*4 middle=2*1.5	groin	complete	6 months	none
3	m	24	crush injury by heavy object	volar in Lt.middle & Lt.index	middle=2.2*2.6 index=2.4*1.5	wrist	complete	9 months	PIP joint stiffness none
4	f	10	post burn contracture	volar in Rt. index	index=2*1.5	mastoid	complete	6 months	none
5	m	27	post burn contracture	volar in Rt.little	little=2*1.5	wrist	complete	6 months	none
6	m	42	crush injury by heavy object	volar in Rt. ring	ring=3*2	groin	complete	6 months	none
7	m	20	degloving injury by sharp object	Dorsolateral in Lt. little	little=3*2.6	groin	Partial loss	6 months	Hyperpigmentation-depression
8	f	5	post burn contracture	volar in Rt. little	little=2*1.6	wrist	complete	6 months	none
9	f	38	degloving injury by sharp object	dorsal in Rt. ring	ring=2*2	mastoid	complete	6 months	none

Operative Technique

All operations were done under general or regional anesthesia (with sedation) under tourniquet control. The operation began by excision and debridement of dead necrotic tissue by using scalpel or sharp scissors, the excision continued until all dead tissue is removed and healthy wound bed is achieved.

The exposed tendon was lightly debrided by blunt curette without excision of any healthy tissue; while in post burn contracture fingers, complete release of contracted tissue was done. K-wire was inserted into both the proximal and distal interphalangeal joints keeping the metacarpophalangeal joint freely movable (k-wire was used in 4 patients, 5 fingers) while 5 patients kept on POP slab. Then by using no.15 scalpel or sharp scissors, the margins of healthy skin surrounding the defect were de-epithelialized at least for 3mm, this will provide a new vascularized healthy tissue bed for receiving the skin graft.

Then donor site of full thickness skin graft is chosen according to defect size. Mastoid region was chosen for small defects (<2 cm), and the wrist region in patients who refused mastoid site as a donor, while for large defects FTSG was harvested from groin region (>2 cm). The donor site was injected of at least 3 ml of xylocaine 2% with 1:100000 adrenaline. FTSG harvested by using scalpel and the donor site is closed in layers.

The FTSG then defatted by using sharp scissors, the fascia and fat tissue trimmed from its under surface, keeping the subdermal plexus and scanty fat tissue on its central part, which will eventually cover the exposed tendon. Then the peripheral margin of FTSG is converted to STSG by excision of the deep dermis by careful use of sharp scissors; as in (Fig. 1).

The SG was sutured to the recipient area by using 6/0 nylon, the previously de-epithelialized margin of the wound (3mm) will receive the peripheral margin of the FTSG which was converted to STSG, while the exposed tendon will receive the central part of FTSG which contains scanty amount of fatty tissue. Tie-over dressing was applied to the recipient area and simple dressing to donor site. All patients were discharged on the first postoperative day, and the dressing is changed on the 4th postoperative day, the wound is inspected every three days for at least 2 weeks to ensure complete graft intake.

At 14th day postoperatively, the k-wire or POP slab is removed, and the patient is instructed to do active range of motion exercise. The fingers were kept for at least 3-4 months in bandage with topical moisturizer (Vaseline) and massage. The patients were followed up for at least 6-months post operatively. In every visit, photographs were taken.

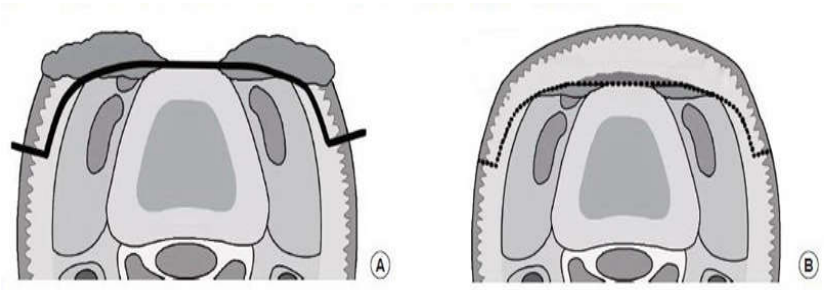

Figure 1: Operative technique [10]

A: De-epithelialization of wound margin

B: Application of FTSG to wound center, and the STSG to wound edge.

RESULTS:

Nine patients with 12 fingers were evaluated in this study. The causes of the defect were; crushed injuries in 3 fingers, acute electrical burn in 2 fingers, de-gloving injury in 4 fingers, and an elective post burn contracture in 3 fingers. The sites of defects were in the volar area of 9 fingers, dorsal area in 2 fingers, and in one finger the defect was in dorsolateral area, the defects were in Rt. hand of five patients, and Lt. hand of four patients. Of the 12 involved digits, the middle finger was involved in 2 cases, ring finger in 4 cases, and index finger in 2 cases and little finger in 4 cases. Donor site was from the mastoid in 2 cases, and for those defects larger than 2-5cm, the donor site was from groin region (4) cases, and 3 cases from wrist area.

