CASE REPORT

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Transmetacarpal replantation

Transmetakarpalna replantacija

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Abstract

Introduction. Transmetacarpal amputation (TA) distal to the superficial palmar arch is one of the most difficult procedures in replantation surgery because it requires the reconstruction of blood vessels, muscles, tendons, bones, nerves, and skin. We present a case of a patient with TA of the left hand and microsurgical replantation. **Case report.** A 23-year-old left-hand dominant male worker with a positive smoking history sustained TA from a radial saw blade and avulsion injury of the palmar side of the thumb with no other apparent injuries. The time between the amputation and replantation was 4 hrs. The patient sustained the amputation at the level of metacarpophalangeal joints. The successful replantation included: wound and intrinsic muscles debridement, microvascular anastomoses of the blood vessels, internal fixation of the metacarpal bones, neurorrhaphy, tenorrhaphy, and wound closure with local skin flap for thumb soft tissue defect. The patient was followed for seven years postoperatively. **Conclusion.** The replantation surgery requires a specialized department and well-educated teams of hand microsurgeons, orthopedic surgeons, and anesthesiologists. The most important factors that influenced the outcome after the replantation in the presented case included the type and level of injury, ischemia time, comorbidities, age, smoking history, and physical therapy.

Key words:
amputation, traumatic; hand injuries; metacarpal bones; plastic surgery procedures; quality of life; replantation.

Apstrakt

Uvod. Transmetakarpalna amputacija (TA) distalno od površinskog dlanskog luka je jedna od najtežih procedura u replantacionoj hirurgiji jer zahteva rekonstrukciju krvnih sudova, mišića, tetiva, kostiju, nerava i kože. Prikazan je slučaj bolesnika sa TA leve šake i mikrohirurškom replantacijom. **Prikaz bolesnika.** Radnik star 23 godine, pušač, dominantno levoruk, zadobio je TA cirkularom i avulzionu povredu palmarne strane palca bez drugih, vidljivih povreda. Vreme između amputacije i replantacije iznosilo je 4 sata. Bolesnik je zadobio povredu, amputaciju u nivou metakarpofalangealnih zglobova. Uspešna replantacija je uključivala: debridman rane i intrizičnih mišića, mikrovaskularne anastomoze krvnih sudova, unutrašnju fiksaciju metakarpalnih kostiju, neurorafiju, tenorafiju i zatvaranje rane lokalnim kožnim režnjem za defekt mekog tkiva palca. Bolesnik je praćen sedam godina posle operacije. **Zaključak.** Replantaciona hirurgija zahteva specijalizovani centar i dobro obučen tim mikrohirurga šake, ortopedskih hirurga i anesteziologa. Najznačajniji faktori koji su kod prikazanog bolesnika uticali na rezultat posle replantacije bili su tip i nivo povrede, vreme ishemije, komorbiditeti, životno doba, anamneza pušenja i fizikalna terapija.

Ključne reči:
amputacija, traumatska; šaka, povrede; kosti, metakarpalne; hirurgija, rekonstruktivna, procedure; kvalitet života; replantacija.

Introduction

Transmetacarpal replantation (TR) is a challenging procedure, but it is the patient's only chance to restore the function of the hand. The first successful replantation of the thumb was performed by Komatsu and Tamai [1] in 1965. Until today, many techniques have been developed to improve the function of the hand, and good results were

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associated with the replantation at several levels. Reports of the functional outcome of TR have been mixed because transmetacarpal amputation (TA) always injures the intrinsic muscles, rendering the amputated part ischemic. In TRs, the distal portions of any transected intrinsic muscles must be debrided [2, 3]. Vascular thrombosis is the most feared complication and a common cause of TR failure. Considering the numerous anastomoses of the blood vessels in TR, the thrombosis of one or more arterial anastomoses may lead to losing one or all fingers [3, 4].

We present a case of TR with the reconstruction of soft tissue defect of the palmar side of the left thumb and good postoperative outcomes at 2-year clinical follow-up and 7-year telemedicine follow-up.

