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Surgeon point-of-view recording: Using a high-definition head-mounted video camera in the operating room

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Objective: To study the utility of a commercially available small, portable ultra-high definition (HD) camera (GoPro Hero 4) for intraoperative recording. **Methods:** A head mount was used to fix the camera on the operating surgeon's head. Due care was taken to protect the patient's identity. The recorded video was subsequently edited and used as a teaching tool. This retrospective, noncomparative study was conducted at three tertiary eye care centers. The surgeries recorded were ptosis correction, ectropion correction, dacryocystorhinostomy, angular dermoid excision, enucleation, blepharoplasty and lid tear repair surgery (one each). The recorded videos were reviewed, edited, and checked for clarity, resolution, and reproducibility. **Results:** The recorded videos were found to be high quality, which allowed for zooming and visualization of the surgical anatomy clearly. Minimal distortion is a drawback that can be effectively addressed during postproduction. The camera, owing to its lightweight and small size, can be mounted on the surgeon's head, thus offering a unique surgeon point-of-view. In our experience, the results were of good quality and reproducible. **Conclusions:** A head-mounted ultra-HD video recording system is a cheap, high quality, and unobtrusive technique to record surgery and can be a useful teaching tool in external facial and ophthalmic plastic surgery.

Key words: Camera, GoPro, intraoperative videography, photography, recording, surgical documentation

Recording surgical procedures is of great value for teaching and training residents and fellows. It creates recordings of surgical procedures in the setting of ever-decreasing opportunities and time for training and demonstrating.^[1] Ocular surgery namely anterior segment surgery and vitreoretinal surgery are relatively easy to record because, in most cases, the required hardware is built-in within the microscope viewing system. Facial plastic surgery, however, is usually difficult to record since a microscope is rarely used. Often, an externally mounted video camera and an additional cameraperson are required to record external procedures. Facial plastic surgery, especially lacrimal and orbital surgeries additionally have poor visibility owing to small incisions and fields, the presence of blood, multiple retractors, and two or more assistants, which make it difficult for the camera operator to be at the ideal vantage point to record without obstructing the surgeon's view. As a result, the camera operator may seek to obtain the best views of the surgery, which may be distracting for the surgeon.^[2] Often times, cameras are fixed to the ceiling-mounted external light source such that the camera as a "bird's eye" view of the surgery from above. While this technique may give good results,

often times, the surgeon has to stand up and change positions or even stoop and bend for better access or maneuverability, obstructing the camera's view, notably during orbital surgeries. While the idea of a "surgeon's eye" where the camera was placed in between the surgeon's eyes (mounted on a loupe) has been discussed in the past, such recording systems lack high resolution and are prohibitively expensive (with the additional cost of a loupe) making it inaccessible to everybody.^[3-5] A similar technique, but a different camera, has been used in the past to record scleral buckling.^[6] The ideal camera system is one that is simple, affordable, user-friendly, and captures the surgeon's view without interrupting the proceedings of the surgery. The operating room is a busy environment, and tempers can run high if there is constant movement of personnel and interference due to the necessary presence of electrical equipment.^[3,4,7]

Methods

GoPro, Inc., (San Mateo, CA, USA) manufactures and markets high-definition (HD) personal cameras, used in extreme action video photography. They are compact, lightweight, rugged, and are wearable or mountable on vehicles. The cameras capture still photos or video in HD through a wide angle lens and can be configured to work automatically

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with minimum intervention, or remotely controlled. The GoPro Hero 4 Black Edition camera, which was used by the authors, has a 12 megapixel CMOS and a $f/2.8$ fixed maximum aperture lens. This camera can record 4K video at frame rates of 24, 25, and 30 frames/s. To put things into perspective, an HD TV with 1080p resolution is composed of two million pixels (1920×1080), whereas a 4K TV (Ultra HD) has over eight million pixels (3840×2160). Therefore, 4K display has around 4 times more resolution than 1080p and produces a clearer picture. The camera is extremely small with dimensions of 41 mm (height) \times 59 mm (width) \times 30 mm (breadth) and weighs 147 g when placed inside the plastic casing [Fig. 1a]. The GoPro Hero 4 camera costs approximately US \$ 499.00 (₹ 30,000). The camera alone weighs 87 g; however, it weighs approximately 150 g when housed in its transparent casing. In comparison, the average cordless binocular indirect ophthalmoscope weighs between 480 and 650 g. The camera has a fixed focus setting; this means that the focus does not change if something gets closer or further away, the focus stays the same.

