High-Definition Point-of-View Intraoperative Recording Using a Smartphone: A Hands-Free Approach

Amir A. Hakimi, BS; Allison C. Hu, BA; Tiffany T. Pham, MS and Brian J. F. Wong, MD, PhD

Objectives/Hypothesis: Intraoperative recording devices are being increasingly used to provide video for contemporary surgical training. The objective of this study was to evaluate the use of a smartphone as a low-cost alternative to obtain high-resolution video from the surgeon’s perspective.

Study Design: A study evaluating the feasibility of using a head-mounted smartphone with a telephoto lens for point-of-view surgical videography.

Methods: Video recordings of a rhinoplasty procedure were taken using a head-mounted smartphone and two handheld cameras, a Canon Powershot SD1400 IS and a Sony HandyCam HDR-CX160. Video clips were shown to 16 blinded otolaryngology residents (n = 10) and attending physicians (n = 6) for individual video evaluation using a Likert scale (1 being poor quality, 5 being excellent quality). In addition, the study participants were asked to select which video clip they preferred when presented to them side by side.

Results: The iPhone 7 was given the highest overall mean video quality rating of 3.9 ± 0.57 and was preferred over the two handheld cameras by nearly all surveyed surgeons. The Canon Powershot SD1400 IS was given a mean rating of 3.3 ± 1.0 and preferred over the Sony HandyCam HDR-CX160 by all surgeons. The Sony HandyCam HDR-CX160 was given a mean rating of 1.5 ± 0.13.

Conclusions: A head-mounted smartphone equipped with a telephoto lens provides a novel method to intraoperative surgical recording. The design is simple, low cost, and allows the surgeon to capture fine anatomical detail from the desirable point-of-view perspective.

Key Words: Rhinoplasty, facial plastics/reconstructive surgery, aesthetic surgery.

Level of Evidence: NA

INTRODUCTION

High-definition intraoperative digital recording has demonstrated great value in surgical education and quality improvement.1 Both attending physicians and surgical residents prefer assessments based on surgical video compared to drawings, or written or verbal feedback.2,3 However, current options for intraoperative recording devices can be expensive, bulky, cumbersome to operate within the operating room (OR), and/or require a person to operate the camera.

Various techniques have been devised to use handheld recording devices in the OR. The recording devices have been integrated with operating light handles, mounted to the ceiling, or mounted on tripods to record surgical footage.4,5 The drawbacks of such techniques include lack of point-of-view (POV) recording, potential obstruction of overhead operating room lamps, lack of OR equipment, or lack of knowledgeable personnel to operate the camera and focus on the correct elements of the operation.

POV digital recording in the OR through the use of portable devices, such as Google Glass and the GoPro Hero series, have gained increasing popularity, but also have had significant drawbacks (Fig. 1). Google Glass is relatively expensive, cannot zoom in or out during a live stream, and has been associated with poor image quality, low battery life, and data protection issues when used in the clinical setting.6,7 The GoPro Hero series can also be costly and has been shown to lose fine anatomical detail in its recordings.8 As such, it is imperative to look for alternative, low-cost, easily accessible methods of optimizing the practice of POV digital recording.

Smartphones have a role in nearly every aspect of daily life, and their high-definition and easy-to-use cameras are finding niche applications in surgery. Use of smartphones has been reported to record video during surgery, but lack the highly desirable surgeon’s POV recording, obscured by the overhead operating room lamp, or led to off-axis framing.9–11 The purpose of this study was to: 1) evaluate the feasibility of assembling a head-mounted smartphone with Bluetooth control...
equipped with a telephoto lens for surgical videography, and 2) compare the video quality of such a setup to other handheld recording devices commonly used in the OR.

MATERIALS AND METHODS
The head mount was created by using an adjustable head strap (AmazonBasics Head Strap Camera Mount for GoPro; Amazon.com Inc., Seattle, WA), a universal conversion adapter set for smartphone attachment (Action Mount 4 pc Screw Adapter Set; Action Mount Inc., Boise, ID), and a cell phone tripod adapter (Cell Phone Tripod Adapter--iPhone Tripod Mount; WarehouseDeals LLC, Seattle, WA), which totaled $20.42 in cost. Additionally, a MOMENT 2× magnification telephoto lens for the iPhone 7 (Moment Inc., www.shopmoment.com; Moment, Seattle, WA) was purchased for $129 to allow for optical zoom. Assembly of these pieces was rapid and straightforward (Fig. 2). The free Airplay application on the MacBook Air provided wireless monitoring of the smartphone’s imaging frame in real time. An additional Bluetooth remote was stored in a sterile plastic bag that allowed the surgeon to start and stop digital recording. The iPhone was set to automatic focus, default exposure, and default ISO sensitivity. Digital video footage of a rhinoplasty procedure was recorded with ultra–high-definition 4K pixel resolution at 30 frames per second and ultimately cropped to 1080p in postrecording edits (Fig. 3).