Case report

A 23-year-old man, left-hand dominant, was transferred to our hospital 4 hrs after a left-hand TA from a radial saw blade. He was working at the factory as a carpenter. The patient was a smoker. Examination of the left hand showed a total amputation of the left hand at the level of metacarpophalangeal joints (MPJ) and avulsion injury with soft tissue defect of the palmar side of the left thumb. The surgery was performed according to ischemic protocol. The microbiological samples were taken from the stump and amputated part of the left hand. We identified superficial dorsal veins, common palmar digital arteries, radial artery of index finger, ulnar artery of little finger, common palmar nerves, superficial and deep flexor tendons, and metacarpal bones. The articular cartilage of all MPJ was destroyed. Metacarpal bones were shortened to avoid tension in microvascular anastomoses after osteosynthesis (Figure 1). We used four Kirschner wires (K-wires) for the osteosynthesis of metacarpal fractures (Figure 2). The distal portions of all interosseous muscles were debrided. We performed five microvascular anastomoses of palmar arteries with 9–0 monofilament sutures after washing with heparinized saline solution. Neurorrhaphy of common palmar digital nerves II–V was made with 8–0 monofilament with epineural sutures. We used modified Kessler sutures 3–0 and 4–0 for suturing superficial and deep flexor tendons for the index, middle, ring, and little finger. After examining the dorsal side of the left hand, we performed tenorrhaphy of extensor tendons for fingers II–V and three microvascular anastomoses of superficial dorsal veins. The skin was primarily closed. The soft tissue defect of the palmar side of the left thumb was closed with the local skin flap. The surgery was performed under general anesthesia and tourniquet control. A postoperative replant dressing was applied immediately after the surgery. The wrist was placed in 10° to 15° of extension and MPJ in 70° of flexion. Total ischemia time was 9 hrs. Total procedural time was 5 hrs. Vascular flow in the replanted hand was correct, and saturation was 96%. We administered ceftriaxone 2 g intravenously (iv) daily for seven days, enoxaparin 4,000 IU for two weeks, and acetylsalicylic acid 100 mg daily for two weeks. The K-wires were removed at the clinic six weeks after the replantation. Soft massage of the hand and passive physiotherapy of the proximal and distal interphalangeal joints started ten days following the replantation surgery to prevent scar adhesions. In the sixth week postoperatively, the patient began muscle-strengthening exercises, hydromassage, and

