Complications and Pitfalls after Finger Replantation in Young Children

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Abstract

Study Design This is a retrospective cohort study.

Objective The authors report surgical outcome in a series of very young children who underwent finger replantation after traumatic amputation.

Methods During a 10-year period, 65 children were treated with replantation for finger amputation in two institutions. This study focused on replantation of 15 fingers in 13 young patients under 6 years of age (mean age: 2.9 years; range: 1.1–5.7 years). Early postoperative complications were categorized into major or minor. At the time of assessment, the authors evaluated everyday life activities, pain and cold tolerance, total active range of motion (TAM) in patients with successful replantation, and growth disturbance.

Results The overall success rate for children younger than 6 years was 47% (7 out of 15), and the authors had 67% of major complications, mainly in patients with crush injuries. There was venous ischemia in 13 (86%) fingers treated with controlled bleeding. The hemoglobin level decreased more than 2 g/dL in six patients, and blood transfusion was necessary in two patients. At the last follow-up, patients with successful replantation had a mean TAM of 72%.

Conclusion Despite numerous complications mainly in relation with venous congestion, the functional outcome is satisfactory after successful replantation in young children, which should always be attempted.

Level of Evidence/Type of Study Level III, case series, therapeutic study.

Keywords
- finger replantation
- children
- venous congestion
- digital amputation
- revascularization

Introduction

Literature about finger replantation in children include case reports and case series trying to identify factors contributing to the outcome and restoration of function.[1,2] Various factors have been suggested to be associated with the outcome, including type and mechanism of injury, level of injury, involved digit, and number of arterial or venous anastomoses.[3] However, most of these articles include children regardless of their age. Indeed, finger replantation in a 15-year-old child cannot be compared with that in a 1- or 2-year-old child in term of microsurgical technic, postoperative management, and long-term follow-up.

Although children account for only 10 to 20% of replantation in the published series, a few studies have dealt specifically with survival of the amputated part and functional outcome in very young children.[4] Thus, the aim of this study was to report complications, pitfalls, surgery, and outcome of replanted fingers in children younger than 6 years of age.

Methods

Children younger than 6 years of age who underwent microsurgical procedure for finger replantation after a traumatic amputation were included in this study. Two senior hand surgeons performed the procedures during a 10-year period in

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two institutions. All the procedures were performed under operating microscope. All amputated parts were kept in humid sterile gauze and put on ice. The team of surgeons started the procedure by exploring the amputated part under microscope. During this time, the anesthesiologist prepared the patient for the surgery. The sequences of a replantation always included bone stabilization, tendon repair if necessary, arterial anastomosis, venous anastomosis if available, and nerve sutured (►**Figs. 1** and **2**). Vessels and nerves were sutures under microscope with 10–0 or 11–0 Ethilon nylon suture. Flexor tendons were suture with a Prolene 4–0 using a modified Kessler technique with a 6–0 running epitenon suture. When no vein was found, or in case of early postoperative venous congestion, a scarification was made on the pulp. A nurse then applied a compress soaked with heparin on the scarification area every 3 hours, to achieve controlled bleeding (►**Fig. 3**). The hemoglobin level was thereafter controlled every day.

Fig. 1 Patient 4 with second and third fingers after crush injury by a television fall on the hand.

Fig. 2 Microsurgical bypass with venous graft on digital arteries.

Early postoperative complications were categorized as major or minor. Major complications included arterial ischemia, venous ischemia leading to amputation, or significant blood loss requiring transfusion. Minor complications included venous ischemia with favorable outcome, blood loss greater than 2 g/dL but with no need for transfusion, or local infection. No physiotherapy program was initially performed as these young children are usually not compliant with the physiotherapy programs. At the time of final assessment, the authors evaluated everyday life activities, finger exclusion during recreational activities, and pain and cold tolerance. In patients with successful replantation, total active range of motion (TAM = proximal interphalangeal [PIP] active flexion + distal interphalangeal [DIP] active flexion-extension deficit/175) and growth disturbance were recorded.

Results

Data regarding patients' demographic characteristics and presurgery conditions are depicted in ►**Table 1**. Surgical and postsurgical features, success rate, and outcome are provided in ►**Table 2**. Postsurgical evaluations and physical examinations are provided in ►**Table 3**.

A total of 65 children were treated with replantation for finger amputation during the studied period. Fifteen fingers were replanted in 13 patients (5 males and 8 females) younger than 6 years. For this young age group, mean age at the time of the injury was 2.9 years (range: 1.1–5.7). Mean follow-up was 2 years (range: 0.5–6.8). Two patients (cases 4 and 11) had two digits amputated in a single accident. There were four sharp and nine crush injuries. Twelve fingers were totally amputated. In three fingers, the only structure that remained in continuity was a digital nerve in one and the flexor digitorum profundus in two (case 4). Bony level of amputation was distal to flexor digitorum superficialis (FDS) insertion in 11 fingers and proximal to FDS insertion in 4. In four fingers, no vein was available for anastomosis.