In our operating room, a GoPro Hero 4 camera was mounted on a head mount designed specifically for this camera (commercially available as an accessory for GoPro cameras) [Fig. 1b]. The operating surgeon wore the head mount with the camera attached over the surgical cap [Fig. 2]. The headband has an adjustable nut [yellow arrow in Fig. 2], which allows the surgeon to change the viewing angle. The camera did not pose any difficulties in cases where the surgeon chose to wear a surgical loupe while operating. The camera can transmit live images via Bluetooth technology to any smartphone or tablet; in our case, an iPad Air (Apple, Inc., Cupertino, CA, USA), which was with the circulating nurse and the camera, was controlled with the GoPro application installed on the tablet. No additional lighting was required while operating the camera. To ensure that patient privacy was protected, the recording was commenced only after the patient was draped and prior written informed consent was procured beforehand in every surgery that was recorded. No sound was recorded to preserve confidential professional interactions in the operating theater.



Figure 1: (a) The GoPro Hero 4 camera: Front and back, enclosed in a protective transparent casing. (b) The head mount strap with the camera fixed on it

Results

The captured footage was found to be of high quality and offered a unique perspective [Figs. 3a-c, 4 and 5]. The high-resolution camera sensor allows minute structures to be well-visualized. The GoPro Hero 4 has the option of changing the following parameters while recording: Color, sharpness, white balance, ISO, and exposure. However, in our experience, we find the “Auto” mode to give best results. The capture of images from the surgeon’s point-of-view, we believe, is an additional advantage as a teaching tool since students can see exactly what the surgeon sees and there is a familiarity which residents and fellows perceive when they themselves start operating.

However, the singularly compelling advantage that this camera has over all previously described head-mounted or external video recording systems is the high resolution of images. The captured footage allows extreme high zooming without distortion, pixelling, or loss of resolution [Figs. 3b and c and 4]. In addition, in case the surgeon may have tilted his or her head, postproduction on the GoPro studio application also allows the user to rotate the image through $0\text{--}360^\circ$. In our experience, none of the two surgeons perceived any shadow of the head-mounted camera on the surgical field. No ill effects of the additional weight on the head were reported by any of the surgeons.

Discussion

Bizzotto *et al.* have previously discussed the use of a GoPro camera in the operating room.^[8] They used an earlier version of the camera - the GoPro Hero 3. They recommended that a narrow field of view setting, a video resolution of 1080p, and a frame rate of 30 fields per second.^[8] In our experience, although 1080p resolution with narrow field gave good results; on comparing of 1080p footage along with 4K resolution footage with appropriate zooming and framing, we felt the 4K resolution was clearer and crisper.

This technique and device however are not without its own set of shortcomings. The small camera allows a little <90 min of continuous recording on a fully charged battery while shooting



Figure 2: The surgeon with the head-mounted camera in place to record the surgery. The yellow arrow points to the adjustable nut

