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Mastering the Deep Inferior Epigastric Artery Perforator Flap (DIEP): Refining Techniques and Improving Efficiency

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Additional information is available at the end of the chapter

1. Introduction

1.1. Patient selection

Most women seeking breast reconstruction are candidates for Deep Inferior Epigastric Perforator (DIEP) flaps. The only absolute contraindication is prior abdominoplasty [1]. Other types of abdominal surgery including liposuction are relative contraindications [2], and need to be evaluated with respect to the extent of the abdominal surgery and the result of the magnetic resonance angiogram (MRA.) If a patient is too thin and simply does not have enough abdominal tissue for the breast reconstruction (one or two breasts), she can either have a low-volume reconstruction with the intent to augment the reconstruction later, or use another donor site, like the thighs or buttocks. We tend not to operate on patients with BMI over 36, and require that they lose weight prior to elective DIEP surgery. We also require that patients quit smoking for three months prior to surgery, but exceptions may be made in select patients.

2. Preoperative imaging

Our technique for MRA of the abdomen has been published [3-5]. We obtain MRA on all patients undergoing perforator flap procedures. This includes patients who have expanders or implants in place at the time of MRA. In our experience, there have not been adverse effects from performing MRA on patients with expanders or implants. The appropriate

vessels are selected preoperatively and the patient is marked either the day before surgery or the in the holding area the day of surgery. It is important to evaluate the MRA and to mark the patient preoperatively in order to think about and understand the anatomy. This allows for excellent planning and the ability to predict possible pitfalls and back-up plans. An example of a MRA showing a DIEP is Figure 1. We have found preoperative imaging to be vitally important for planning and execution of perforator flap surgery. The MRA enables the surgeon to evaluate perforators with respect to their location in the abdominal flap, intramuscular course and size. The key perforators are selected preoperatively and marked on the patient's abdomen according to measurements from the umbilicus. A handheld Doppler ultrasound is used to confirm the locations of the perforating vessels at the time of marking.
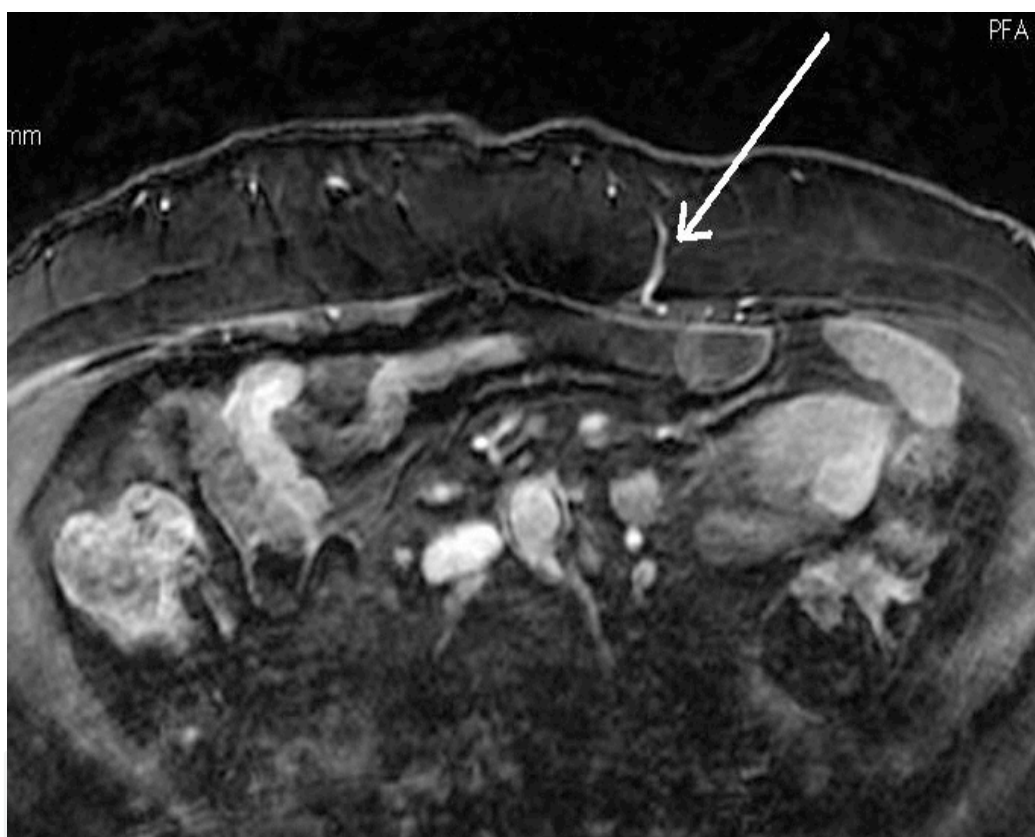

