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Original article

Breast oedema following free flap breast reconstruction

Jennifer Greenhowe, BMSc(Hons), MBChB, MRCSEd, AFHEA, MSc, DPhil. Specialty Registrar *, Christopher Stephen, MBChB, MRCS, MSc., Liusaidh McClymont, BMSc(Hons), MBChB., D. Alex Munnoch, MBChB, FRCSEd(Plast)

Department of Plastic Surgery, Ninewells Hospital and Medical School, Dundee, United Kingdom

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ABSTRACT

Objectives: Breast oedema causes significant morbidity and is historically difficult to quantify. The aim of this study was to identify changes in breast tissue water content from pre-operative levels in the native breast to post-operative levels in mastectomy skin flaps and free flaps in the reconstructed breast.
Materials and methods: One hundred patients undergoing unilateral mastectomy and immediate free flap breast reconstruction were examined pre-operatively and at three post-operative appointments. A validated moisture meter was used to record dermal water percentages of each breast quadrant and areola in both breasts pre-operatively, then four quadrants of both breasts plus the unaffected areola and free flap at each post-operative review.
Results and conclusion: Native skin of the reconstructed breast showed significant, persistent increase in MWC from 45.6% ± 0.5% to 72.8% ± 0.9% at 1st follow up ($p < 0.001$), decreasing only to 67.6% ± 0.8% by 3rd follow up. There was a marked difference ($p < 0.001$) in the mean water content (MWC) of the initial free flap (39.7% ± 0.6%) compared to 61.8% ± 1.7% at 1st follow up, then 55.1% ± 1.4% at 2nd and 53.7% ± 1.3% at 3rd follow ups. The unaffected breast showed a small but significant increase in MWC of all quadrants at subsequent follow up (greatest difference 3.1% at 1st follow up).
This patient group demonstrates significant, persistent oedema of the reconstructed breast, which can be monitored using a non-invasive moisture meter.

1. Introduction

Breast cancer related lymphoedema of the upper limb is a recognized sequelae of breast cancer and its treatment [1,2], which is relatively easy to monitor with volumetric measurements. Oedema within the breast is also a source of morbidity, but quantification is more difficult.

A recent systematic review highlighted the lack of evidence in literature supporting clear definition of breast oedema and a standardised method of assessment [3]. Current criteria assess breast oedema clinically using signs which include; increase in breast size, peau d'orange, skin erythema, hyperpigmented skin pores and positive pitting sign, as well as symptoms of breast pain and the sensation of heaviness in the breast [3,4]. Fig. 1 shows a patient with significant oedema in her reconstructed breast following radiotherapy.

Tissue oedema may be subclinical [5] and at present, there does not appear to be an objective measurement of breast tissue oedema independent of clinical signs. The use of high frequency ultrasound (HFUS) in examining oedema in breast tissue has previously been reported as unsuccessful in quantifying tissue oedema [6]. Mammography offers an alternative method of assessing breast tissue, however, this is clearly not a practical tool to monitor ongoing postoperative breast oedema.

Risk factors for increased risk of developing breast oedema following breast conserving surgery include increased breast size, lymph node clearance and reduced time between surgery and radiotherapy treatment [7,8]. Breast oedema has been reported as two processes; one involving increased fluid in the breast parenchyma itself and the second involving oedema of the epidermis and dermis [9]. Often a combination of parenchymal and cutaneous oedema occur, both contributing a less than satisfactory outcome to breast surgery.

It is clear therefore that an objective measurement tool for

* Corresponding author. Department of Plastic Surgery, Ninewells Hospital and Medical School, Dundee, DD1 9SY, United Kingdom.
E-mail address: jgreenhowe@nhs.net (J. Greenhowe).

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Abbreviations

MWC	Mean Water Content
TDC	Tissue Dielectric Constant
DIEP flap	Deep Inferior Epigastic artery Perforator flap
TRAM flap	Transverse Rectus Abdominus Musculocutaneous flap
IGAP flap	Inferior Gluteal Artery Perforator flap

Fig. 1. Significant clinical oedema of the right reconstructed breast post-radiotherapy.

breast oedema is required. The MoistureMeterD Compact (Delfin Technologies Ltd, Finland) is a water-specific instrument for the assessment of water content in biological tissues [10,11]. This version of the probe is portable and measures the tissue dielectric constant (TDC) in the skin and subcutis at a constant depth of 2.5 mm. It has a pressure gauge on the probe to eliminate inconsistency from variable third space fluid dispersion. The TDC is then converted into percentage water content on a theoretical scale of 0–100%. This method is non-invasive and rapid, producing readings within a few seconds.

