

How to Shoot and Edit High-Quality Surgical Videos for Hand and Upper Extremity Surgery

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A surgical video can improve patient care, surgical education, as well as scientific presentations and publications. Previous authors have outlined a basic understanding of how to produce high-quality surgical videos. With continuous technological improvements in video-filming hardware and editing software, multiple options for producing high-quality surgical videos are available. This article described important aspects of filming and editing videos to create a video that the surgeon can watch before performing the procedure. The authors reviewed camera terminology, including resolution, optical and digital zoom, shutter speed, and frame rate, as well as equipment options or setup for recording high-quality surgical videos. We provided information regarding computer requirements and editing on Windows and Macintosh operating systems, optimizing educational value for the viewer. (*J Hand Surg Am.* 2022;47(5):471–474. Copyright © 2022 by the American Society for Surgery of the Hand. All rights reserved.)

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A SURGICAL VIDEO CAN IMPROVE patient care, surgical education, as well as scientific presentations and publications.^{1,2} Previous authors have outlined a basic understanding of how to produce high-quality surgical videos.^{3,4} These are more dependent on details of filming, such as the surgeon's point of view (POV) as well as appropriate zoom and focus, than on specific equipment. Modern

cellular phone cameras, budget video camcorders, or high-end video cameras can all produce high-quality videos. Capturing optimal surgical videos relies on the effective use of the camera, proper recording settings, appropriate setting up and framing of the shot, and thoughtful editing.

The creation of a high-quality surgical video depends on 2 equally important processes: filming the video and editing the video to produce the final product.

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CAMERA TERMINOLOGY

Resolution

Surgical videos can be shot in 1,080 full high definition and 2.7K or 4K ultra high definition. Moreover, 1,080 pixel (p) displays 1,920 × 1,080 p per inch, whereas 4K displays 3,840 × 2,160 p per inch.⁵ More pixels per inch create a higher resolution and a more detailed image. Surgical videos should be recorded with a minimum resolution of 1,080 p.

Although 4K recordings offer greater resolution, they generate large file sizes (approximately 4 GB for a 12-minute video), use more battery and memory, and require greater central processing unit processing power for editing. Shooting in a higher resolution, such as 2.7K or 4K, can be particularly advantageous for hand surgery procedures because it allows for substantial cropping of the image after production without compromising video quality.

Optical and digital zoom

Digital zoom uses a magnification technology within the camera to enlarge an area of the image. However, this also enlarges the pixels, reducing the image's resolution and overall quality. If a substantial amount of "zoom" is required, the image's quality decreases when enlarged. Cellular phone cameras often offer both optical and/or digital zoom. Optical zoom is the standard with which digital zoom is compared because it uses lenses to increase focal length, magnifying the image without compromising its resolution. However, the greater the optical zoom, the narrower the focal window for a clear image. Proprietary kits, zoom lenses, or cameras that allow for optical zoom do exist, greatly enhancing overall picture quality as long as the image remains in focus.

Shutter speed and frame rate

Shutter speed is the length of time the camera shutter is open, exposing light on the camera sensor. When using a long (slower) shutter speed, the camera sensor gathers a lot of light, and the resulting photo is brighter and/or whited out. Slower speeds also result in moving subjects appearing blurred. Frame rate is the number of images recorded per second of video. Thirty frames per second is standard and ideal for shooting most surgical videos. Recording at 60 frames per second is useful for showing a specific action in slow motion (but this increases file size). The ideal video shutter speed is approximately double the frame rate. Therefore, for recording at 30 frames per second, the shutter speed should be 1/60th of a second. Shutter speed often increases far beyond 1/60 in order to accommodate the brightness of operating room (OR) lighting. This is especially noticeable with light-emitting diode lights, which cause the "auto-shutter" function on the camera to increase to 1/480, leading to "flickering" of the image. To address this issue, a neutral-density filter can be used, which functions as "sunglasses" for the camera to provide a better image at a slower (1/60) shutter speed.

