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ORIGINAL ARTICLE

Primary split thickness skin grafting for hand and finger defects: do not hesitate

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Summary

Introduction: Hand injuries often result in soft tissue defects. The treatment of these defects belongs to the most difficult challenges in reconstructive surgery. There are numerous options for covering soft tissue defects, including flaps and skin grafts**.**

Material and methods: This retrospective observational study included seventeen patients with 24 skin defects of the hand, who were treated by primary split-thickness skin graft (STSG) in a single center. The average follow-up period was 6 months**.** The age of the patients ranged from 36 to 80 years. The majority of patients (n=16) were males, and one patient was female. Skin defects varied in size from 7x8mm to 39x40mm. Primary goals were STSG survival, recipient site infection, and donor site morbidity. Secondary goals were cosmetic appearance and time needed for complete wound healing.

Results: All 24 wounds healed successfully in a mean of 28,11±9,94 days. There were no graft infections. Partial graft loss occurred in one case. There was no major donor site morbidity reported. Six patients described the cosmetic result as good (score 3), 10 patients ddescribed it as acceptable (score 2), and one patient described it as poor (score 1).

Conclusion: Split thickness skin graft is an excellent option for immediate treatment of hand and finger skin defects. This method is simple, has less consequences than secondary grafts, requires minimum equipment and can sometimes be done in the emergency room, without hospitalization. Therefore, there is no need to be afraid of primary skin grafting.

Keywords: hand, finger, soft tissue defects, primary reconstruction, split-thickness skin graft

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INTRODUCTION

The skin of the hand is specifically designed to provide tactile input from the environment and it must be resistant to numerous factors and forces (1). Therefore, restoration of the skin coverage is extremely important and it must provide a good aesthetic result and the earliest and maximal recovery of function (2, 3).

Hand injuries are extremely common in home and industrial setting. These injuries are of particular interest because they often result in soft tissue defects. The treatment of these defects represents one of the most difficult challenges in reconstructive surgery.

Tissues should be replaced as soon as possible, but not necessarily at the time of injury. The aim of the initial treatment is to provide primary wound healing whenever possible, because it minimizes inflammation and reduces the length of hospital stay (4). In an ideal situation, the primary procedure is definitive and early wound closure and rapid healing are obtained (2,3).

There are numerous options for covering soft tissue defects, including flaps and skin grafts. A flap is a healthy tissue with its own blood supply, attached to the donor site by a pedicle (4). Skin grafts are avascular, therefore their survival depends on the ingrowth of blood vessels from the recipient area.

When deciding upon the most suitable method of tissue replacement, each case must be accessed individually and various factors must be considered – age, sex, general health and previous condition of the hand, as well as the patient's social and economic status (5).

MATERIAL AND METHODS

Seventeen patients with 24 skin defects of the hand were treated by primary split-thickness skin graft (STSG) between January 2017 and August 2020 in a single center. Each patient underwent a complete evaluation which consisted of preoperative clinical and radiological assessment, prescription of antibiotics and tetanus prophylaxis. The procedure was done in axillary block anesthesia. The hand and arm were prepared and draped above the elbow. The njured hand was inspected thoroughly for tissue viability and integrity of tendons and neurovascular structures. Firstly, meticulous debridement and irrigation were performed. The injury dictated whether other procedures had to be done. Fractures and fracture-dislocations had to be stabilized. In our cases, only Kirschner wires (K wires) were used. Tendon and nerve repair were performed if needed. Homeostasis was secured by cauterization. The exact size of the skin defect was measured by a surgical ruler and traced with a sterile marking pen on the donor site. Depending on the size of the defect, an STSG was taken using a dermatome or a Humby knife. A petroleum gauze was firmly applied on the donor site, covered with an iodine solution soaked gauze, and then tightly bandaged.

The graft was fenestrated by a surgical blade, applied to the soft tissue defect and secured by peripheral sutures (Dafilon® 4-0 nylon). Petroleum gauze was applied and gently molded around the edges of the defect. The hand was immobilized using a plaster splint and maintained in position. The dressing was not changed for three days. The stitches were removed on the 14th postoperative day. The immobilization was removed after the wound had completely healed. If there were any associated injuries (tendon lesions and/or fractures), the immobilization was prolonged. When the cast and K wires were removed, physical therapy was introduced.