Ten grafts (out of 12 fingers) survived completely, with good functional and aesthetic results.

Regarding functional point of view, the grafting resulted in durable coverage without interference with tendon gliding in those cases with exposed tendon. Regarding aesthetic point of view, all grafts had an acceptable appearance with slight hyperpigmentation (especially seen in those grafts which were harvested from groin region and wrist), this hyperpigmentation faded gradually during follow up period which was extended up to 6 months postoperatively.

Most of our patients were satisfied with their postoperative finger appearance. Two of our patients had slight depression in skin graft (one of them who has partial loss of skin graft), but in general those patients had no complaints about this slight depression and they don't ask for any secondary surgical revision. One patient had stiffness in PIP joint due to trauma itself.

Figure 2: Case no.9

a) Patient with de-gloving injury, defect on dorsum of Rt. Ring finger
b) Defect size after wound margin de-epithelialization 3mm, **c)** FTSG from mastoid, d) Fixation of SG to defect
e&f) After 2 months
g&h) After 6 moth follow up.

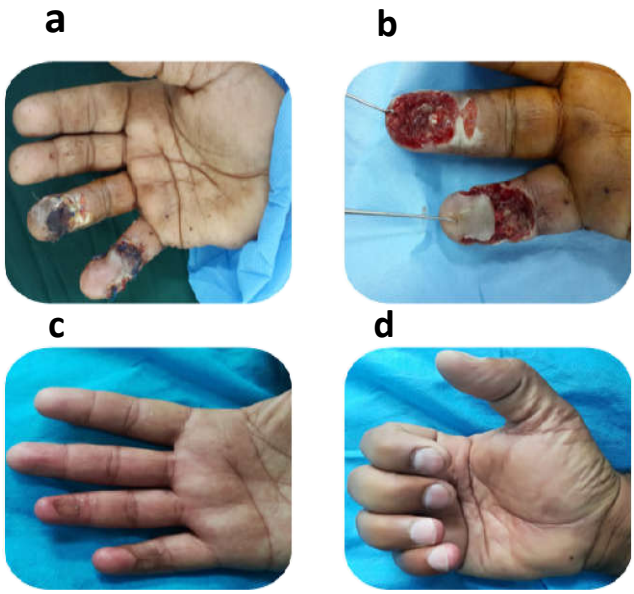

Figure 3: Case no.1
a) Patient with acute electrical burn to Rt. little &ring fingers,
b) After wound debridement,
c&d) After 6 months follow up.

DISCUSSION:

The take of free SG depends on its early and efficient revascularization which directly depends on blood supply from the wound bed. The classic plastic principles always said that, tissues with limited blood supply such as tendon denuded of paratenon does not accept skin graft. So when a surgeon encounters these situations i.e. tendon denuded of paratenon, the surgeon will have to close the defect by using flaps or modify the wound to become more vascular, for example, the cortical bone may be surgically debrided to allow granulation tissue to proliferate, and then SG applied on it while membranous bone is relatively vascular, as in the denuded orbit of radical maxillectomy that may accept a skin graft.[10]

In this study FTSG was used to cover exposed tendon up to 10mm width, this was achieved by keeping a small amount of subdermal fat in the center of FTSG, this subdermal fat is essential as a surrounding for the vascular plexus and a good gliding surface for the denuded tendon. The subdermal plexus was supported and augmented through the margins of the SG which was thinned in periphery to convert it to STSG, this was compared in the beginning of the study with one finger of full thickness the defect of the exposed tendon, where it was covered with FTSG which was thinned in center in addition to holes in the graft center and with no de-epithelialization of margins, we find that there was failure of graft with severe contracture, stiffness and adhesion later on follow up.

The study results are, in general, consistent with Lee et al.[11] where FTSG with de-epithelialized wound edges were used for coverage of exposed tendon and bones in 10 patients and (16) fingers.All graft in this study survived completely with good functional and aesthetic results without any major postoperative complication or the need for secondary surgical revision during follow up period, which was ranged from 6-9 month. In the above mentioned study of Lee et al, they encountered two patients who had developed postoperative mild-swan neck deformity and mild mallet finger; those two postoperative complications were seen in those two patients since they already had injury that lead to extensor tendon defect, in this study, we didn't encounter these complications,

since our patients didn't have any tendon defect preoperatively.