The overall success rate was 47% (7/15). Success was obtained in three cases with sharp injury, three cases with crush injury, and in one case with avulsion. Complications

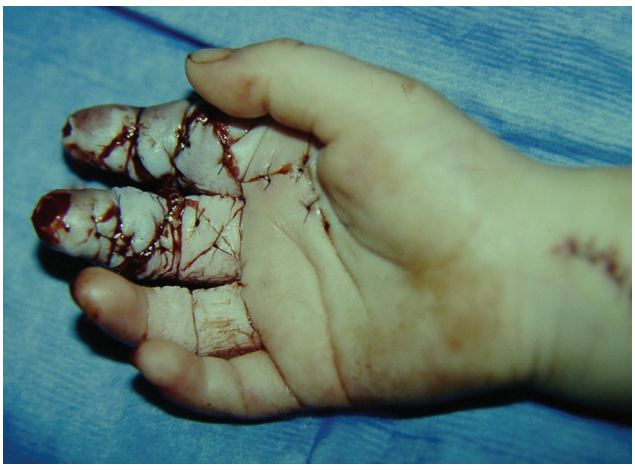

Fig. 3 Venous congestion treated by distal scarification.

Table 1 Demographic characteristics and presurgery condition

Patient number	Sex	Age (mo)	Mechanism of injury	Location of injury	Side
1	Male	54	Crush	Trans P1—4th finger	Right
2	Female	69	Sharp	Trans P3—3rd finger	Right
3	Male	36	Crush	Trans P2—3rd finger	Left
4	Female	30	Crush	Trans PIP—2nd finger	Right
				Trans P2—3rd finger	Right
5	Female	13	Crush	Trans P3—2nd finger	Left
6	Female	24	Sharp	Trans DIP—2nd finger	Left
7	Female	24	Crush	Trans P3—5th finger	Left
8	Male	25	Crush	Trans P2—4th finger	Right
9	Female	16	Sharp	Trans PIP—4th finger	Right
10	Male	48	Crush	Trans P2—4th finger	Left
11	Female	54	Avulsion	Trans P2—4th finger	Right
				Trans P3—3rd finger	Right
12	Female	36	Sharp	Trans P2—2nd finger	Right
13	Male	32	Crush	Trans P3—3rd finger	Right

Abbreviations: DIP, distal inter phalangeal joint; P1, proximal phalanx; P2, middle phalanx; P3, distal phalanx; PIP, proximal inter phalangeal joint.

Table 2 Surgical and post-surgical features

Patient number	Complication	Duration of hospitalization (d)	Scarification	Significant decrease in Hb level (g/dL)	Follow-up (mo)	Outcome
1	Venous ischemia	6	Yes	No	12	Unsuccessful
2	Venous ischemia	12	Yes (Leech)	2.5	24	Successful
3	Venous ischemia	3	Yes	2.7	12	Unsuccessful
4a	Venous ischemia	8	No	> 3 (requiring transfusion)	82	Successful
4b	Venous ischemia					Successful
5	Venous ischemia	6	Yes	No	12	Unsuccessful
6	Venous ischemia	3	Yes	2.2	12	Unsuccessful
7	Venous ischemia	2	Yes	No	14	Unsuccessful
8	Venous ischemia	6	Yes	> 3 (requiring transfusion)	12	Unsuccessful
9	Venous ischemia	15	Yes	No	82	Successful
10	Venous ischemia	10	Yes	2.3	12	Unsuccessful
11a	Arterial ischemia	12	No	No	60	Unsuccessful
11b	Venous ischemia		Yes			Successful
12	None	5	Yes	No	14	Successful
13	None	3	No	No	6	Successful

were numerous: 67% of replanted fingers had major complications and 60% had minor complications. Six patients had two complications. There was venous ischemia in 13 fingers (86%). The hemoglobin level decreased more than 2 g/dL in six cases. Blood transfusion was necessary in two patients: one case survived and one failed. There was one case of arterial ischemia, which failed. No case of infection was encountered. At the last follow-up (mean 27.2 months; range: 6–82), patients with successful replantation had a mean TAM of 72% (range: 34–97) (►**Fig. 4A–C**). The patient with the lower TAM (patient 9) had PIP level amputation with articular involvement and sustained a PIP joint arthrodesis with growth disturbance. Five patients had cold intolerance at the last follow-up. Seven patients did not feel any pain and six felt occasional pain at the time of revision. All patients with successful replantation used their replanted fingers in dailies activities, at school or during recreational activities.