Smartphone video recording

The iPhone 7 or newer versions, as well as current android smart phones, are capable of shooting in 4K and generally have sufficient battery and memory storage for lengthy videos. Smartphones can be held in the hand or mounted on the head. A head mount allows for a more stable image and provides the surgeon's POV.

GoPro video recording (Video 1)

The GoPro brand of cameras makes compact action cameras. The GoPro Hero 6 model and newer versions are equipped with digital zoom. Various optical zoom-conversion kits and specially configured GoPro cameras that can provide superior image quality are available. Without optical zoom, there is a significant "fisheye" effect, and overexposure is often an issue. Light-emitting diode lights in the OR may increase overexposure and/or flickering in the video. In this instance, one may need to add a neutral-density filter for correction. Although they can record up to 4K, the GoPro camera's internal battery time is relatively short (approximately 50 minutes at this resolution). Therefore, some other accessories are needed to optimize recording using a GoPro camera. An external battery connected to the GoPro camera via a universal serial bus cable can increase battery time by approximately 9 hours. A fast memory card (128 or 256 GB "UHS Class 3" write speed) can provide increased data storage for the camera. An elastic head mount (\$8) can be used to record from the surgeon's POV. The benefit of using a simple action camera system, such as GoPro, is its low cost (\$300–\$500) and decreased overall complexity. The major downside is the lack of optical zoom, which, at times, can notably compromise image quality (Table 1).

See-what-I-see surgical video recording

The see-what-I-see surgical video system is a more expensive (\$1,500–\$4,000) recording system that expands upon GoPro cameras. It has a remote lens with a direct POV setup based on the surgeon's loupes and has optical zoom. It allows for a 1x–4x optical zoom while shooting in 4K and provides excellent resolution and picture quality. Additionally, it has a 10-hour remote battery. The image quality is outstanding; however, it is easier to miss the surgical field, and it may be more difficult to maintain image focus while using this system. The advantage is that it yields the best image quality, and the disadvantages are that it is expensive and more complicated than the standard GoPro camera.

TABLE 1. Suggested GoPro Settings for Surgery

1. Protune-on
2. Frame rate 30 FPS
3. Field of view is linear (with max digital zoom)
4. Resolution is 2.7K (digital zoom not currently available at 4K)
5. ISO (min 100, max 1,600)
6. White balance on auto
7. Sharpness is set on high
8. Color set on GoPro
9. Shutter speed is 1/60–1/480 depending on lighting
10. ND filter (ND 32)

FPS, frames per second; ISO, International Organization for Standardization; max, maximum; min, minimum; ND, neutral-density.

Keys for successful video recording: Set up your video camera prior to recording. Frame your shot prior to prepping and draping, which includes setting the image POV, chair and table heights, patient's arm or hand position, and OR lights. We recommend shooting videos from the surgeon's POV (as close as possible to the surgeon's eye level).⁶ Use a stable mount that minimizes ancillary motion.

Appropriate lighting is critical for shooting an excellent surgical video. Operating room lights that are too bright may lead to overexposure or shadowing, which is very difficult, if not impossible, to correct with video editing after production. Neutral-density filters can be used while shooting in bright light to avoid overexposure. Homogeneous lighting is better than focused lighting for the purpose of shooting a video. Therefore, defocus the OR lights onto the entire surgical field as opposed to the incision only. This results in less variation in lighting intensity.

Zoom in as much as possible without sacrificing resolution. The other tips for optimization include using dark-colored gloves and background (towels) while avoiding white background material (reduces glare). Try to keep the body part clean, and remove dried blood frequently. Remove lap sponges and Raytecs from the surgical field, and replace towels when they become soiled. In general, a dry field reduces image glare. During video shooting, have someone periodically check to ensure that the video is getting recorded and that the image remains centered.

Finally, while recording procedures that involve arthroscopy, an external video demonstrating portals and equipment should be viewed with the arthroscopy video. This can be made using the picture-in-picture concept so that the viewer is able to see the external video as well as the arthroscopy video.

