Papaverine Effect on Superficial Vein in Thumb Replantation Procedure: A Case Study

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AUTHOR CONTRIBUTIONS

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ETHICAL STATEMENT

This case report is not reviewed by the IRB as there are no identifying patient factors.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data supporting the findings in this case report is available within the article and its supplementary materials.

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Introduction:

Thumb replantation is a complicated microsurgical procedure with the aim of restoring the functionality and appearance of a severed appendage. The bones and surrounding soft tissue must all be intricately reattached. A major component in thumb replantation is establishing a suitable connection between the vessels that supply the replanted thumb (1). The size mismatch between the veins and the venous coupler used for anastomosis can be a point of conflict in the venous anastomosis stage (2). Vasodilators, such as

papaverine, can be utilized when the diameter of veins is smaller than that of the coupler in order to achieve a successful anastomosis (3). Papaverine, an alkaloid vasodilator produced from the opium poppy plant, has been used in a variety of surgical operations to increase blood flow and improve anastomotic results (3).

In this case study, we explain how papaverine was administered as a vasodilator to widen a superficial vein with a diameter of 0.7mm during thumb replantation with the goal of accommodating a 1mm coupler whilst still ensuring satisfactory anastomosis.

Case History/examination:

A 26 year old, previously healthy, male presented to the emergency department following an electric saw injury to the left thumb while cutting wood at work. His dominant hand is the right hand. No past medical or surgical history. Review of system was otherwise negative. He brought the amputated part with him and it was wrapped in wet gauze and placed in a container that was immersed in ice. On examination, he was vitally stable, primary and secondary survey were unremarkable except for the base of the left thumb amputation just distal to the metacarpophalangeal joint (figure 1).

Methods (Differential diagnosis, investigations and treatment):

X-ray of the hand showed amputated first proximal phalanx with residual bone fragment at the base (figure 2). He was managed with IV amoxicillin/clavulanic acid and IM tetanus toxoid; for the pain a digital block was done and he was given ketorolac and paracetamol. The patient was admitted under plastic surgery's service, and the surgery was performed 9 hours after the amputation.

Conclusion and Results (Outcome and follow-up):

In the operating theater, the digital artery from the ulnar aspect was repaired with 9-0 nylon. The digital veins were badly crushed and only one small 0.7mm vein was found on the dorsal aspect of the thumb, but since the smallest coupler size we had was 1mm it was difficult to perform the anastomosis. A trial of topical papaverine, 1mg/ml, was given to vasodilate the vein and after many cycles of papaverine in addition to mechanical dilation; the vein could accommodate the 1mm coupler and anastomosis of the veins was possible within 25 minutes. One digital nerve was identified and repaired on the radial aspect. Flexor and extensor tendons were repaired with PDS thread, however the flexor tendon was shuttered badly. The bone was shortening by 0.5cm from the proximal phalanx on the amputated side. Wound was closed with prolene and the coupler was covered with a small skin flap. The ischemia time was already 10 hours before restoring circulation (figure 3,4).

The patient was followed in the clinic for re-assessment and wound care. Almost two months after the replantation, the patient was noted to have left thumb flexor pollicis longus (FPL) tendon rupture on examination. So secondary FPL tendon repair was done. Four months after the primary surgery the patient had good range of movement and function of the left thumb, his wounds were healed and he had good sensation and circulation (figure 5). The patient was discharged from our care with full satisfaction.

Discussion:

Thumb replantation is an intricate procedure that necessitates venous anastomosis to prevent venous congestion in the attached appendage and eventual replantation failure (4). A meta-analysis published in 2018 evaluated the correlation between venous anastomosis and replant survival, they found that the higher the anastomosis number the higher the chance of survival. Zero versus one versus two anastomosis were evaluated, with two anastomosis showing a survival rate of 92.3% and 61.1% survival in zero anastomosis (5).

Venous anastomosis can be achieved by either hand-sewn technique or the use of couplers. A meta-analysis published in 2020 looked at studies comparing coupler use versus hand-sewn technique in venous anastomosis; it reported anastomotic time and postoperative complications. Their results showed that the use of couplers when compared to hand-sewn venous anastomosis significantly decreased anastomotic time and postoperative failure risk, but it did not decrease postoperative venous thrombosis risk (2). In one study, time reduction from approximately 12 minutes with hand-sewn anastomosis to 3 minutes with a coupler was noted (6).

One of the problems faced during the anastomosis phase of the replantation surgery is the post-traumatic vasospasm experienced by vessels in the zone of injury. Additionally, intra-operative vessels dissection and manipulation are also reasons for the narrowing of vessels. Vasospasm during microsurgery affects up 5-10% of the procedures due to the aforementioned reasons. There are several ways to deal with this issue; some of which are: mechanical dilation, perivascular lidocaine injection, axillary block anesthesia, and systemic papaverine use (3).

