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Emergency toe-to-hand transfer for post-traumatic finger reconstruction: A multicenter case series[☆]

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ABSTRACT

Background: The aim of this paper was to evaluate the outcomes of a homogenous series of emergency toe-to-hand transfer reconstructions with a different timing: immediate (same surgical step with the debridement), primary (in the first 24 h), early (24–72 h after the debridement) or delayed (72 h–7 days).

Materials and methods: Between 2001 and 2011, 31 patients received an immediate reconstruction with a toe-to-hand transfer. Data on indications, timing, type of surgery, complications and outcomes (sensory and motor recovery, patient satisfaction) were extrapolated and recorded.

Results: Most of the procedures in our series (71%) were performed in the first 24 h. Survival rate was 100%. The only complications were 3 venous thrombosis (10%), solved with surgical re-exploration. Only 1 patient required secondary surgery for web deepening. No functional problems were recorded at the donor site. Sensibility recovery was acceptable in all patients; toe mobility was higher for the reconstructed thumb (85%) than for other digits (77%). Patient satisfaction was high with regard to functional results and lower but acceptable with regard to the aesthetic outcome. There was no difference in satisfaction rate of patients treated within 24 h or within 7 days.

Conclusion: No conclusive evidence exists in favor of an immediate versus a primary, early or delayed emergency reconstruction. Emergency toe transfer for finger reconstruction is a safe procedure and its outcomes are comparable to those reported in the literature for secondary reconstruction. Immediate reconstruction has the advantage of an easier dissection, but early or delayed reconstruction gives more time to discuss with the patient and to plan surgery.

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Introduction

Nowadays, toe transfers represent the gold standard for secondary reconstruction of missing amputated fingers [1–4], while

discussion still exists on indications and appropriate timing for emergency reconstruction [1,5–8].

The concept of emergency free flaps is not a new one. Lister considered as "emergency free flaps" those flaps used within 24 h after debridement [9]. Godina and Ninkovic respectively defined "early" and "primary"/"delayed primary" reconstructions (2–7 days from the debridement) [10,11]. Georgescu et al. completed these classifications by adding the category of "immediate" emergency flaps (immediately after the debridement) (Table 1), [1]. Table 1 shows the classification of emergency reconstruction which we will refer to through the text.

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Table 1
Georgescu et al.'s classification of emergency free flaps (1, 2, 21–23).

Name of the procedure	Moment of procedure
Immediate emergency free flap	In the same surgical step with the debridement
Primary emergency free flap	In the first 24 h, but not in the same surgical step with the debridement
Early emergency free flap	In the interval between 24–72 h after the debridement
Delayed emergency free flap	In the interval between 72 h and 7 days after the debridement

Emergency microsurgical reconstruction is generally recognized to have similar outcomes to secondary reconstruction, but with surgical, economical and psychological advantages [5–6].

What are the indications for emergency surgery? Are the success rate and the outcomes of immediate reconstruction comparable to those of other emergency reconstruction?

We present a case series of emergency toe transfers for post-traumatic finger reconstruction performed in two hand trauma centers and discuss pertinent literature on indications, advantages, short and long-term outcomes of emergency toe transfers.

Materials and methods

Between 2001 and 2011, 31 patients with traumatic finger loss received 44 emergency toe-to-hand transfers at two different hand and microsurgery centers. Detailed data on age, sex, hand/dominance, finger and level of injury and mechanism of injury are presented in Table 2. The thumb was involved in 21 cases

(68%) and long fingers (total number: 44) were interested in 15 cases (multiple amputations in all cases). Five cases were failure of replantation.

Data on timing and kind of procedure, donor site, vascular variance, site of anastomosis, complications and reoperations, follow-up and outcomes were recorded (Table 2). Outcomes were evaluated in terms of sensory (static two-point discrimination) and motor recovery; toe mobility was compared to preoperative toe mobility and expressed as rate of active range of movement. Also, patient satisfaction was recorded from both a functional and an aesthetic point of view on a 5-point rating scale (very good, good, fair, poor, very poor), (Table 3).

The subgroups “immediate”, “primary”, “early”, and “delayed” were compared with respect to complications rate, sensory and motor recovery and patient satisfaction, using the Kruskal-Wallis test. Differences with a p value ≤ 0.05 were regarded as significant.