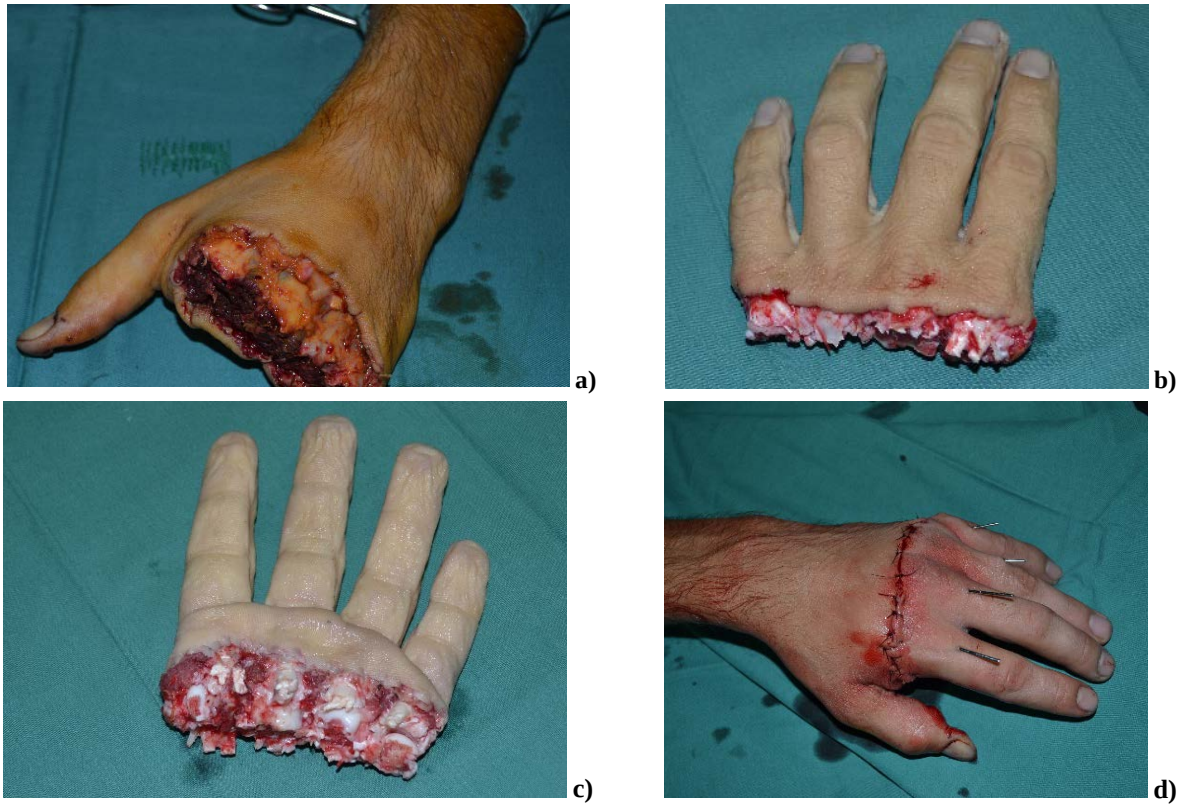


Fig. 1 – a) left-hand stamp; b) amputated hand – dorsal side; c) amputated hand – palmar side; d) intraoperative result after replantation.

electrical stimulation. Transcutaneous and neuromuscular electrical stimulation were used as well. At six months, the Tinel sign hand reached his fingertips. Then, he was admitted to the hospital for tenolysis of flexor tendons of the index and middle finger of the left hand five months after the replantation. The patient's follow-up was done one month, six months, two years, and seven years after the surgery. Figure 3 shows the postoperative result after TR (two-year follow-up).

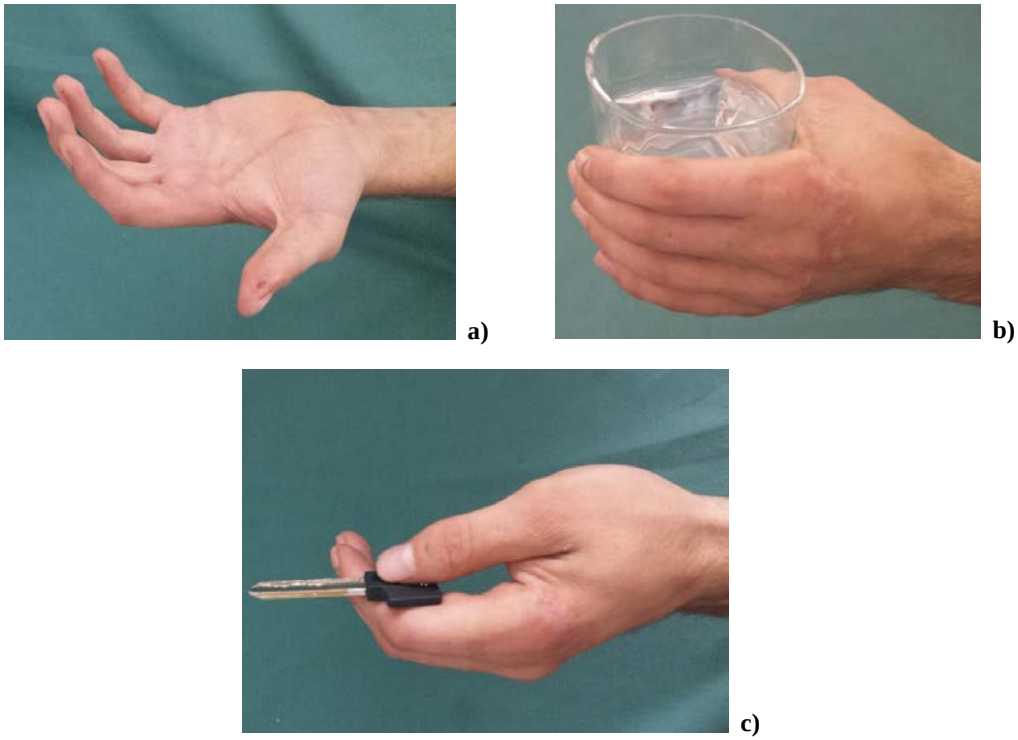
After a period of occupational therapy, the patient regains good cosmetic and functional results with two-point discrimination equal to 10 mm. At seven months, grip strength was 12 kg, and key pinch strength was 3 kg. He was employed full-time, reported no difficulty or mild difficulty with most daily activities, and preferred using his replanted hand.