Discussion

This work is interesting mainly because it is a unique series of complications after finger replantation in a very young children's group with a mean age of 2.9 years.[5] The results showed a high rate of early postoperative complications and a success rate of only 47%, which is lower than what is usually obtained in general pediatrics series which has a success rate between 58 and 98%.[5,6] Other authors[5,7] also found greater difficulties in treating children younger than 2 years of age Several factors may explain a lower rate of success in young children. First, the mechanism of trauma in young children is more often crush injuries (50%) and less frequently sharp injuries[7] as in adults. Most of the successful procedures were obtained on patients who had a sharp injury. In Asian countries, sharp injuries are more widespread in children with better prognosis of the microsurgical procedure.[6] The second explanation is technical. Surgery outcomes are influenced by the quality of the microvascular sutures.[8] The size of the digital vessels is estimated at 0.3 mm at 7 months,[9] 0.4 mm at 12 months,[10] and 0.7 mm at 22 months[1] of age. Although microanastomosis is feasible in very thin vessels,[11–13] the authors had great difficulty in finding, dissecting, and suturing large enough veins in their young population, especially in cases with crush and when the level of injury was distal to the PIP joint. In this series, arterial sutures were well managed in all the cases, but quality or even feasibility of venous sutures was much more unpredictable and was clearly an issue in almost every case.[14] This has led the authors to use controlled bleeding in postoperative cares, which brings other complications.[15] In almost one-half of the cases (6 out of 13), there was a significant decrease in hemoglobin rate in relation with a small blood volume in young children. According to the literature, the authors believe that it is a high rate, and might bring ethical discussion about whether a distal replantation should be maintained, if a transfusion is secondarily needed. For Dautel and Barbary, the controlled external bleeding due to venous congestion should not exceed 3 days in children and blood transfusion should not be justified.[8] For Han et al, a mean of 5.5 days of external bleeding was required for patients younger than 10 years.[15]

Table 3 Postsurgical evaluation

Patient number	Pain	Cold tolerance	TAM (%)
1	Mild	Yes	N/A (Unsuccessful)
2	Mild	No	71
3	Mild	Yes	N/A (Unsuccessful)
4a	No	No	80
4b	No	No	69
5	No	Yes	N/A (Unsuccessful)
6	No	No	N/A (Unsuccessful)
7	Mild	No	N/A (Unsuccessful)
8	No	Yes	N/A (Unsuccessful)
9	No	No	34
10	No	No	N/A (Unsuccessful)
11a	No	Yes	N/A (Unsuccessful)
11b	No	Yes	97
12	Mild	No	80
13	No	No	90

Abbreviation: TAM, total active range of motion.

Nevertheless, the authors noted that despite many early complications, their patients with successful replantation almost all had a good functional outcome.[16] They could use the replanted finger and include it in the hand function. Except for one patient with a PIP joint involvement, the range of motion was satisfactory with a high mean TAM at 81%. None of the patients suffered from neurologic pain, and some had a diminished cold tolerance. However, sensibility according to Weber's test was not assessed, as most of the children were younger than 6 years of age at the review. Future studies are therefore mandatory to assess long-term pulp sensibility.

With their cerebral plasticity, children have powerful recovery potentials, higher adaptation abilities, and better functional outcomes than adults.[5] The authors therefore believe that finger replantation should always be attempted in any cases of finger amputations in children younger than 6 years, even though venous sutures are difficult or sometimes impossible.[17]

Limitations

The authors have a small series of patients over the 10-year period of the study, whereas their departments are focused on hand trauma emergencies in children. The authors believe

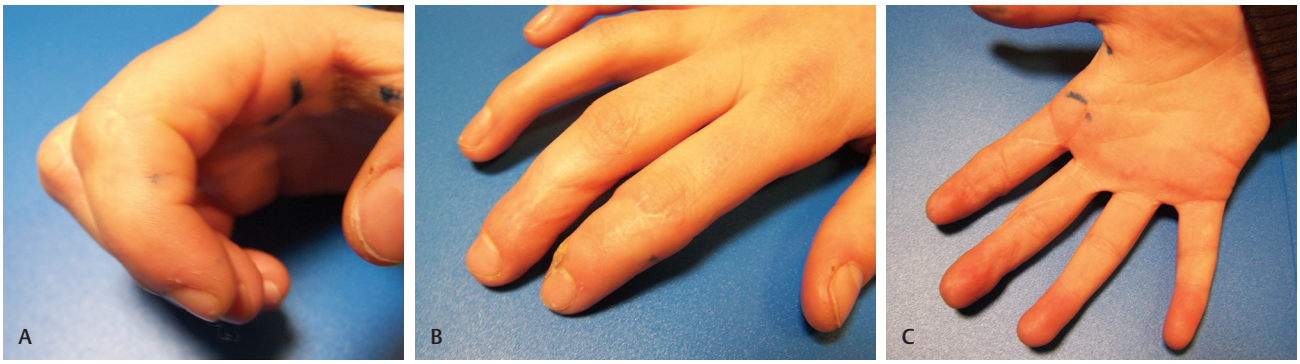

Fig . 4 (**A–C**) Active range of motion at the last follow-up.