Results

Most of the procedures (71%) were performed in the first 24 h, (14 immediate and 8 primary reconstructions). Seven early and 2 delayed reconstructions were performed; 44.4% of all early or delayed procedures were performed after failed replantation.

Of the 31 consecutive procedures, 2 cases were a combined reconstruction of thumb and long fingers, 19 were thumb reconstructions, 10 were (single or multiple) long fingers reconstructions.

In 20 cases of thumb reconstruction (95%), a big toe was transferred. In 2 of them, it was combined with a forearm flow-through flap, and in one with a combined 2nd and 3rd toe transfer. In most cases (13 patients) a trimmed big toe was transferred, while the

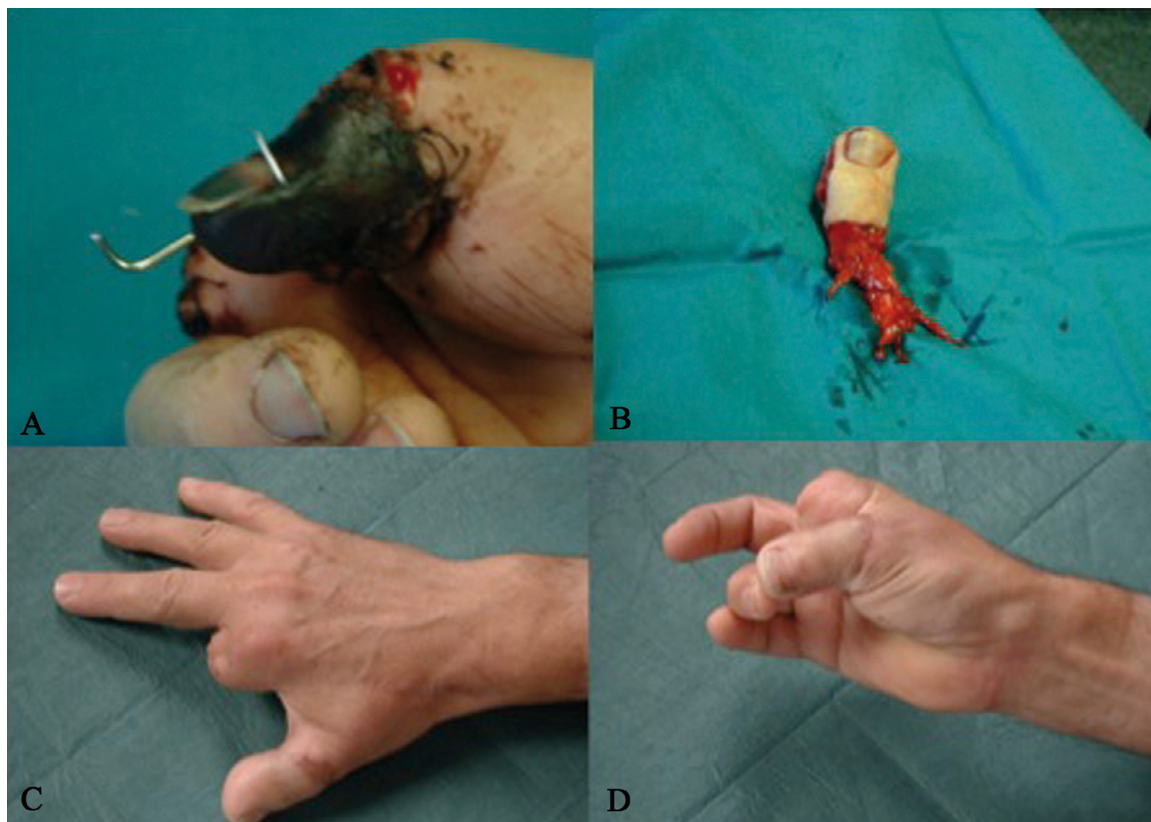


Fig. 1. Early thumb reconstruction with a wrap around toe transfer. (A). Distal thumb necrosis at interphalangeal level following failed replantation. (B) Toe flap ready for transfer. (C-D): Final result at 15 months follow up.

Table 2
Case series of emergency toe transfers at two hand trauma centers. Patients' characteristics, details of injury and surgical reconstruction are presented. P: phalangeal, MP: metacarpophalangeal, M: metacarpal, RC: radiocarpal.