EDITING

Personal computer video editing (Video 2)

Windows video editor can be used to edit videos; however, it may be underpowered for shooting high-quality surgical videos. Adobe Premiere Pro is an alternative professional video-editing program with many easy-to-use tutorials and online discussion forums. Editing a 4K video requires a powerful computer. One can initially degrade video quality for editing so that the computer runs faster, then export it in a high resolution. Videos can also be edited in Microsoft PowerPoint. Although this is generally better for short video clips rather than for an entire procedure, it can be used for either because the videos can be cropped, trimmed, and compressed. 4-K files must be compressed to be used in PowerPoint. An example of editing using the Windows video editor is available at: <https://www.youtube.com/watch?v=nUQO8KnwrCc>.

Mac video editing (Video 3)

The iMovie application is a free, powerful, and user-friendly software to edit surgical videos. Final Cut PRO is a professional editing program available for purchase that provides more features than iMovie, such as advanced color correction. The keyboard shortcut "command + B" greatly speeds up workflow by allowing 1 clip to be split into 2. This command speeds the editing process because it is the most commonly performed task throughout the video production process. A detailed video on the workflow or demo of the editing process for surgical videos using iMovie is available at: <https://www.youtube.com/watch?v=ffwBEn0wvOc>.

Universal tips for video editing

Ideally, an i7 multicore processor or a better version with a minimum of 32 GB of random-access memory is needed. A good graphics card, 1-TB solid-state drive operating system, and 4-TB disk drive storage are also required for the editing of a 4K video. For editing 1,080 p videos, a less powerful system will suffice.

Remove the audio from the video files. Crop (functions like zoom) the image as much as possible so that the incision takes up the entire screen without compromising resolution. Compliance with the Health Insurance Portability and Accountability Act is required: any visual identifiers specific to the patient (tattoos, anatomic anomalies, birthmarks, and scars) should be blurred out during the editing process. Initially, edit the video on a macro level, and

further edit small or micro details with each run-through of the video. Finish editing the video before adding the audio portion. This can be done in a few ways. Audio can be inexpensively recorded using a standard headphone with a built-in microphone. The Yeti Blue microphone can be used for more refined audio recordings. The addition of a “pop” filter avoids excessively percussive consonants and mellows the overall dialogue. Voice overs can be recorded as a voice memo on a smartphone and imported to the video. In most video-editing software, it is possible to record audio directly through the editing program. It may be useful to watch the entire video a few times before recording to rehearse the timing of pairing the audio with the visual.

Once finished, convert the video to .mp4 format, which is a universal format. Finally, we recommend computer backup to avoid losing data. There are a variety of backup options, including local and offsite options. Although there is no clear superior choice, we find cloud programs, such as Dropbox, Box, and iCloud, easy to use. Lastly, when starting out, choose a short procedure in order to establish your workflow before taking on bigger projects.

SURGICAL VIDEO FORMAT

The goal should be to allow the surgeon watching the video to go to the OR the next day and perform the procedure. Full-length surgical videos detailing the entire surgery from start to finish (length 1–2 hours) can be helpful for weekend viewing and preparation prior to a planned complex surgical procedure. However, shorter videos (5–8 minutes) are ideal as a refresher between surgical procedures on a busy OR day to quickly brush up prior to starting the procedure.⁷ Surgical videos should be surgical step oriented with clear time progression from start to finish. A slide detailing the major steps with their associated times delineated can be included in the video itself. Clinical vignettes detailing the patient’s preoperative history and physical examination, as well

as generalized surgical indications and contraindications, may also be included. The addition of post-operative outcomes with associated supporting literature and references can further enrich the surgical video, making it more interesting and memorable for the viewer. Two versions of a surgical video can be made to optimize learning for the audience (a longer full-length video, detailing each individual step, and a shorter one lasting 5–8 minutes meant as a quick refresher to be viewed immediately before starting the procedure). The primary goal is to be informative and educational. Therefore, it is critical to avoid making a “highlight film” because steps that do not work are often just as important as those that are successful. Similarly, taking time to describe pearls with regard to patient positioning, x-ray setup, draping, retracting, job of OR assistants, etc can add substantial educational value to the video and should be included if warranted.

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