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Original Article

Study of Management of Post-Burn Flexion Contracture of Finger by Glabrous and Non-Glabrous Split Skin Graft

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Abstract

Background: Young males are the most common victims of hand burn and mostly sustain injury at work place. Healing by secondary intention, inappropriate positioning, and lack of physiotherapy lead to contractures causing functional disability. Conventionally, non glabrous skin grafts of variable thickness (intermediate or thick split thickness or full thickness) are mostly used for coverage of palmar skin defects.

Materials and Method: A detailed history of each patient was taken and patients were randomly divided in two groups by simple randomization method. Group A was offered treatment with split thickness graft from glabellar region and other Group B was offered treatment with split thickness graft from non-glabellar skin. Frequencies and percentages of both recipient and donor sites complications such as infection, hypertrophic scarring on Vancouver scar assessment scale, recurrence, and difficulty in walking were noted. Patient satisfaction for color and texture match to neighboring skin at recipient site was assessed 3 months after the operation using five points Likert scale.

Results: At follow-up of the group A, the donor areas were completely healed in all the cases 100%. The grafted area showed excellent color and texture match with the adjacent palmer skin. The graft was mobile, stable and without any pigmentation. There was also no hypertrophic scarring, hyper pigmentation or pain at the donor site as compared to ordinary skin graft. Walking and weight bearing was smooth and the instep curvature appeared normal. And in Group B, 100% patients had hyperpigmentation, 20% had marginal scarring, and scar hypertrophy at hand. While, 40% had scar hypertrophy at 80% had hyperpigmentation over donor site. Recurrence was noted in 32% patients in Group B as compared to 8% in Group A.

Conclusion: Glabellar skin of the instep is the best replacement for the palmar skin of the digits and hand because of the similarities in their characteristics. Results are excellent in terms of color and texture match, no hyperpigmentation, less marginal scarring, scar hypertrophy, and less recurrence of contracture in patients with area grafted with glabellar skin to conclude for management of post burn flexion contracture of finger. Ideal skin substitute is glabellar skin grafts from the instep region of foot.

Key words: Burn, Glabella, Skin

INTRODUCTION

Burns constitute the second highest incidence of trauma related deaths globally, second only to vehicular trauma both in developed and developing countries.[1] Burn injury is a common form of trauma affecting hands. Young males are the most common victims of hand burn and mostly sustain injury at workplace.[2] Inadequate management (healing by secondary intention, inappropriate positioning, lack of physiotherapy, and inadequate scar therapy) of these burn injuries leads to hypertrophic scarring and contractures causing functional disability. Individuals with burn injuries are at risk for developing contractures due to multitude of factors. Patients with burns often are immobilized, both globally, as a result of critical illness in the severely burned, and focally, as a result of the burn itself because of pain, splinting, and positioning. Post-burn contractures (PBC) need releases to improve hand function. Coverage of defects after releases of these contractures on palmar aspect of hand requires skin with structural and functional characteristics

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similar to palmar skin. Palmar skin is thick, inelastic and hairless. It is designed to combat the daily strong and tough work of an individual.[3] Conventionally, non glabrous skin grafts of variable thickness (intermediate or thick split thickness or full thickness) harvested from medial arms, thighs, buttocks, or groin are mostly used for coverage of palmar skin defects. These non-glabrous skin grafts lack similarities with palmar skin and use of these skin grafts is associated with hyper-pigmentation, scarring, recurrent contractures, hair growth, and unacceptable cosmetic appearance.[4] Glabrous Plantar skin is the only area of body sharing characteristics of palmar skin. Plantar skin can be harvested as split thickness, dermal only, or full thickness skin graft.[5,6] There are few studies available describing effectiveness of use of intermediate thickness plantar (ITP) skin graft for coverage of defects after release of PBC of hand. This prospective study is designed to determine the outcome of split thickness glabellar skin graft for the coverage of defects on Palmar aspect of hand after release of PBC in terms of graft take, complications, recurrence, and patient satisfaction for color and texture match.

MATERIALS AND METHODS

This prospective comparative study was carried out on patients of Department of Burns and Plastic Surgery, Civil Hospital and B. J. Medical College, Ahmedabad, Gujarat, India, from December 2018 to December 2020. A total of 50 patients with PBC of hand satisfying inclusion criteria were included in the study. Patients were randomly divided in two groups by simple randomization method of dividing patients into alternate study group after assigning serial no. Group A consisted patients with odd number were offered treatment with split thickness graft from glabellar region and Group B consisted patients with even number were offered treatment with split thickness graft from non-glabellar skin.

