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Varioscope M5: A New Type of Magnification System in Anterolateral Thigh Perforator Free-Flap Surgery

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ABSTRACT

Free microvascular tissue transfer has become a key procedure for the surgical treatment of large tissue defects that requires specialized practitioners and magnification instruments. The operating microscope traditionally has filled this requirement. A study was performed focusing on the evaluation of a new magnification system, the Varioscope M5 (Life Optics, Vienna, Austria), in reconstructive procedures with a perforator free flap. The device was employed by the same operator during dissection and microvascular anastomosis of 12 anterolateral thigh perforator flaps in head and neck reconstruction. The need to operate in a different way, not provided by an operating microscope, gave us the idea of exploring an alternative to the classical visualization systems. Specific advantages such as reduced cost, freedom of movement, auto focus, minimal upkeep, and a variable range of magnification are some of the reasons that convinced us to try this new type of magnification system. Increasing interest in microsurgery magnification highlights the need for further technical developments in this field. We consider the Varioscope M5 an alternative option for surgical magnification in most free tissue transfers, especially when an operating microscope is not supplied.

KEYWORDS: Perforator free flap, magnification system, microsurgical anastomoses

Since 1992, perforator flaps have permitted the reliable transfer of the patient's own skin and fat with minimal donor-site morbidity.[1] A perforator flap is a flap based on the dissection of a "perforating vessel" that originates from one of the axial vessels of the body. It passes through certain structural body elements and interstitial connective and fat tissue, reaching the subcutaneous fat layer. Surgeons usually discriminate between perforators that do not pass through muscle, either coursing directly through subcutaneous fat or through an intermuscular septum, and those that do pass through muscle.[2] Basing the blood supply of a skin flap on one or more perforators is likely to provide a versatility in design that includes as little or as much tissue as required. This also permits a choice of orientation to allow primary closure. One of the key aims of a perforator flap is to preserve the muscle, which reduces morbidity by leaving functional muscle at the donor site. Koshima and Soeda[3] and Kroll and Rosenfield[4] suggested that perforator flaps combine the reliable blood supply of musculocutaneous flaps such as the free rectus abdominis musculocutaneous flap with the reduced

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functional donor-site morbidity of a skin flap. However, the elevation of perforator flaps requires meticulous dissection of the musculocutaneous perforating vessels through the underlying muscle. The dissection of the small perforating vessels through the muscle or septum is often tedious and can be challenging. It places greater technical demands on the surgeon, usually with an increase in operative time.[5] Another disadvantage of perforator flaps is the high variability in the position and size of the perforator vessels.[6,7] Therefore, microsurgical success is closely linked to a clear and well-magnified field of vision to achieve a correct flap elevation and a proper anastomosing procedure. Loupes and operating microscopes are the most widely used magnification instruments. The operating microscope traditionally has fulfilled this requirement, and its use for accurate manipulation of structures ≤ 3 mm is widely endorsed.[8,9] Other methods of magnification such as optical loupes are also available, but these have been usurped by the microscope at the time of anastomoses even if they are still used for flap elevation. Problems with illumination and the requirement of a fixed distance, with subsequent neck discomfort when using loupes, has led to a search for other magnification options to avoid or reduce these inconveniences. Recently, a new enhanced visual microsurgical system was introduced on the market, called Varioscope M5 (Life Optics, Vienna, Austria). This device offers a better technological support to the surgeon during microsurgical procedures and therefore on perforator microsurgery. We present our experience and comment on using the Varioscope M5 for dissection of the anterolateral thigh perforator flap (ALTp) and vessel anastomosis, focusing on the pros and cons in terms of cost, technical characteristics, and comfort.

MATERIALS AND METHODS

The study was performed at the Department of Plastic and Reconstructive Surgery of "La Sapienza" University Hospital of Rome between 2005 and 2007. Patients requiring post-oncological reconstruction of the head and neck were considered for enrollment in the study. Patients had to be willing and able to comply with the treatment and to give informed consent. A therapeutic protocol was made to select patients, characterized by inclusion and exclusion criteria. Inclusion criteria were age between 18 and 65 years, an operable tumor located in the head and neck requiring reconstruction, and an indication for ALTp for reconstruction. Exclusion criteria were the presence of an associated vascular disease, a smoking habit, alcohol abuse, hypertension, obesity, a clinically known history of poor compliance to medical treatment, a clinically clear deteriorating general condition, and cortisone-based therapy.

All patients were treated by the same surgical team. Flap dissection and vessel anastomosis were performed with the Varioscope M5 device by the same operator. Daily subcutaneous injections of calcium nadroparin were administrated to all patients. Flaps were monitored by visual inspection and eventually handheld Doppler hourly for the first 3 days, then every 2 hours until the fifth postoperative day.

