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Reverse Digital Island Flap with Skin Strip Retention to Prevent Flap Congestion

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Purpose: The reverse digital island flap is useful for the repair of various fingertip injuries. We present a modified surgical technique with skin strip elevation for the prevention of postoperative congestion.

Methods: From January 2005 to October 2015, we performed 31 reconstructive procedures for finger injury using a reverse digital artery island flap with and without skin strip retention. Patients' clinical characteristics, surgical outcomes, and complications were investigated.

Results: All flaps survived and there were no donor site problems. The mean follow-up time was 5 months (range, 3–8 months). In skin strip retention group, mild venous congestion was observed in 1 case, although it resolved spontaneously. Another case retained flexion contracture, and 2 patients had stiffness at the distal interphalangeal joint. Whereas, in no retention group, venous congestion was observed in 3 cases, 1 patient had partial flap necrosis and 2 patient suffer in flexion contracture at metacarpophalangeal joint.

Conclusion: The reverse digital island flap procedure produces consistent results and is reliable for the treatment of fingertip injury. Our modified surgical technique of elevating the flap accompanied by skin strip retention helps prevent postoperative congestion.

Keywords: Fingertip injury, Reverse digital island flap, Prevention of congestion

INTRODUCTION

Fingertip injury is a commonly encountered and challenging problem for hand surgeons. Various treatment modalities have been reported depending on the types of injury[1-5]. In the case of amputation, composite graft or microsurgery is possible. Without amputation there are various possible treatment modalities, such as secondary intention, simple shortening, local flap, regional flap, or free flap[6-8]. Among these methods various local flaps have been effective for the treatment of fingertip injury, although volar oblique injury or large defects cannot be covered by a local finger flap[9,10].

In this circumstance, the most frequently considered flap is the reverse digital island flap (RDIF), which has been used widely over previous decades because it can cover large defects of the fingertip in single-stage surgery[11,12]. It is also reported to be an excellent choice for fingertip injury because of its safety, reliability, postoperative cosmetic appearance, and favorable sensibility[13,14].

Despite these advantages, vascular complications may arise such as venous congestion or partial flap loss. Many reports have been published about modifications of surgical techniques to improve surgical integrity and prevent complications. However, there are few reports of modified surgical techniques for the prevention of postoperative congestion. In a previous study, more than 20% of patients experienced venous congestion or subsequent flap necrosis[15].

We designed a modified surgical technique for elevation of the flap to prevent congestion. Here we report our surgical outcomes using skin strip retention and discuss how to ensure flap success without congestion.

MATERIALS AND METHODS

Between January 2005 and October 2015, we performed 31 reconstructive procedures for finger injury using RDIF, with skin strip retention in 20 cases and without skin strip in 11 cases. The patients included 22 males and 9 females, with an average age of 44.87 years (range, 10–84 years). Types of injury were amputation (n=18), crushing (n=5), necrosis (n=4), and defect (n=4). The injured digits included 6 thumbs, 6 index, 5 middle, 9 ring, 4 little fingers, and 1 case of injured thumb and index finger. The donor digits included the index (n=4), middle (n=16), ring (n=9) fingers, and little (n=1) with 1 case of index and middle fingers. We selected patients on the basis of the following criteria: age 10 years or older; 1 or 2 finger defects; island flap 1 to 2 cm in length; skin strip thickness 2 to 3 mm. The size of the defects ranged from 0.5 to 3.0 cm long and 0.7 to 7.5 cm wide. The flaps ranged in size from 0.7×1.0 to 2.5×3.0 cm^2 (mean, 3.00 cm^2). All cases were in general anesthesia and tourniquet was applied in all cases.

We selected patients on the basis of following: age 10 years or greater; volar soft tissue defect involving the middle phalanx, distal third of the proximal phalanx, or both. Patients were excluded for the following reasons: patient age under 10 years; occurrence of the defect in a region the flap is unable to reach; and pulp defect.

We compared the outcome of with and without skin strip retention groups in all 31 patients. And we analyzed the complications arising from them.