Figure 1. MRA of the abdomen with arrow pointing to a DIEP.

3. Flap harvesting and tips for success

The patient is placed on the table supine with arms prepped and wrapped with gauze roll or stockinette (Figure 2). The arms are placed on arm boards and covered with sterile arm drapes in order to bring the arms in later during the procedure when the microscope is brought in for vessel anastomosis (Figure 3).

Figure 2. Sterile drape of the arms

Figure 3. Sterile drape of the arm in adducted position.

In delayed breast reconstruction, three surgeons can start at the same time (where availability of personnel permits). One surgeon will start harvesting the internal mammary vessels while the other two surgeons harvest the abdominal flaps simultaneously.

4. Abdominal flap dissection

Abdominal incisions are made according to the preoperative markings. If a large flap is desired, beveling is used to capture as much fat as possible in the upper abdomen [6]. The upper abdominal flap is turned over superiorly so that the skin edges can be stapled pulling the upper abdominal skin/fat in static cephalad retraction (Figure 4). The lower, suprapubic incision is initially made very superficially in order to evaluate and possibly preserve superficial vessels (Figure 5).
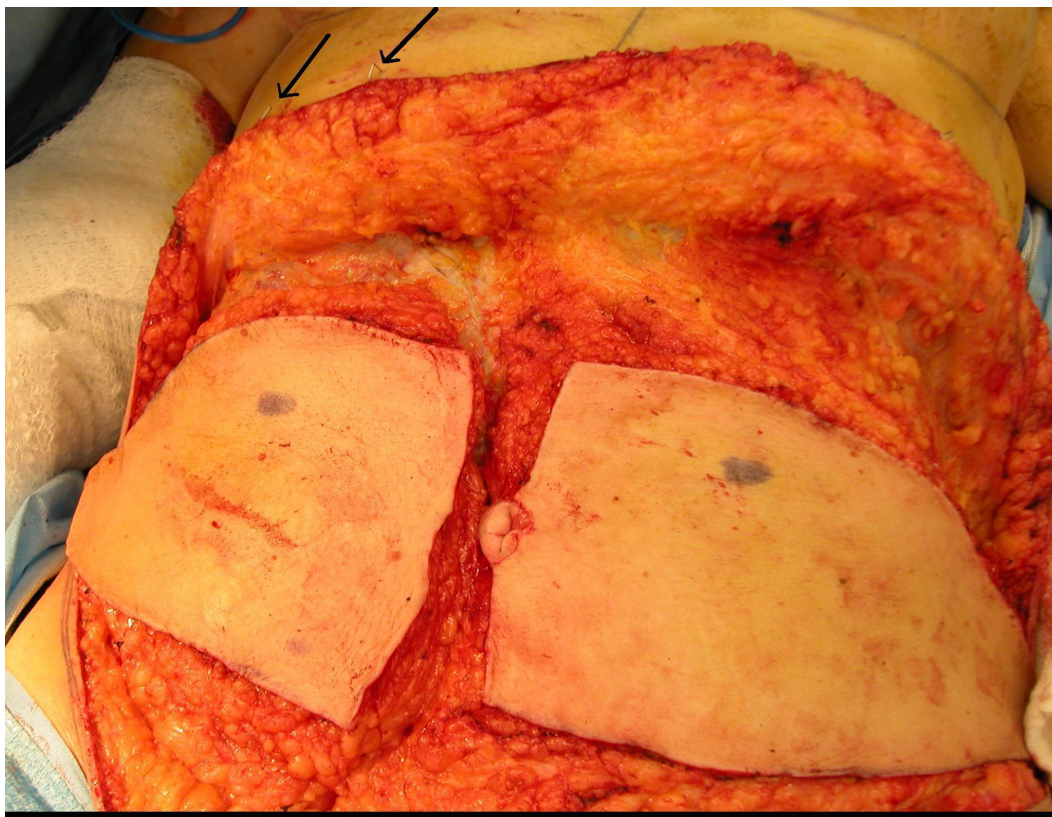