Discussion

The goals of TR are to restore circulation and reestablish the function and sensation of the amputated hand. The vascular supply to the palmar surface of the hand and

a) **b)**

Fig. 2 – a) and b) Postoperative plain radiograph showing the Kirschner wires (K-wires) fixation after transmetacarpal replantation.



a) **b)** **c)**

Fig. 3 – a), b), and c) Postoperative results after transmetacarpal replantation (2-year follow-up).

atypical anatomical variants of the arteries must be well-known as they are essential for the successful result [5–7]. Suppose the volar metacarpal vessels are not ligated. In that case, they may allow continued bleeding into the palm following the reattachment of TA. Still, they can also cause compression and hematoma on the microvascular anastomoses of the arterial blood vessels [8]. For this reason, the key to the survival of the replanted fingers is close monitoring of vascular patency in the immediate postoperative period. It can be achieved by monitoring the perfusion of fingers and evaluating the color, pulp turgor, capillary refill, and temperature of the replanted digits [8, 9]. Furthermore, the most important factors influencing the long-term results of TR are the type and level of amputation, ischemia time, history of diabetes, age, gender, smoking, and postoperative care [10]. According to the literature [11, 12], the survival rate in metacarpal level replantation varied between 66% and 100%, showing that laceration and guillotine-type injuries had the best survival rate. They reported that the success of the surgery was good because the arterial system of the fingers is anatomically well described, and there are no difficulties when preparing and performing microsurgical unions. However, achieving an efficient venous union is challenging because microclots forming in an incompetent union may add to thrombosis of the replanted hand [13].

Based on our experience and numerous reports [2, 3, 11, 12], we see that the main factors contributing to the poor functional results after TA are the type and level of amputation and intrinsic muscle ischemia. In crush injuries with an extensive zone of injury, the intrinsic muscles are usually irreparably damaged. For this reason, vast numbers of authors recommend the debridement of injured intrinsic muscles and early protective active mobilization with anti-claw splinting initiated 72 hrs after the replantation [3, 9, 11, 14]. Furthermore, prolonged ischemia time when performing TR can compromise the functional results. In this sense, the amputated hand should be brought to the operating room as soon as possible, and all vital structures must be identified to save time and minimize the ischemia of the fingers. During the replantation procedure, osteosynthesis of the fractured metacarpal bones, tendons repair, arterial and venous anastomoses, neurorrhaphy, debridement of interosseous muscles, and skin coverage must be performed [8].

In this case, we performed TR at the level of MPJ with soft tissue reconstruction of the left thumb. TA destroyed the articular cartilage, capsule, and ligaments of MPJ II–V. This level of amputation with the destruction of joint structures may cause contractures of MPJ and impair the functional result. Furthermore, this type of replantation is most complicated since we need to restore many blood vessels, soft tissue structures, and metacarpal bones. In addition, it is well-known that the reconstructive method depends on the level of the injury related to the superficial palmar arch. If the amputation is at the level of the superficial palmar arch, only the superficial palmar arch must be reconstructed. On the other hand, if the amputation level is distal to the superficial palmar arch, each common palmar digital artery must be repaired [15]. In our case, since the amputation occurred distally, each common palmar digital artery was restored. Likewise, we tried to achieve some recovery of the intrinsic function by shortening the bone and resection of devitalized intrinsic muscles. This concept was described by Paavilainen et al. [16], showing that four of ten patients with intrinsic tendon repair achieved some finger abduction and MPJ flexion.

The patient's level of functional recovery was assessed as follows: the ability to return to work, recovery of sensibility and muscle power. According to Zhong-Wei et al. [17] criteria, pinch and grip strengths, return of sensibility, and functional recovery were good in our case. Moreover, Zhong-Wei et al. [17] reported that the functional result after TR was satisfactory in 59% of patients, while Scheker et al. [18] had poorer results. The discouraging results have been primarily linked to the inadequate recovery of intrinsic muscle function, which is due to direct intrinsic muscle injury, ischemia, or postoperative scarring [12, 18].

