Mechanical Leeching with Venocutaneous Fistula and Monitoring with Near-infrared Spectroscopy

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Summary: The report herein describes the use of a venocutaneous fistula with angiocatheter attachment and near-infrared spectroscopy device to correct venous congestion of a vertical upper gracilis free flap used for breast reconstruction. This method of mechanical leeching was precisely controlled through monitoring trends in the tissue oxygen saturation levels of the flap, allowing venous congestion to be relieved before it became clinically apparent. (Plast Reconstr Surg Glob Open 2013;1:e56; doi:10.1097/GOX.0b013e3182aa8752; Published online 18 October 2013)

Venous congestion is one of the most common causes of microsurgical breast flap failure. Multiple methods have been used to mitigate this problem, including medicinal leeches, turbocharging,1 and mechanical leeching including venocutaneous fistulas.2 Any form of leeching is imprecise and may result in excessive hemorrhaging requiring transfusions, infection, and ineffective leeching leading to flap compromise.

Herein we report a unique case where an external, near-infrared spectroscopy device (ViOptix T.Ox Tissue Oximeter, ViOptix, Fremont, Calif.) was used to precisely monitor the trends of venous congestion and relief in a vertical upper gracilis (VUG) free flap, where a venocutaneous fistula was used to periodically relieve flap congestion. We believe that this is the first reported case where this combination of venocutaneous fistula with angiocatheter attachment and ViOptix system led to precise correction of venous congestion and flap salvage without complications from leeching.

CASE DESCRIPTION

A 55-year-old female with a history of breast cancer underwent a bilateral mastectomy in 2010. Her initial delayed reconstruction was performed using autologous abdominal tissue, based on the deep inferior epigastric perforator flaps. After her right-sided flap failed due to venous compromise, she was reconstructed with a latissimus dorsi flap and implant. She eventually opted for implant removal due to discomfort and was reconstructed with a VUG flap in 2013.

METHODS

Using standard markings and technique, a right VUG myocutaneous flap was elevated.3,4 During harvest, the saphenous vein was identified, preserved within the flap, and ligated at the skin. A 2-mm artery and 3-mm vein were anastomosed retrograde to the internal mammary vessels at the fifth intercostal junction. The weight of the flap was 352 g, and ischemia time totaled 72 minutes.

RESULTS

At the time of anastomosis, there was excellent flow into and out of the flap. However, during inset,
signs of venous congestion were noted. The arterial and venous anastomoses were explored and deemed widely patent with no compression. It was evident that this was a partially drained flap, with possible dominant drainage from the saphenous vein. The saphenous vein was sutured to the skin, creating a venous stoma, and a 2-inch, 14-gauge angiocatheter was inserted into the vein for mechanical leeching (Fig. 1). Upon releasing 5 mL of blood, the flap showed immediate clinical and saturation improvement (Fig. 2). Initial ViOptix readings were 70–72% but decreased to as low as 49% with signs of flap congestion. However, with intermittent draining of the flap at a rate of 5–10 mL per hour, the ViOptix readings returned to their initial level concomitant to improvements in the clinical examination (Fig. 3). We continued this drainage protocol hourly, or upon decrease in the ViOptix measurements, during the first 2 postoperative days. On postoperative day 3, we began to decrease the leeching via increased drainage intervals, as the clinical examination and ViOptix readings remained stable. On postoperative day 4, the angiocatheter was removed, the venocutaneous fistula was ligated, and the incision closed (Fig. 4). The patient required no blood transfusions during her hospital stay. The flap was viable and seemed well perfused upon discharge and at subsequent clinic visits.

**DISCUSSION**

Partial or complete venous occlusion arises from many causes, including anastomotic failures, prolonged vasospasm, vessel kinking, thrombosis, compressive hematoma, tight closure, or positional changes. Although some cases may require reexploration, many techniques have been shown to be effective in alleviating venous congestion and improving outflow. Alternatives include medicinal leeching (*Hirudo medicinalis*) and topical, injected, and systemic thrombolytics. These treatments may not always effectively relieve vascular problems and are accompanied by intrinsic risks. The use of medicinal leeching increases the risk of infection with associated bacteria *Aeromonas hydrophila*, necessitating antibiotic administration during treatment. This technique is cumbersome, and bleeding is difficult to control, resulting in inadequate drainage or overbleeding. Other systemic thrombolytics may not fully target the affected vessel, may be contraindicated, and have the inherent risk of hemorrhage. Direct thrombolytic injection into the anastomosis...
bypasses the potential for systemic problems, but requires reexploration, and poses a risk to already delicate flap vasculature.

Another solution for venous congestion is the creation of a venocutaneous fistula. Venocutaneous fistulas were first described for their use in replanted digits, and a recent case study highlights their use in relieving congestion in an osteocutaneous free flap. Although ours is not the first reported case of venocutaneous fistula use in free flaps, the combination of the angiocatheter and the ViOptix system introduces several novel improvements to this treatment option. First, temporarily maturing the saphenous vein to the skin and intubating it with a heparin-locked angiocatheter allowed us to precisely control the drainage. Additionally, ViOptix monitoring enabled us to regulate the status of our flap and know exactly when it needed to be drained. The use of the angiocatheter reduced the risk of venous desiccation (vs leaving the vein open to the skin), thrombosis, and infection and also provided an additional access point for blood draws.

The use of the ViOptix monitoring system provides real-time constant monitoring of free flaps in a noninvasive manner. Several studies concluded that this device is effective in detecting vascular compromise before it becomes clinically evident. Keller examined the use of ViOptix on breast reconstruction free flaps and concluded that by measuring tissue oxygen saturation and its changes over time, ViOptix could predict vascular complications before

**Fig. 3.** ViOptix oxygen tissue saturation readings predicted venous congestion and indicated need for flap drainage. The real-time constant monitoring of the ViOptix system provided information about when the flap should be mechanically leached via the venocutaneous fistula. Immediately post-op, the variations in tissue oxygen saturation produced a sawtooth-shaped graph, showing an immediate improvement after flap drainage (A). On post-op day 1, the flap required less drainage, with increased intervals between drops in ViOptix readings (B). On post-op day 3, the ViOptix readings had stabilized, drainage with discontinued, and the venocutaneous fistula was suture ligated (C).
the onset of clinical changes—allowing intervention and salvage of every flap in his study. Pelletier et al.\(^{10}\) reached similar conclusions, while also showing that the ViOptix system is a cost-effective flap monitoring device. Given that prompt and accurate recognition of vascular occlusion leads to higher flap salvage rates, the ViOptix system is a useful and economical addition to the arsenal of flap monitoring options.

**CONCLUSIONS**

This case highlights a closely regulated solution for relief of venous congestion in free flap reconstruction using a venocutaneous fistula and a better understanding of how ViOptix data correlate with the clinical presentation of a flap, giving us the knowledge that can be applied to future patients.

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*Fig. 4.* VUG flap before takedown of angiocatheter and suture ligation of venocutaneous fistula. On post-op day 4, the appearance and the saturation readings of the flap had stabilized and the VC fistula was no longer necessary for venous drainage.

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