N	Sex/Age	Mechanism of injury	Hand	Finger involved	Level	Associated lesions	Donor/Procedure	Timing	Complications/Reoperations
1	M/41	Circular saw	Left	Thumb	Distal 1/3		2nd toe (including part of M)	immediate	none
2	M/50	Crush	Right Dominant	2nd finger 3rd finger	M1 MP		Combined 2nd/3rd toes	immediate	none
3	M/29	Circular saw	Right Dominant	Thumb	MP		Big toe	immediate	none
4	M/23	Circular saw	Right Dominant	Thumb	P1		Trimmed big toe	immediate	none
5	M/35	Crush	Right Dominant	Thumb	MP		Trimmed big toe	primary	none
6	M/37	Circular saw	Left Dominant	Thumb 2nd finger 3rd finger	MP MP P2		Trimmed big toe	immediate	none
7	M/43	Circular saw	Left Not dominant	Thumb	P1		Trimmed big toe	immediate	none
8	M/39	Avulsion	Right Dominant	Thumb	MP		Trimmed big toe	immediate	venous thrombosis on 3rd day- solved with a vein graft
9	M/36	Crush	Left Not dominant	2nd finger 3rd finger 4th finger	MP MP MP	Thumb and 5th finger: fractures and tendons lesions	Combined 2nd/3rd toes Fractures and tendon repair	immediate	none
10	M/35	Circular saw	Right Dominant	Thumb	P1		Trimmed big toe	immediate	none
11	M/27	Crush fingers 2-5	Right Dominant	2nd finger 4th finger	MP MP		Bilateral 2nd toe	immediate	none
12	M/42	Circular saw	Right Dominant	Thumb 2nd finger 3rd finger 4th finger 5th finger	P1 MP MP MP MP		Trimmed big toe Combined 2nd/3rd toes	early	none
13	M/5	Crush	Right Dominant	Thumb 4th finger	MP MP	Skin defect forearm Ulnar nerve and ulnar artery injury	Flow-through radial forearm flap Trimmed big toe Ulnar nerve repair	immediate	none
14	M/18	Circular saw	Left Dominant	Thumb 2nd finger 5th finger	MP P1 M	3rd and 4th finger: devascularization and flexor tendons injury Palmar and dorsal skin defect	Flow-through radial forearm flap Big toe Revascularization and tendons repair 3rd and 4th finger	immediate	none
15	M/23	Circular saw	Right Dominant	Thumb	MP		Trimmed big toe	immediate	none
16	F/24	Crush	Left Not dominant	Thumb	MP		Trimmed big toe	delayed	none
17	M/42	Circular saw	Right Dominant	All fingers	RC		Big toe (right foot) on the radius Combined 2nd/3rd toes (left foot) on the ulna	immediate	none
18	M/50	Avulsion	Right Dominant	Thumb	IP		Wrap around big toe (including the 2nd phalanx and the skin of the 1st phalanx)	primary	none

(continued on next page)

Table 2 (continued)