Figure 4. The stapled cephalad skin edge provides a static cephalad retraction.

The surgeon has knowledge about the caliber of superficial vessels from the MRA, but it is always a good idea to reevaluate them in-situ. Once the superficial vessels are identified, a decision can be made as to whether they should be used, and if so, how much length should be harvested. Generally, a large Superficial Inferior Epigastric Vein (SIEV) (>2mm) and Superficial Inferior Epigastric Artery (SIEA) (>1mm) should be preserved as a back-up drainage for the flap. A few extra centimeters are adequate for the vein, but remember that the
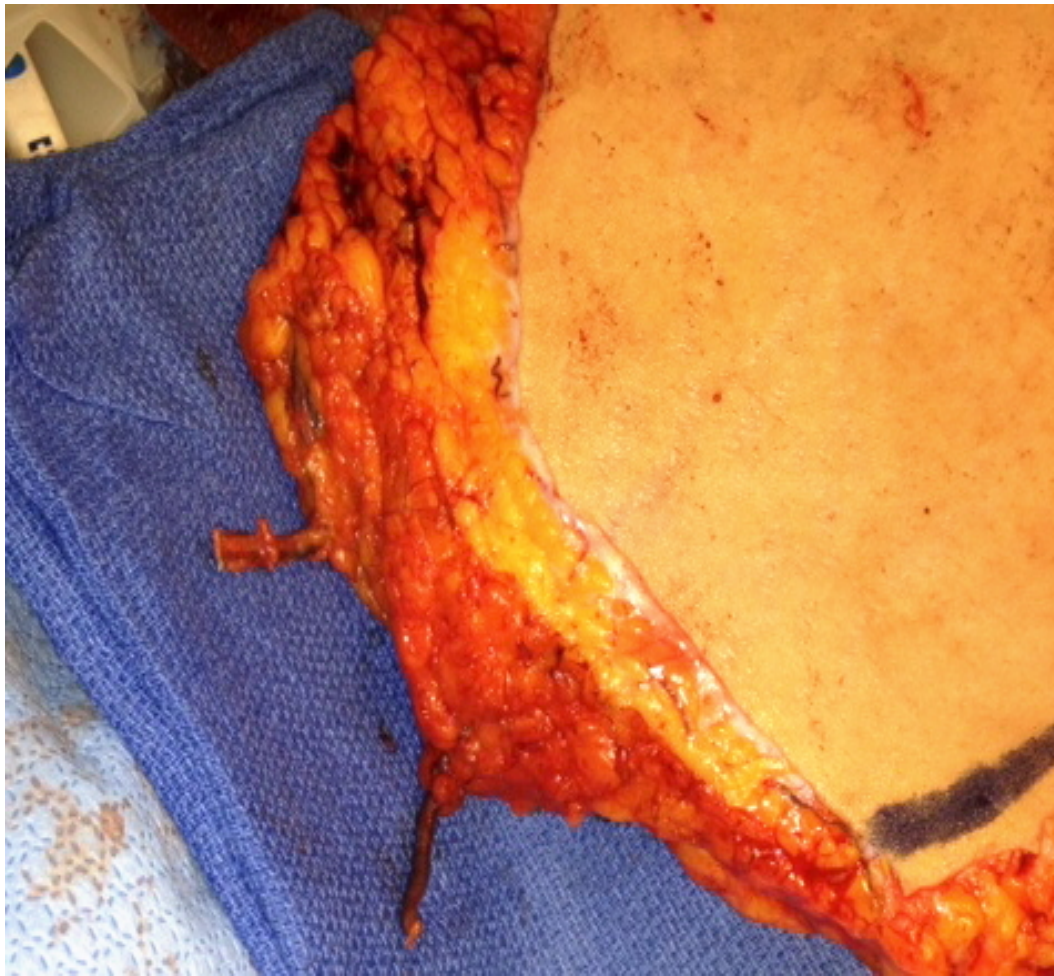
Figure 5. Preservation of SIEA and SIEV