that the number of cases of amputation is lower in children than in adults because of the frequency of work accidents in this population. On the other hand, the authors only included patients who were operated upon with the aim of replantation, thus excluding many complex distal injuries, which simply were regularized or treated with flaps or other reconstructive methods.[17,18] Because of the low number of patients, statistical analysis was not possible. Nevertheless, the results are not comparable with any others because there is no series focusing on such young children.

Conclusion

The authors propose a unique series of finger replantation in very young children with mean age 2.9 years. Success rate is low compared with biggest series of the literature, including adults. Venous blood flow is a key factor of success, but it is usually difficult to obtain in this young population. Crush and distal injuries are more frequent in young children and explain both the difficulty in finding a suitable vein to suture and this lower success rate. Nevertheless, the functional outcome is good after successful replantation in children, which should always be attempted. However, a longer period of follow-up is required to reach a definite conclusion.

Note
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Conflict of Interest
None.

References

1 Beris AE, Soucacos PN, Malizos KN. Microsurgery in children. Clin Orthop Relat Res 1995;(314):112–121
2 Chicarilli ZN. Pediatric microsurgery: revascularization and replantation. J Pediatr Surg 1986;21(8):706–710
3 Tark KC, Kim YW, Lee YH, Lew JD. Replantation and revascularization of hands: clinical analysis and functional results of 261 cases. J Hand Surg Am 1989;14(1):17–27
4 McC O'Brien B, Franklin JD, MacLeod AM. Replantation and revascularisation surgery in children. Hand 1980;12(1):12–24
5 Yildirim S, Calikapan GT, Akoz T. Reconstructive microsurgery in pediatric population—a series of 25 patients. Microsurgery 2008;28(2):99–107
6 Cheng GL, Pan DD, Zhang NP, Fang GR. Digital replantation in children: a long-term follow-up study. J Hand Surg Am 1998;23(4):635–646
7 Hattori Y, Doi K, Sakamoto S, Yamasaki H, Wahegaonkar A, Addosooki A. Fingertip replantation. J Hand Surg Am 2007;32(4):548–555
8 Dautel G, Barbary S. Mini replants: fingertip replant distal to the IP or DIP joint. J Plast Reconstr Aesthet Surg 2007;60(7):811–815
9 Gaul JS III, Nunley JA. Microvascular replantation in a seven-month-old girl: a case report. Microsurgery 1988; 9(3):204–207
10 Nagase T, Sekiguchi J, Ohmori K. Finger replantation in a 12-month-old child: a long-term follow-up. Br J Plast Surg 1996;49(8):555–558
11 Goldner RD, Stevanovic MV, Nunley JA, Urbaniak JR. Digital replantation at the level of the distal interphalangeal joint and the distal phalanx. J Hand Surg Am 1989;14(2 Pt 1):214–220
12 Gilbert A. Reconstruction of congenital hand defects with microvascular toe transfers. Hand Clin 1985;1(2):351–360
13 Devaraj VS, Kay SP, Batchelor AG, Yates A. Microvascular surgery in children. Br J Plast Surg 1991;44(4):276–280
14 Hattori Y, Doi K, Ikeda K, Abe Y, Dhawan V. Significance of venous anastomosis in fingertip replantation. Plast Reconstr Surg 2003;111(3):1151–1158
15 Han S-K, Chung H-S, Kim W-K. The timing of neovascularization in fingertip replantation by external bleeding. Plast Reconstr Surg 2002;110(4):1042–1046
16 Walaszek I, Zyluk A. Long term follow-up after finger replantation. J Hand Surg Eur Vol 2008;33(1):59–64
17 Hattori Y, Doi K, Ikeda K, Estrella EP. A retrospective study of functional outcomes after successful replantation versus amputation closure for single fingertip amputations. J Hand Surg Am 2006;31(5):811–818
18 Yabe T, Muraoka M, Motomura H, Ozawa T. Fingertip replantation using a single volar arteriovenous anastomosis and drainage with a transverse tip incision. J Hand Surg Am 2001;26(6):1120–1124