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Special Topic

Video Capture of Perforator Flap Harvesting Procedure with a Full High-definition Wearable Camera

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Summary: Recent advances in wearable recording technology have enabled high-quality video recording of several surgical procedures from the surgeon's perspective. However, the available wearable cameras are not optimal for recording the harvesting of perforator flaps because they are too heavy and cannot be attached to the surgical loupe. The Ecous is a small high-resolution camera that was specially developed for recording loupe magnification surgery. This study investigated the use of the Ecous for recording perforator flap harvesting procedures. The Ecous SC MiCron is a high-resolution camera that can be mounted directly on the surgical loupe. The camera is light (30 g) and measures only 28×32×60 mm. We recorded 23 perforator flap harvesting procedures with the Ecous connected to a laptop through a USB cable. The elevated flaps included 9 deep inferior epigastric artery perforator flaps, 7 thoracodorsal artery perforator flaps, 4 anterolateral thigh flaps, and 3 superficial inferior epigastric artery flaps. All procedures were recorded with no equipment failure. The Ecous recorded the technical details of the perforator dissection at a high-resolution level. The surgeon did not feel any extra stress or interference when wearing the Ecous. The Ecous is an ideal camera for recording perforator flap harvesting procedures. It fits onto the surgical loupe perfectly without creating additional stress on the surgeon. High-quality video from the surgeon's perspective makes accurate documentation of the procedures possible, thereby enhancing surgical education and allowing critical self-reflection. *(Plast Reconstr Surg Glob Open 2016;4:e765; doi: 10.1097/GOX.0000000000000749; Published online 28 June 2016.)*

Perforator flaps have been gaining popularity in every field of reconstructive surgery. Procedures for harvesting perforator flaps require technical expertise because meticulous dissection of submillimeter vessels is needed. These procedures are usually performed under loupe magnification. Thus, visually sharing the surgical experience is difficult because the surgeon's perspective differs significantly from those of the assistants and the observers.

Currently, video recording of a surgical procedure is likely to be the best available technique for analyzing the operative performance, augmenting surgical education, and presenting cases to a wide audience.[1,2] Recent advances in wearable record-

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ing technology have enabled high-quality video recording to be taken from the surgeon's perspective. Several wearable cameras have been used to record plastic surgical procedures, including the Google Glass, GoPro Hero, and Contour helmet camera.[1,3–7] However, these cameras are not optimal for recording flap harvesting procedures because of their size, weight, image quality, and compatibility with a surgical loupe.

The Ecous is a small wearable camera that was originally developed for recording cardiovascular surgical procedures. We describe the use of Ecous for recording harvesting perforator flaps and investigate its utility.

METHODS

Device Specifications

The Ecous SC MiCron (Air Water Safety Service Inc., Kobe, Japan, http://www.awb.co.jp/medical_en/index.html) is a commercially available camera for medical use. The Ecous was originally developed for recording pediatric cardiac surgical procedures. It is mounted on the surgical loupe on the side of the dominant eye (Fig. 1). It can fit any manufacturers' loupe, and fixation and removal are easily accomplished. When the surgeon does not wear a loupe, the Ecous can be mounted on the dedicated headlight.

The Ecous is capable of recording high-definition (HD) video at various resolutions ranging from 480p to 1080p at a rate of 30 frames per second. The Ecous does not have audio capability. The camera unit alone weighs only 30 g, and the size of the camera itself is 28 × 32 × 60 mm. Because the Ecous does not have a battery and does not accommodate a memory card, it must be connected to a laptop through a USB 2.0 cable and is driven by USB bus power (Fig. 2). The USB cable can be elongated up to 5 m. The video data can be stored directly in the PC as an AVI file using dedicated application software. Currently, the Ecous is available only in Japan. The cost of the system, including the laptop PC, is JPY 1,960,000 (USD 16,300).

Recording

In this study, the Ecous was used to record 23 perforator flap harvesting procedures in 23 patients. The elevated flaps included 9 deep inferior epigastric artery perforator (DIEP) flaps, 7 thoracodorsal artery perforator (TAP) flaps, 4 anterolateral thigh flaps, and 3 superficial inferior epigastric artery (SIEA) flaps. Prior informed consent for video recording was obtained from each patient, and no images that could identify the subject were recorded.

