A Picture Speaks a Thousand Words

The Use of Digital Photography and the Internet as a Cost-Effective Tool in Monitoring Free Flaps

Prashanth Varkey, MCh Plastic Surgery,† Ngian Chye Tan, MRCS,* Riccardo Girotto, MD,* Wen-Ruay Tang, MD,* Yi-Tein Liu, MD,* and Hung-Chi Chen, MD, FACS**

Abstract: Microsurgical free tissue transfer is progressing rapidly and is being used more frequently the world over. Monitoring these cases is crucial for a satisfactory outcome. More sophisticated methods are available for monitoring, though they are often expensive. We propose a novel technique using digital photography and the Internet to offer a reliable and cost-effective method to monitor free-tissue transfers. During an 8-month period, 163 microvascular procedures were monitored using this technique. Serial photographs taken were stored in a separate case folder and sent to the surgeon as deemed necessary.

Analysis of the 67 cases is presented. Five reexplorations were done. The early diagnosis of venous congestion was possible using this technique. Timely intervention contributed to the success of the reexplorations, and these flaps could be salvaged. The file size of images was in the range of 1 MB to 6 MB. The file size of a set of photographs was usually around 7 MB to 9 MB. These were sent across the asymmetric digital subscriber line Internet lines.

The use of the digital images and the Internet allows reconstructive surgeons to have a reliable picture of the state of their free-tissue transfers. This allows decreasing observer error and saves valuable time which otherwise needs to be spent to verify situations of doubt.

Key Words: monitoring free flaps, ADSL, digital photography, early identification of thrombosis, telemedicine

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Microsurgical free-tissue transfer is developing in leaps and bounds and more centers today are using this method as the preferred choice for reconstruction. The success of microsurgical reconstruction revolves around preoperative planning, proper flap selection, meticulous execution of the anastomosis, and careful closure of the donor site to decrease morbidity. These factors do not need any further explanation. Often not stressed is the postoperative management of these cases. Postoperative intensive care and monitoring facilities are a prerequisite. Clinical examination of the flap for color, temperature, and turgor is the commonest method in monitoring these flaps. State-of-the-art techniques such as thermocouples, noninvasive laser Doppler perfusion imaging, reflectance photoplethysmography, and microdialysis in which there is sampling of the dialysate to monitor the metabolism of a flap continuously are also used in centers which can afford them. The high cost of these techniques often makes them less practical. The present-day practice of a plastic surgeon often involves dedicated time to esthetic surgery, which occasionally is practiced at a different clinic or a separately designated area of the same hospital. The follow-up of the free-tissue transfer may thus pose problems with mere telephonic messages. The present day's technologic advances permit us to gather a more realistic picture. We used a regular digital camera and image transmission through the Internet, as well the hospital intranet, as a reliable way in monitoring free flaps as we are a center with a high volume of free-tissue transfers.

MATERIALS AND METHODS

Over a period of 8 months, from September 2005 to March 2006, a total of 163 microvascular procedures were done in the Department of Plastic and Reconstructive Surgery. These were done by a group of 5 surgeons. Digital photographs were taken using a camera with resolution of 4 megapixels. The individual case photographs were retained in separate folders. At the time of discharge, they were removed from the system and transferred to the individual physician's photo database. Photographic documentation was done for all flaps, with a set of 2 or 3 views taken at the time of admission to the ICU. These were followed by photographs taken at 3-hour intervals for the first 12 hours. The subsequent day onwards photographs were taken once every 6 hours, and a final one was taken prior to shifting the patient out of the

From the *Department of Plastic and Reconstructive Surgery, E-Da Hospital, Yanchao Shiang, Kaohsiung County, Taiwan; and the †Department of Plastic and Reconstructive Surgery, Amrita Institute of Medical Sciences, Kochi, India.

Reprints: Prashanth Varkey, MCh, Department of Plastic and Reconstructive Surgery, E-DA Hospital, Yanchao Shiang, Kaohsiung County, 824, Taiwan. E-mail: drpvarkey@gmail.com.

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ICU. In any instance of doubt, should a dermal scratch test be done, it was recorded as a 15-second video clip. The file size of this image was in the range of 1 MB to 6 MB. The file size of a set of photographs was usually around 7 MB to 9 MB. Commonly used Internet mail portals enable one to send a file size of up to10 MB as attachments. The Internet lines were all ADSL (asymmetric digital subscriber line). The download speed was 2 Mbps. The data could be accessed through personal computers or PDA phones almost instantaneously. The hospital has an intranet facility linking all computers; hence, this facility was also used.

