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Title: ANGIO CT PREOPERATIVE EVALUATION FOR ANTEROLATERAL THIGH FLAP HARVESTING

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Abstract: Background. The vascular anatomy of the anterolateral thigh flap (ALTF) has many possible variations, and none of the currently used mapping techniques (e.g., Echo Colour Doppler) gives a thorough knowledge of all details. Among the last generation of angiographic diagnostic techniques, Multi Detector Computed Tomography, popularly known as Angio CT, has emerged as an outstanding non-invasive operator independent option, and has been described for DIEP and pTRAM planning. This study was conducted to evaluate its usefulness prior to ALTF harvesting. Methods. Nine consecutive patients were considered for oral or lower extremity reconstruction with the ALTF. After written informed consent was obtained from all patients, a preoperative Angio CT study was performed for surgical planning.

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Abstract

Background. The vascular anatomy of the anterolateral thigh flap (ALTF) has many possible variations, and none of the currently used mapping techniques (e.g., Echo Colour Doppler) gives a thorough knowledge of all details. Among the last generation of angiographic diagnostic techniques, Multi Detector Computed Tomography, popularly known as Angio CT, has emerged as an outstanding non-invasive operator independent option, and has been described for DIEP and pTRAM planning. This study was conducted to evaluate its usefulness prior to ALTF harvesting.

Methods. Nine consecutive patients were considered for oral or lower extremity reconstruction with the ALTF. After written informed consent was obtained from all patients, a preoperative Angio CT study was performed for surgical planning.

Results. Accurate identification of septocutaneous or muscolocutaneous perforator vessels was achieved and their location, course and anatomical variations were reported and influenced surgery.

Conclusion. Angio CT allows a complete vascular study of the donor area of the ALTF and evaluation of the best perforator vessels before surgery allows surgeons to get an ideal planning of the flap. This imaging method is currently proposed to every patient undergoing ALT flap reconstruction.

Introduction

The ALTF is now considered probably the first choice among most of the commonly used soft tissue microsurgical flaps, for the advantage of reduced donor site morbidity (1-3), combined with a long pedicle with excellent vessel diameter, the availability of different tissues with large amount of skin and its adaptabilty as a sensate (4-8) and flow through flap if necessary (9).

The pedicle is the descending branch of the lateral circumflex femoral artery (LCFA), which gives musculocutaneous (90%) or septocutaneous perforators (10%). These vessels might have several anatomical variations as regard to size, number and pathway. Furthermore, in about 10% the vascular supply comes from an anomalous pedicle from the transverse branch.

In order to locate perforators, which are so essential to survival of the flap, use of Echo Colour Doppler (ECD) has been suggested, although several pitfalls have been noted.

Among the last generation of angiographic diagnostic techniques, Angio CT has emerged as an outstanding non-invasive operator independent option and defines a technique that combines the technology of a conventional CT scan with that of traditional angiography to create detailed images of the blood vessels in the body

The angio CT technology, which has been proposed for DIEP and pTRAM pre-operative study, has never been reported for ALTF planning, and could give interesting results.

Materials and methods

Between 2006 and 2007 nine consecutive patients, six males and three females, were considered for oral or lower extremity reconstruction with the ALT flap. After written informed consent was obtained from all patient, a preoperative Angio CT study was performed for surgical planning using a 16 detector-row CT scanner Somatom Philips U.S.A. MX 8000 model with the following parameters: 120kVp, 80-120mA, 23mm table travel per rotation, 512x512 matrix.

All scans were obtained with IV administration of 120ml of non-ionic iodinated contrast with a concentration of 370 mgI/ml (iopromide 370, Bayer-Schering Germany and Bracco Imaging

Italia). The volumetric data acquired was then used to reconstruct images with a slice width of 1.3 mm and a reconstruction interval of 0.6mm for the 18 thighs. A 3D reconstruction of thighs (Fig.1a, Fig.1b, Fig.1c) was performed in order to locate precisely the points on the skin surface where the best perforators emerged. Finally, six patient were underwent surgery.

Results

A total of 43 perforators amenable to the ALTF was detected. Two perforator vessels in 10 and three in 6 thighs were detected, 4 perforator vessels in one case and 1 perforator in one case. Septocutaneous perforators (Fig.2a) were found in 6.97% (3/43), muscolocutaneous ones (Fig.2b) in 93,03% (40/43). In 90,69% (39/43) perforator vessels originated from the descending branch of LFCA, and in 9,31% (4/43) they originated from the transverse branch (Table 1). The highest concentration of reliable perforators was found as expected in a circular area with a radius of 3 cm, with the midpoint between the anterior superior iliac spine and the superolateral corner of a patella.

No allergy or adverse effects after administration of nonionic iodinated contrast agents were observed.

Discussion

The anterolateral thigh flap was first described by Song (10) et al in 1984, but only in the past 10 years it has been widely used in clinical practice for upper extremity (4, 5, 11, 12), for oral cavity (4, 6, 13-15), for hand (16), for foot (9) and for lower extremity soft tissue reconstruction (4-11-17). Its use has been reported also for abdominal wall reconstruction (18-19), for postmastectomy breast reconstruction (20-21) and for vulvar (22) and penile (23) reconstruction. It has also been used in post-burn reconstruction (24-25).