At the end of the study, the operator compared the Varioscope M5 to loupes (for flap dissection) and to microscope (for anastomosis) in term of dimension of surgical field, freedom of movements, focus rapidity, consequence of the weight of the device on the cervical spine, illumination, magnification power, and global judgment, using five scores (+2, a lot better; +1, better; 0, similar; −1, worse; −2, a lot worse).

Varioscope M5 Characteristics

Varioscope M5 is a sophisticated high-end head-mounted vision system, weighing ~298 g, that combines the traditional features of the Varioscope AF3 (auto focus, zoom, and parallax control) with powerful illumination and high-end documentation (Fig. 1). Surgeons can choose among light and camera options as well as interchangeable oculars. It has a working range distance of 300 to 700 mm; therefore surgeons have complete freedom of movement, and the foot switch allows both auto and manual focus. Varioscope M5 is characterized by excellent mobility, enabling it to be carried from one operating room to another. Moreover, a variable pupillary distance and individual vision correction produce a system that can be adjusted to each user, and modularity guarantees flexibility. The most important technical data include interchangeable oculars (× 20 [× 2.9 to 7], × 14 [× 2.0 to 4.8], and × 26 [× 3.75 to 9]); field of vision from 30 to 224 mm; pupillary distance from 56 to 74 mm; swiveling angle of 72 degrees; integrated light optics with light cables with adaptors for most commonly used light sources; a head-mounted multivision system with further possibilities for data visualization (Augmented Reality, Navigation, and Photodynamic Vision) and special teaching systems; and an integrated auto-focus camera system with camera 0.5-inch CCD color and 752 (H) × 582 (V) of effective video pixels.

RESULTS

Twelve patients were enrolled in the present study: 8 women and 4 men. Patients ranged from 52 to 76 years of age (mean, 60 years). Tumor histological type was squamous cell carcinoma of the oral mucosa in four cases, salivary gland carcinoma in four cases, and skin melanoma in four cases. In all patients, the reconstruction was performed with an ALTp. During reconstruction, flap

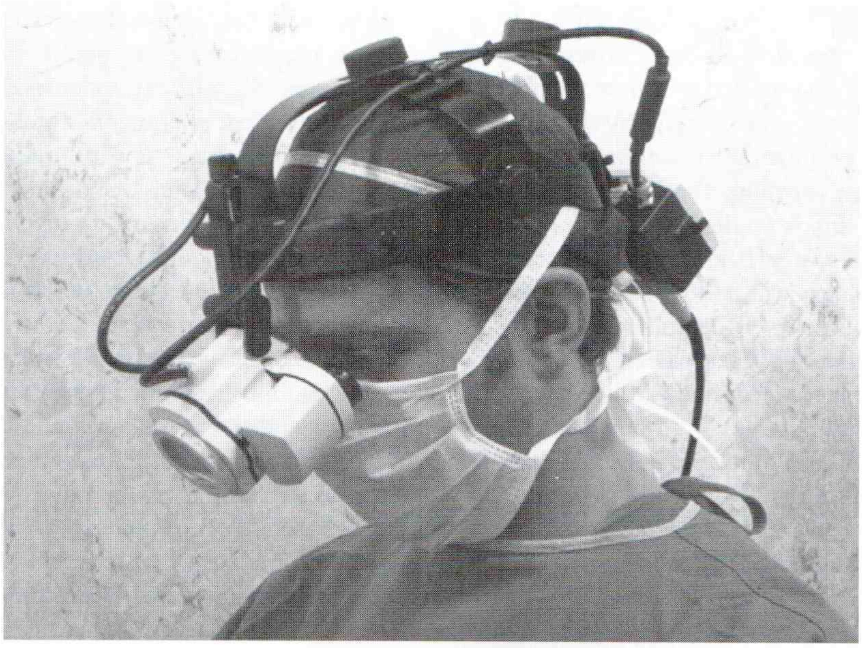

Figure 1 A view of the Varioscope M5 (Life Optics, Vienna, Austria) during use.

