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Video recording of hand surgeries using a field of view (FOV) matching USB camera module and smartphone in the era of COVID-19

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Abstract

Background: As the online medium has gained in popularity due to the recent coronavirus disease (COVID-19) pandemic, video recording of surgical procedures has become crucial in medical education. Various methods for recording are available but many require professional equipment and experienced personnel. Here, we propose a feasible and acceptable method for video recording of surgeries.

Methods: An M12 mount USB camera, which is based on an Android micro-USB, was utilized. The device was purchased from a website for $32–$40. The camera was mounted between the eyes of the binocular loupes. Surgical procedures were recorded with the camera. The optimal settings were determined according to the types of surgeries.

Results: We recorded the following surgical procedures: radial artery superficial palmar branch (RASP) free flap harvest, carpal tunnel release, and free flap operation. The default values were retained for all settings, but the highest image quality (1080 p) was selected with an 8 mm lens. The camera battery was sufficient to record each surgery in its entirety.

Conclusions: The USB camera produced high-quality videos that perfectly matched the surgeon's field of view without the need for additional staff for recording. This low-cost equipment could be widely employed for the recording of educational videos for surgeons, especially in the era of COVID 19.

Introduction

Video recordings of surgical techniques are widely used for educational purposes, such as academic presentations and reviewing surgical processes. As online media has gained popularity due to the recent coronavirus disease (COVID-19) pandemic, recording surgical procedures has become crucial for medical education. Several methods have been reported for recording surgeries, the most accurate of which involves the presence of dedicated staff to record the procedure during surgery. However, the inclusion of additional staff may interfere with the surgical procedures during the recording process; further, there is a risk of contamination in the operating theatre. Additionally, cameras are occasionally unable to capture the procedure with sufficient detail because of the difference between the viewpoints of the surgeon and the camera. To address this problem, various authors have reported the use of an action camera (cam) to record the surgical process from the viewpoint of the surgeon.[1–4] However, the action cam itself weighs more than 120 g, which can cause the surgeons to experience fatigue. A further challenge is that during prolonged surgeries, the battery of the action cam may be exhausted before recording is completed. Furthermore, the viewpoint of the action cam does not perfectly match that of the surgeon, because it is typically mounted on the forehead area; hence, a difference in the angle of view is unavoidable.

Although professionally manufactured cameras mounted on binocular loupes are available, they are expensive to use. Therefore, this study investigated the feasibility of employing a USB camera module connected to a smartphone to record high-quality surgical clips at optimal settings.

Methods

Camera

This study was performed in accordance with the tenets of the Declaration of Helsinki and was approved by the Public Institutional Ethics Committee of the Ministry of Health and Welfare.

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In this study, we utilized an M12 mount USB camera (Pu Anshi, Shenzhen, China) loaded with a 1/2.7-in. CMOS module (Hon Hai, Shenzhen, China) that supports an Android micro-USB. The device was purchased from Aliexpress (https://www.aliexpress.com/store/1396798?spm=a2g0o.cart.0.0.41f43c00zglKCX), priced between 32 and 40 USD, depending on the lens combination. It weighs approximately 20 g, and the USB cable weighs approximately 1.5 m long. The camera was mounted between the left and right eyes of the binocular loupes and could be used while wearing them.

Figure 1 shows an M12 screw-lens-mounted camera, which allows for the swapping of simple and affordable lenses to achieve multiple angles of view. An 8 mm lens was used to achieve an angle of view of approximately 60°. This camera was lightweight and comfortable because it was not equipped with devices other than screw-type lens mounts and sensors. Thus, it does not cause additional fatigue when mounted on binocular loupes (Fig. 2).

Settings

The camera unit can be easily attached in two ways. We used the accessories provided when we bought the loupe. Furthermore, a customized setting using Lego pieces fixed with a glue gun and that could be interlocked is also possible.