In this study the SG provides good coverage of exposed tendons, with good bulkiness, and without interference with tendon gliding and movement; No patient had limitation of tendon movement or had postoperative joint stiffness due to graft itself and all patients had satisfactory aesthetic results with their fingers appearance. Although some patients had slight hyperpigmentation, they were not much concerned about it, since it was fading down with time. Slight skin depression was seen in 2 patients, but they had not complained about it. Only two of the patients had partial FTSG loss but fortunately the final results were satisfactory, those two of our patients had developed partial skin graft loss, (one smoker and one diabetic) the diabetic patient had wide exposed area (3*2.6) cm2, no further skin graft was needed in these patients and the sloughed area healed completely with conservative measurement of daily local moist wound care without any sequelae. No major postoperative complications were seen in all of our patients like complete graft loss, wound infection, finger contracture or donor site morbidity

By changing the margin of FTSG to STSG, this will provide rich and easy vascular reach to its periphery. So that it will connect horizontally oriented sub-dermal and intradermal plexus to the center of the graft, which will depend (i.e. FTSG) on the horizontal plexus coming from its edge rather than depending on the vertical plexus from the avascular bed and this will increase the probability of complete graft intake.

Rees and associates (1968) inserted different silicone rubber widths between skin auto-graft and host bed in rats. The insertion of silicone rubber sheet with 10mm width and less didn't prevent the development of vascular supply in these small SGs. This finding strongly supports the concept that, while the blood vessels in the host bed may well be the main source of graft revascularization, the ingrowth of new blood vessels from the edge of the host bed can also play an important role in the revascularization of skin graft.[10]

In another study which was conducted by Peter Gingrass (1975) he showed that full thickness rat skin grafts placed over the same sized underlying silicone sheet implant did not survive, but when the SG was made 3mm larger on all the sides than the silicone implant, all or portion of the graft over the implant survived.[12]

Wright JK et.al in their study (1980) inserted silicone implants of different sizes below FTSGs in rabbit back and concluded that there is an absolute sized avascular defect, irrespective of graft size, that can be bridged and once the blood supply is established from the periphery, the contribution of blood vessels from the graft bed is superfluous; the graft can be supported solely by the vessels at the periphery of the graft.[13]

Jin Silk Burn et.al (2010) used FTSG to cover denuded cartilage (without perichondrium) after helical rim keloid excision; the surrounding normal skin was de-epithelialized 3mm over the defect border to provide the graft with a new healthy bed.

The study has shown that small bridges of graft survive over small avascular defect. A FTSG had an intact vascular system that arranged in horizontal pattern such as the subdermal plexus, while split thickness skin graft had a vertically organized vascular plexus. Many clinical and experimental studies suggest that both the thickness and vascular pattern of SG determine survival on avascular bed, and the bridging ability is much higher for FTSG than for STSG. Also this study suggested that the FTSG intake over avascular area is enhanced by rapid marginal revascularization, [14] which was enhanced by our study through de-epithelization of wound margin.

The advantage of using mastoid skin graft is that it contains sufficient intradermal and subdermal vascular plexus networks [15], in addition to that it has less degree of pigmentation or hair growth formation that may affected the final aesthetic result.

There are many local, regional and free flaps that have been utilised for closure of finger defect with exposed tendons. These include the dorsal metacarpal reverse flap, reverse dorsal digital island flap, homodigital subcutaneous flap for cover of dorsal finger defects, adipofacial turn over flap for dorsal skin defect of the hand and finger.

All these flaps mentioned above require meticulous and tedious dissection, long operation time, donor site morbidity, flap venous congestion, and lack of sensation. Free flap transfer for the hands often result to bulky appearance, with unacceptable color match and mobile surface, with poor sensation. The bulkiness of free flap on the hand will also hamper the range of finger movement so this will ultimately affect the function of the hand. Free thin flaps have been used for the management of the soft tissue defect in the hand because they contain less bulky tissue that not hampers hand motion. However, partial necrosis may occur because of excessive defatting of these flaps, and even this thin flap can be further thinned down to 3-4 mm thickness but it still bulky if it is on the hand.[16]

Using FTSG to cover the defect with exposed tendon is simple, easily performed single stage operation that provide good coverage to the finger that is not bulky and doesn't interfere with function of the hand, with good postoperative aesthetic appearance; it needs no secondary surgical revision.

CONCLUSION AND RECOMMENDATION:

Full-thickness skin grafts with de-epithelized edge of recipient wound used for coverage of exposed tendons in finger trauma seem to be easily performed single stage operation, with good functional and aesthetic outcomes, in this study, defects with up to 10 mm width of exposed tendons were managed.

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