Cap-plasty reattachment for unreplantable fingertip amputations

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Background
Treatment options for fingertip amputation distal to flexor digitorm profundus (FDP) insertion include toe pulp transfer, microsurgical replantation, and nonmicrosurgical cap-plasty reattachment. Microsurgical replantation is costly and often fails because of poor venous drainage.

Patients and methods
We reported the results of 12 patients (eight male patients and four female patients) who underwent fingertip reattachment. All patients had type 4 fingertip injury according to Allen's classification. The mean age was 19.5 years. Cap-plasty technique was used for fingertip reattachment in which the amputated tip is sutured back primarily as a composite graft after a thorough debridement with minimal defatting.

Objective
The aim of this study was to evaluate the results of cap-plasty technique in the management of unreplantable fingertip injuries.

Results
All reattachments were successful, with small areas of tip necrosis in three fingers (healing occurred by secondary re-epithelialization) and infection in one patient. The mean static two-point discrimination was 5.8 mm and pulp pinch was 75% of normal. The mean shortening in the finger length was 3.33 mm.

Conclusion
The cap technique of nonmicrosurgical reattachment is a simple and reliable method of functional preservation of pulp tissue, as well as normal appearance of the nail complex.

Keywords:
cap-plasty, fingertip reattachment, amputations

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Introduction

Many methods have been used to reattach amputated fingertips [1]. Of these methods, microsurgery has been accepted as the procedure of choice because the defining characteristic of a microsurgically replanted finger is that its survival in the recipient bed is dependent on the functioning of the intravascular circulation [2]. Although considerable progress has been made in the techniques for microvascular replantation of amputated fingers, the replantation of an amputated fingertip is difficult because digital arteries branch into small arteries [3]. This is in addition to digital veins that run from both sides of the nail bed to the median dorsal sides, which are difficult to separate from the immobile soft tissue. Furthermore, even with the most technically skilled microsurgeon, replantation failure often occurs, especially in cases of severe injury [4]. Therefore a new strategy for fingertip reattachment is needed [5]. Reattachment of the amputated fingertips as composite grafts has been performed for distal levels in children, with high rates of good outcome [6], but the majority of the reports emphasized that this procedure had success rates only up to 50% in adults. Several techniques to enhance composite graft take in adults have been defined [7].

Patients and methods

We followed up 12 patients who underwent digital replantation with cap-plasty technique and evaluated the outcome of this procedure during the period from May 2009 to October 2010. Initially, patients selected were those who had undergone amputations at or distal to the distal interphalangeal joint that were not suitable for replantation, as intraoperatively successful microvascular anastomosis of the artery could not be achieved or no suitable vein could be found. There were 12 patients (eight male patients and four female patients) with 12 amputated digits (one thumb, three index, four middle, three ring, and one little). The right hand was affected in seven patients, whereas the left hand was affected in five patients. All digits had a crush amputation. The mean age was 19.5 years, ranging from 2 to 37 years. The mean length of the amputated part was 13 mm, ranging from 8 to 19 mm. The mean follow-up period was 8 months, ranging from 5 to 10 months. The study protocol was approved by the Ethics Committees of Faculty of Medicine, Benha University. An informed consent was obtained from all study subjects prior to their inclusion in this study.

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Surgical technique

We performed a digital block using 1% lidocaine (xylocaine) without epinephrine administered on both sides of the proximal finger to achieve adequate anesthesia. If more extensive debridement was needed, sedation with an agent such as midazolam (versed) was carried out. Thereafter, we drained blood from the finger and applied a tourniquet using a rubber band or a small Penrose drain at the base of the affected digit. We cleaned the wound thoroughly using saline with antibiotic, and any devitalized tissue was removed (Fig. 1a). The amputated part was prepared on a separate table with debridement and irrigation (Fig. 1b), followed by vessel identification under a microscope. When no suitable artery and vein could be found, the bone of the avulsed part was excised and the fat was removed. The nail plate was removed, whereas the nail bed was preserved, and de-epithelialization of the proximal stump was carried out to improve the take at the cap-nail complex. After the cap-nail complex was sutured to the proximal stump, multiple punctures were made in it and tie-over suturing was performed to improve survival of the cap. The wound was cared for with moist wound healing by applying an antibiotic ointment to the area. A protective splint was applied to increase the graft survival.

Repeated dressing was performed every 3 days during the first 2 weeks. Patients were checked regularly for graft survival, finger function (static two-point discrimination and pulp pinch power were recorded), and appearance (shortening in the finger length and patient satisfaction).

Results

The cap-nail complex graft was successful in all cases (100% survival rate) (Figs. 2–4). The finger pinch power

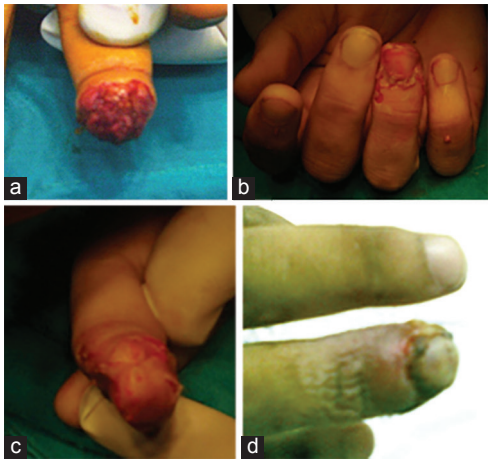
Figure 1

(a) Proximal stump after debridement, (b) distal stump after defatting.

Figure 2

Amputated distal phalanx of the left ring finger in a 35-year-old male patient (a) at the time of injury, (b) after reattachment.

Figure 3



Fingertip injury of the right ring finger in a 30-year-old male patient (a) at the time of injury, (b, c) after reattachment, and (d) after 2 months.