more you get, the easier it will be to use the vessel if needed. If the flap becomes congested after anastomosis to the DIEP perforator pedicle, the superficial vein will become engorged and easy to find. If the length is inadequate, further dissection into the flap can be easily done on the enlarged vein. If the SIEA is to be considered as a pedicle or a back-up inflow system, its dissection should be postponed until after the perforator has been selected. This is because the SIEA dissection is very tedious and time consuming, and an adequate perforator pedicle is almost always preferable to an SIEA pedicle [7]. Of course, choosing a perforator pedicle obviates the need for the SIEA dissection. Keep in mind, leaving the suprapubic flap too thin will create the risk of prolonged seroma formation and a defect of the abdominal wall contour. Therefore, after finding the superficial epigastric artery and vein, adequate fat thickness should be left within the distal (suprapubic) skin flap. This is done by coning the dissection as you proceed toward the harvested end of the vessels, leaving more and more fat behind.

To enable two surgeons to harvest in tandem, the best technique is to start from the midline and harvest simultaneously. After the midline incision is made, the umbilicus is incised circumferentially down to the abdominal wall. The two abdominal flaps can then be elevated at the level of the fascia under loupe magnification with bipolar electrocautery

from medial to lateral. It may be necessary to elevate from any of the other three edges of the flap in order to proceed to the perforators of choice. Constant repositioning and resetting of retraction devices may be necessary. Even a lateral-row perforator can be dissected by raising the abdominal flap from medial to lateral, but it may require burning medial row perforator options. This should only be done after the lateral row perforator of choice had been evaluated under direct vision and selected as the perforator of choice. A large perforator on the MRA usually correlates with a large perforator in-situ, but not always. Thus, it may be necessary to look at more than one option if there is no clearly dominant perforator on MRA. Constant communication with the other surgeon is imperative so that one does not get in the other's way.

Once the appropriate perforator has been selected, a small incision is made superiorly and inferiorly around the perforator in the anterior rectus fascia. This will begin the intramuscular muscular dissection, and also allow the surgeon to further evaluate the quality of the perforator. The perforator is then dissected free from the anterior abdominal wall fascia circumferentially. A small cuff of fascia may be left around the perforator as trying to dissect the vessels from the fascia may cause damage to these fragile vessels. The fascia incision is carried out generously both superiorly and inferiorly to allow adequate exposure.

Muscle fibers are delicately separated with bipolar diathermy in a longitudinal direction within the natural septum through which the perforator emerges. The muscle fibers are gently teased away until reaching the deep inferior epigastric vessels. There will be branches off of the perforator requiring cauterization or ligation and division. Intraoperative reference to the MRA will be extremely helpful in predicting the intramuscular course of the perforator. A short intramuscular course may be associated with a fast and safe dissection. However if the perforator emerges through an inscription, it may be quite challenging.

Retraction and exposure are extremely important, and thus should be constantly evaluated and improved as the dissection progresses. During muscle dissection, muscle fibers are initially retracted with "fish hook" retractors secured to a clamp on skin staples or drapes. As the dissection continues larger Gelpi retractors replace the "fish hooks." Examples of static retraction is shown in Figures 6-8.

