A novel technique for distal fingertip replantation: Polypropylene suture guided interpositional vein graft

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Abstract

Background: Despite current advances in microsurgery, fingertip replantation is still controversial, mainly due to its difficulty and cost. The purpose of this study is to describe a new technique of interpositional vein graft guided by polypropylene suture to facilitate distal fingertip replantation. Methods: A total of eight consecutive Tamai zone 1 fingertip replantations performed by the same author were included. All replantations were performed using an interpositional vein graft guided by polypropylene suture. This technique involved a vein graft of ~2 cm in length, with appropriate calibration, obtained from the volar part of the forearm and a 2-0 polypropylene suture passed through the interpositional vein graft. Then, a polypropylene suture guide carrying the vein graft was inserted into the artery. The anastomosis was easily performed with the aid of 10-0 or 9-0 nylon in a bloodless medium and without encountering the posterior wall problem. Results: Average surgery time was 2.5 hours (range: 2–3 hours). Among eight Tamai zone 1 replantations, six were successful (75%). There were two replantations lost because of arterial failure. Conclusion: This technique may ease fingertip replantations and increase the success rate for Tamai zone 1 injuries.

Key Words: Fingertip replantation, interposition vein graft, polypropylene suture

Introduction

The fingertips are the most frequently injured and amputated segment of the hand. Despite current advances in microsurgery, fingertip replantation is still controversial, mainly due to its difficulty and cost. On the other hand, it remains the gold standard when compared to alternative non-microsurgical approaches in terms of function, cosmesis, and patient satisfaction.

In Tamai zone 1, which extends from the fingertip to the base of the nail, digital artery diameters range between 0.4–0.7 mm at the base of the distal phalanx [1]. The diameter of the terminal branches range between 0.2–0.5 mm and the distal central artery at the pulp level is usually the most suitable for microvascular anastomosis. In Tamai zone 1, this distal central artery is capable of providing arterial circulation to a fingertip on its own [2–7].

It is not always possible to perform arterial anastomosis in Tamai zone 1. This requires advanced micro-surgical equipment and microscopes, and experienced microsurgeons. Working deep in the fingerpulp is challenging, and it is critical to expose and prepare the artery in the amputated segment. However, the artery can often not be elongated by dissection and a vascular approximator cannot be placed and, thus, the anastomosis is often done using a single vascular clamp placed in the proximal segment. Furthermore, rotating the artery to perform a repair of the posterior wall during the anastomosis is often very difficult.

The present study describes our results with a novel anastomosing technique using an interposition vein graft guided by a polypropylene suture for replantations in Tamai zone 1.

Materials and methods

A total of eight consecutive Tamai zone 1 fingertip replantations performed using this technique by the same author (MD) between 2012–2014 were included in the study. All replantations were performed using operating microscope magnification (10–25×). Three of the replantations were performed under general anaesthesia and five under regional anaesthesia, decided according to the age, compliance, and fasting status of the patient. Replantation was not performed in advanced crush avulsion injuries with impaired integrity or in patients with gross contamination. This decision was given in some cases preoperatively according to the gross inspection of the amputated part, and in some cases intraoperatively through surgical exploration. Three fingers were explored and not included in the series because of advanced crush avulsion. Three patients had clean-cut and five had crush injuries. Patient charts were retrospectively reviewed to assess patient demographics, details of the surgical procedure, and complications. Informed consent was obtained from all participants in the study.

Surgical technique

The surgical procedure began with temporary fixation of the distal amputated fingertip segment on the operating table with stay sutures or with the help of an assistant (Figure 1). The distal segment was explored under the operating microscope for identification of neurovascular structures. In Tamai zone 1, the artery with the largest diameter available was preferred.
Without any concerns on pedicle dominance. Then, a vein graft of ~2 cm, with appropriate calibration, was obtained from the volar part of the forearm. A 4 cm segment was cut from the tip of a 2-0 polypropene suture and was passed through the vein graft without damaging the vessel wall. The default cut side of the suture was preferred, as it had a smooth cut. The interior of the amputated artery was washed with heparin and ruptured branches were ligated to decrease thrombosis. Its tip was trimmed and the polypropylene suture guide carrying the vein graft was inserted into the artery. The localisation of suture in the artery was easily observed by the blue colour of the polypropylene (Figure 2). In this way, the anastomosis was easily performed with the aid of 10-0 or 11-0 nylon in a bloodless medium and without encountering the posterior wall problem. In order to ease the posterior wall repair, the finger or the vein graft was rotated 180° and, as such, surgical exposure was achieved. Anastomosis of the small sized artery was safely performed. The polypropylene suture was removed after anastomosis. The dissection was performed on the receipt artery proximal to the zone of injury and prepared for anastomosis. Most repairs were performed 0.5–1 cm proximal to the amputation line. Bone fixation was accomplished with a single, 2-mm-diameter, longitudinal, Kirschner wire. As the replanted parts were too small and the wire was immobilised with the aid of skin sutures, a single Kirschner wire was sufficient. The vein graft was brought to the proximal anastomosis site and its length was adjusted, so as not to be stretched, and anastomosis was performed at an artery with a wider calibration using 10-0 nylon fibre. Nerve coaptation was not performed on the patients.