The average follow-up period was 6 months. Patients' age ranged from 36 to 80 years with a mean age of 56,76±13,6 years. There were sixteen male patients and one female patient. They sustained their injuries by industrial machines (10 patients), agriculture machines (two patients) and other (five). Skin defects varied in size from 7x8 mm to 39x40 mm. Wound localization, associated injuries, the length of hospital stay and STSG size are shown in **Table 1**.

Primary measures were STSG survival, recipient site infection and donor site morbidity. Secondary measures were cosmetic appearance and time needed for complete wound healing. The criteria for the wound to be considered healed included complete epithelialization, no wound drainage, as well as the patient being allowed to wash their hands. Patients were asked to rate their cosmetic outcome on a 3-point scale, developed by the authors. The score of 0 denotes patient's unhappiness; the score of 1 denotes poor appearance; the score of 2 denotes acceptable appearance, and the score of 3 denotes total satisfaction with cosmetic results.

RESULTS

The purpose of this paper was to report the clinical results of immediate treatment of hand defects based on the hypothesis that primary STSG shortened the surgery time and the length of hospital stay, the number of interventions needed with no additional surgery skills or expensive equipment required. This was a retrospective observational study without a control arm. All 24 wounds healed successfully in a mean of 28,11±9,94 days without further surgical interventions. There were no graft infections. Partial graft loss occurred in one case over the perichondrium. There was no donor site morbidity reported, except for slight hypopigmentation in seven cases and hyperpigmentation in six cases. Six patients described the cosmetic result as good (score 3), 10 patients described it as acceptable (score 2), and one patient described it as poor (score 1). None of the patients reported any wound drainage, tissue disintegration, xerosis, scaling or pruri-

Table 1. Patient data

Patient	Age	Side /L-left R-right/	Cause	Skin defect	Associated injuries	Hospital length of stay */days/*	STSG size */mm x mm/*
1	71	L	Grinder	Radial side of 3rd finger and radial and volar side of 2nd finger	Fracture	9	27x13 68x21
2	36	L	Explosive device	Mangled hand with dorsal skin destruction	Fracture, tendon lesion,	19	20x13 34x28
3	45	L	Printing press	Ring avulsion, 3rd finger	Fracture	6	15x22
4	36	R	Planer machine	Tip of 2nd, medial and distal phalanges 3rd and 4th and distal phalanx 5th finger	Tendon injury	8	7x8, 38x13, 12x7, 34x11
5	55	R	Traffic accident	Dorsal skin avulsion of the proximal phalanx of 2nd finger MCP joint	Fracture, tendon injury	10	39x40
6	36	R	Corn grinding machine	Mangled index finger, amputation of thumb's distal phalanx	Fracture	11	37x19
7	80	L	Carpentry machine	Mangled distal phalanges from II to V finger	Fracture	8	21x7, 7x9, 9x8
8	63	L	Circular saw	Thumb's distal phalanx.	Fracture, tendon lesion	11	26x12
9	47	R	Circular saw	Dorsal over PIP joint, middle finger	Fracture, tendon lesion	12	14x21
10	54	L	Metal pipe	Proximal and middle phalanges, index finger	Fracture, tendon lesion	9	42x20
11	61	L	Fall	Medial and distal phalanges, 4th finger	Fracture	9	46x32
12	72	R	Planer machine	Dorsal, medial phalanx, PIP joint of 3rd finger	Fracture	12	28x16
13	57	R	Corn picker	Volar side, 3rd finger's distal phalanx	Fracture, tendon lesion	22	23x16
14	80	L	Sickle	Dorsal, PIP joint, index finger	Fracture, tendon lesion	9	13x21
15	58	L	Circular saw	Mangled hand with index finger amputation. STSG over the 1st web space	Fracture, tendon lesion	10	46x30
16	62	L	Circular saw	2nd and 3rd finger amputation, partial amputation of the 4th finger. STSG for fingertip of the thumb	Fracture, tendon lesion	6	9x7
17	52	R	Circular saw	2nd finger	Fracture	10	66x17

tus at the 6-month mark following their injuries, when the last control assessment was conducted.