Papaverine was initially discovered in 1848 by Georg Merk (7). It is a phosphodiesterase (PDE) inhibitor commonly used in microsurgery. It antagonizes the PDE that breaks down cyclic guanosine monophosphate (cGMP) thus increasing the concentration of this second messenger within the vessel's smooth muscles, consequently inhibiting the effect of myosin light chain kinase and thus causing vasodilation (8). It is approved for the use in cerebral vasospasm, biliary duct spasms, and erectile dysfunction through its anti-spasmodic action on smooth muscles (9,10,11). One study looked at the time of action of papaverine in preventing vasoconstriction in response to phenylephrine and potassium (60 mmol/L); it showed that it reversed vasoconstriction for a maximum of only one hour (12). Another study looked at the effect of preventing vasoconstriction on the radial artery during coronary artery bypass grafting (CABG) in vitro. The radial artery was pre-treated with papaverine and prevention of vasoconstriction to norepinephrine was tested; results showed that the effect of papaverine was lost after eight hours (13).

An article published in 2016 looked at the alternative drugs that can be given in the case of shortage of papaverine. Topical lidocaine and nicardipine (calcium channel blocker) were used as alternative antispasmodics and the rates of re-exploration, complications, and flap salvage were compared when matched with papaverine controls. Results showed that there was no higher risk of flap loss or re-operation, making these drugs safe and effective alternatives to papaverine (7). Other anti-spasmodic were studied in animal models; for example, phosphodiesterase inhibitors (pentoxifylline, papaverine, and amrinone), calcium channel blockers (verapamil, nicardipine, nifedipine, and magnesium sulfate), local anesthetics (lidocaine), alpha antagonists (chlorpromazine and phentolamine), and direct vasodilators (prostaglandin E1, sodium nitroprusside, hydralazine, and nitroglycerin). However, to guide evidence-based management, well-controlled translational studies are required in order to reliably generalize the data (14).

In our case, there was no salvageable vein for anastomosis except one superficial vein with a diameter of 0.7mm and the smallest coupler size was 1mm, so we gave the patient a trial of topical papaverine, 1mg/ml, to vasodilate the vein. Several cycles were given in addition to mechanical dilation and finally the vein could accommodate the 1mm coupler and anastomosis of the veins was possible in 25 minutes; 30% increment in the vein diameter was achieved. The coupler was covered with a small skin flap. Consequently, the thumb survived with no post-operative complications.

Conclusion:

Thumb replantation is a difficult surgical technique that necessitates high precision and skills. Anastomosis of small diameter superficial veins can be difficult, and vasodilation may be required to allow the venous coupler to fit into it. The use of papaverine is safe and efficient to achieve sufficient vasodilation and allow for successful anastomosis. Nonetheless, as with any medication, the patient's existing co-morbidities should be carefully evaluated before using papaverine. The effective application of papaverine in this example and the significant increment in the vein diameter demonstrates its potential value in microsurgery, particularly when vessels are small relative to that of the coupler.

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Figure 1. Amputation of left thumb distal to the metacarpophalangeal joint

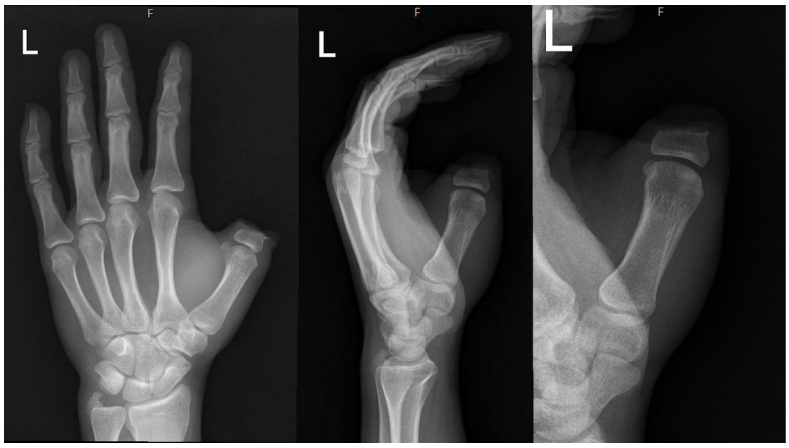

Figure 2. Hand x-ray post-amputation

Figure 3. Hand x-ray post-replantation

Figure 4. 1mm coupler connecting the sole salvageable superficial dorsal vein pointed with the yellow arrow

Figure 5. 3 months post-replantation surgery