In these cases, adjunctive venous interventions are necessary to decompress venous stasis until neo-vascularisation takes over. This was done using a fish mouth incision placed in the digital pulp near the kirschner wire. Bleeding was provoked by applying a heparin impregnated sponge every hour or every second hour for the first 5 days. Thereafter, bleeding was every 3–5 hours. Medical leeches were applied six times daily for the first 5 days, then applied twice or three times according to venous congestion when needed (Figure 3).

Patients received a single 5000 IU dose of intravenous heparin intraoperatively. Postoperatively, low molecular weight heparin (0.6 cc) was administered twice daily for the first week, and once a day for the next week. The postoperative regimen also included low molecular weight dextran (500 ml, once a day for 5 days) and aspirin (100 mg, one a day for 30 days).

**Results**

Eight males, median 33.5 years of age (range = 19–65 years) participated. All injuries were complete amputations (five right hand, three left hand). The amputations comprised of three thumbs, two index fingers, one middle finger, and two little fingers. Average ischaemia time was 3 hours (range = 1–7 hours). Average surgery time was 2.5 hours (range = 2–3 hours). The average follow-up period was 15 months (range = 3 months to 3 years). The average duration of hospital stay was 6 days (range = 3–12 days). Out of eight replantations, six were successful (75%). Two replantations, which were crush injuries, were lost on the postoperative third and sixth days due to arterial failure. Revisional microsurgical repair was not performed, instead the fingertip was amputated and the skin closed with v-y advancement flaps in the two failures. Postoperative late complications in the patients having successful replantation included pulp atrophy in one patient. Fingertip sensation returned to normal in all survived cases except the one that had pulp atrophy. Wound site infection was not
observed in any patient. Based on patient reports, the range of movement in the finger returned to normal.

Discussion

Fingertip amputations have been traditionally managed by various methods such as primary repair, composite graft, secondary healing, skin grafts, and flaps. Among these traditional methods, only composite grafting can actually produce results similar to replantation. In adults with amputation through the nail base, composite grafts have very little chance of survival. However, there are some successful reports in children. Elsahy [8] reported a success rate of 20% for finger tips that were replanted as a composite graft at or proximal to the lunula of the nail in children. Advances in microvascular surgery have increased the survival rate of fingertip replantations to a point that is much higher than those of composite grafting. Today, microvascular replantation is superior to any alternative methods of reconstruction for amputated fingertips [1-7].

The main challenge of replanting fingertip amputations distal to the lunula is performing microvascular anastomoses. Foo [7] described the open guide suture technique to ease anastomosis and recommended its use, particularly in the fragile anastomosis of distal finger replantations. The procedure described in the present study was developed to ease distal anastomosis and ensure that tip replantation can easily be performed also by the less experienced microsurgeons [1-7]. In their study, Bitik et al. [9] used a silastic tube introduced temporarily into the lumen of the vein as a carrier to facilitate anastomoses of vein graft. A silastic tube that is introduced temporarily into the vessel lumen acts as a carrier of vein graft a tool for easy manipulation and perfect three-dimensional template of the cylindrical vascular architecture that prevents collapse and back-wall biting during anastomosis. The proposed modification resulted in a statistically significant reduction in operative time and also enhanced patency rates significantly.

In our study, polypropylene was preferred as a coloured suture material, is easily accessible, was compatible with the artery size, and did not fill in the lumen completely. 2-0 polypropylene (UPS diameter = 0.3–0.339 mm) [10] is ideal for the size of distal central artery. A 4 cm segment was cut from the rear of the 2-0 polypropylene suture and used as a carrier. It could be observed in the lumen, as it has a blue colour. It prevented collapsing of the vein graft and the artery and eased anastomosis.

The most important feature of our technique is that it allows the less experienced surgeons to perform the most difficult anastomosis using a guide and in a region that is independent from the patient. In this way, back-wall biting can be prevented during anastomosis. Additionally, the possible leakages at the anastomosis site can be observed with saline injection and repaired. The disadvantage of our technique is performing two anastomoses, as a vein graft is used. However, the authors believe that performing two anastomoses is less difficult than a single anastomosis performed at a deep plane, since they can be performed in a bloodless region and by moving the finger.

The success rates of fingertip replantation with artery and vein repairs are reported to be between 70–90%, and those of replantations with only artery repair are between 64–87% [1-7,11,12]. The success rate in the present study is similar to the rates reported in the literature. The authors believe that this technique may help increase the mean success rate of the microsurgeons who are new to the tip replantations.

Sometimes in patients with Tamai zone 1 injuries, neither a dorsal nor a palmar vein suitable for microvascular anastomosis can be found. In cases of amputations through Tamai zone 1, when a primary vein repair was not possible, alternative methods such as arterio-venous shunt, veno-cutaneous fistula, and external bleeding created by pulp/nail plate incisions were described in the literature to establish external venous drainage through the skin. The authors of the current study prefer fish mouth incisions near the Kirschner wire emerging from the pulpa for external venous drainage. Haemorrhage is provoked by using heparin-soaked sponges or medical leeches when necessary [13-17].

After fingertip replantations, complications such as nail deformities, total or partial necrosis, and pulp atrophy can be seen. Atrophy of the finger pulp can be related to impairment of circulation and excessive fibrosis due to crush injuries [16,17].

Conclusion

This technique eases the tip replantation procedure for the surgeons who are less experienced in microsurgeries. It may increase the success rate, especially for the replantations performed in Tamai zone 1. Replantation with this technique should be considered in patients with distal fingertip amputations.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References