Conclusion

The replantation surgery requires a specialized department and a well-educated team of hand microsurgeons, orthopedic surgeons, and anesthesiologists. Our patient was very happy with his replanted hand, which helped him return to everyday activities and have a good quality of life.

REFERENCES

1. *Komatsu S, Tamai S*. Successful replantation of a completely cut-off thumb. Plast Reconstr Surg 1968; 42(4): 374–7.
2. *Ono S, Chung KC*. Efficiency in digital and hand replantation. Clin Plast Surg 2019; 46(3): 359–70.
3. *Zhang G, Ju J, Jin G, Tang L, Fu Y, Hou R*. Replantation or revascularization for the treatment of hand degloving injuries. J Plast Reconstr Aesthet Surg 2016; 69(12): 1669–75.
4. *Hegazi MM*. Hand and distal forearm replantation--immediate and long-term follow-up. Hand Surg 2000; 5(2): 119–24.
5. *Zekavica A, Milisavljević M, Erić D, Ćurčić B, Popović S, Vitošević B,* et al. Vascular anatomy of the thenar eminence: its relevance to a pedicled or free thenar flap. Folia Morphol (Warsz) 2017; 76(2): 232–8.
6. *Ilić M, Milisavljević M, Maliković A, Laketić D, Erić D, Boljanović J,* et al. The superficial palmar branch of the radial artery: a corrosion cast study. Folia Morphol 2018; 77(4): 649–55.
7. *Erić D, Milisavljević M, Ninković M, Kojić S*. Vascularization of the hypothenar's skin as the basis for raising the fasciocutaneous flaps. Biomedicinska istraživanja 2010; 1(1): 20–4.
8. *Billington AR, Ogden BW, Le NK, King KS, Rotatori RM, Kim RL,* et al. A 17-year experience in hand and digit replantation at an academic center. Plast Reconstr Surg 2021; 148(4): 816–24.
9. *Kwak SH, Lee SH, Rhee SJ, Jang HS, Kim DH, Kim YJ*. Multilevel dysvascular injury of the hand: replantation versus revision amputation. Plast Reconstr Surg 2020; 146(4): 819–29.

10. *Ninkovic M, Voigt S, Dornseifer U, Lorenz S, Ninkovic M.* Microsurgical advances in extremity salvage. Clin Plast Surg 2012; 39(4): 491–505.
11. *Gerostathopoulos N, Efstathopoulos D, Misitzis D, Bouchlis G, Anagnostou S, Daoutis NK.* Mid-palm replantation: Long-term results. Acta Orthop Scand 1995; 66(Suppl 264): 9–11.
12. *Weinzweig N, Sharzer LA, Starker I.* Replantation and revascularization at the transmetacarpal level: long-term functional results. J Hand Surg Am 1996; 21(5): 877–83.
13. *Elsaftawy A, Jabłecki J.* Unsuccessful replantation of metacarpal hand after venous thrombosis – case report. Pol Przegl Chir 2013; 85(12): 721–6.
14. *Sabapathy SR, Venkatramani H, Ramkumar S, Mohan M, Zhang D.* Cross-Hand Replantation. Indian J Plast Surg 2020; 53(1): 124–30.
15. *Thorne CHM, Beasley RW, Aston SJ, Bartlett SP, Gurtner GC, Spear SL.* Grabb and Smith's plastic surgery. 6th edition. Boston: Lippincot, Williams & Wilkins; 2006. p. 879–81.
16. *Paavilainen P, Nietosvaara Y, Tikkinen KA, Salmi T, Paakkala T, Vilkki S.* Long-term results of transmetacarpal replantation. J Plast Reconstr Aesthet Surg 2007; 60(7): 704–9.
17. *Zhong-Wei C, Meyer VE, Kleinert HE, Beasley RW.* Present indications and contraindications for replantation as reflected by long-term functional results. Orthop Clin North Am 1981; 12(4): 849–70.
18. *Scheker LR, Chesher SP, Netscher DT, Julliard KN, O'Neill WL.* Functional results of dynamic splinting after transmetacarpal, wrist, and distal forearm replantation. J Hand Surg Br 1995; 20(5): 584–90.

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