DISCUSSION

The first skin transplantation was performed by Reverdin in 1869 (6). In 1929 Brown introduced his technique of STSG and was the first to differentiate between full-thickness and epidermal (Thiersch) grafts (6). Since then, there have been no significant changes in the basic principles.

Even though the only indication for the use of skin grafts mentioned in this paper is hand trauma, there are numerous other indications suggested in literature (2). Generally, they can be divided into two main groups, primary and secondary. Primary skin grafting was described in traumatic wounds. Secondary grafting is taken into consideration for granulating wounds (2).

Primary Thiersch graft use has been described in literature for treating hand and finger defects, fingertip skin defects, donor defects of hypothenar flaps, palm and finger defects following the release of Dupuytren's contracture, skin avulsion of the upper and lower extremity, crush injuries of the foot, severe open fractures and mangled extremities (split-thickness skin excision technique) (7-13). Also, in coverage of the vascular pedicle in free tissue transfer, extensive traumatic skin loss and surgical

wounds after scar or neoplasm excision, biofilm-associated infections in chronic diabetic ulcers and even in the treatment of chronic osteomyelitis alongside surgical debridement (2,14-16).

A consensus has not been reached about primary wound closing. It is obvious that primary coverage is not indicated in crush injuries and wounds with a high risk of infection such as farm injuries, as well as those with necrotic tissue (12). Many papers disagree with the role of primary STSG in hand injuries, as they are not suitable for exposed tendons, bones and joints (17,18). Elliott and colleagues advised against skin grafting in finger and thumb tips, stating that the procedure resulted in donor site morbidity, delayed mobilization, poor sensation and esthetics (19). Instead, they opted for healing by secondary intention, full-thickness and venous flaps, with the advent of full-thickness skin graft because of better skin quality (19). Numerous authors also mention sanatio per secundam as a good option for finger injuries (1, 20, 21). Others disagree, and Patton found that spontaneous healing took one to three months to heal enough for the patient to go back to work and the finger may have decreased function (10). Pros and cons of STSG versus full-thickness skin graft have been a subject of discussion for a long time. Krister prefers full-thickness over split-thickness skin grafts in fingertips because STSG is difficult to hold in place and it leaves a sensitive scar after healing (22). STSG can survive in a less vascularized bed, no suture of the donor site is necessary and it is easier to take because there is no hematoma forming due to meshing (6,8,13). On the other hand, STSG gives greater contractures post-operatively, especially on the flexor side of the joint, worse cosmetic results than full-thickness and less resistance on shear stress (6,13). Wood prefers full-thickness grafts on areas where scarring would result in a significant loss of function and poor cosmetic result, such as the hand (17). The donor site of full-thickness heals quicker with less pain and a smaller scar than STSG. Beasley stated that there was no significant difference between a full-thickness graft and a very thick STSG (4).

We agree with the philosophy that the fresh wound is an adequate site to be covered with healthy donor tissue (12). As Pshenisnov and colleagues stated, emergency coverage in hand injuries results in the most rapid bone healing, fewer surgical interventions, shorter hospital stay and the lowest infection rate (18). The use of STSG as a primary treatment in traumatic hand wounds is not a new idea. Many papers describe this method as superior to alternatives in providing skin coverage with minimum morbidity, and without the need to wait for clean healthy granulations suitable for skin grafting (7-10,15). On the other hand, with delayed coverage there is a higher potential risk of secondary infection, and it may result in prolonged hospitalization, which has economic and psychosocial consequences (11, 12).