Neural (7) and vascular (10-26-32) anatomy of the ALTF has been thoroughly studied. The blood supply of the ALTF has several variations. It is based on septocutaneous or muscolocutaneous perforator vessels, or both, usually arising from the descending branch of the

lateral circumflex femoral artery (LCFA) (26-32). In 75% of patients the LCFA originates form the deep femoral artery, whereas it originates directly from the femoral artery in the remaining 25% (15). From its point of origin, LCFA runs laterally and posteriorly to the femoral nerve, behind sartorius and rectus femoris muscles, and then bifurcates into its ascending, transverse and descending branches. The ascending and transverse branches run parallel and supply the gluteus and the tensor fasciae latae muscles and the upper portion of the vastus lateralis muscle, including the overlying skin. The descending branch is larger (33); it runs behind the rectus femoris muscle and supplies the rectus femoris and the vastus lateralis and medialis muscles; it then runs inferiorly and along an oblique line throughout the thigh and in between the rectus femoris and the vastus lateralis muscle. Perforators originate from this area and can follow a course between the rectus femoris and the vastus lateralis muscle and cross the fascia lata as septocutanous to supply the skin of the lateral thigh, or more frequently they can cross the vastus lateralis muscle and the deep fascia as musculocutaneuos to supply the skin (26-32). The anatomic variation of cutaneous perforators have been especially emphasized because of their critical role for the survival of the flap. In about 10% of cases the vascular supply comes from a large anomalous pedicle from its transverse branch (26-32), which enters the muscle superiorly.

Currently, two options are considered for ALTF design by surgeons worldwide. First, because it has been shown that the majority of perforators are located in the inferolateral quadrant of a circle, with a radius of 3 cm, with the midpoint between the anterior superior iliac spine and the superolateral corner of the patella, the surgeon simply centers the flap over the location of these vessels (4). Alternatively, ECD is used to map the location and supposed size of perforators., which has been described preoperatively by Zhou et al (30), Koshima et al (13) , Pribaz et al (31), Blondeel et al (34) and Hallock (35).

As we know, some data about the use of ECD are debated. Operator dependance, false positives in detection of perforating vessels are reported in the literature (34, 36). Furthermore, it is hard to tell which thigh has the best perforators, if perforators are muscolocutaneous or

septocutaneous, which are the best perforators to use, if there are anatomical variations, such as origin from the transverse branch. In the real setting, the surgeons explore the anatomy of perforators, check for size and anomalous origins (like transverse branch of LCFA), and begin dissection. In case of insufficient perforators, the other thigh or ultimately another flap is chosen. Of course, this might expose the patient to unnecessary scars, tissue dissection and in the end prolonged surgery with suboptimal decision in reconstruction.

Among the last generation of angiographic diagnostic techniques, Angio CT has emerged as an outstanding non-invasive operator independent option. Angio CT defines a technique that combines the technology of a conventional CT scan with that of traditional angiography to create detailed images of the blood vessels in the body (37,38). In a CT scan, x rays and computers create images that show cross-sections of the body. Angiography involves the injection of contrast dye into a large blood vessel, usually a periphery artery, to help visualize the blood vessels and the blood flow within them. CT angiography is similar to a CT scan, but the contrast dye is injected into veins shortly before the x ray image is performed. Because the dye is injected into a vein rather than into an artery, as in traditional angiography, CT angiography could be considered less invasive (38,39). Moreover, thanks to the advanced post-processing protocols as Maximum Intensity Projection and Volume Rendering it is possible to obtain easily exquisitely detailed visualization of vessels and its potential anomalies (38-41). It has been shown that Angio CT scanning gives new information about perforator location and size in planning of abdominal perforator flaps (pTRAM and DIEP) (42-45).

In the patients we studied, Angio CT allowed us to get a study of the donor area which was very easy to interpret, not only by the radiologist but also by the surgeon, as it provides anatomical images (46).The information that we get was used to locate perforators (which we also could have with ECD) , to check the size, the septal / intramuscular pathway and to visualize the origin of the pedicle (which data are obtainable only with Angio CT). Translated into clinical practice, this made it possible for us to choose between the right or the left thigh, or eventually to abandon this flap in

favour of other reconstructive options. Our Angio CT findings had a strong impact on surgery. In particular, in patient '2' and '3', another flap was chosen, because of inconsistent perforators. In patient '7', where a reverse ALTF had been planned, reconstruction with this technique was delayed because the pedicle would have been too short. Pulmonary metastases were detected with the same scan and surgery was abandoned. Ultimately, we were able to save a lot of time during surgery, without an extensive overview looking for the best perforator vessel.

There was no failure of the flap after Angio CT and operative findings always correlated perfectly with pre-operative imaging.

To our thought, an important point to discuss with the patient is the radiation rate, which reaches 10mS for each patient, which is 3 times the annual exposure to natural radiation. A standard x ray exposure is 0,1mS. Costs are about $200 for each MDCTA. This is why our current policy is to propose this imaging technique to every patient where an ALTF is planned, pointing out disadvantages (which in cancer patients are more than justified because they would get a CT scan anyway). For the other patients, we discuss with them the item of having an ideal planning of the flap at the price of a high dose of radiation. Should the patient decline having the Angio CT imaging, we surely use ECD to map the perforators.

We think that Magnetic Resonance Angiography (MRA) is an option that has to be evaluated in the future (47). Although it offers less radiations to patients and has less adverse reactions reported, imaging of tiny vessels is still reported not as accurate as Angio CT. This technique is also well tolerated by patients because it is simple and speedy.

In conclusion, it is certainly possible to harvest the ALTF flap without an Angio CT study. However, the advantages are so many that this technique in our thought must be a part of the armamentarium of the Plastic Surgeon.