Use of the Implantable Doppler in Free Tissue Breast Reconstruction

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KEYWORDS

• Free flap • Monitoring • Implantable Doppler
• Reconstruction

Free tissue transfer has advanced significantly as a reconstructive modality since its advent in the 1950s. Success rates have increased considerably as techniques have improved, with some investigators reporting less than 5% failure.[1–3] However, failure remains a very costly outcome in terms of time, resources, and patient morbidity, and delayed salvage efforts negatively affect the likelihood of flap success. Considerable attention is understandably directed to optimizing monitoring techniques and devices.

The growing list of indications and evolving techniques for free flaps have posed challenges to conventional monitoring techniques. Clinical examination can often fail to detect early thrombotic complications in free flaps. Hand-held Doppler ultrasonography and skin-surface temperature probes have limited uses in monitoring.[4] As a result, other monitoring methods have gained popularity more recently. Among these is the implantable Doppler system.

The implantable Doppler was first described by Swartz and colleagues[5] in 1988. The device allows for continuous invasive monitoring of blood flow through a vessel. This system uses an implantable 20-MHz pulsed ultrasonic probe to directly monitor the vascular anastomosis of a free flap.

TECHNIQUE

The electrode is typically mounted on a silicone cuff, which is wrapped gently but snugly around the venous pedicle (**Fig. 1**), and a thin wire connects the probe to the external monitor (**Fig. 2**). The Doppler probe produces a pulsatile sound when attached to the artery and a venous hum when attached to the vein. The monitoring system is designed to be used for 5 to 10 days, after which the electrode is detached from the silicone cuff with minimal tension by pulling on the externalized wire.

INDICATIONS AND SETTINGS FOR THE IMPLANTABLE DOPPLER

The use of the implantable Doppler has been described by numerous investigators in a variety of settings, including reconstruction of the head and neck,[6–9] breast,[10–12] and extremities.[9,13] Guillemaud and colleagues[6] published one of the largest series on head and neck free flaps, mostly for oncologic defects, monitored via the implantable Doppler. In the retrospective series of 351 patients, the investigators found that a change in the Doppler signal increased the salvage rates from 61.5% to 92.0%, when compared with flaps in which no vascular complication was detected. The investigators attributed failures in detection to their choice of arterial monitoring.

A more recent retrospective review by Paydar and colleagues[7] of 169 consecutive free flaps for head and neck reconstruction also found a high overall salvage rate of 94.7%. Of the 19 flaps (4 buried flaps) that had changes in Doppler signals, the only flap failure occurred in 1 of the buried flaps. In contrast with Guillemaud and colleagues,[6] Paydar and colleagues[7] used the implantable Doppler to monitor venous flow, with

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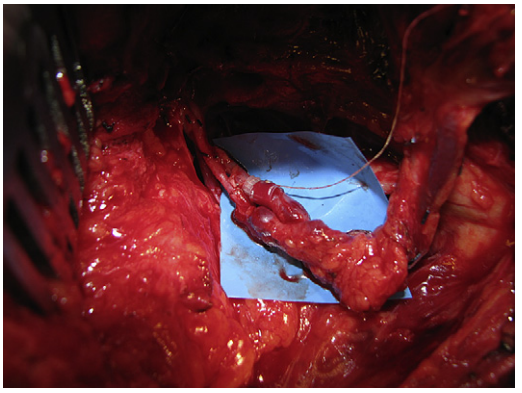

Fig. 1. The electrode is typically mounted on a silicone cuff, which is wrapped gently but snugly around the venous pedicle.

a sensitivity and specificity of 100% and 98.7%, respectively. None of the false-positive results required operative exploration after correlation with clinical examination, and there were no complications attributable to use of the implantable Doppler.

The implantable Doppler has also demonstrated applications in breast reconstruction. Rozen and colleagues[14] recently published their experience with 527 consecutive patients who underwent breast reconstruction using free tissue transfer, including deep inferior epigastric perforator, superficial inferior epigastric artery, and superior gluteal artery perforator. The investigators compared the efficacy of clinical monitoring in the first 426 patients with that of monitoring using the implantable Doppler in the subsequent 121 patients, with salvage rates of 66% and 80%, respectively. Although this difference was not significant, the investigators' meta-analysis of related literature showed a significant improvement in salvage rates associated with the use of this device. Smit and colleagues[11] similarly reviewed

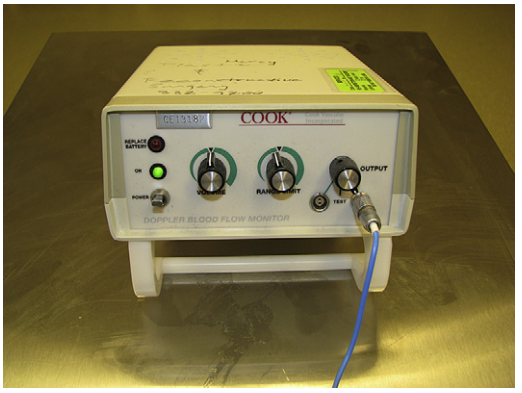

Fig. 2. A thin wire connects the implantable Doppler probe to the external monitor.

121 microvascular breast reconstructions retrospectively, all of which were monitored with implantable venous Doppler probes. A total of 14 flaps required salvage efforts, with an overall false-positive rate of 6.7% and a false-negative rate of 0%.

Whereas nonburied flaps can be monitored with a combination of clinical observation and implantable Doppler, buried flaps pose a particular challenge in postoperative care. In a retrospective review of 750 free flaps monitored only with conventional techniques, Disa and colleagues[4] reported that buried flaps had a significantly lower salvage rate of 0% compared with 77% for nonburied flaps. This result was associated with a significantly higher failure rate in buried flaps, 6.5% when compared with 1.8% in nonburied flaps. Unsurprisingly, the implantable Doppler has been used to monitor buried free flaps for head and neck, as well as for breast reconstruction.[6,7,10] Rozen and colleagues[10] published a unique series of 8 patients who underwent microvascular breast reconstruction using completely buried flaps; the investigators suggested that the implantable venous Doppler allows for the expanded use of such techniques.

RELIABILITY AND VALUE OF THE IMPLANTABLE DOPPLER

Advocates of the implantable Doppler point out that the monitoring technique is minimally invasive and adds little time or morbidity to free tissue transfers. Moreover, the device can detect flap compromise in settings in which other modalities are not easily implementable. However, these potential benefits are balanced against considerations of reliability and utility of the implantable Doppler in the setting of free flaps. In addition, the signal obtained from the device requires a learning curve for physicians as well as for hospital staff to interpret the analog sounds obtained. Lineaweaver[15] proposed a framework with which to evaluate the utility of any flap-monitoring device, based on the following 3 criteria: (1) the rate of false-positive results, (2) the device's sensitivity to true vascular complications, and (3) perhaps most importantly, the device's effect on the flap salvage rate.[15]

Sensitivity

Sensitivity of the implantable Doppler is critical in the timely management of flap compromise, and has improved since its advent in 1988. The device was originally described as a means of arterial monitoring.[5] Swartz and colleagues[16] noted a marked improvement in sensitivity, from 66.7%