Figure 1. Hypo- and hyperpigmentation of the donor site

STSG may be taken from any area of the body (6). When deciding upon the donor site for hand defects, important factors to consider are the absence of hair, similar skin color and texture, dermal thickness, and potential donor site morbidity. Tissues near the recipient site will obviously be the best match (4, 17). The most common donor sites are thigh, inner aspect of the arm, forearm and hypothenar eminence (2,7,14,15,22). In almost all of our cases, the front of the forearm was used, except in one patient in whom the size of the defect dictated using a larger donor site, so we used anterolateral aspect of the thigh. The clear advantage of using the forearm is that it requires no additional preparation or drape and the procedure is usually done in regional anesthesia so no other type of anesthesia is needed. We did not have any donor site morbidity, except a slight hypo- or hyperpigmentation of the skin, also described by other authors and presented in **Figure 1** (6,17).

There are different types of instruments for removing STSG. The most commonly used are hand-held skin knife and the electrical dermatome. The choice of instrument depends on the size of the defect and the surgeon's experience (23)**.** The procedure can be done with minimum equipment and in the emergency room, without hospitalization. We only used a dermatome in one case, and a Humby knife in others.

STSG can be meshed or not. When the skin is perforated, an increased area can be covered, exudate and hematoma can be drained and graft modeling on irregular surfaces is better, although the result may be pebbled and less aesthetically pleasing (15, 17, 21). According to some authors, meshing even promotes angiogenesis (24, 25). In all the cases in our study, we perforated the STSG with a surgical blade, given that the largest defect was still too small for a mesher.

The recipient site must have effective blood microcirculation. Therefore, skin grafts can be applied on fascia, muscle, periosteum, paratenon, perichondrium, granulation surface and adipose tissue (6). In our paper, the graft was applied on finger pulp in 11 cases, paratenon in eight cases, muscle in two cases and on the periosteum and

Figure 2. Recipient site examples

perichondrium in three cases. Some of the recipient sites from this paper are shown in **Figure 2**. Even a mangled hand can be a good recipient site **(Figure 3)**.

The most common causes of graft failure are infection and haematoma leading to mechanical separation (2, 17). Post-operative care is crucial for skin graft success (8). Failure can sometimes be caused by inadequate fixation of the graft (2). Fixation is performed through the margin by suturing (14, 17). In all the cases in our study, the grafts were sutured. The graft should cover the whole defect. The limb must be splinted, especially around joints

Figure 3. The use of STSG in a mangled hand

(2). By decreasing the movement of the dressings, a graft is protected from shear stress and trauma (21). The patient must be informed about the protection of the graft and donor area (10). According to Rank, fixation and firm pressure are more important for primary graft take than the local blood supply (2).

The average healing time in our patients is 28,11±9,94 days, which is similar to the findings of other authors (8-10). Out of 24 defects, partial graft loss occurred in one case, in which the graft was applied on the perichondrium. Patton describes one graft failure and Mosher a few cases of partial loss out of 40 patients (8, 10). Rank used primary STSG in three cases for fresh trauma, and his original research included numerous different indications for STSG (2). Results shown referred to the total number of cases. Complete graft take was achieved in 59% and incomplete in 36% (2). Innis describes the use of STSG in six severe hand injuries and the graft take was 90-100% (11). We had no major donor site morbidity, as is seen in other papers as well (8,10). The cosmetic appearance was assessed on a scale of 0-3 and most of our patients (n=10) rated it as acceptable (58,82%). 35,29% rated the result as good and 5,88% as poor. Cosmetic results are shown in **Figure 4**. We found no similar data for primary STSG in the available literature. Schenck used a similar tool, but for full-thickness grafts (3).

Hand defects can also be covered with various flaps. For smaller finger or fingertip defects, there are different available options, such as V-Y advancement flap, cross finger flap, Moberg or thenar flap (1,8,26-31). For defects with exposed bone and tendons, a dorsal metacarpal artery flap or island flap can be used (28, 32-34). In recent years, there have been more papers describing the use of perforator flaps, venous free flaps and even the use of free vascularized toe pulp and partial toe transfers (28,35-40). Flaps also cause greater donor site morbidity, may necessitate sacrifice of a peripheral artery and result in a longer hospital stay (39). With all of these flaps and techniques in mind, we must ask ourselves whether primary

Figure 4 - Preoperative, postoperative and follow-up state

STSG still has a place in the management of hand soft tissue defects.