RESULTS

All procedures were recorded with no equipment failure. The surgeon did not feel any stress or interference from wearing the Ecous. The only problem with the Ecous was that it dropped an occasional

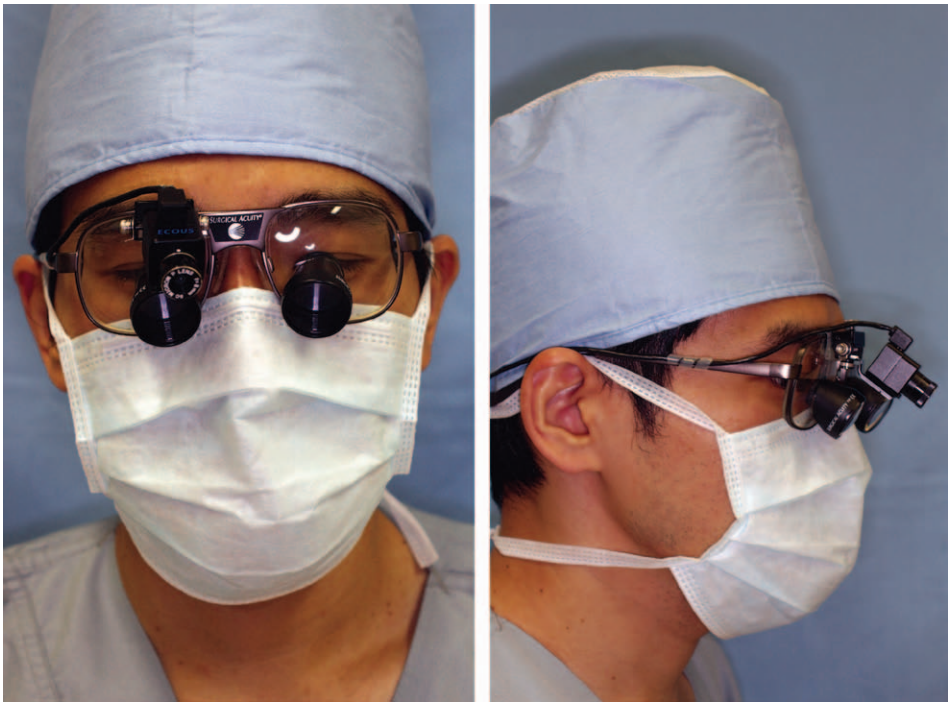
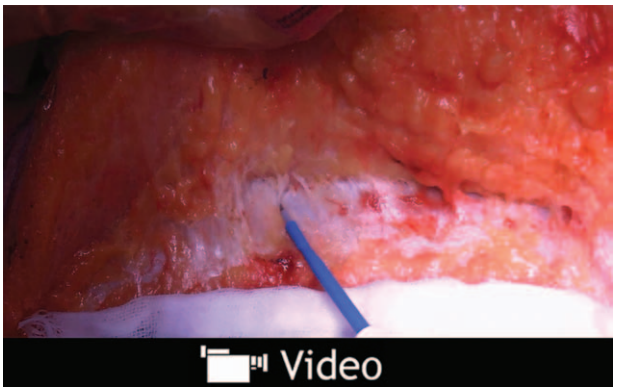
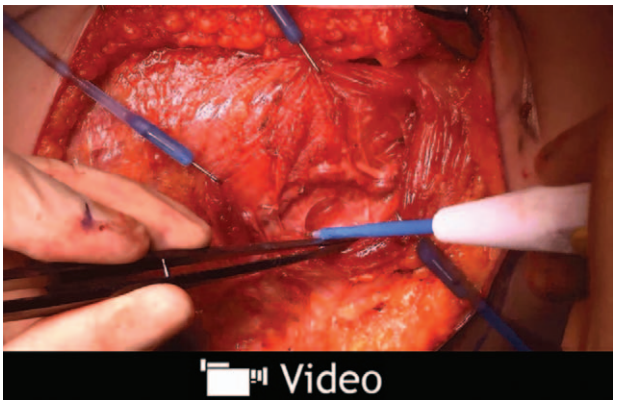


Fig. 1. Appearance of the Ecous SC Micron mounted on the surgical loupe and ready for use.

Fig. 2. Intraoperative appearance of the surgeon with the Ecous, connected to the laptop.



Video Graphic 1. Supplemental Digital Content 1 demonstrates a DIEP flap-harvesting procedure, ***http://links.lww.com/PRSGO/A208***.



Video Graphic 2. Supplemental Digital Content 2 demonstrates a TAP flap-harvesting procedure, ***http://links.lww.com/PRSGO/A209***.

frame. The main reason for dropping a frame was an abrupt head movement from the surgeon. Thus, surgeons must take care not to move their heads abruptly when recording.

Case 1: DIEP Flap

A 61-year-old man underwent facial reconstruction with a free DIEP flap transfer. The flap was elevated based on 3 perforators from the left deep inferior epigastric artery. The Ecous recorded the details of the entire procedure at a high-resolution level. (**See Video 1**, **Supplemental Digital Content 1**, which demonstrates the DIEP flap-harvesting procedure. This content is available at **http://links.lww.com/PRSGO/A208**.)