During dissection, the large bulky abdominal wall flaps should be handled with great care. Skin edges can be folded over and secured with skin staples. An assistant holding the bulky and often slippery flap may inadvertently pull the flap and may cause intimal damage to perforator vessels or even rupture them. Therefore, static, mechanical retraction is preferred as described above.

With imaging we have been able to reliably select the best perforator for each flap, increasing the likelihood of selecting only one dominant perforator per flap. When a perforator is of medium or small size, more perforators can be harvested if they are in line with the others. The superior continuation of the deep inferior epigastric vessels are ligated and divided and the dissection continues inferiorly until there is adequate pedicle length and diameter of the vessels.
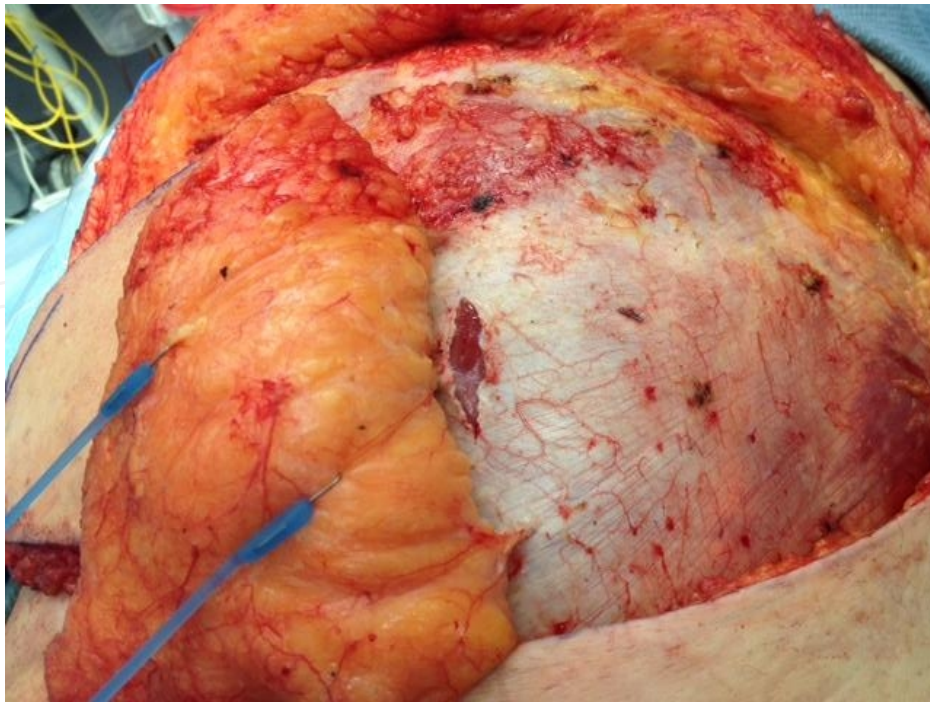
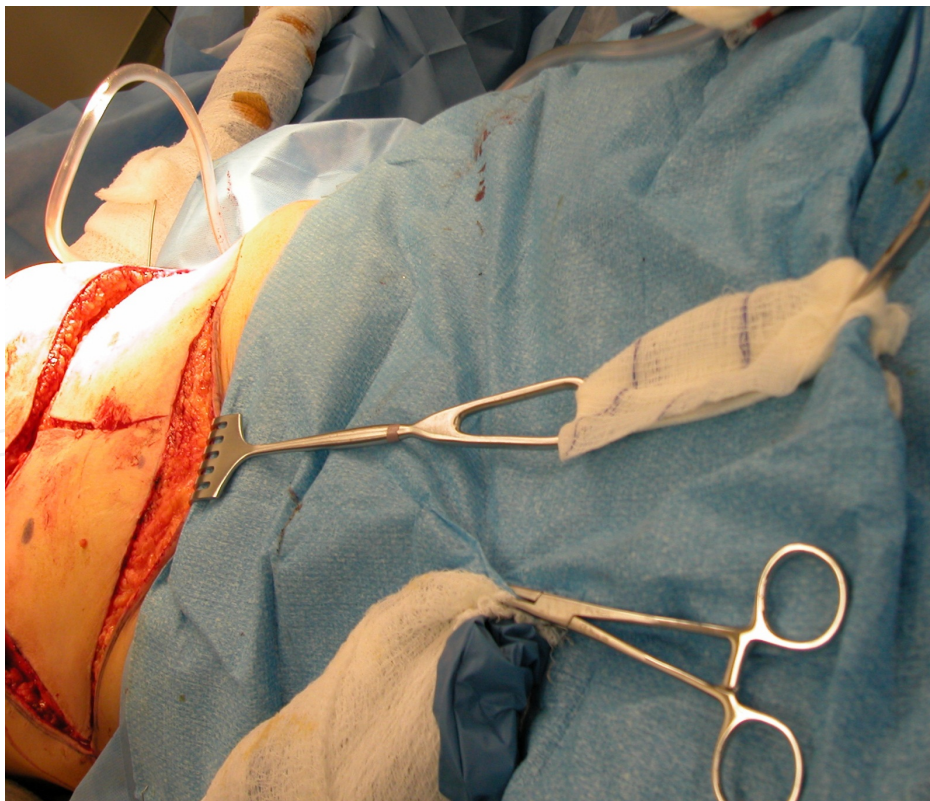**Figure 6.** Fish hook providing adjustable static retraction.