RESULTS

Of a total of 410 plastic surgery ICU admissions during the period from March 2005 to February 2006, 163 had undergone some form of microvascular surgery. One hundred forty-two were free flaps, and 21 had revascularization or replantation of amputated parts, commonly digits of the upper limb. Of these, a total of 67 flaps were done by the principal author (P.V.). The individual flaps used have been summarized in Table 1. Analysis of these cases has been presented below. Of the 67 flaps, 52 of them were done for head and neck reconstruction and 15 of them were done for defects in the extremities. Twelve flaps in the head and neck region were completely intraoral. In the present series, there were no flaps that were completely buried. However, 5 of them were muscle flaps and had skin grafts. In the series of 67 cases, 5 flaps required reexploration. All of these were due to venous problems. The color change of the paddle or changes in the nature of the pinprick bleed were in all cases first noticed by the nursing staff that has sufficient experience in monitoring such cases. Two of these cases were detected as early as the change in capillary refill time, and this was confirmed by the principal author, who received a short video clip proving the same.

The examples of use of these images as in the case of a latissimus dorsi flap to cover a tibial defect are shown in Fig. 1, with the immediate postoperative picture of a well-perfused flap (Fig. 1A) and the venous congestion seen few hours later (Fig. 1B). A similar case in which timely detection of a possible venous compromise contributed to the salvage of the flap is shown in Fig. 2, with a normal perfusion in an anterolateral thigh flap over the dorsum of the hand (Fig. 2A) and the early venous congestion as evidenced by the color change of the blood in the drain, as well as the color change in the skin edges. The color of the pinprick bleed was also useful, as in Fig. 3, but was more useful as a short video clip. The established venous congestion as detected by serial photographs did have venous thrombosis detected on reexploration. However, the 2 cases in which they were detected as early as alteration in refill time did not show any change with the Doppler; though they had venous thrombosis detected at surgical exploration.

Early identification in our cases was possible by comparing the serial photographs that helped assess the changes. In case of doubt, expert opinion was sought from the senior author (H.-C.C.), without his having to actually come over to the bedside. The video clips of the dermal scratch test or the pinprick test, which assessed the speed and color of the bleed from the flap, were decisive in this regard. Of the 67 flaps, 5 were muscle flaps that had no skin paddle and had skin graft done at the same time or had been left for a delayed skin

TABLE 1. Individual Flaps Done in This Series

Type of Flap	Number
Anterolateral thigh flap	44
Radial forearm flap	7
Free groin flap	5
Fibula osteoseptocutaneous flap	5
Gracilis	4
Latissimus dorsi with serratus anterior	2
Total number of flaps	67

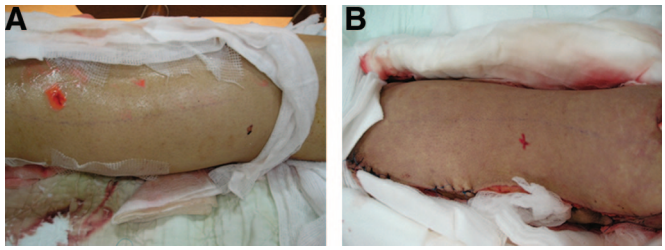

FIGURE 1. A, immediate postoperative picture of a Latissimus dorsi flap. B, early congestion recorded.

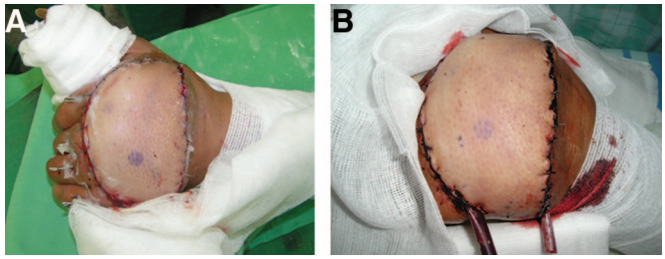

FIGURE 2. A, anterolateral thigh flap on the dorsum of the hand. B, early congestion detected by recording the color change of blood in the drain and the flap edges.

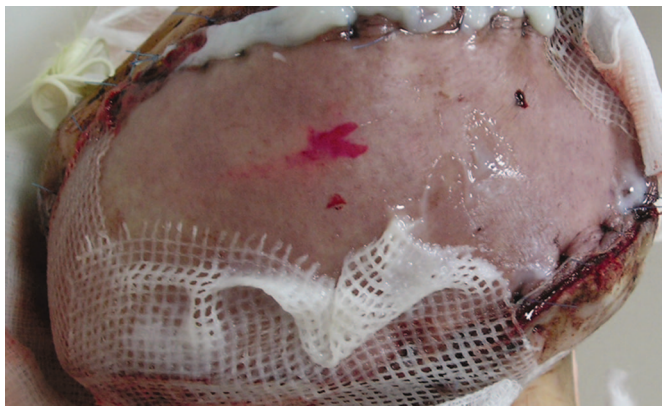

FIGURE 3. Congested flap with dark bleed on pinprick test.

grafting. The photographic record was especially useful in these cases too. Of the 5 flaps that were reexplored, 4 were salvaged. The single complete failure was due to a proximal venous injury that went unnoticed even after the first reexploration. This was due to the drug hit phenomenon of intravenous drug abuse.

