Case Report
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Vascular Remodeling with a Microvascular Anastomotic Coupler System: A Case Report

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Despite increased utilization of microvascular anastomotic coupler (MAC) devices, the consequences have yet to be fully explored in terms of vascular regeneration. Removal of an exposed venous coupler is described herein, documenting normal circulatory flow through the remodeled site of application. A 25-year-old man who underwent open reduction and rigid fixation elsewhere for traumatic calcaneal fracture ultimately presented with a necrotic postoperative wound. The debrided defect was treated by free thigh perforator flap, incorporating a MAC device. Three months later, the flap remained viable, but the MAC itself was exposed. Structural integrity of the vessel and blood flow were sustained as the device was carefully removed, confirming true vascular remodeling in this example of MAC usage.

Key Words: Venous coupler, Anastomotic device, Vascular remodeling

The microvascular anastomotic device first developed by Nakayama et al.[1] in 1962 failed to gain immediate clinical acceptance. Owing to subsequent material and design changes, usage has grown substantially, especially with introduction of the GEM MAC System (Synovis Micro Companies Alliance, Inc., Birmingham, AL, USA). Microvascular anastomotic coupler (MAC) devices have become increasingly popular for venous anastomosis.[2,3] In a prior study of assorted free flap surgeries (n=1,000) done between 2002 and 2008 using MAC devices, only six instances (0.6%) of venous thrombosis were documented.[2] Compared with suture anastomosis, patency rate was also similar or better.[4-7] Furthermore, such devices help limit ischemia-reperfusion injury by reducing anastomotic time requirements.

Applied research using ring-pin devices for coupling femoral arteries and veins in rabbits indicates that regeneration of vessels proceeds similarly in device-enabled and sutured anastomoses.[8,9] However, clinical data and details of vascular regeneration in the aftermath of MAC system use are lacking.

The purpose of this report is to confirm the gross integrity and patency of a venous anastomosis achieved by MAC system, having removed the exposed device from a reparative free flap.

CASE REPORT

A 25-year-old male injured in a motorcycle accident and suffering a calcaneal fracture underwent open reduction and rigid fixation at a private hospital. He was later transferred to our facility due to localized skin and soft tissue necrosis. Specifically, the dorsum of foot was necrotic, with Achilles tendon, calcaneal bone, and part of fixation plate all exposed at the heel (Fig. 1). Bony union of calcaneus was complete, so the fixation plate was removed. Debridement of necrotic tissue then left a sizeable (7×4 cm) soft tissue defect.

Fig. 1. Ankle wound with exposed calcaneal bone and fixation plate.

Fig. 2. Split-thickness skin graft of anastomotic site (arrow) after skin paddle of flap proved inadequate for coverage.

To reconstruct the defect, a fasciocutaneous perforator flap (8×5 cm) of anterolateral thigh was elevated, without thinning. Dorsalis pedis artery and vein served as recipient vessels. We first performed venous anastomosis, enlisting a MAC device. After proper adventitiectomy, venous diameters were measured (dorsal vein, 3 mm; vena comitans of lateral circumferential femoral artery descending branch, 2 mm). A 2.5-mm coupler was selected, and anastomosis proceeded according to product instructions. Arterial anastomosis was achieved using a 9-0 nylon suture from end to end. Circulation was re-established without arterial or venous leakage.

Flap inset was then completed. However, the skin paddle proved inadequate, so a split-thickness skin graft was applied at the site of vascular anastomosis (Fig. 2). Although flap

Fig. 3. Reanastomosis, applying a 2.5-mm coupler (arrow) to the vena comitans of the lateral circumferential femoral artery descending branch; thrombus noted at prior anastomotic site (arrowhead).

circulation appeared satisfactory postoperatively, congestion was evident the next day, necessitating revision. Thrombus had formed in the vein, precluding reanastomosis, so the femoral arterial vena comitans (as above) was anastomosed instead by same method, using a 2.5-mm coupler (Fig. 3).

The flap was viable and free of noticeable complication following revision. By the third postoperative month, however, prevailing conditions (i.e., loss of soft tissue and atrophy) had forced the coupler to breach the skin. Convinced that 3 months was ample time for vascular regeneration, the MAC device was carefully removed. Initially, the exposed half of the coupler was excised to check vessel contours. Once vascular integrity and patency were confirmed, the rest of the coupler (buried in tissue) was gently extracted as well (Fig. 4). Flap debulking was performed 8 months after the surgery. There have been no complications 16 months later (Fig. 5).

DISCUSSION

Proper microvascular anastomosis is essential for a free flap to succeed. By traditional means (i.e., suturing) the failure rate is approximately 2% to 5%.[1] Failures are often attributable to insufficient suture eversion (promoting intravascular laceration), luminal contraction, and anastomotic mismatching due to irregularly sutured or distorted vessels. Moreover, if the suturing process is time-consuming, prolonging ischemia-reperfusion injury, then flap viability may be undermined.

