Educational Video Recording and Editing for the Hand Surgeon

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Digital video recordings are increasingly used across various medical and surgical disciplines including hand surgery for documentation of patient care, resident education, scientific presentations, and publications. In recent years, the introduction of sophisticated computer hardware and software technology has simplified the process of digital video production and improved means of disseminating large digital data files. However, the creation of high-quality surgical video footage requires a basic understanding of key technical considerations, together with creativity and sound aesthetic judgment of the videographer. In this article we outline the practical steps involved in equipment preparation, video recording, editing, and archiving, as well as guidance for the choice of suitable hardware and software equipment. (J Hand Surg Am. 2015;40(5):1048–1054. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

Key words: Equipment, video editing, video recording/instrumentation, software.
(OR) that can be effectively integrated into the hand surgeon’s daily practice.

Creating a surgical video involves 4 sequential and reproducible steps, including equipment preparation, video recording, video editing, and finally video archiving and distribution for publication and/or presentation of the recorded material.

**EQUIPMENT PREPARATION**

Before video capture takes place, the hand surgeon must first acquire the equipment necessary to record and then edit the procedure of interest (Table 1). The camera used for video recording is one of the most important pieces of equipment for this process. Several types of cameras are suitable for recording surgical videos; these include operating room light handles with built-in cameras, remote-controlled cameras mounted on metal tripods, and new-generation wearable devices such as head-mounted cameras, among others. In our institution, we prefer to use a high-definition handheld camcorder without a special lens or accessories because they are easy to operate and provide a quick and consistent method of video recording in both the clinic and OR settings. We use a point-and-shoot camcorder Sony Handycam HDR-CX160 (Sony, Minato, Tokyo, Japan) with a swivel liquid crystal display side flat screen attached to the camera with a flexible hinge that allows the operator to move the camera in different directions and shoot from a wide range of angles (Fig. 1). Camcorders are relatively inexpensive; the average price of a modern handheld video camera ranges between $300 and $700. However, the disadvantage of handheld cameras is the need for a dedicated person to operate the camera steadily without tremor.

Although most camcorders are calibrated (ie, default settings) to capture the highest-quality images automatically, it is important for the operator to have a basic understanding of the camera manual of operations as well as its features and associated lens equipment. A video camera has 3 main elements: the lens, an imaging device (sensor), and a recorder. The lens gathers and transmits light reflected off an object and focuses it on the imaging device. Subsequently, the imaging device transforms light waves into electrical signals, which are then converted into video pictures by the recorder. The auto-iris of the lens or diaphragm known as the aperture controls the amount of light transmitted (exposure) through the lens and the depth of field (DOF). The aperture of the lens opens and closes to adjust the light exposure of the image so that it is neither too dark nor too bright. The DOF is the area between the closest and the farthest objects in an image that appears in focus. Areas in front and beyond the DOF will appear blurry. A large DOF (also known as deep focus) increases the sharpness of the entire image, whereas a small DOF (shallow focus) keeps a small plane of the image in focus while the rest of the image is out of focus. At a given magnification, decreasing the aperture increases the DOF, and vice versa. For medical video recordings, it is therefore recommended to use a small aperture and a large DOF to keep the whole image in focus and capture important anatomical details.

**VIDEO RECORDING**

After equipment needed to record a surgical video is assembled, informed consent should be obtained to seek patients’ permission to use the recorded material for purposes of academic publications, to comply with Health Insurance Portability and Accountability Act regulations. The patient’s face must not be shown while recording a hand procedure and other patient identifiers such as name, address, or hospital number must not be identified.

Recording a good video depends not only on camera specifications but also on the skills of the videographer in selecting the correct position, angle, and distance that should clearly demonstrate the procedure of interest. Poorly recorded video footage can be detrimental to the final product and often cannot be salvaged later. The first step in recording involves correct and consistent positioning of the camera operator directly behind the surgeon to record videos from the surgeon’s view (Fig. 1). Frequent change of view from the surgeon and the assistant’s perspectives is disruptive to viewers in understanding the anatomic features of the operation. During recording, the surgical field should be cleared of equipment not in use (eg, retractors, scissors, metal forceps, cotton gauze) and surgeons and assistants

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**TABLE 1. Necessary Equipment for Production of Surgical Videos**

| 1. Camera (eg, handheld camcorder) |
| 2. Desktop or notebook computer |
| 3. Video editing software |
| 4. Storage devices (eg, flash drive, external hard drive > 1 TB) |
| 5. External/built-in microphone |
| 6. Connectors, adaptors, cables, and a spare fully charged battery |
should not obstruct the view. The surgical field should also be cleaned of bloodstains and debris as much as possible so that the viewers’ attention is not detracted (Fig. 2). Prolonged shooting should be avoided because 15- to 30-second shots should suffice to capture the key steps of an operation. For example, there is no need to capture a long sequence of exposure or skin closure. Furthermore, the surgeon and video operator should have constant communication during the operation to capture critical steps. The camera operator should therefore be familiar with the procedure performed and prepare a storyline beforehand so that the recorded video illustrates a concise and coherent sequence that includes all of the important steps of the procedure.

