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Virtual Planning and Mixed Reality for the Thin Anterolateral Thigh Perforator Flap

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INTRODUCTION

The use of computed tomography angiography (CTA) has been described for mapping perforators of the deep inferior epigastric artery perforator,[1] the superficial circumflex iliac artery perforator,[2–4] the profunda artery perforator,[1,4,5] and the anterolateral thigh (ALT)[6] perforator free flaps. Virtual preoperative planning (VP) is not only valuable for locating perforators, but also for knowing the anatomy of the vessel within the subcutaneous tissue, which allows us to safely customize flap thickness.[5,7]

The information from the VP is generally translated to the surgical theater by using measurements and anatomical landmarks, hand-held Doppler, or duplex ultrasound.

Pereira et al[3] have described their technique using an augmented reality application and a smartphone to successfully plan a series of superficial circumflex iliac artery perforator flaps. However, they superimpose two-dimensional (2D) images of the CTA, meaning that the depth of the images is not represented.

Mixed reality (MR) or hybrid reality is an evolution of augmented reality. In MR, digital data can be manipulated in vivo, rather than merely being overlapped in the real-world environment. We strongly support that the main advantage of using three-dimensional (3D) VP is to gain knowledge on the perforator anatomy within the subcutaneous tissue, to better design thin and super thin perforators flaps (dissected in the plane of the superficial adipose fascia or above[8,9]). This article describes our step-by-step technique using MR to plan thin ALT perforator flaps. We have applied this method with a 100% success rate of perforator mapping in six consecutive ALT flaps.[10]

METHODS

A CTA was performed on a high-speed VCT 64 multislice CT (General Electric Healthcare, Milwaukee, Wis.). The radiologic study was performed after administrating a single 110 mL of iopromide 370 mg/mL (Ultravist, Bayer).

Data postprocessing was done using the open-source software HorosTM v 3.3.6 (GNU Lesser General Public License, version 3) and Elements (BrainLab, Germany). (**See Video [online]**, which displays the step-by-step procedure of using virtual planning and mixed reality for a thin ALT flap.) The time consumed ranges between 15 and 30 minutes and needs to be done by the surgeon. The technique is explained using a clinical case of a patient with trismus and orocutaneous fistula due to an oral carcinoma, previously treated with surgery and radiotherapy. This patient required a thin flap with two skin paddles to cover both the intraoral and extraoral components of a through-and-through defect.

First, Horos is used to study the vascular anatomy. It has a software tool named maximum intensity projection mode, which allows to project the voxel with the highest attenuation value on every view throughout the volume onto a 2D image. This is useful to assess small subcutaneous vessels, which become more visible. Next, we change to Elements to complete the manual segmentation of the vessels and the VP, which is superimposed onto the patient using the Magic Leap Headset.

CONCLUSIONS

The combination of Horos and Elements allows a better understanding of the ALT-free flap anatomy to virtually plan the surgery and to transfer the digital data to the Magic Leap Headset. MR is a valuable tool to design thin perforator flaps safely.

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