The Canon Powershot SD1400 IS camera and Sony HandyCam HDR-CX160 camera were also used during the same rhinoplasty procedure to provide comparisons. Both devices were set to default settings with automatic focus and hand-held by the researcher at a nearly identical angle and distance from the patient as the smartphone head-mounted camera to mimic the surgeon’s perspective.

A 25-second clip was taken from each digital recording method and shown to 16 blinded otolaryngology residents (n = 10) and attending physicians (n = 6) for evaluation (Fig. 4).

The first method of evaluation involved the participant grading each recording based on their perception of video resolution using a five-point Likert scale (1 being poor quality, 5 being excellent quality). A second method of evaluation involved participants identifying their preferred video when shown recordings from two of the devices side-by-side.

RESULTS
The 16 surveyed otolaryngology residents (n = 10) and attending physicians (n = 6) gave the iPhone 7 the
highest overall mean rating of $3.9 \pm 0.57$. The Canon Supershot SD1400 IS was given a mean rating of $3.3 \pm 1.0$, and the Sony HandyCam HDR-CX160 was given a mean rating of $1.5 \pm 0.13$. The iPhone 7 was preferred over the Canon Powershot SD1400 IS by 15 (93.75%) surgeons. The iPhone 7 was preferred over the Sony HandyCam HDR-CX160 by 16 (100%) surgeons. The Canon Supershot SD1400 IS was preferred over the Sony HandyCam HDR-CX160 by 16 (100%) surgeons. Results were statistically significant between group means as determined by a one-way analysis of variance ($P < .001$).

**DISCUSSION**

Given the field of view is narrow and that surgical video recording is a normal educational practice, and no personal identifying factor of the patient was either linked or incorporated in the recording, this study was exempt from institutional review board approval of the University of California, Irvine. Patients do sign a consent authorizing the use of any video or photography for training and teaching purposes as well as its use in lectures and medical journals.

Video footage from the smartphone was preferred over both handheld cameras almost unanimously, and
the Canon Powershot SD1400 IS was well preferred over the Sony HandCam HDR-CX160. The footage captured with the head-mounted iPhone 7 was found to be of high quality, offered the desirable surgeon’s point-of-view, and reduced the need for an additional videographer in the operating room. Surgical light overexposure, a limitation in numerous previous studies, was not an issue with the autofocus capability of the camera phone. Additionally, the telephoto lens allowed the surgeon to capture fine anatomical detail without compromising image quality, a downfall of the digital zoom provided by other recording devices.

Today’s options for intraoperative digital recording devices that can display the surgeon’s perspective range in cost from $190 for a basic GoPro and mount to upward of $3,000 for a Dr. Kim USA Shadowless Headlamp and HD Camera (www.drkimusa.com) (Table I). In contrast, this study shows that one can obtain exceptional video quality using an already available smartphone alongside head-mount hardware and a telephoto lens for approximately $150.

Battery life and limited internal memory are limiting factors to recording longer surgeries, but these issues can be overcome through the use of smartphone cases with a built-in battery charger and storage device cards. The weight of our design can also serve as a barrier to long-term use. The headpiece, MOMENT 2x telephoto lens, and iPhone 7 together weigh approximately 290 g compared to 247 g for the GoPro HERO4, its head mount, and its case. However, the additional weight should not significantly increase strain for shorter-duration procedures, and better, more rigid head mounts can be used, including those similar to the head mounts used to secure surgical headlights.

The specifications of the head-mount are not limited to an iPhone 7. An Android smartphone can easily replace the iPhone 7 by purchasing an Android-compatible telephoto lens and by downloading an Android-compatible screen-sharing application like SideSync for monitoring purposes.

### CONCLUSION

A head-mounted smartphone equipped with a telephoto lens is a simple, effective, and economical method to obtain high-quality, POV recordings during surgeries.

### BIBLIOGRAPHY