Case 2: TAP Flap

A 69-year-old woman underwent sole reconstruction with a free TAP flap transfer. The flap was elevated based on a perforator from the transverse branch of the left thoracodorsal artery. The perforator was dissected through cleavage of the latissimus dorsi muscle, and the branches of the thoracodorsal nerve were dissected and preserved. The Ecous recorded the details of the entire procedure at a high-resolution level. (**See Video 2**, **Supplemental Digital Content 2**, which demonstrates the TAP flap-harvesting procedure. This content is available at **http://links.lww.com/PRSGO/A209**.)

Case 3: SIEA Flap

A 40-year-old woman underwent immediate breast reconstruction with a free SIEA flap. The flap was elevated based on the left superficial inferior epigastric artery. The superficial inferior epigastric vein and the superficial circumflex iliac vein were included as drainage veins. The Ecous recorded the details of the entire procedure at a high-resolution level. (**See Video 3**, **Supplemental Digital Content 3**, which demonstrates a SIEA flap-harvesting procedure. This content is available at **http://links.lww.com/PRSGO/A210**.)

DISCUSSION

The present study demonstrates that the Ecous can capture HD video of perforator flap harvesting procedures from the surgeon's perspective. There is an increasing need for HD video recording of surgical procedures in a variety of areas, including surgical education, critical analysis of

Video Graphic 3. Supplemental Digital Content 3 demonstrates a SIEA flap-harvesting procedure, ***http://links.lww.com/PRSGO/A210***.

technical skill, and patient safety. Although video recordings of several plastic surgical procedures have been reported, HD videos of perforator flap harvesting procedures are scarce and have been awaited with great anticipation. The technique for dissecting perforator vessels is difficult for junior microsurgeons because there is no adequate training model for the procedure. The technical details of the procedures have been difficult to record with conventional video cameras. HD video of the procedure from the surgeon's perspective could improve the simulated experience for junior microsurgeons. Even for attending microsurgeons, the opportunity to critically self-reflect by reviewing their own videos will enable them to continuously hone their craft.[7] Moreover, the addition of video clips is now essential for surgical presentations.[8] From the perspective of medical safety, routine recording of surgical procedures is anticipated to serve as a surgical "black box" to improve patient care, prevent complications, and allow accident analysis.[9,10]

For recording perforator flap harvesting procedures, the Ecous has several advantages over other cameras such as the Google Glass, GoPro, and Contour. The first and main advantage is that the Ecous fits onto the surgical loupe perfectly because it was originally developed for this purpose. This feature enables video recording from the main surgeon's perspective. The Google Glass cannot be worn at the same time as a surgical loupe.[7] The GoPro and the Contour cannot be mounted on the surgical loupe and must be mounted on the head.[1,3] Second, the Ecous is lighter than the other cameras. The Ecous weighs only 30 g [compared with the Google Glass at 43 g, the GoPro HERO 3+ (with housing) at 136 g, and the Contour HD at 122 g]. Third, the Ecous is smaller than the other cameras. The Ecous is 28 × 32 × 60 mm (compared with the Google Glass of 150 × 50 mm, the GoPro HERO 3+ of 69.5 × 70.5 × 39.0 mm, and the Contour HD of 95 × 53 × 34 mm). These features make wearing the Ecous more comfortable during procedures than the other HD cameras.

The ProHD is also a wearable camera developed for surgical loupes and headlights. The usability of the ProHD is similar to that of the Ecous, and it weighs only 13 g. However, the ProHD is not a fully HD video camera, and its resolution is only 720p.

The major limitation is that the Ecous must be connected to a laptop. The surgeon's movement, therefore, is restricted during recording. Conversely, it means that there is no time limit on recording because the Ecous is driven by USB bus power instead of a battery. In addition, the data from the recording are stored directly in the laptop. This feature is helpful because the file size of an HD video can be quite large (15–20 GB/h), which is too much for a normal flash memory card. Another limitation of the Ecous is its high cost. The Ecous (at USD 16,300) is much more expensive than the other cameras (Google Glass at USD 1,500, GoPro HERO 3+ at approximately USD 400, Contour HD at approximately USD 300, and ProHD at USD 4,000).

CONCLUSION

The Ecous is an ideal camera for recording perforator flap harvesting procedures. It is extremely small and light, and it fits onto a surgical loupe perfectly without creating any additional stress for the surgeon. It enables HD videos to be recorded from the main surgeon's perspective, which allows all the surgical details of perforator dissection to be demonstrated.

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