Study Design

This was a prospective comparative study.

Study Location

This is tertiary hospital-based study done in the Department of Burns and Plastic Surgery, Civil Hospital and B. J. Medical College, Ahmedabad, Gujarat, India.

Study Duration

This study was from December 2018 to December 2020.

Sample Size

The sample size was 50 patients.

Inclusion Criteria

All the patients presenting to outpatient department with PBC fingers or indoor patients developing contractures during their stay for treatment of acute burns in the aforementioned time frame were included in the study. For the purposes of analysis, a limitation in the range of motion (ROM) in at least one plane of motion at a specified joint was considered to be a contracture at that joint.

1. Patients with PBC of fingers were included in the study.
2. Patients with good passive ROM at joints were included in the study.
3. Patients who had agreed to take part in study were included in the study.

Exclusion Criteria

The following criteria were excluded in the study:

1. Patients refusing for treatment.
2. Patients with contractures due to any other etiology other than burns.
3. Joint stiffness.
4. Acute infective condition.
5. Patients having wounds with exposed vessels, tendon, or bone.
6. Patient with wound size more than 20 cm^2 were excluded from the study.
7. Patients with history of diabetes mellitus, hypertension were excluded from the study.

Procedure Methodology

Collection of data

A detailed history of each patient was taken covering the duration of deformity, cause of contracture, effect of deformity on daily activities, any previous surgery for the deformity, and any associated medical problem. Active ROM was measured before and after surgery. Preoperatively and postoperatively photographs were taken for records purposes X-rays for the involved digits including anteroposterior and lateral views, full blood count and screening for hepatitis B/anti-hepatitis C virus was performed.

Procedure

The classification of Sheridan *et al.* and McCauley for the hand was modified for the current study involving all sites with contractures. Patients with contractures in Grades III and IV of this modified classification were considered for surgical release of their contractures.

All patients were operated under general anesthesia with tourniquet using tumescent solution. One dose of intravenous antibiotic was injected, at the starting of surgery to every patient. Incision was marked and infiltration was performed with tumescent fluid of 2% lidocaine with 1:200,000 adrenaline. Surgery was started 7 min after infiltration of tumescent solution. Contracture was released and all abnormal tissue was excised down to healthy tissue Figure. Depending on treatment group

assigned, coverage with either split thickness graft from non-glabellar (preferably thigh) or glabellar (Instep area of foot) area was taken.

In case of Group A with glabellar split thickness graft, resultant defect was measured and marked out on instep of foot in 1:1 fashion. ITP skin graft was harvested with Watson knife (Downs Surgical Sheffield England) and was stabilized to recipient site. Recipient site was dressed with Vaseline gauze dressing. This was reinforced with tie over wet cotton dressing followed by dry gauze and crepe bandage. Donor site was also dressed with Vaseline gauze dressing covered with dry gauze and crepe bandage.

Similarly intermediate split thickness graft was harvested from thigh in Group B with non-glabellar donor site group and similar procedure was performed for donor site region. Operated hand was splinted in postoperative period with POP caste. Patients were allowed to bear weight after surgery as tolerated. First change of dressing and recipient site inspection was done at 7th post-operative day. Patients were discharged at 7th postoperative day.

Donor site was inspected at 14th postoperative day. Graft take (defined as graft which is well adherent to its bed without the aid of sutures) was measured on 14th postoperative day in terms of percentage using formula (Graft take %= size of graft take/total size of graft applied × 100). Massage with coconut oil twice to thrice daily was advised 3–4 weeks after surgery and continued for 3 months at both recipient and donor sites. Patients were advised to wear pressure garments on hand as well as donor foot for 1 year. Patients were followed till 3 months postoperatively.

Frequencies and percentages of both recipient and donor sites complications such as infection (defined as discharge of pus), hypertrophic scarring (defined as red and raised scar measured on Vancouver scar assessment scale), recurrence (defined as development of new flexion contracture at operated site), and difficulty in walking (defined as pain on walking and abnormal gait) were noted. Patient satisfaction for color and texture match to neighboring skin at recipient site was assessed by adult patients themselves 3 months after the operation using five points Likert scale, where score 1 was considered as not at all satisfied, and score 5 was considered as highly satisfied. In case of children this assessment was done by their parents.