dissection and anastomosis were performed by the same surgeon with the Varioscope M5 while the assistant wore × 3.5 magnification loupes. Also, recipient vessels preparation was performed simultaneously by another surgeon with × 3.5 magnification loupes. The autofocus function was usually employed during superficial flap dissection. The foot-activated focus was preferred during deeper dissection to avoid any disturbing effects by changing the focal length caused by wound margins or long instruments. In this series, vessel anastomoses were limited to the head and neck region. The superior thyroid artery and the facial artery were used as recipient arteries; the facial vein and external jugular vein were used as recipient veins. Anastomosis sizes ranged between 1.8 and 2.4 mm. Vessels anastomoses were performed end to end with a 9–0 nylon suture using the posterior wall first technique. The average time for arterial anastomosis was 30 minutes and 12 seconds (range, 20 to 40 minutes). The average time required for vein anastomosis was 24 minutes and 31 seconds (range, 20 to 35 minutes). The total time of Varioscope M5 head handling ranged from 2 hours and 34 minutes to 3 hours and 41 minutes (mean, 2 hours and 57 minutes). The operator complained about cervical neck pain at the end of two procedures (in the first and the fourth case) that resolved in a few hours after a single dose of a nonsteroidal anti-inflammatory drug. Total operation time (from first skin incision to the last suture) ranged from 3 hours and 55 minutes to 5 hours and 49 minutes (mean, 4 hours and 35 minutes). A trend was observed in reducing operation time from the first procedures to the last ones.

One flap required re-exploration because of venous thrombosis 6 hours after surgery. The flap skin appeared violaceous and capillary refill was brisk. Flap re-exploration was performed by the same operator 1 hour after detection of the flap congestion using the Varioscope M5. The vein appeared thrombotic; the artery was patent and left untouched. The vein anastomosis was reopened and the thrombus gently removed. Pedicle and recipient veins were flushed with heparinized (10 U mL^{-1}) saline solution until good backflow was observed. Then, vein anastomosis was redone. Flap circulation was restored, with good capillary refill. No further problems were encountered with this flap. Two other flaps suffered a partial skin necrosis (< 20% loss) requiring revision. Complete healing was evidenced at 1 month postoperative follow-up in all cases without a case of total flap loss. One patient died within the first year after surgery due to tumor metastasis.

Table 1 shows operator satisfaction at the end of the study with the use of the Varioscope M5 in comparison with loupes and with a microscope.

Table 1 Operator Comparison of the Varioscope M5 with loupes, during flap dissection, and with Microscope, during anastomosis, at End of Study

Evaluated Aspects	Loupes	Microscope
Surgical field dimension	+1	+1
Freedom of movements	+1	+1
Focus rapidity	0	+1
Consequence of weight of device on cervical spine	−1	−2
Illumination	+2	0
Magnification power	+2	−1
Global judgment	+2	0
Total score	**+7**	**0**

Five scores were possible (+2, a lot better; +1, better; 0, similar; −1, worse; −2, a lot worse).

DISCUSSION

Microvascular tissue transfers are used extensively in reconstructive plastic surgery. Since its introduction in aural surgery in 1954, the microscope has developed a great deal, and it is synonymous with microvascular techniques. High magnification, together with illumination and zoom ability, are the microscope's strong points. However, the cost of the device, its bulk, the requirement for trained personnel, the need for tilting, and the difficulties in focusing in cavities are some of the microscope's drawbacks. Specific studies challenged the microscope's use in microsurgery and extolled the use of high-power magnification loupes.[9–11] Loupes are widely used by plastic surgeons for routine skin-tumor removal and for hand clinical cases. No adaptation period is required, and the sense of freedom is incomparable. Some authors have reported that the performance of free flaps only using high-power magnification loupes produces results comparable with the operating microscope in terms of success rates and operating time.[9–11] Some authors indicated that in practiced hands, high-power ocular loupes provide an alternative to the operating microscope for microvascular anastomosis of vessels ≥ 1.0 mm in diameter. They advocated use of the loupe on the grounds of cost effectiveness, portability, and operator freedom.[10] Other authors suggest that loupes should be used in so-called macro microsurgery with vessels > 1.5 mm in diameter.[11] However, problems were reported with illumination, and the requisite of a fixed distance caused subsequent neck discomfort.[12]

Nevertheless, the range of achievable magnification varies among these devices. The operating microscope has a magnification range between $\times 6$ and $\times 40$; the Varioscope M5 has a range between $\times 2$ and $\times 9$; each loupe model has a fixed magnification ranging from $\times 2$ to $\times 6$.

The purpose of this article was to focus on the Varioscope M5 magnification properties in a more demanding microsurgical technique such as the perforator free tissue transfers. Certainly, this device offers many advantages during the performance of microanastomoses. The surgeon is allowed a closer access to the field as well as a wider view of the field for improved orientation. Its use is advocated on the grounds of cost effectiveness, portability, efficiency, and operator freedom. Additionally, changes in viewing angle, depth of field, and movements to a different area of the field are easily accomplished with a change in the surgeon's position or head and neck position. The ability to obtain swift magnification during different stages of an operation is an extra advantage of the Varioscope. This is particularly useful when dissecting perforator flaps. The Varioscope's highest magnification is suitable, especially at the initial dissection of the perforator artery.