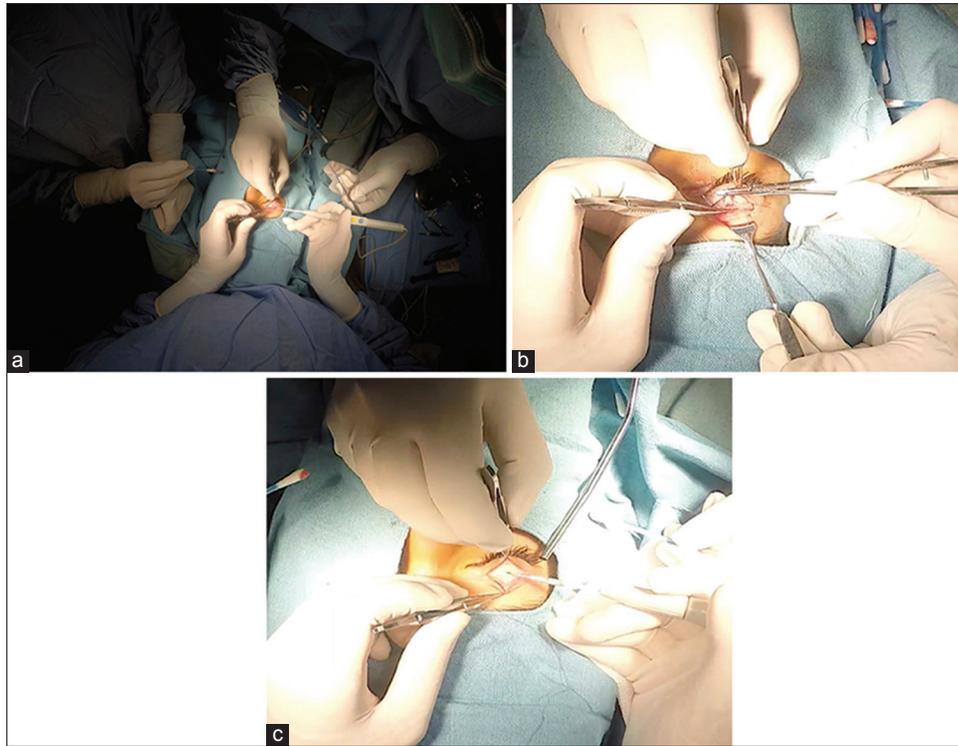


Figure 3: (a) A screenshot of the unprocessed raw footage from a surgery; note the distortion and slight fish-eye lens effect. (b and c) Screenshots of the zoomed in area of interest; there is no loss of resolution or “pixellation” despite zooming in considerably. The anatomy of the structures is well preserved. The surgery recorded was a levator resection surgery for ptosis. The surgeon is demonstrating the tarsus in Figure 3c



Figure 4: A still from a recording of a dacryocystorhinostomy: The surgeon is holding the nasal mucosal flap

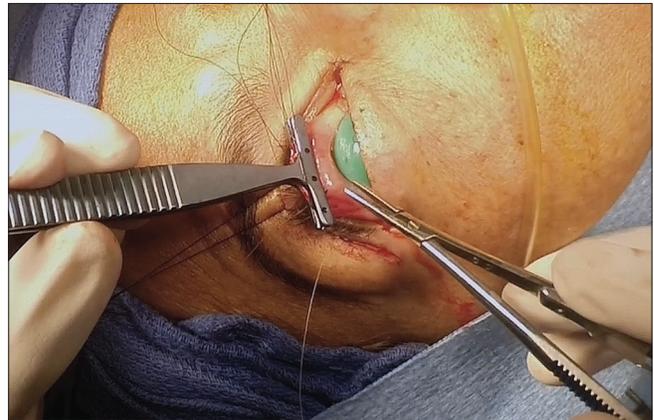


Figure 5: A still from a video of a conjunctivo-Müllerectomy being performed: The passing of the suture in this surgery is often times too complicated to be comprehended by trainees the first time they see or read about it. A surgeon point-of-view video demonstrates exactly how the needle is held and passed in a serpentine fashion, simplifying it

at 4K resolution. Due to the ultra-wide angle lens, there is some amount of visual distortion (fisheye lens effect) [Fig. 3a]; this however can overcome using the horizontal and vertical zoom features while editing the raw footage. The high-resolution of the footage translates into large sized digital files, which require time and processor capability to handle (for example: A 30 min surgery shot at 4K resolution requires 5 GB [gigabytes] of storage space). The availability of interchangeable lenses may help to avoid the fisheye lens distortion. We also agree with Bizzotto *et al.* that at times, excessive brightness was noticed in the videos because of the operating room lights.^[8]

The drawbacks of the overhead light-mounted camera and the need for additional trained cameraperson is obviated by the ease of the tablet/smartphone based application, which can be surgeon-controlled too if the phone is placed in a sterile sealable ziploc bag. The surgeon need not be worried if any finding/surgical step was completely recorded since the field of the view of the surgeon is the same as that, which is captured in the camera. Occasionally, during orbital surgery and decompression surgery, even the assistant may not have visual access to the actual surgical field, which may be deep

within the orbit. Even in such scenarios, the head-mounted camera was able to capture satisfactory images, which are of particular value as teaching aids. In addition, the wireless transfer of images makes for an uncluttered setup without dangling wires. The live video transmitted by the camera can help trainees and residents watch the surgery as being done and discuss surgical steps without getting close to operating area and assistants. This is suitable especially for some surgeons who do not like people talking around them.

We feel that this technology is still a “work-in-progress,” when it comes to its applicability in the operating room and it requires further fine-tuning to optimize its utility. In the above discussed setting, this commercially available camera setup, we believe, can help surgeons in auditing, demonstrating, and teaching purposes. Our manuscript presents systematic feedback from only four surgeons who have used this camera; however, as more surgeons use the described technique, over a longer period of time, a wider consensus regarding its adequacy and utility will evolve.

Conclusions

Video recordings are an excellent tool in education and surgical training, particularly in oculoplastic surgery where opportunities for trainees to get hands-on surgical experience may be limited.^[7,9] The evolution of technology has now brought a high resolution, portable cameras within the reach of the average consumer. Application of one such imaging system, the GoPro Hero 4K camera, in operating room serves as a useful, high-quality recording, and teaching tool in craniofacial surgery.

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Conflicts of interest

There are no conflicts of interest.

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