Statistical analysis was done using Statistical Package for the Social Sciences software. Continuous variables (age, pain, graft take, and patient satisfaction for color and texture match) were presented as mean ± standard deviation. Categorical variables (gender, complications, and recurrence) were presented as frequencies and percentage.

RESULTS

A total of 50 patients with post burn flexion contracture (PBC) of fingers were studied over period from December 2018 to December 2020. The duration of deformity varied from 6 months to 20 years (mean = 4.11 years). About 48% (24 patients) of them were males and 52% (26 patients) were female accounting to ratio of almost 1:1. 44% (22 patients) belonged to the most active age group of 10–25 years, followed by adults within age group 26–50 years which were 36% (18 patients). Patients above 50 years were the least involved people 2% (1 patient) and patients below 10 years constituted 18% (9 patients) of the study model.

All patients in study had contractures post burn. Out of which 80% (40 patients) had PBC finger post flame burns, 10% (5 patients) were post scald burns, and remaining 10% (5 patients) were post electric burns.

The contractures mainly affected the proximal interphalangeal joints (PIP). Pre-operative median active ROM at PIP joint was 60°–90° (extension/flexion). In majority of the patients (70%) Left hand was involved.

About 34% (17 patients) presented with one finger involvement mainly affecting the interphalangeal joints. There were 26% (13 patients) with two fingers, 22% (11 patients) with more than 2 fingers, and 18% (9 patients) had PBC finger associated with scar syndactyly or finger webbing.

Among all the patients who were included in study, 45 patients 90% were operated for 1st time and five patients 10% were operated for recurrence of PBC 2nd time, all of which were operated for PBC with non-glabellar STG from thigh.

In those with glabellar skin as donor, separation and peeling of corneal layer and the appearance of pink Palmar skin underneath was considered as the criterion for graft take and healing which usually occurred on 14th day in 92% cases (23 patients). Partial loss of glabellar skin graft happened in 8% cases (2 patients) either due to infection or inadvertent removal of skin along with corneal layer. These hands were allowed to heal by secondary intention. In all the patients of plantar donor areas healed completely. In four patients defects after release of PBC were big that skin graft was harvested from both feet at the same time.

Among other half of patients in whom PBC finger defect was covered with non-glabellar split skin grafts from thigh with graft take in 88% (22 patients), Grafts were lost in 12% cases (3 patients) due to infection. Among these patients

areas of only one patient was covered secondarily by grafting after the infection subsided and wounds become clean. Remaining 2 patient's area recovered by secondary intention.

In non-glabellar donor area thigh, and glabellar donor area plantar instep area, donor site did not show delayed healing in any cases and there was no need for grafting on donor area in any case.

PBC Release with Glabellar STG

At follow-up all those with glabellar skin grafts showed excellent color and texture match with the adjacent palmar skin with 5 points on Likert's scale. The graft was soft, supple, mobile, and stable, without any pigmentation. About 12% (3 patients) had slight marginal scarring and scar hypertrophy in the operated area of fingers, which was taken care with intralesional steroid injections and pressure garments.

Grafted areas showed smooth contour merging with rest of the palm.

Contracture recurred in 8% (2 patients), both were below 10 years of age prime cause of recurrence was mainly due to infrequent use of splintage and poor compliance with post-operative physiotherapy protocol.

None of these patients developed scar hypertrophy, marginal scarring hyper-pigmentation, arch deformity or persistent pain at the plantar donor sites. About 4% (1 patient) developed marginal scarring with hyper-pigmentation at donor plantar site. Walking and weight bearing was smooth with most of the patients starting weight bearing from 4 to 7 post-operative day in case of glabellar skin as donor site.

PBC Release with Non Glabellar STG

Non-glabellar skin grafts from thigh were used in remaining 25 patients. All had color and texture mismatch with the rest of the hand with 2 out of 5 points on Likerts scale. All 25 patients had hyperpigmentation, that is, 100% patients exhibited hyperpigmentation. Some of the grafted areas were smooth, soft, stable, and mobile while others were with dry and thickened skin. About 20% (five patients) had marginal scarring and scar hypertrophy of hand.

Out of 25 patients incidence of recurrence was in 32% (eight patients) of which five patients belonged to age group below 10 years of age.