1. Surgical technique

The flap was designed on the finger adjacent to the injured site or injured finger. The flap was easily found at the distal third of the proximal phalanx, and was designed according to the size and shape of the defect. The subcutaneous pedicle and skin strip of the flap were elevated on the lateral middle line of the proximal phalanx adjacent to the injured finger (Fig. 1), and maximum ped-

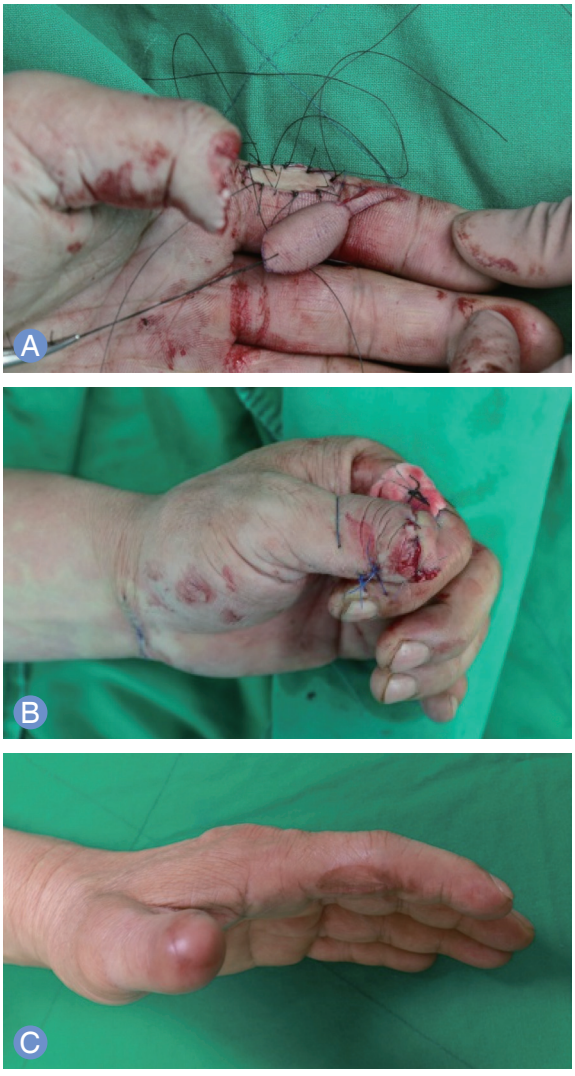

Fig. 1. A 61-year-old-male with posttraumatic amputation, the defect size was about 1.5×2.0 cm over the left thumb. **(A)** Reverse-flow heterodigital island flap with skin strip was elevated from index finger. **(B)** The flap with skin strip was transferred into the defect. **(C)** Five months after the operation, the flap circulation was intact.

icle length was achieved. We included subcutaneous tissue of at least 0.5 cm width in the pedicle. A 2- or 3-mm-thick skin strip should be retained to preserve blood supply. After the digital artery was ligated at the proximal base, the flap was turned 180° on the pivot point to reach the fingertip defect. No neurorrhaphy was performed. We covered the flap donor site with a full-thickness skin graft. No difficulties from inflammation or adhesion were encountered when harvesting these flaps, even after failed fingertip replantations.

RESULTS

All flaps with or without skin strip survived and there were no donor site problems. In all cases, the operation was performed to maintain as far as possible the original length of the injured fingers. All defects were successfully covered by the flap. We cannot find either digital tip ischemia or revascularization failure on injured fingers. The mean follow-up time was 5 months (range, 3–8 months). In no skin strip retention group, venous congestion was observed in 3 patients, 1 patient had partial flap necrosis (Fig. 2) and 2 patients suffer in flexion contracture at metacarpophalangeal joint (Tables 1, 2). Whereas, in skin strip retention group, mild venous congestion was observed in 1 patient, which resolved spontaneously. Total active range of motion of the affected fingers was 180° to 260°. Flexion contracture persisted on PIP joint in 1 patient, while stiffness at the distal interphalangeal joint was apparent in 2 cases (Table 3, 4). The venous congestion incidence was about 27% in no skin strip retention group and about 5% in skin strip retention group, however, there is not significant difference (p=0.077).