Figure 4

Fingertip injury of the right middle finger in a 25-year-old male patient (a) the amputated stump, (b) after reattachment, and (c, d) after 6 months.

reached 75% of normal side and the static two-point discrimination at the fingertip was 5.8 mm; all patients could use their injured finger normally in daily work. As regards appearance, there was shortening in the digits ranging from 1 to 5 mm (the mean shortening was 3.33 mm), although the reconstructed digits gave the 'illusion' of a normal finger. The esthetic outcomes were evaluated using a self-report questionnaire; all patients were satisfied and could use their injured finger normally. Complications occurred in four cases: three had fingertip necrosis, which was treated with re-epithelialization, and one digit had superficial infection (Table 1).

Discussion

Too often, fingertips are not replanted because suitably sized veins cannot be located for microanastomosis. Attempts at 'cap-plasty' that rely on restoration of the dermal circulation are a race between revascularization (that starts from the sutured dermis proximally) and necrosis (that affects tissues located distally the most) and tend to be more successful and predictable in children [8]. The majority of the reports emphasized that this procedure had success rates only up to 50% in adults [1]. Several techniques to enhance composite graft take in adults have been defined. Some authors tried cap-plasty with cooling of the amputate [9]. Others have bled the distal stump in an effort to relieve venous congestion while awaiting neovascularization [10] or by using leeches [11]. Pocketing of the digit was proposed [12]. In this study, we evaluated the results of cap-plasty technique in 12 digits: four in children and eight in adults. The success rate was 100% as regards the survival of the distal stump.

We achieved good results in graft survival after introducing some modifications in the technique. In the proximal stump, after complete debridement, de-epithelialization of the distal 2 mm of the stump was carried out, which helped revascularization at sutured dermis proximally. In the distal stump, the nail plate was removed, whereas the nail bed was preserved, giving a bleeding surface to relieve venous congestion while awaiting neovascularization. After the cap-nail complex was sutured, multiple punctures were made in it and tie-over suturing was performed to help revascularization and relieve venous congestion.

The survival rate was the same in children and adults; during 8 months follow-up no complications occurred in children and complications occurred in four adults. The children gave better results as regards the two-point discrimination, degree of shortening, and external appearance (Table 2).

In a study conducted by Uysal *et al.* [1] which included 23 patients of whom 20 were adults, a success rate of 86.95% was achieved in total, and 85% in adults. The mean value for the two-point discrimination was 7.26 mm. The mean shortening was 6.80 mm.

In a study conducted by Chen *et al.* [2], which included 27 patients with 31 injured fingertips, the overall

Table 1 Patient data and results

Number of patients	Age (years)	Sex	Affected finger	Mechanism of damage	Lesion size (mm)	Two-point discrimination (mm)	Finger shortening (mm)	Follow-up (months)	Complications
1	6	F	Right index	Crushing injury	9	4	1	6	
2	4	M	Left little	Cutting injury	11	5	1	8	
3	28	M	Right middle	Cutting injury	18	6	2	9	Tip necrosis
4	35	M	Left ring	Crushing injury	19	7	2	10	Infection
5	25	M	Right middle	Crushing injury	10	9	4	7	Tip necrosis
6	30	M	Right ring	Cutting injury	8	8	5	5	
7	37	F	Left middle	Crushing injury	17	7	5	6	
8	18	M	Right middle	Crushing injury	8	6	4	9	
9	4	M	Left index	Crushing injury	10	4	4	8	
10	2	F	Left thumb	Crushing injury	9	3	4	10	
11	19	M	Right index	Cutting injury	18	5	5	10	
12	26	F	Right ring	Crushing injury	19	6	3	8	Tip necrosis
Mean	19.5	8 M 4 F	4 middle3 index, 3 ring1 thumb, 1 little7 right, 5 left	4 cutting injury 8 crushing injury	13	5.8	3.33	8	

Table 2 Comparison of results between children and adults

Patients	Number	Two-point discrimination (mm)	Pulp pinch of normal (%)	Finger shortening (mm)	Follow-up (months)	Complications
Children	4	4	75	2.5	8	0 case
Adults	8	6.75	75	3.75	8	4 cases

graft survival rate was 93.5% and the average two-point discrimination was 6.3 mm, and 86.2% of the patients could use their injured finger normally in daily activities.

In a study conducted by Rose *et al.* [8] that included seven adults, all cases were successful, with small areas of tip necrosis in two. The mean static two-point discrimination was 6.5 mm (range, 3–10 mm) and pulp pinch was 67% of normal.

The functional recovery was excellent in all cases, with acceptable sensibility, as the mean value for the two-point discrimination was 5.8. The pinch power of reattached fingertip reached 75% of normal side and all patients returned to their normal activity.

The esthetic outcome was evaluated using a self-report questionnaire; all patients were satisfied (with average shortening of 3.33 mm), and the affected fingers had normal appearance.

Complications occurred in four digits. Infection occurred in one digit; it was superficial and was cured with medical treatment without debridement. Tip necrosis occurred in three digits in adults; as revascularization in adults is slower compared with that in children, these digits were healed by re-epithelialization.

These complications had minor effect on the overall results, and it was therefore considered minor complication. The limitations of this study are that it was a small series and the follow-up duration was also short. Further study is needed to prospectively assess other social issues, such as medical costs, time to return to work, and functional outcome, and compare it with the results of patients who undergo replantation, local flap, and revision amputations.

Conclusion

This easily performed and one-stage surgical procedure provides a reliable method for treating microsurgically nonreplantable fingertip amputations caused by hand trauma. The high overall success rate, satisfactory esthetic outcome, and good functional preservation help patients return earlier to their daily life.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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