There are no recent papers that describe primary STSG use. All the literature concerning this subject was published 40 to 80 years ago, before the introduction of various flaps, intraoperative Doppler use and advancement of microsurgery technique (2, 5, 8-11). Although flaps are a powerful tool in a surgeon's hand, they require specially trained surgical staff and the procedure itself is more complicated and significantly longer. We think that even in modern times, STSG, as a less invasive method, lower on reconstructive ladder, can still be used with similar outcome.

CONCLUSION

A fresh wound after surgical debridement is an ideal bed for skin grafting. Many risks associated with delayed treatment can be avoided by primary coverage. The method is simple, it is easy to learn and requires minimal equipment so it can be done in the emergency room. The wound heals more quickly, the hospital stay is shorter and the functional result is better with earlier return to work. Even with all the new techniques available, STSG still has an important place on the reconstructive ladder and there is no reason for any diffidence in managing skin defects.

CONFLICT OF INTEREST

We know of no conflict of interest associated with this publication, and there has been no financial support for this work that could have influenced its outcome.

AUTHOR CONTRIBUTIONS

According to the authors, the following contributed to the paper: conceptualization and design of the study: Sladjana Matic. Katarina Gambiroza and Petar Vukman, who collected the data, performed the statistical analysis, and created the figures. Sladjana Matic and Tomislav Palibrk carried out the analysis and interpretation of the

findings. Sladjana Matic and Darko Milovanovic prepared the draft manuscript. Katarina Gambiroza edited the manuscript's grammar. Petar Vukman and Mihailo Ille provided technical and administrative help during the writing. An article revision of the scientific content was performed by Mihailo Ille. The final draft of the manuscript was approved by all authors after they had evaluated the findings.

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PRIMARNI GRAFT PARCIJALNE DEBLJINE KOŽE ZA POKRIVANJE MEKOTKIVNIH DEFEKATA ŠAKE I PRSTIJU: NE OKLEVAJTE

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Sažetak

Uvod: Povrede šake često uzrokuju defekt mekih tkiva, čije lečenje predstavlja jedan od najtežih izazova u rekonstruktivnoj hirurgiji. Postoje brojne opcije za pokrivanje mekotkivnih defekata, uključujući flapove i kožne graftove.

Materijal i metode: Sprovedena je retrospektivna opservaciona studija, koja je obuhvatila 17 pacijenata sa 24 kožna defekta šake, koja su lečena primarnim graftovima parcijalne debljine kože u jednom medicinskom centru. Prosečan period praćenja je bio šest meseci. Starost pacijenata se kretala od 36 do 80 godina. Bilo je 16 pacijenata muškog pola i jedan pacijent ženskog pola. Kožni defekti su varirali po veličini, od 7x8mm do 39x40mm. Primarni ciljevi su bili preživljavanje grafta, infekcija recipijentnog mesta i morbiditet donorskog mesta grafta. Sekundarni ciljevi su bili kozmetički rezultati i potrebno vreme za kompletno zarastanje rane.

Rezultati: Svih 24 rana je sraslo u prosečnom periodu od 28,11±9,94 dana. Nije došlo do pojave infekcije grafta ni kod jednog pacijenta. U jednom slučaju je došlo do parcijalnog gubitka grafta. Nije prijavljen značajan morbiditet donorskog mesta. Šest pacijenata opisuju kozmetički efekat kao dobar (skor 3), 10 pacijenata kao prihvatljiv (skor 3) i jedan pacijent kao loš (skor 1) .

Zaključak: Graft parcijalne debljine kože predstavlja odličnu opciju za inicijalni i definitivni tretman defekta kože prstiju i šake. Ovakav način lečenja je jednostavan, nosi manje posledica od sekundarnog pokrivanja defekta, zahteva minimalnu medicinsku opremu i ponekad se može uraditi u okviru hitnog prijema, bez potrebe za hospitalizacijom pacijenta. Ne treba oklevati u primeni ovakvog načina pokrivanja defekta, ukoliko postoji takva klinička indikacija.

Ključne reči: šaka, prsti, defekt mekih tkiva, primarna rekonstrukcija, kožni graft parcijalne debljine

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