A Microsurgical Suture Technique Without the Need for Vascular Clamps

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Abstract Vascular clamps are often used during microvascular repair and anastomosis. However, pressure exerted by the clamps may damage the vessels, which compromises patency of vessels. This article reports on a microsurgical suture technique performed without any clamp to avoid clamp-related problems.

Keywords Vascular clamp · Microsurgical repair · Suture technique

Introduction

Vascular clamps are often used during microsurgical anastomosis of a vessel. The double clamp system developed by Ikuta is widely used nowadays [1, 2]. By holding both ends of the vessel, this device provides good approximation, a tension-free anastomosis, and easy rotation of the vessel from front to back. However, pressure exerted by the clamps may damage the small vessel [3], and sometimes, a small vessel is difficult to be mounted in a clamp system [2]. The purpose of this

study is to report on a microsurgical suture technique performed without any vascular clamp.

Materials and Methods

From March 2011 to November 2012, 47 digits in 44 patients were replanted without use of clamp system. The levels of amputation are the proximal phalanx ($n=3$), middle phalanx ($n=4$), distal interphalangeal joint ($n=4$), and distal phalanx ($n=36$). We excluded the cases that required vein grafting due to tension at the repair site. The mean age at surgery was 40.9 years (range, 6–66 years). There were 38 male (40 fingers) and six female (seven fingers) patients. The injury mechanisms were crushing in 34 patients, guillotine in 9, and avulsion in 4 patients. The mean operation time was 2.5 h (range, 1.5–4.5 h). The mean follow-up period was 3 months (range, 1–9.9 months). Operation was performed either under a brachial plexus block or general anaesthesia. We used a digital tourniquet for an amputation at or distal to the interphalangeal joint, and an arm tourniquet for a proximal amputation. All steps of standard replantation technique were followed. No vascular clamps were used in the anastomoses procedure.

Common knot-tying terms were used to describe the steps of the suture technique we followed during the vessel anastomoses [4]. The first step was to take a two-point bite at the ends of the vessel. Then a single through was made in the suture like the general suture technique (Fig. 1). After that, an additional second throw was made. Two throws were kept without tension (Fig. 2). Two strands of the suture were held by two knot-tying forceps. At the crossing of the strands, the right strand was turned to the left side to make a loop

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Fig. 1 One throw is made, similar to general suture technique. Here, *yellow color* represents the front wall, and *orange color* represents the back wall

Fig. 4 While holding the neck of the loop (*blue strand*), the other strand is pulled (*red strand*) to tighten the knot by sliding the strand (*red strand*)

(Fig. 3). While holding the neck of the loop with the forceps, the other strand was pulled to tighten the knot by sliding the strand (Fig. 4). By controlling the pulling pressure of the strand, the tension at the repair site was controlled and checked. If the shape of the knot was not

acceptable, the knot was untied and redone from the beginning, since the knot had not yet been tightened at the time (Fig. 5). Next, while holding this tightened strand like a post, another strand was pulled to tighten the knot. Thus the knots would not loosen. Finally a granny knot and a square

Fig. 2 One more throw is made without tightening

Fig. 5 The tension of the repair site can be controlled by controlling the pulling of the new right strand (*red strand*). The knot is tightened with appropriate tension

Fig. 3 By turning the *right strand (blue strand)* to the *left side*, a loop is made (*blue strand*)

Fig. 6 By holding the *right strand (red strand)* as a post, stability of the repair site is maintained. In this state, the *left strand (blue strand)* is pulled and the initial knot is tightened

Fig. 7 The granny knot is made at the anastomosis site. One more square knot is added. A long strand is left for easy rotation of the vessel

knot were made on the knots to reinforce its stability (Fig. 6). A long strand was left to facilitate vessel rotation for its back wall repair (Fig. 7). In the same manner, additional stitches were added to complete the anastomosis procedure. The suture method was performed in the remaining small vascular coaptation (Figs. 8 and 9).

Results

The overall success rate of replantation was 78.8 %. Among them, 66.6 % occurred at the proximal phalanx, 50 % at the middle phalanx, 75 % at the distal interphalangeal joint, and 83.3 % at the distal phalanx level.

Fig. 8 Both ends are repaired using the same method

Fig. 9 To repair back wall (orange color), by turning the suture strands, a gauze was put on the undersurface of the repair site

Discussion

Even a minor injury to the intima, the innermost layer of vessel wall, will compromise patency of small vessels by thrombosis, a major cause of replantation failure [5]. Biemer and Dusipiva [6] reported that injured intima of vessel ends is one of the cause of thrombosis in replantation. Bunt et al. [7] reported that vascular injury may occur during microsurgery secondary to application of vascular clamps. Owing to relatively weak in strength, small digital arteries and veins are more likely to be injured by pressure generated by a clamp system. Especially, pressure on the vessels for a prolonged duration may cause the injury, resulting in failure of replantation [2]. Richling et al. [8] reported that time of arterial occlusion and pressure exerted by the clamp is correlated with severity of vessel injury.

In order to overcome these clamp-related problems, we developed the clamp-less suture technique.

This technique can be applied at nearly all types of finger amputation, including atherosclerotic vessel. The advantage of this technique is that it can be used in the narrow space where applying clamps is impossible. The disadvantage is that leakage of blood from the proximal vessel end may happen during anastomosis.

Early and late failure of an anastomosis can increase due to anastomosis site tension and vein grafting [2, 9]. To negate possibility of bias, we excluded the digits requiring vessel grafting in primary or revision procedures.

Conclusion

Our technique can prevent clamp-related vascular injuries and can be an alternative in all types of digital replantation.

Conflict of interest All named authors hereby declare that they have no conflicts of interest to disclose.

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