N	Sex/Age	Mechanism of injury	Hand	Finger involved	Level	Associated lesions	Donor/Procedure	Timing	Complications/Reoperations
19	F/22	Crush - failed replantation	Right Dominant	2nd finger 3rd finger 4th finger 5th finger	MP		ALT flow-through flap Combined 2nd/3rd toes	Delayed (debridement 2 days after replantation)	none
20	M/19	Circular saw	Right Dominant	2nd finger 3rd finger 4th finger 5th finger	P1		Combined 2nd/3rd toes	immediate	venous trombosis on 2nd day solved with trombectomy+reanastomosis; deepening of the web space after one year
21	M/18	Crush - avulsion	Right Dominant	Thumb	P1		Wrap around big toe	immediate	none
22	M/29	Thumb - Failure of replantation IP	Left Not dominant	Thumb	IP		Wrap around big toe	primary	none
23	M/38	Thumb - Failure of replantation IP	Right Dominant	Thumb	IP		Trimmed big toe	early	none
24	M/30	Thumb - Failure of replantation IP	Right Dominant	Thumb	IP		Trimmed big toe	early	none
25	M/40	Avulsion	Right Dominant	Thumb	P1		Trimmed big toe	primary	venous trombosis on 2nd day solved with trombectomy+reanastomosis
26	M/26	Thumb - Failure of replantation	Left Not dominant	Thumb	P1		Wrap around big toe	early	none
27	M/36	Crush - avulsion	Right Dominant	2nd finger 3rd finger 4th finger 5th finger	MP MP MP MP		Combined 2nd/3rd toes (2nd toe on 3rd metacarpal; 3rd toe digital block)	primary	none
28	M/40	Crush-avulsion injury	Right Dominant	2nd finger 3rd finger 4th finger 5th finger	MP MP MP MP		2nd toe on 5th metacarpal	early	none
29	M/45	III and IV metacarpal - Crush avulsion all fingers at MF	Left Not dominant	3rd finger 4th finger	MP MP		Combined 2nd/3rd toes (3rd toe digital block)	primary	none
30	M/25	Crush-avulsion injury	Left Not dominant	3rd finger 4th finger	MP MP		Combined 2nd/3rd toes (3rd toe digital block)	early	none
31	F/30	Crush-avulsion injury	Right Dominant	2nd finger 3rd finger 4th finger 5th finger	MP MP MP MP		2nd toe (digital block)	early	none

Table 3

Sensory and motor outcomes, and patient satisfaction from a functional and an aesthetic point of view.

N	Follow-up (years)	Sensibility (mm)	Motility (%)	Patient satisfaction	
				Functional	Aesthetic
1	3	10	70%	very good	poor
2	5	8	60%	good	good
3	5	10	80%	very good	good
4	1.5	6	90%	very good	good
5	7	7	90%	very good	good
6	2	9	70%	good	good
7	3	7	90%	very good	good
8	3	10	70%	good	good
9	2	12	70%	good	fair
10	4	9	90%	very good	good
11	1	11	80%	good	good
12	4	13	80%	good	fair
13	7	10	95%	very good	very good
14	5	9	95%	very good	very good
15	3	12	95%	very good	very good
16	2	10	90%	very good	good
17	2	14	70%	very good	good
18	1.5	8	90%	very good	good
19	8	16	90%	very good	fair
20	6	10	80%	good	fair
21	3	11	90%	very good	good
22	2	9	80%	very good	good
23	4	12	90%	very good	good
24	2	9	90%	very good	good
25	3	7	80%	very good	good
26	3	6	90%	very good	fair
27	6	14	90%	very good	fair
28	4	13	70%	very good	fair
29	3	11	80%	very good	fair
30	4	12	70%	very good	fair
31	2	10	80%	very good	fair

wrap around technique was used in 4 cases of distal thumb loss (Fig. 1). Only in 1 case a 2nd toe was transferred for thumb reconstruction.

For long fingers reconstruction, in 3 cases, the 2nd toe was used for long fingers (bilaterally in 1 case), while 9 patients required a combined 2nd and 3rd toe transfer, that in one case was combined with an ALT flow-through flap (Fig. 2). Two patients required transfer from both feet.

Survival rate was 100%. The only complications were 3 venous thrombosis (10%), solved with surgical re-exploration. Only 1 (3%) patient required secondary surgery for web deepening (Table 1). No functional problems were recorded at the donor site.

Mean follow up was 1.4 years (range: 1–7). Sensibility recovery was acceptable in all patients, with a mean Weber static two-point discrimination test of 10 mm (range: 6–14 mm). Toe mobility was higher for the reconstructed thumb (85%) than for other digits (77%).

Patient satisfaction was high with regard to functional results: 77% of patients rated their satisfaction as very good, and 23% of them as good. Patients satisfaction with regard to the aesthetic

outcome was lower but acceptable: most patients rated their satisfaction as good or fair (55% and 32% respectively), 3% as very good, and 10% as poor. There was no difference in satisfaction rate of patients treated within 24 h or within 7 days.

The Kruskal-Wallis test showed no significant difference between the subgroups (“immediate”, “primary”, “early”, and “delayed”) with respect to complications rate, sensory and motor recovery and patient satisfaction (Table 4).

Discussion

Our study showed no conclusive evidence in favor of an “immediate” versus a “primary”, “early” or “delayed” reconstruction. We advocate emergency reconstruction for both amputations and failure of replantation, especially in very complex traumas but also in distal and “minor” defects of long fingers [12].