The aim of this study was to identify changes in breast tissue water content from pre-operative levels in the native breast to post-operative levels in mastectomy skin flaps and free flaps in the reconstructed breast. The MoistureMeterD Compact has previously been validated for use in monitoring upper limb lymphedema [12] and to the author's knowledge this is the first study to validate its use in the breast.

2. Materials and methods

One hundred patients undergoing unilateral mastectomy and immediate free flap breast reconstruction were examined pre-operatively and at three post-operative appointments. The MoistureMeterD Compact (Delfin Technologies Ltd, Finland) was used to measure the Tissue Dielectric Constant (TDC) of the skin and superficial tissue of each breast quadrant and areola in both breasts pre-operatively, then four quadrants of both breasts plus the unaffected areola and free flap at each post-operative review. These reviews took place at 5 days, 2 weeks and 3 months post-operatively, as these are our usual discharge date and initial follow up intervals for breast reconstruction patients. Beyond 3 months ongoing follow up intervals vary depending on patient need, further treatments or planning secondary procedures such as nipple reconstruction. The TDC values were converted to water percentages by the meter software, and these percentage water contents were compared using the two-tailed Student's T test for paired samples.

3. Results

There was a significant difference ($p < 0.001$) in the mean water content (MWC) of the unaffected breast (41.9% ± 0.4% SEM for combined quadrants, 54.6% ± 1.1% for areola) and the pre-operative breast with cancer (45.6% ± 0.5% for combined quadrants, 60.3% ± 1.1% for areola) (Fig. 2).

Of the 100 free flap reconstructions in this study there were 85 Deep Inferior Epigastic artery Perforator (DIEP) flaps, 1 Transverse Rectus Abdominus Musculocutaneous (TRAM) flap and 14 Inferior Gluteal Artery Perforator (IGAP) flaps. MWC of the initial free flap was 39.7% ± 0.6%. Free flap oedema increased significantly resulting in MWC values of 61.8% ± 1.7% at 1st follow up, then 55.1% ± 1.4% at 2nd and 53.7% ± 1.3% at 3rd follow ups (all $p < 0.001$) (Fig. 3).

The unaffected breast showed a small increase in MWC of all quadrants at subsequent follow up (Fig. 4), whereas the reconstructed breast showed significant, persistent increase in MWC from 45.6% ± 0.5% to 72.8% ± 0.9% at 1st follow up ($p < 0.001$), decreasing only to 67.6% ± 0.8% by 3rd follow up (Fig. 5).

The amount of oedema within the native skin flaps in the reconstructed breast (MWC 67.6% ± 0.8% by 3rd follow up for all four quadrants) is significantly greater ($p < 0.001$) than the oedema within the free flap reconstruction by 3rd follow up (53.7% ± 1.3%) (Fig. 6).

The type of free flap reconstruction did not influence the amount of oedema within the native breast skin flaps (Fig. 7). There was only one TRAM flap within our series which was excluded from analysis. Comparison of the 85 DIEP flaps with the 14 IGAP flaps showed no significant difference in mean water content of the native breast skin flaps at any of the three follow up periods. The mean water content of the pre-operative breast skin and areola was higher in the IGAP group (51.2% ± 1.2% compared with 44.8% ± 0.5% for breast skin and 68.6% ± 1.9% compared with 58.8% ± 1.2% for areola), but this difference was not evident in post-operative results. The IGAP flaps had a lower mean water content than the DIEP

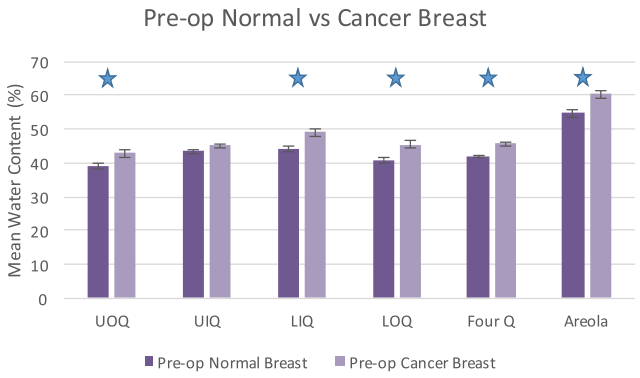

Fig. 2. The pre-operative breast with cancer Has a significantly higher MWC than the pre-operative 'normal' breast. UOQ = Upper Outer Quadrant, UIQ = Upper Inner Quadrant, LIQ = Lower Inner Quadrant, LOQ = Lower Outer Quadrant, Four Q = Four Quadrants Combined. (Stars denote $p < 0.001$, two-tailed Student's T-test for paired samples. Error bars show standard error of the mean.)