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Editorial

The New Imaging Techniques in Reconstructive Microsurgery: A New Revolution in Perforator Flaps and Lymphatic Surgery

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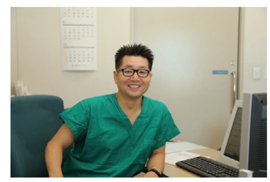

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Microsurgery has continuously evolved over the past 40 years. The early period was dedicated to the delineation of soft tissue microvascular anatomy and understanding the hemodynamic of flaps and their perfusion led to the establishment of fasciocutaneous, musculocutaneous muscle and bony flaps.[1] In late 1980s, the anatomical work from Taylor and Palmer led to the introduction of the angiosome concept and to the description of an average of 374 major perforators through the human body.[2] Later, the clinical work by Koshima and Soeda opened the perforator era in microsurgery.[3]

After the introduction of perforator flap concept, the following 20 years were focused on the discovery of new perforator flaps and large case series reports on the outcomes of the most common perforator flaps for specific indications and reconstructions. It progressively became clear and evident that perforator flaps represent the natural evolution of conventional flaps, which lead to a paradigm shift in the reconstructive algorithm: from the older "flap-of-choice" to the newer "flap choosen."[4]

After the establishment of perforator flap concepts, it became also obvious that traditional perforator flaps cannot always accommodate reconstruction needs especially when the purpose is resurfacing rather than creating volume or filling space. In this perspective, the thinning procedures already described for traditional flaps were then successfully applied to perforator flaps,[5,6] although this generated different grade of confusions, especially in terminology.

Later, the advent of supermicrosurgery again pioneered by Koshima et al[7] further stimulated the next level of evolution: the ability to safely manipulate vascular structures below 0.8mm means a further expansion in reconstructive freedom and a reduction in surgery invasiveness. It is in fact possible, when indicated, to harvest perforator flaps without dissecting the main pedicle and revascularize them using recipient perforating vessels. Moreover, supermicrosurgery revolutionized also the lymphatic surgery, with the introduction of supermicrosurgical lymphaticovenular anastomosis that nowadays is an established method for treating lymphedema patients.

This fascinating evolution of microsurgery, however, still has a common denominator limiting factor for all the procedure described: the exact knowledge of soft tissue anatomy and microvascular anatomy of each patient varies from patient to patient. This drawback has been already addressed in the past, initially by using the audible Doppler examination and then introducing multidetector computed tomography scan[8] and magnetic resonance imaging[9] with the intent of locating reliable perforator and define the peculiar microanatomy of each patient. However, those technologies still have shortcuts and were not enough to enhance the confidence of microsurgeons, who still needed explorative dissection to confirm the imaging findings as well as rely on skin coordinates system to locate the hot perforator areas.

In the last decade, there was a fast evolution of portable imaging technologies that can be directly used by the operating microsurgeon. First, plastic surgeons progressively recognized the usefulness of ultrasound technology in perforator flap surgery that allows a highly specific and highly sensible preoperative planning compared with any other technology, especially when in the hands of the operating surgeon.[10] Moreover, the

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improved skills in high-frequency ultrasound and the introduction of ultra-high frequency ultrasound allowed an enhanced visualization of very tiny structures (such as terminal perforator branches within the subcutaneous tissue up to and within the dermis as well as lymphatic channels) comparable to histologic images, which further expand the preoperative preoperative vision, allowing high detailed preoperative studies that lead to improve safety, efficacy, reliability, and microsurgical creativity.[11–20] Ultrasound in experienced hands allows to skip the explorative time in perforator flap dissection and move the process of study the "chosen flap" to that of ultrasound-choice of the flap based on the most suitable microanatomy for the given indication. The magic of mastering ultrasound is to perform a high-precision, more predictable, and effective lymphatic supermicrosurgery procedure as well as increasing the confidence related to perforator flap dissection leading to further creative solutions such as thin, superthin and even pure-skin perforator flaps.[11–20]

We can say that ultrasound, either high-frequency and ultra-high-frequency, represents nowadays the quintessence in microsurgery.

New imaging technologies are emerging with promising applications that may further improve microsurgical outcomes and safety. The intraoperative microscope-integrated laser tomography[21] allows to have more intraoperative details of lymphatic channel morphology and anastomosis quality and photoacoustic technologies are emerging as a further low-invasive three-dimensional technology for preoperative evaluation of microvascular and lymphatic anatomy.[22]

The advances in technologies must be strictly followed by plastic surgeons and microsurgeons as the power of new imaging technology may further improve safety, efficacy, and cost-effectiveness of microsurgery and may lead to new frontiers also eventually integrating such technologies with the augmented reality[23] and the artificial intelligence of software.

We look forward to seeing microsurgical technology enthusiastic colleagues at the next Imaging in Reconstructive Microsurgery Symposium on June 5, 2022 as Official World Society of Reconstructive Microsurgery (WSRM) Postcongress meeting.

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Conflict of Interest

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