Before surgery, binocular loupes were worn and connected to the smartphone via a USB cable to determine the working distance under the field of view (FOV) of the loupe. Accordingly, the lens must be positioned to achieve focus at the correct distance. One method to adjust the focus involves looking through the loupe at the hair on the back of the hand when it is placed at a distance similar to that of the surgical field and positioning the lens, whereas the other involves magnifying the smartphone screen. The lens was then carefully adjusted according to the farthest distance at which the loupe remained in focus to prevent it from losing focus during surgery. A video recording application (USB camera) was downloaded and installed from the Google Play Store (Google, CA, USA). Before scrubbing, the application should be opened and the resolution set to the default screen settings of 1080 p. Following this, the screen orientation (vertical or horizontal) should be set, depending on the requirements, while the camera is mounted on the binocular loupes. The settings were verified by recording sample clips. After verifying the settings, the screen was turned off and the smartphone was set to airplane mode to ensure that the radio waves did not interfere with any surgical equipment. It was considered that the lamps in the operating room could have affected the recording quality. We found that blurring might occur if the lighting was concentrated only at the centre of the surgical field. Therefore, whenever possible, the lighting should be set to illuminate the entire surgical field equally.

Fig. 1. USB M12 screw lens mount camera.

Fig. 2. The lens was mounted on binocular loupes.

Editing

Editing, such as snipping and inserting simple captions, can be performed using the native video-editing application installed on the smartphone. However, to achieve professional editing quality, various editing software, such as Adobe Premier (Adobe, CA, USA) or iMovie (Apple, CA, USA), can be used.

Results

We provided a comparison of various action cameras (currently used) with respect to the weight and cost (Table 1). We recorded several surgical procedures, including radial artery superficial palmar branch (RASP) free flap harvest (see Supplemental Video 1: Video recording of RASP flap harvest), carpal tunnel release (Fig. 3), trigger finger repair (Fig. 4), RASP elevation (Fig. 5), and anterolateral free flap (see Supplemental Video 2: video recording of anterolateral thigh free flap). For this, we selected the highest image quality (1080 p) and captured the videos at a frame rate of 29 fps with an 8 mm lens. We did not use a spot meter to capture any specific details because we wanted to maintain a high-quality

Table 1 Comparison of surgical recording cameras (weight and cost)

	Weight (g)	Cost ($)
GoPro Hero9 series by GoPro	158	399–499
Osmo Action by DJI	124	229–245
HDR-AS300 by Sony	109	198–248
USB camera by HonHai	12	32–40

Note: GoPro Hero9 (GoPro, CA, USA), Osom Action (DJI, China), HDR-AS300 (Sony, Japan), and a USB camera (Hon Hai, China).

output without reducing the intensity of the operating room lights. In the case of the RASP flap harvest, the recording was obtained in a narrow view, and for carpal tunnel release, the FOV was angled at approximately 60°. All the other settings were left at their default values, including the white balance and exposure level. The camera battery was sufficient for recording each surgery in its entirety. The output file type was set to H.264 MP4 format.

Discussion

Recently, an increasing need for surgical recordings to facilitate online education and obtain performance feedback has been observed. Previous studies have suggested the use of action cams such as the GoPro in the operating room.[2] Although earlier versions did not have a polarizing filter or a spot meter, the settings were continuously developed to offset any limitations.

While the application of an action cam has become an excellent method to record surgeries, it has the disadvantage of causing considerable fatigue during time-consuming procedures, such as a free flap, owing to its weight. Furthermore, when mounted on the forehead, the FOV follows the direction of the surgeon's head rather than the surgeon's eyes. Consequently, reviewing the recordings after the surgery revealed limitations in capturing the desired scenes. Recording the video at ultra-wide angles and cropping the output is a potential solution; however, it lengthens the subsequent process of editing. Action cameras were originally designed for ultra-wide-angle shots in sports; therefore, using them at their default settings would require a wide-angle screen to be digitally cropped. This presents the disadvantage of significantly degraded image quality, which is unsuitable for recording surgeries. To