Hyperpigmentation is seen on non-glabellar area of thigh in 80% (20 patients) and scar hypertrophy at donor area reported in 40%, that is, in ten patients.

About 20% of patients with glabellar skin grafts had a hospital stay of up to 3 weeks as compared to About 30% in those with grafts from non-glabellar skin 80% of the patients with graft from glabellar skin went home in 2 weeks. Recovery of sensation and sweating was not done as patient failed to come for long-term follow-up [Figures 1-4] and [Tables 1 and 2].

DISCUSSION

Glabrous skin is unique because of its specialized function and appearance. Found on the plantar surface of the feet and the palmar surface of the hands, glabrous skin differs from hair-bearing skin. Functionally, glabrous skin needs to withstand greater forces, pressures, and shear. It has greater capacity to perceive sensations, to protect, and to heal. The anatomy of glabrous skin has evolved to perform these functions. This also affects the appearance of glabrous skin. It is hairless without sebaceous glands and contains few melanocytes. Southwood in 1955 demonstrated that the skin and its epidermis and dermis vary in thickness, depending on the location on the body, age, and sex, and between hair-bearing and glabrous skin. He showed that the epidermis is thicker in glabrous skin, measuring 529–1377 m in the sole and 420–673 m in the finger. Southwood[7] reporting on the thickness of human skin at different sites states that the epidermis on the sole is thicker than that on the hair bearing skin but the dermal thickness is similar. The epidermis of the instep is thinner than the epidermis of the neighboring weight bearing areas but is not significantly thicker than the epidermis of the palm and fingers.

Release of flexion contracture of digits and palm is one of the most commonly performed procedures in the plastic surgery unit. Plantar skin is the most suitable replacement for the skin defects onto the palmar aspect of hand. For the sake of convenience traditionally the thigh or buttock skin is used as split skin graft donor sites. The skin from these areas is too dissimilar for the volar aspect of hand. Webster[8] was the first to introduce full thickness skin grafts to the volar aspect of the hand from the instep area of the foot in his attempt to obtain appropriate tissue. A second split skin graft was needed to cover the donor defects in those cases. Le Worthy[9] advocated the use of split skin graft from the insteps to resurface the palm of the hand. LeWorthy in 1963 introduced the first split-thickness glabrous skin graft. He treated 12 patients with 13 wounds with this method. In his series, however, he experienced significant loss of grafts, and three patients needed their donor sites skin grafted from hair-bearing areas. Since these reports, there have been many variations of these two techniques.

Nakamura *et al.*[10] presented a series of 64 patients and favored very thick split thickness skin graft from instep to palm. They reported satisfactory healing in 2 ± 3 weeks, good color match, stability and lack of hyperpigmentation in their results. Zoltie *et al.*[11] described full thickness plantar grafts to hand in syndactily repair.

Roboti and Edstrom[12] used split thickness skin grafts from instep area of foot in their cases and found it as an excellent technique for avoiding hyperpigmentation, marginal scarring, and hyperkeratosis resulting from the use of skin graft from the traditional donor sites. Recovery of sensation and sweating was optimum with a superb color and texture match.

Recently, Tanabe *et al.*[13] reported a modification of the use of plantar skin grafts in eighteen cases of Granulating and fresh wounds of the volar aspect of hands. Two skin grafts were harvested from the same site, first the split thickness skin graft and then the dermal graft exposing subcutaneous fat. Split skin graft was returned to the original site and dermal graft applied over the defect. Good cosmetic and functional results were obtained at both donor and recipient sites.

Hyperpigmentation, scarring, and recurrence of contracture are the common problems encountered with the traditional skin grafts to palm. Skin grafts from plantar area of foot prove better probably because they have sparse pigment cells and tend to contract less because of the less elastic and more compact connective tissue in the dermis.

In Bunyan[14] series, who used medium thickness split skin graft, the donor area did not heal in three patients and had to be covered with the skin graft. Wendt[15] harvested full thickness skin graft from lateral great toe skin but this was associated with the additional split thickness skin graft placed on the donor site. Tenabe *et al.*[13] used planter dermal graft to resurface the palm but the harvest was limited to the planter instep. In our technique split thickness skin graft could be harvested from almost the entire sole or from both sole at the same time. The reason for restricting the harvest in the present series to the planter instep was to avoid risk of complication at the donor area that would restrict early ambulation

Tanabe *et al.*[13] used dermal grafts from plantar skin to cover palmar defects in eighteen of their cases.

