Journal of Plastic, Reconstructive & Aesthetic Surgery (2016) 69, 376—380

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Displaying inguinal lymph nodes before transplantation in a deep inferior epigastric perforator flap breast reconstruction using an innovative projection method

S. Hummelink [a,b,*], L.J. Schultze Kool [b], D.J. Ulrich [a]

[a] *Department of Plastic Surgery, Radboudumc, Nijmegen, The Netherlands*
[b] *Department of Interventional Radiology, Radboudumc, Nijmegen, The Netherlands*

Received 27 July 2015; accepted 25 October 2015

KEYWORDS
DIEP flap;
Deep inferior epigastric perforator flap;
Breast reconstruction;
Vascularized lymph node transfer;
CTA;
Pico video projector

Summary *Introduction:* Lymphedema of the arm is a common postoperative complication as a result of breast cancer surgery. One of the surgical treatments comprises modification of a deep inferior epigastric perforator (DIEP) flap breast reconstruction to facilitate additional lymph node transplantation from the inguinal area. Using computed tomography angiography (CTA), the distribution of these lymph nodes can be assessed. A virtual planning based on this CTA created for the DIEP flap is presented, with the inguinal lymph nodes included, followed by preoperatively projecting this information on the patient's abdomen.
Methods: A total of 10 patients underwent the standard imaging protocol: A preoperative CTA to assess the vascular anatomy of the lower abdomen. A three-dimensional (3D) model of the blood vessels was produced, and the inguinal lymph nodes in this reconstruction were included. Preoperative projection of the 3D model onto the patients' abdomen and inguinal area was performed, followed by tracing of this image. Intraoperatively found lymph nodes were identified by touch and compared with the markings on the skin.
Results: In all 10 patients, all lymph nodes located preoperatively were found intraoperatively within a 1-cm radius of the marking on the skin; and these were more easily located by two operating surgeons.
Conclusion: Virtual planning of lymph node transplantations in a deep inferior epigastric artery perforator flap breast reconstruction seems feasible and can be performed quickly. This additional visual support aids the surgeon in locating the lymph nodes in the inguinal area.

* Corresponding author. Department of Plastic Surgery, Radboudumc, Nijmegen, The Netherlands.
E-mail address: stefan.hummelink@radboudumc.nl (S. Hummelink).

http://dx.doi.org/10.1016/j.bjps.2015.10.041

Introduction

Lymphedema of the arm is one of the most common postoperative complications after breast cancer surgery, with an incidence ranging between 9% and 41%.[1–3] This impairing complication remains a challenge with few curative treatment options available. Single or a combination of therapies have been proposed in the literature and include various compression, physiotherapeutic, and surgical treatments.[1,4]

One of the surgical possibilities comprises modification of a deep inferior epigastric perforator (DIEP) flap breast reconstruction to facilitate additional autologous lymph node transplantation (ALNT). During this procedure, several vascularized lymph nodes from the inguinal region were included in the free abdominal skin flap and transferred to the affected axilla.[5] The symptoms of lymphedema were improved through an unknown method of action. The excess lymph fluid from the edematous extremity was possibly drained either through intra-flap lymphatic-venous connections, by lymphangiogenesis induced by the transferred flap, or a combination of both.[1,4]

Most of the difficulties faced during surgery concern the intraoperative identification and preservation of the lymphatic nodes and vessels. Computed tomography angiography (CTA) can be used to localize and quantify the distribution of the lymph nodes in the inguinal area.[6] In our earlier work, we proposed a novel method of creating a virtual DIEP flap planning based on CTA, and projecting this information on the patient's abdomen.[7] The three-dimensional (3D)-reconstructed DIEP flap planning can be further elaborated by also indicating the locations of lymph nodes before surgery.

The aim of this paper is to share our clinical experience regarding the addition of lymph nodes into the virtual DIEP flap planning and projecting this information using a self-aligning pico laser projector onto the patient's skin to guide the surgeon towards the location of inguinal lymph nodes.

Methods and materials

Between January and June 2015, a total of 10 patients underwent a deep inferior epigastric perforator breast reconstruction with a vascularized lymph node transfer. All patients followed the standard imaging protocol which consisted of a preoperative CTA to determine deep inferior epigastric artery vascular quality and its perforator locations.

Patients were scanned with a Toshiba Medical Systems Aquilion One 320 slice CT scanner. Using VitreaAdvanced fX Workstation (Toshiba Medical Systems, Europe), the intramuscular trajectory of the deep inferior epigastric artery and its branches towards perforators were highlighted. All significant perforators (diameter $\geq$1 mm) were annotated with yellow arrows perpendicular to the CT table and purple arrows to represent the most favorable perforators for transplantation. Additional to this planning, all lymph nodes in the inguinal area and the superficial circumflex iliac artery were reconstructed in the Vitrea software with little extra effort (Figure 1).

To achieve global orientation of the highlighted anatomical features, four landmarks were indicated in the 3D reconstruction. These landmarks were the symphysis, bilateral spina iliaca anterior superior, and the umbilicus. At these exact locations, black and white markers were temporarily placed on the patient's landmarks (Figure 2a). Using an in-house developed projection device, the projected CT data were automatically aligned to the indicated landmarks and displayed on the patient through a laser projector. The projected image was traced with a marker pen to be used as a visual reference during surgery in order to find not only the deep inferior epigastric perforators but also the lymph nodes hidden in the subcutaneous fat (Figure 2b).

A modified technique of harvesting the inguinal flap originally described by Sulo et al. (2015) was used.[8] Besides indicating lymph nodes through projection, 0.5 ml of Patent Blue (ACROS Organics, Geel, Belgium) was injected intradermally into the lower abdominal wall above the iliac crest 10 min before the first skin incision. Dissection was initiated laterally with the deep inferior epigastric artery perforator flap. The superficial circumflex iliac artery (SCIA) was identified laterally and followed by the harvest of a fat flap from the inguinal area around the SCIA including tissue under Scarpa's fascia. The dissection was always limited to the level of the femoral artery. We included only the first palpable lymph node surrounding the SCIA pedicle into the flap. The lymph node was intraoperatively identified by the operating surgeon through touch and Patent Blue visualization, if possible. By pushing an instrument outward, such as a needle or finger perpendicular to the found node, the marked location could be reviewed (Figure 3). The projected and marked location was deemed acceptable if the intraoperative lymph node was found within a radius of 1 cm from this position. For all patients, the surgeon's opinion was recorded and reviewed on the accuracy of the lymph node localization for all patients. After the lymph node flap dissection, the DIEP flap was raised in a normal manner.

Results

Inguinal lymph nodes were preoperatively projected and traced with a marker pen in a total of 10 patients. All patients were found intraoperatively to have preoperatively indicated lymph nodes within a 1-cm radius of the marking on the skin by the two operating surgeons (Table 1).

The recorded opinions of the surgeon indicated that harvest of the lymph node flap could be altered towards a more direct approach instead of conservative converging technique intraoperatively. Lymph nodes were located in the subcutis more conveniently, and surgeons felt that less tissue could to be dissected before harvest by doing so.

Discussion

Intraoperative localization of inguinal lymph nodes is a difficult task for surgeons, as these nodes are concealed in the subcutaneous fat. During surgery, available products such as Patent Blue may not migrate to all lymph nodes in the inguinal area. As a result, large harvested inguinal