DISCUSSION

Microvascular surgery has offered the plastic surgeon greater options in reconstruction and has progressed in leaps and bounds during the last 2 decades. Alongside this has occurred the progress of esthetic surgery. In the present time, a plastic surgeon has to balance his practice of reconstructive surgery and esthetic surgery. The follow-up on cases in which a microvascular procedure has been done is of utmost importance, and time devoted to this should ideally not restrict such kinds of combination practice. Conventional free-flap monitoring techniques (clinical observation, handheld Doppler ultrasonography, surface temperature probes, and pinprick testing) are proven methods for monitoring free flaps.[1] Whitaker et al[2] investigated the postoperative management of free-tissue transfers to the head and neck in the United Kingdom and found that frequency and location of monitoring postoperatively was highly variable in the survey of the 26 units they included in their study. Nurses were responsible for the routine monitoring of flaps in almost every unit. This was true in our institution too. Nevertheless, from a practical point of view this resulted in observer variability, more so in those cases in which the changes in blood flow were marginal. The nurses had an 8-hour shift duty, and thus there was an observer change over the crucial first 24 hours also. In employing the method of viewing the images, we were able to decrease these differences. A visual image of the flap definitely keeps the surgeon more comfortable than a telephonic message, which, if not properly conveyed, could be detrimental. We embarked on the simple idea of photographing the flaps using a regular digital camera with a resolution of 5 megapixels and mailing these images through the Internet to offer the surgeon a firsthand feel of the situation, even if he is away.

A study by Krieger and Lee[3] found that plastic surgeons have adjusted their practice profiles in recent years. This can be attributed to the changing profile of cases, which is partly due to the increasing popularity for esthetic surgical procedures. The ever-broadening scope of work for plastic surgeons requires optimal usage of time. Maintaining a constant vigil on the microvascular procedures performed cannot be neglected in view of such changes. Nonetheless, the novel idea of using digital photography and the Internet to allow a physician to view the actual clinical situation of a flap contributed to establishing a better utilization of valuable time. This is our initial experience with using this method, and its reliability can be established after analysis of false-positive or -negative cases. However, in this series there has been no occurrence of the same.

The logistic restraints of a hospital located on the outskirts of a city, as in our situation, is likely to be encountered by many others in this field. Prior to using the described method, it was necessary for the surgeon to occasionally revisit the patient, with the need to travel significant distances, often late at night, to verify the state of the flap. The use of the image transfer offers the benefit that one can avoid many such visits, which may be time consuming and superfluous.

The dual advantage was that it permitted a less experienced microsurgeon to seek advice from a senior colleague without having him or her physically come to see the patient. Reports of use of telemedicine and video conferencing in the management of medical illness have been in vogue. This requires more expensive equipment and dedicated personnel and has the disadvantage of the discussants having to be at a fixed place.

Innovations similar to the modality described in this report have been used earlier in interpreting radiologic images in an emergency unit which used images displayed on a picture archiving and communication system (PACS) monitor, which were captured on the inbuilt camera of a PDA telephone directly and were transmitted from an emergency center to a remote physician via a wireless high-bandwidth network.[4] There were impediments when higher-resolution pictures had to be transmitted. Tele-consultation in plastic surgery using images from inbuilt camera of cell phones has been used by Hsieh et al.[5] The clarity in some of these reported cases has been mentioned to be suboptimal in decision making as the built-in cameras had resolution of 1.1 megapixels.

Telemedicine has been well established in many centers. This requires dedicated equipment and personnel. We envisaged using available resources to offer a reliable alternative in monitoring free flaps at no extra cost. It has been agreed upon that complications with respect to the anastomosis in free-tissue transfer would usually occur in the first 48 hours. It would be impractical to use telemedicine. Using the hospital intranet and the PACS system monitors, it was possible to access the photographs from any computer networked on the system as they were tagged with the same inpatient numbers. The quality of pictures did not seem to have a significant difference if viewed on a dedicated PACS monitor or a personal computer based remotely, as also studied by Parasyn et al.[6] Short video recording using the digital camera was also useful in viewing dynamically the color and speed of bleeding from the flap following a dermal scratch test. It was also possible to record the Doppler sound, which could also be heard when these short video clips were sent across the Internet. Medical literature, however, does not have reports on the use of similar techniques in monitoring free flaps. We propose this technique to be handy, time-saving, and most of all to be reliable. Advances in telecommunication with the cutting-edge 3G multimedia handsets will in the future offer these high-quality images and videos to be viewed on a mobile phone. These would be at an obvious cost. As of now, the described method in using a PC in viewing the transmitted images does appear affordable and practical to most surgeons.

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