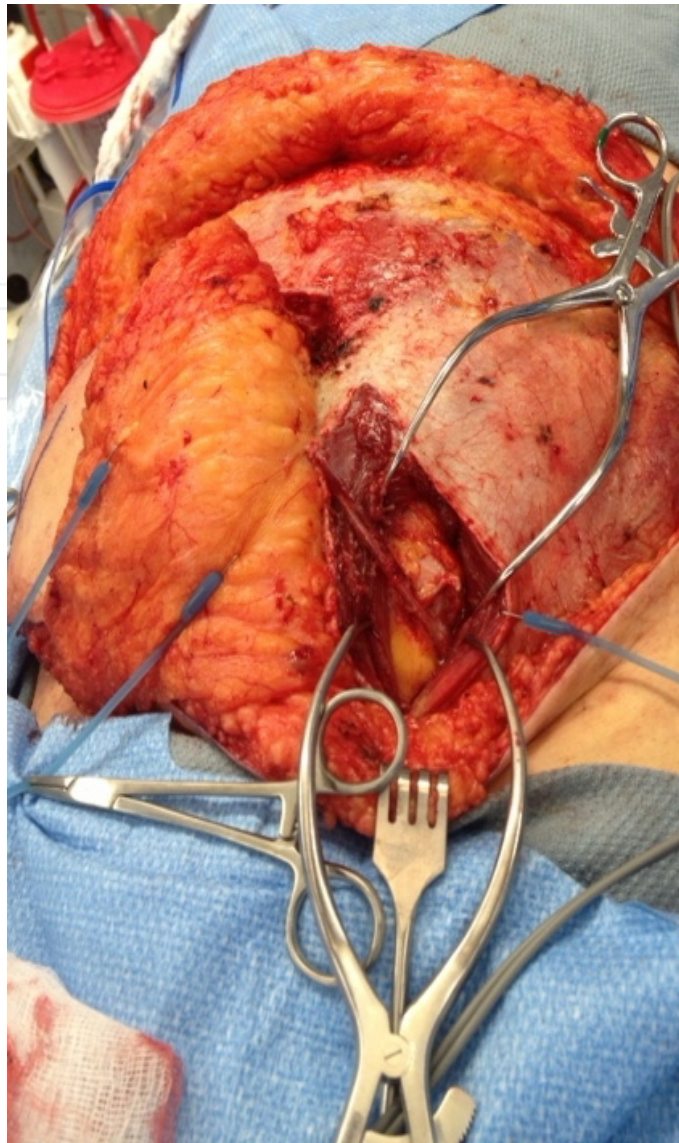**Figure 7.** Rake retractor providing static tissue retraction.