Immediate emergency toe transfers yield surgical (single stage reconstruction, easier dissection, preservation of length of bone, tendons and nerves, shorter convalescence time) and economic advantages (shorter hospital stay, more rapid return to work, lesser job quit than with delayed reconstruction) [5]; it has also been reported for elective reconstruction of the thumb [13–14].

Disadvantages of emergency toe transfers include the need for both a more extensive debridement and reconstructive surgery; unrealistic expectations and decrease patient satisfaction have also been suggested, as they do not mourn the loss of their fingers before reconstruction [5].

The main issue related to emergency toe transfer is the difficulty to obtain a truly informed patient consent. Thus, maybe a 2–3 days delay could be a reasonable compromise to allow for a through discussion with the patient, retaining the advantages of an early surgery, although in our series, there was no difference in satisfaction rate of patients treated immediately or within 7 days. Severe wound contamination, unsuitable physical conditions of the patient and referral from another center are other indications for delaying surgery of 2–3 days. As for delayed reconstructions, the great toe is most commonly harvested for thumb reconstruction and partial transfers are commonly applied [15].

Our case series showed that emergency reconstruction is associated with reliable short and long-term outcomes even in complex reconstructions with multiple transfers and/or associated flow-through flap transfer. Most patients were satisfied both from an aesthetic and functional point of view. Also, statistical analysis showed no differences between the different subgroups, suggesting, although on a small patients' sample, that all kinds of emergency reconstructions achieve similar short and long-term outcomes.

Literature review confirmed that success rates are similar for emergency and secondary reconstructions (>95%), with a low rate of complications [5,16]. Also, good results are generally reported irrespectively of the timing of reconstruction, although the sensory and motor recovery is far from the pre-traumatic hand function: toes are less mobile than fingers, thus a normal range of move-

Table 4

Comparison between complications rate, sensory and motor recovery, and patient satisfaction between the subgroups “immediate”, “primary”, “early” and “delayed” emergency reconstruction. No statistically significant difference was evident ($p > 0.05$).

Type of reconstruction	Patients (n)	Complications n (%)	p	Sensibility (mm) mean (range)	p	Motility (%) mean (range)	p	Patient satisfaction-functional (mean, range)	p	Patient satisfaction-aesthetic (mean, range)	p
Immediate	14	1 (7.1)	0.272	9.8 (6–14)	0.542	80.4 (60–95)	0.556	3.6 (3–4)	0.454	3 (1–4)	0.110
Primary	7	2 (28.6)		9.7 (7–14)		85.7 (80–90)		3.9 (3–4)		2.6 (2–3)	
Early	8	0 (0)		10.5 (6–13)		81.3 (70–90)		3.9 (3–4)		2.4 (2–3)	
Delayed	2	0 (0)		13 (10–16)		90 (90–90)		4 (4–4)		2.5 (2–3)	



Fig. 2. Early reconstruction after long fingers avulsion at a metacarpal level. (A-B): Palmar and dorsal view of the defect. (C-D): the second metacarpal head was moved, vascularized, on the third injured metacarpal to deepen the first commissure and improve grip function. (E) A combined 2nd/3rd toes transfer (3rd toe digital block) was transferred on the 3^o and 4^o metacarpal (only one metatarsal was harvested). (F): Immediate post-operative result. (G): One year post-operative result. (H): Functional result, with restored grip function. (I): Radiographic appearance.

ment cannot be achieved; sensory recovery is usually fair, but good in comparison to the sensitivity of toe in situ [17].

Conclusions

No conclusive evidence exists in favor of an immediate versus a primary, early or delayed emergency reconstruction. Emergency toe transfer for finger reconstruction is a safe procedure and its

outcomes are comparable to those reported in the literature for secondary reconstruction.

Delaying the procedures of few days is as safe as performing it in the immediate or primary emergency setting, but gives more time to discuss with the patient and to plan surgery.

Emergency toe transfer is indicated for thumb or multidigital amputation, provided a complete informed consent is obtained; cooperative and interested young patients are the ideal candidates for this surgery.

Declaration of Competing Interest

All authors declare no conflict of interest in relation to the work of this manuscript.

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