A number of devices currently are in development for this purpose, including the vascular closure system (VCS) microclip

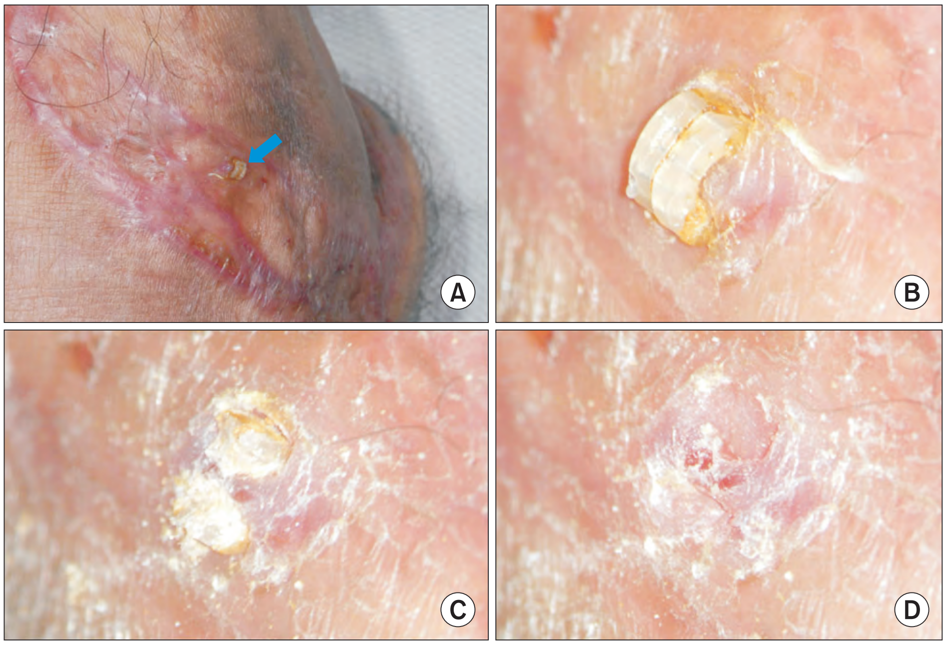

Fig. 4. (A) Coupler exposed 3 months after procedure (arrow). (B) Close-up of exposed coupler. (C) Exposed half of coupler excised. (D) Remaining half (buried in tissue) also extracted, with vascular contours and blood flow intact.

(Autosuture Norden, Stockholm, Sweden) and the GEM MAC system (Synovis Micro Companies Alliance, Inc.). An earlier study investigating times required for femoral vein anastomosis via suturing (39.8 minutes), VCS (26.3 minutes), and MAC (11.9 minutes) methods underscores the superiority of MAC devices. In anastomosis of the aorta, the same holds true (MAC, 14.7 minutes; suture, 39 minutes; VCS, 20.8 minutes), and the MAC system outperforms the others in terms of patency.[10]

In our experience, the MAC venous coupler has yielded a 96.3% success rate.[3] The thrombosis that developed upon first attempt in this patient likely reflected recipient vein damage. Adjacent soft tissues were edematous, implying venous compromise in the milieu of a chronic wound. A perfectly healthy vessel ordinarily should be traced proximally for anastomosis. Rather than finding a healthier vein, the short existing pedicle was used. Alternatively, a tear at the anastomotic site may have resulted from novice handling of the venous coupler. Still another possibility is that the pedicle lacked a reasonable mantle of soft tissue, essentially leaving skin graft as sole protection. Hence, sound microvascular practices must be utilized, even when venous couplers are involved.

Eight months after the procedure, superomedial debulking was done to accommodate the patient's need for shoe fitting. We incised along the flap margin, minimizing the fat layer above the calcaneus and Achilles tendon. The deep fat layer was then dissected and removed in part, along with redundant skin. Healing proceeded without complications of any kind.

This report is limited in that our assessment of vascular regeneration was based on external visual inspection of the anastomosis, without a biopsy for histologic corroboration. However, in an animal model, using absorbable ring-pins in rabbits, clefted intima of anastomotic sites was completely re-endothelialized by 3 weeks.[9] A 3-month period thus seemed more than adequate for vascular regeneration to conclude, and it is certainly feasible that an even shorter interval would have sufficed.

The exposed MAC in this instance was ostensibly linked to final positioning of the coupler near the skin suture or to an insufficient soft tissue mantle. Therefore, couplers should be distanced from suture lines and situated deeper within soft tissue for protection. Inordinate exposure may negatively impact early-stage vascular regeneration through infection, thrombosis, or excessive inflammation. In uncomplicated lateral exposures, vascular remodeling may still proceed smoothly. Coupler removal at an appropriate point in time (sufficient for regeneration) should be undertaken with care, protecting the exposed area. Although histologic proof is lacking, vascular remodeling via MAC device did approximate original vessel

Fig. 5. Flap circulation unchanged after coupler removal and debulking procedure.

contours in this patient.

A 2.5-mm MAC device used in the course of a reparative free flap had breached the skin and was removed without altering structural vascular integrity or flow of blood. Although these findings confirm that true vascular remodeling is achievable through MAC system application, extended study of coupler positioning is needed.

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