Figure 8. Use of both "fish hook" and Gelpi retractors.

5. Third surgeon: Internal mammary vasculature dissection

The third surgeon prepares the chest wall for anastomosis. For a delayed procedure with explantation of implants, the skin over the implants is elevated off the pectoralis muscle and internal capsule, creating a large space for the flap. The space between the skin and muscle is created up to the clavicle superiorly, and should be about 1.5X the predicted size of the flap. The implant is then removed, and the pectoralis muscle is tacked back down on the chest all (where it belongs). We prefer the second or third intercostal space since the vessels are 1.5-2.5 mm in diameter and a good size match with DIEP vessels.

At the second or third intercostal space, a transverse incision is made parallel to the fibers of the pectoralis muscle exposing two consecutive rib cartilages. An incision is made in the perichondrium longitudinally in each rib. The perichondrium is stripped off with a Freer

elevator and the intervening intercostal muscle is removed. At the costochondral junction, rib is sometimes removed to provide enough space for anastomosis. The internal mammary vessels can be found in a thin layer of fat under the intercostal muscle and are dissected. A branching point of the internal mammary vein is identified and can allow for greater diameter for improved size match with a DIEP vein. Care is taken to leave enough distal artery and vein stump of internal mammary vessels in case an anastomotic revision becomes necessary. These vessels can be successfully used for retrograde anastomosis in case of an anastomotic failue or damage to proximal vessels.

Previous implants with or without radiation therapy can result in a significantly thick posterior capsule making the initiation of the internal mammary dissection more difficult; once through this capsule and into the proper plane below the intercostal muscle, dissection proceeds more easily. An internal mammary lymph node can frequently be encountered. Although it may demonstrate inflammatory changes only, the identified node should be sent for permanent pathology in patients with a cancer history, as this can change stage and treatment. Of note, the internal mammary vessels are typically smaller in caliber on the left than the right side[8].

6. Flap harvest

Before division of the DIEP vessel we mark the anterior surface of the vessels with ink for later anatomic orientation and to avoid kinking of the vessels during insetting. It is also helpful to reconfirm the position of the Doppler signal on the skin prior to harvest.

After the dissection is finished, the abdominal flap is harvested and weighed. The abdominal flap weight can be compared with the mastectomy specimen weight. The flap is held up above the chest wall and the vessels are dangled free over the chest to find the natural orientation of this long pedicle. The ink mark on the anterior wall of DIEP vessels may help with orientation. The flap is secured to the chest wall with sutures. At this point, the arms, which had been prepped into the field are brought into adduction and clamped to the sheets. The arm boards are removed. This allows for two microsurgeons to approach the table and work together under the microscope. The table is slid caudally so that there is room for the surgeons' knees when sitting for the microsurgery. The microscope pedal is used so that the scope can be adjusted while operating with two hands.

7. Under the microscope

The vein is coupled with the coupler (Synovis, Microcompanies Alliance, Inc. Birmingham, AL) and the artery is hand sewn. Arterial coupling can also be done. Once the anastomosis is complete, skin signals are marked on the flap and flap is carefully placed under chest wall skin flaps. Careful positioning of the flap is done under direct vision of the pedicle. Many failures can be attributed to pedicle kink at the anastomosis due to long pedicle length.

8. Insetting

The excess skin on the flap is de-epithelized and adequate bleeding is evaluated. The flap is tacked into position to avoid movement, and to cover the depression created medially at the anastomosis. In cases of nipple sparing mastectomy, a skin paddle is left in the mastectomy incision for monitoring. This skin paddle can be excised 4 days later and closed before the patient leaves the hospital.

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