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LIGHTGUIDE SPECTROPHOTOMETRY TO MONITOR FREE TRAM FLAPS

Jenny Caddick*, Cameron Raine, David Harrison, Matt Erdmann

1. INTRODUCTION

With improvement in microvascular techniques within the field of plastic surgery, free flaps are increasingly used in the reconstruction of many anatomical defects. Breast reconstruction following mastectomy is perhaps one of the most important areas in terms of the size of the patient group affected and the psychological impact of the oncological surgery and subsequent reconstruction.[1, 2] Here, the free transverse rectus abdominus myocutaneous (TRAM) flap has achieved popularity because of the superior cosmetic result, particularly in reconstructing larger breasts.[3]

While the importance of a meticulous surgical technique cannot be over-emphasised, equally important in ensuring flap survival is the post-operative maintenance of tissue perfusion. Free flaps fail due to a thrombosis within an artery or a vein. This initiates a cascade of events within the microvasculature allowing microthrombi and sludge to accumulate.[4] Early recognition of these events is vital in determining flap salvage should a problem arise. [5, 6, 7]

2. FREE FLAP MONITORING

The importance of early recognition of flap compromise before it becomes irreversible is undisputed. Nevertheless, human observation, which is inherently subjective, remains the most practical monitoring method among many surgeons.

Various alternative monitoring devices have been explored both experimentally and clinically over the past 6 decades.[4, 8] Despite the invasiveness and technical expertise required to use many of these devices, a recent study[9] suggests that 90% of microsurgeons in the USA use some kind of monitoring device routinely.

* Jenny Caddick, Cameron Raine, Matt Erdmann, Department of Plastic Surgery, University Hospital of North Durham DH1 5TW, UK. David Harrison, Regional Medical Physics Department, Durham Unit, University Hospital of North Durham.

In a plastic surgical context, visible wavelength range lightguide spectrophotometry (LGS) was first described by Jones et al.[10] using a rat epigastric flap model. The authors found that at specific wavelengths they were able to identify failing flaps and to differentiate between arterial and venous thrombosis. However, the heavy, cumbersome equipment precluded continuous monitoring and the careful calibration necessary for each measurement made the instrument impractical for clinical use.

More recently Wolff et al.[11] used the Erlangen Microlightguide Spectrophotometer II (EMPHO II) to measure intracapillary haemoglobin oxygenation from the spectrum of backscattered light. The device was shown to be useful in both animal models and human studies but could not differentiate between arterial and venous occlusion. It was also large and cumbersome limiting its practicality to laboratory work.

3. METHODS

3.1 Lightguide Spectrophotometry

A Whitland Research RM200 SO_2 monitor was used for this study. The features of the instrument are described elsewhere in this volume.[12] Values of tissue oxygenation (SO_2) and relative haemoglobin concentration (HbI)[13] were recorded every 10 seconds. The data were subsequently then smoothed to create a 5 minute moving average.

3.2 Patients

Consecutive women undergoing TRAM flap breast reconstruction at the University Hospital of North Durham were recruited between November 2001 and June 2004. A total of 14 women were studied and mean demographic data are shown in table 1. All gave informed consent to the study.

Patients were monitored on return from theatre for up to 72 hours post operatively using LGS and the two most clinically applicable alternatives: clinical observation (by a standardised patient care pathway) and laser Doppler flowmetry (Moor DRT4). Probes were attached to the flap as shown in figure 1. Some modification to probe design was made during the study. In the later part of the study, probe placement was standardised to zone 1 of the flap (the area of the flap with the most reliable blood supply determined by the anatomical distribution of the vessels supplying it).

Table 1. Basic demographic data for patients included in the study.

Total patients	14
Mean Age in Years (Range)	44 (37-64)
Mean BMI (Range)	27 (23-37)
Smokers	4
Previous Radiotherapy	6
Previous Chemotherapy	6