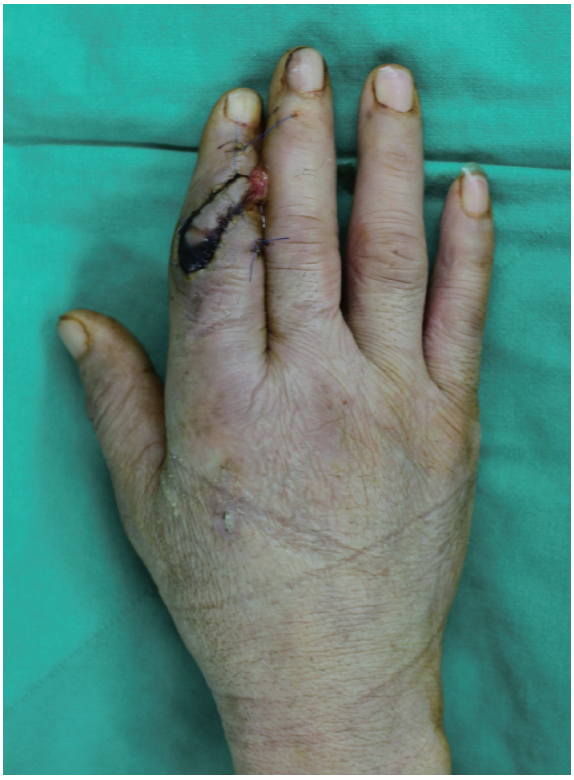

Fig. 2. Partial flap necrosis of reverse digital island flap in no skin retention group.

Table 1. Patient data of the reverse digital island flap without skin strip retention

Case	Age (yr)	Sex	Cause	Lesion		Detach (day)
1	45	Male	Grinder	Rt	Ring	*
2	40	Male	Milling machine	Rt	Little	*
3	48	Female	Press	Rt	Ring	*
4	28	Male	Grinder	Rt	Index	7
5	10	Female	Knife	Rt	Thumb	12
6	48	Male	Grinder	Lt	Middle	*
7	47	Male	Grinder	Lt	Ring	15
8	25	Male	Milling machine	Lt	Ring	15
9	37	Female	Milling machine	Lt	Index	*
10	50	Male	Press	Rt	Middle	*
11	36	Male	Milling machine	Rt	Little	*

Rt, right; Lt, left.

*Homodigital island flap not needing flap detachment.

Table 2. Patient data of postoperative complications without skin strip retention

Characteristic	Value
Mean age (yr)	37.63 (range, 10 to 50)
Male:female	8:3
Mean detach day	12.25 (range, 7 to 15)
Complication	
Early	
Flap necrosis	1
Venous congestion	3
Hemorrhage	0
Dehiscence	5
Delayed	
DIP joint stiffness	0
Flexion contracture	2

DIP, digital island flap.

Table 4. Patient data of postoperative complications with skin strip retention

Characteristic	Value
Mean age (yr)	48.85 (range, 19 to 84)
Male:female	14:6
Mean detach day	11.75 (range, 8 to 14)
Complication	
Early	
Flap necrosis	0
Venous congestion	1
Hemorrhage	0
Dehiscence	1
Delayed	
DIP joint stiffness	2
Flexion contracture	1

DIP, digital island flap.

Table 3. Patient data of the reverse digital island flap with skin strip retention

Case	Age (yr)	Sex	Cause	Lesion		Detach (day)
1	71	Male	Rope	Rt	Middle	14
2	57	Female	Press	Lt	Ring	*
3	61	Male	Press	Lt	Thumb	8
4	44	Male	Grinder	Rt	Thumb	11
5	77	Female	Snake bite	Rt	Ring	11
6	38	Male	Press	Rt	Middle	*
7	54	Male	Milling machine	Rt	Thumb	14
8	35	Male	Traffic accident	Rt	Thumb	10
9	84	Female	Snake bite	Rt	Index	13
10	36	Male	Press	Lt	Ring	11
11	57	Female	Knife	Lt	Thumb	12
12	67	Male	Snake bite	Lt	Index	*
13	48	Female	Milling machine	Rt	Thumb & index	10
14	34	Male	Rope	Lt	Ring	14
15	37	Female	Press	Lt	Middle	*
16	40	Male	Milling machine	Rt	Little	13
17	32	Male	Milling machine	Lt	Little	12
18	57	Male	Snake bite	Rt	Index	12
19	29	Male	Milling machine	Lt	Ring	13
20	19	Male	Press	Lt	Index	10

Rt, right; Lt, left.

*Homodigital island flap not needing flap detachment.

DISCUSSION

Well-performed reconstruction of the fingertip demands preservation of the finger length and provision of a sensate and durable flap. Selection of treatment approach should consider defect size, nail presence, donor site morbidity, and level of amputation[16]. In addition, reconstruction should be achieved in a single session. Numerous treatment modalities such as conservative treatment[17], and local, regional, and distal flaps have been proposed for the reconstruction of fingertip injuries.