Varioscope M5's usefulness, however, is not without limitations, and it has some drawbacks: The weight, although almost three times heavier than a pair of high-power loupes, is well balanced. The purchase price is higher than for a pair of loupes.

In our experience, the total operation time using the Varioscope M5 was absolutely comparable with the time required for the same type of procedure using the traditional operating microscope. The same operator wore the device continuously for an average time of 2.5 hours. The continuous use was achieved voluntarily to test the early consequences of wearing the device. The operator complained about cervical neck pain on two occasions. This problem occurred during the first cases (the first and the fourth one). It was probably related to improper wearing of the instrument, although properly counterbalanced, or to an improper postural attitude. The consequent continuous overload on the cervical spine required the paravertebral muscles to overwork, and cervical pain developed. A better wearing of the instrument and more familiarity with it eliminated this problem in the cases that followed. Later effects were not evaluated in this study and would need longer and larger series. Using the device for a long time during perforator dissection, especially for the first cases, comes with an extra cost in terms of fatigue and operative time. Gradual use is urged, and switching to loupes during surgery might be suitable, at least initially. To reduce such early consequences, the use of the device probably should be limited to specific surgical steps (perforator dissection and vessel anastomoses) until more familiarity and comfort is achieved.

Furthermore, another problem with the Varioscope M5 is that it cannot be worn by the surgeon and the assistant because the infrared auto-focus systems converge. Two systems cannot auto-focus simultaneously on the same surgical field. We did not have any experience with this. Anyway, no difficulties arose when using only one unit because the assistant wore $\times 3.5$ magnification loupes during the procedure.

Also, the Varioscope M5 leaves the operator with less freedom of vision compared with a pair of loupes. One cannot look over the top of the system and outside of the Varioscope M5 like one can with a pair of loupes.

We believe that our success rate with perforator free-flap transfers was linked to our prior extensive experience with the operating microscope. We also did notice a definite learning curve, as shown in the last anastomoses by the drastic reduction of the operating times; in fact, all the international studies emphasized the importance of the surgeon's skill.

Anyway, the device provided a good field of vision and comfort during the dissection of perforators, graded as better than dissection with loupes (Table 1), and during anastomoses, graded as similar to the microscope (Table 1).

However, cost comparison with an operating microscope depends on the model and the sophistication of the latter, but it always remains in favor of the Varioscope M5. The purchase price varies from approximately half to a quarter of the microscope price. Also, cost comparison with a pair of loupes depends on the model and sophistication of the latter, but it remains in this case in favor of loupes, the purchase price varying from approximately a fifth to a twentieth of the Varioscope M5. But some models of loupes, especially the more expensive ones, are specifically manufactured for a single operator.

Also, the operating microscope is an expensive piece of operating room equipment that requires maintenance and care by trained operating room personnel. The Varioscope, in contrast, requires minimal upkeep; it doesn't require in-depth nursing staff orientation to ensure appropriate handling, storage, and transport. Furthermore, the Varioscope M5 augments reconstructive options in hospital settings that are not equipped with an operating microscope. An example of such situations could be small and peripheral units or humanitarian plastic surgery missions. On the contrary, this technology is not needed for clinical purposes in those units that already have a microscope. In such situations, the purchase of a Varioscope M5 would be an unjustified expense. In our experience, routine use of the Varioscope M5 has enabled us to extend the microsurgery boundaries beyond the traditional academic center.

CONCLUSIONS

Successful performance of any surgical procedure depends on correct field of visualization. Magnification plays a key-role in microsurgery. Nowadays, the Varioscope M5 represents a potential means of magnification in perforator free-flap transfers; it has specific characteristics that combine the best of the microscope and loupe. The Varioscope M5 is certainly an upgraded system compared with the Varioscope AF3, highlighting the useful ability to obtain swift magnification during different stages of the microsurgical procedure. This is particularly helpful when dissecting perforator flaps. Moreover, Varioscope's highest magnification is suitable, especially at the initial dissection of perforating vessels. Nevertheless, technical difficulties remain, and those who wish to use this system may require a period of adaptation.

Larger experiences and reports are needed to support the usefulness and to better define application fields of this device. Innovations in surgical visualization, although they may not appear to be better than the standard at first, will lead to more surgical options and improved outcomes. Certainly technology will progress to provide smaller, lighter, and more sophisticated systems, eliminating the weak points of the Varioscope M5.

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