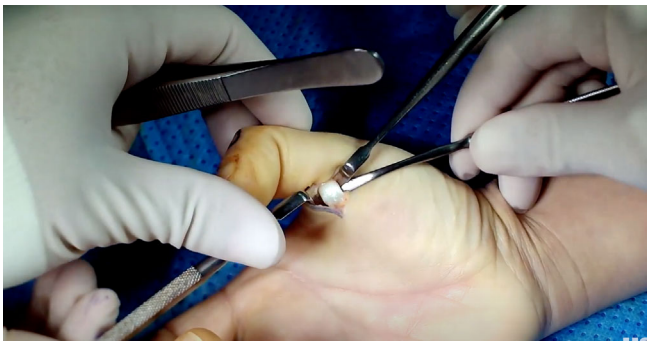

Fig. 4. Screenshot of trigger finger operation.

overcome this disadvantage, some surgeons have attempted to remove the default lens from action cameras and have installed a customized lens. However, optical narrowing of the FOV causes an unavoidable reduction in the area captured during the operation. In contrast, the USB camera used in the present study, which can be mounted between the eyes of the binocular loupes, offers the advantage of precisely capturing the surgeon's view as long as the surgeon performs the operation through the FOV of the loupe lens. Another major advantage is that the surgeon can choose from a variety of affordable lenses to achieve the desired angle of view. For delicate procedures, a narrow-angle lens can be mounted, and when a large area must be recorded, the lens can be swapped with a wide-angle lens. Although zoom lenses are also available, they are not recommended because of their large size and heavy weight. Additionally, our USB camera offers a significant advantage with respect to the media storage. When an action camera or another similar camera is used, there is an added step of transferring the content from the memory card to a computer. However, the USB camera has the advantage of being able to capture videos without losing any data, as the clip is saved directly to the smartphone. Smartphones generally have a longer battery life than action cameras, which allows for safe recording, especially for long periods of time. Furthermore, video clips transferred to a smartphone can be edited directly using the native video editing software application preinstalled on the smartphone. The network connectivity of the smartphone can be used to transfer the video to other media almost

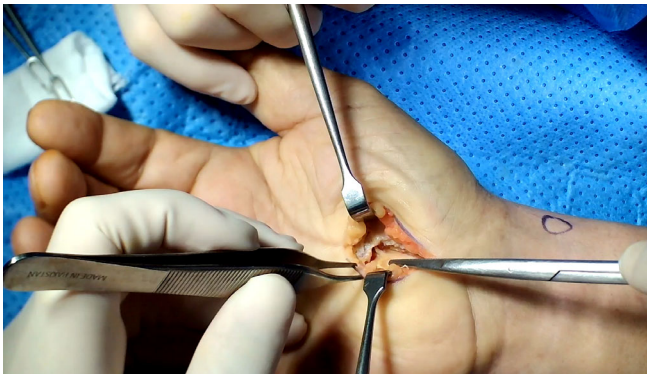

Fig. 3. Screenshot of carpal tunnel release.

Fig. 5. Screenshot of RASP elevation.

instantly. These features are significantly superior to those of other video-recording methods.

Compared to the existing methods, a USB camera offers the following features/advantages in terms of convenience: (1) it is lightweight; (2) it is capable of recording videos that perfectly match the surgeon's FOV; (3) it is capable of matching the FOV and the shooting range when viewed through the loupe lens; (4) it is capable of a longer recording duration owing to the relatively longer battery life of the latest smartphones; (5) it is capable of editing and sharing right away through the use of smartphone applications; (6) it does not require additional staff for video recording; (7) it has a low equipment cost; (8) it is capable of changing to the desired angle of view by swapping inexpensive lenses; and (9) the lens does not go out of focus after manual adjustment. Therefore, we believe that this method could be widely employed for the video recording of surgeries.

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Conflict of interest

None declared.

Ethics approval and consent to participate

The study was performed in accordance with the tenets of the Declaration of Helsinki and approved by the Public Institutional Ethics Committee of the Ministry of Health and Welfare. Informed consent was obtained from all patients and the study was conducted in accordance with the tenets of the Declaration of Helsinki.

Data availability of statement

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Author contributions

Hyun Sik Park: Conceptualization; software. **Bo Young Park:** Methodology; writing.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Supplemental Video 1 Video recording of RASP flap harvest.
Supplemental Video 2 Video recording of anterolateral thigh free flap operation.