Among the various treatment approaches, several re-

gional or distant flaps can be considered when the defect size is too large for conservative treatment or local flap coverage. The RDIF is our first considered option when a local flap is insufficient. The abundant vascular communication between the radial and ulnar digital arteries enables the RDIF to achieve normal blood supply by retrograde flow. Moreover, it does not require a 2-stage operation and long immobilization time. The wide arc of rotation of this flap in relation to the fingertip is also an advantage.

Of course the RDIF also has drawbacks, which may be overcome by modifications in surgical technique. Cold intolerance or hypersensitivity has been discussed as a possible complication. Elevation of the sensate flap at the beginning of surgery has been attempted to overcome this sensory problem[13]. However, several studies reported that there are no significant sensory differences between sensate and insensate flaps[9,14]. Following publication of updated clinical outcomes, sensory problems with the RDIF are no longer recognized as a postoperative complication. Possible hypersensitivity after RDIF due to re-innervation of the nerve has been investigated, which is reported to be temporary until recovery is complete. Although full sensory recovery after RDIF surgery is usually possible after about 1 year, efforts to achieve earlier recovery are ongoing[8,18]. Donor site morbidity is another frequently mentioned complication of RDIF. A donor site proximal to the phalanx can lead to irreversible depressed scar or motor limitations. To prevent such morbidity, a previous study introduced adipofascial flap elevation without skin[19].

Postoperative flap congestion is also a commonly encountered complication of RDIF. Some studies reported postoperative venous congestion in more than 10% and partial flap loss in more than 20% of cases[15]. Several studies reporting the use of specific procedures have underlined the need to resolve the problem of congestion[8,18,20]. While it is recommended that patients be monitored carefully for postoperative congestion, few studies have investigated its prevention.

We used a modified surgical technique of elevated pedicle with skin strip for the prevention of postoperative congestion. An *en bloc* elevation of the subcutaneous venous network has been also introduced for the same purpose[10]. Similarly to this technique, our skin strip retention also can overcome venous congestion by elevation of the skin and subcutaneous venous network. We assumed that skin strip over the pedicle could be helpful for vascular supply by enhancing the subdermal vascular network[21]. In addition, the skin strip serves a protective role for the pedicle in that it prevents venous congestion by twisting or compressing the pedicle, and also easy handling can be possible[22]. Using flap elevation with skin strip retention, vascular problems such as congestion decreased than not using skin strip and we can reduce the need for postoperative monitoring.

CONCLUSION

In conclusion, although the RDIF produces consistent results and reliable flaps for the treatment of fingertip injury, several complications can occur. We suggest modified surgical technique of elevated flap with skin strip retention for prevention of postoperative congestion.

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역행성 수지 도서형 피판술에서 피판 울혈을 예방하기 위한 피부 조각 보존술

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목적: 역행성 수지 도서형 피판술은 수지첨부 손상의 다양한 결손에서 매우 유용한 수술이다. 우리는 이 수술 후 울혈을 방지할 수 있는 변형된 수술 방법을 소개하고자 한다.
방법: 2005년 1월부터 2015년 10월까지 우리는 31명의 수지첨부 손상 환자에서 역행성 수지 도서형 피판술을 피부 조각 보존술을 시행 또는 미시행하였다. 환자에 관한 모든 의학 정보의 합병증을 포함한 수술결과가 조사되었다.
결과: 모든 피판은 성공하였고 피판 공여부의 문제는 없었다. 환자의 평균 추적 기간은 5개월(범위, 3-8개월)이었다. 피부 조각 보존술을 시행한 그룹에서는 한 명의 환자에서 수술 후 울혈이 관찰되었으나 별다른 조치 없이 해결되었다. 한 명은 굽힘 구축이 관찰되었고, 두 명의 환자에서 원위지관절 강직이 관찰되었다. 반면에, 피부 조각 보존술을 시행하지 않은 그룹에서는 세 명의 환자에서 수술 후 울혈이 관찰되었고 두 명의 환자에서 중수지관절에서 구축이 관찰되었다.
결론: 수지첨부 손상에서 역행성 수지 도서형 피판술은 일정하고 믿을 수 있는 결과를 내는 수술 방법이다. 우리는 피부 조각을 보존하여 피판과 같이 거상하는 방법을 사용하여 수술 후 울혈을 예방하였기에 이를 보고하는 바이다.

색인단어: 지첨부손상, 역행성 수지 도서형 피판술, 수술 후 울혈

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