They mention that it is not always easy to harvest sufficiently thick graft to prevent recurrence of contracture, and another skin graft may be needed to cover the donor area if a thick split or full thickness graft is harvested in which the donor site could end up with scar hypertrophy and deformity.

Recurrence rate of contracture is very important indicator of success in the management of digital contracture. The low recurrence rate in the present study was attributed to the fact that glabellar skin graft has minimal or no primary contraction (contraction of graft soon after its removal from the donor area). Furthermore, the secondary contraction which developed late is less as compared to skin graft from the conventional donor areas. This fact is also provided by Jang *et al.* and Southwood.[7]

Table 1: Comparison between surgical management and their outcomes between PBC finger grafted with glabellar and non-glabellar skin

	Glabellar STG (Instep of foot)	Non glabellar STG (Thigh)
	No of patients	
Total cases	25 (100%)	25 (100%)
>95% graft take	23 (92%)	22 (88%)
Partial of complete graft loss	2 (8%)	3 (12%)
Second surgery required	None	1 (4%)
Donor area grafted	None	None

Table 2: Comparison of colour match, texture, scarring, scar hypertrophy, and recurrence of contracture between PBC finger grafted with glabellar and non-glabellar skin

	Glabellar skin	Non-glabellar skin	
	Changes at grafted site (Operated PBC finger)		
Colour and texture match	Likert scale 4–5 point	Likert scale 2–3 point	
	Complications at grafted PBC finger		
Hyperpigmentation at hand	Nil (0%)	All (100%)	
Marginal scarring and scar hypertrophy at hand	3 (12%)	5 (20%)	(*P* value 0.6) Not Significant
	Complications at donor site		
Hyperpigmentation at donor site	Nil (0%)	20 (80%)	(*P* value 0.0005) Significant
Scar hypertrophy at donor site	1 (4%)	10 (40%)	(*P* value 0.002) Significant
	Recurrence at follow-up		
Recurrence of contracture	2 (8%)	8 (32%)	(*P* value 0.06) Not significant

Figure 1: Follow-up of post burn contractures finger with glabellar skin with good color and texture match

Figure 3: Follow-up of glabellar donor site at 3 months follow-up with healed donor area

Figure 2: Follow-up of post burn contractures finger with non-glabellar skin with poor color and texture match

Figure 4: Follow-up of non-glabellar donor site at 3 months follow-up, with hyperpigmentation and scar hypertrophy

It is clear that replacing glabrous skin defects with like tissue is superior with regard to restoring function and aesthetics. Glabrous skin grafts demonstrate durability without hyperkeratosis and hyperpigmentation, and have even demonstrated improved recovery of sensation when compared with hair-bearing grafts.[16,17] However, when taking full-thickness glabrous grafts, the donor site is always limited. With split-thickness glabrous grafts, donor-site morbidity is significant, with prolonged healing, hypertrophic scarring, hyperpigmentation, and pain. Because of these problems, we have evolved to using glabrous dermal grafts to resurface palmar and plantar defects for the past many years similar to the technique reported by Tanabe and associates in 1998.[13]

CONCLUSION

Glabellar skin of the instep is the best replacement for the palmar skin of the digits and hand because of the similarities in their characteristics. Results are excellent in terms of color and texture match, no hyperpigmentation, less marginal scarring, and scar hypertrophy. There is less recurrence of contracture in patients with area grafted with glabellar skin. Split thickness graft from non glabellar area doesn't provide good color, texture match, with hyperpigmentation, scarring, and scar hypertrophy. Donor site of non glabellar skin showed signs of hyperpigmentation and scar hypertrophy. Proper splinting and physiotherapy are key factors in the prevention of recurrence of contracture in the glabellar skin grafted areas. The excellent color, texture match, and the functional advantages in terms of active ROM and sensitivity offered by the split thickness in the long run. Glabellar skin graft is of no match to split thickness conventional skin grafts taken from non-glabellar skin. Cosmetic results of planter skin graft are far superior to any other skin substitute. Donor site morbidity is very low and hardly any donor site scar is visible. So in conclusion for management of

post-burn flexion contracture of finger ideal skin substitute is glabellar skin grafts from the instep region of foot.

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