Other factors should be considered when filming surgical videos, such as image centration, zooming, light and sound, and the use of suitable background material. For image centration, first adjust the screen settings to standard definition image quality with an aspect ratio of 4:3 (4 units width to 3 units height) as opposed to a widescreen aspect ratio of 16:9. A video recorded as 4:3 ratio should not be played back on a widescreen of 16:9 because this will leave dead zones on both sides of the screen; the opposite is also true. Correct settings of the screen allow the camera operator to control how much territory to include in the shot frame and correctly place an object in the center relative to screen edges (image centration). For example, when recording a hand procedure, the hand should lie in the center of the image with the longitudinal axis parallel to that of the captured view. In the meantime, it is useful to shoot a perspective view of the entire limb or a surgical area before zooming in or shooting a close-up so that viewers do not lose subject orientation (Fig. 3).

Zooming is essential for close-up views and to record small details of surgical procedures. Recording fine anatomical details requires use of different types of image magnification such as camera zoom and macro mode. Camcorders typically have 2 types of zooming properties: a digital zoom and an optical...
The digital zoom is not considered a true zoom because it enlarges recorded image electronically by cropping and magnifying existing pixels without adjusting camera optics that may result in a low-resolution image. Nevertheless, most new cameras have a large digital zooming capacity that reach up to 10 megapixels; thus, the image quality remains acceptable with moderate zooming. Optical zoom, on the other hand, brings the object closer by adjusting lens optics without altering image resolution. When bringing the field of view closer using digital or optical zoom or a combination of both, much of the background area and other adjacent relevant details are lost. In this case, a macro mode (usually designated as a symbol of a small flower) can be automatically adjusted while moving the camera closer to the subject.13 Macro mode in some way resembles surgical loupes and is important for capturing fine anatomical details of a subject without the excessive use of zoom so that it keeps the image in focus. A common mistake when recording surgical procedures is to zoom in and out frequently, which causes visual disturbance and should be avoided.

The OR headlights may also affect recorded image quality. Too much light may cause overexposure of images. A slightly underexposed image is preferred. If possible avoid using OR yellow lights because a nonuniform light may create shadows and lowers image quality. Instead, ambient OR fluorescent light or surgical light-emitting diode lights currently available in newly equipped ORs should be used. Regarding audio, the surgeon may record the voice-over during surgery or after video editing. If voice is recorded during surgery, it is best to use a hardwired lava-microphone because electrocautery will interfere with a wireless system. When capturing a video in clinic and recording patients’ conversations, the built-in camera microphone is sufficient.

Last is the background of an image, which can have a substantial effect on image quality. A sky blue or a green surgical towel is a suitable background material when recording surgical videos.8,14 Because consistency is also an important factor, especially when showing a series of footage of the same subject taken at different time intervals, we prefer to use standard 60 × 40-cm green surgical towels in both the clinic and the OR.

There is a steep learning curve for taking good surgical videos. Coordination between the camera operator and the surgeon is essential and needs careful preparation and practice. The surgeon should also take more time and perform the surgery slower than usual during recording without compromising the outcome of the procedure. This can prove to be a large investment in time and efficiency because subsequently the raw video footage will take less time and effort to edit.

### TABLE 2. Commercially Available Video Editing Software

<table>
<thead>
<tr>
<th>Mac Computers</th>
<th>Windows Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adobe Premiere Pro</td>
<td>Adobe Premiere Elements</td>
</tr>
<tr>
<td>Avid Xpress Pro</td>
<td>Adobe Premiere Pro</td>
</tr>
<tr>
<td>Avid Media Composer</td>
<td>Avid Liquid</td>
</tr>
<tr>
<td>iMovie</td>
<td>Avid Xpress Pro</td>
</tr>
<tr>
<td>Final Cut Pro</td>
<td>Avid Media Composer</td>
</tr>
<tr>
<td>Media 100 HDe</td>
<td>Corel Video Studio</td>
</tr>
<tr>
<td>Media 100 SDe</td>
<td>Movie Maker</td>
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<tr>
<td></td>
<td>Pinnacle Studio</td>
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<tr>
<td></td>
<td>Sony Vegas Movie Studio</td>
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</tbody>
</table>

VIDEO EDITING

Nonlinear video editing is the modern way of editing digital video files by having a direct access to video clip frames to change their visual or audio content,
rearrange order, or add transitions and text without destroying or permanently altering the original video source. These programs allow cutting and pasting video together the same way we cut and paste sentences or paragraphs in a word-processing document. Several video editing programs are commercially available for Mac and Windows computers with easy-to-use interfaces both in basic and advanced settings (Table 2). The choice of computer and editing software is a matter of personal preference. For video editing, we use iMovie (Apple Computer, Cupertino, CA) on Apple computers or Sony Vegas Studio (Sony, Minato, Tokyo, Japan) on Windows (Microsoft, Redmond, WA) operated devices, which are both appropriate for beginner and intermediate-level users.

After selecting the appropriate editing program, recorded videos should be downloaded from the camera to the desktop or notebook. Video files can be imported directly and stored in the directory of the editing software. Alternatively, a separate folder can be created on the computer to store video files. The latter is preferred to avoid damaging video content stored within the library of the editing program, which may occur unexpectedly. Furthermore, still images of radiographs, computed topography, and magnetic resonance angiography can be stored within the same folder and incorporated into the video when needed. Once all media material is gathered, video editing starts by opening the editing program and importing recorded videos and captured images.

Most editing programs have 3 workstations: a video timeline track that displays original non-edited video footage, a storyboard that shows edited video clips, and a monitor screen to preview adjustments made to video frames (Fig. 4). First, preview the whole video within the timeline track to see which segments need to be incorporated into the final video. Then drag and drop desired segments from the timeline track to the storyboard space. This process is repeated until all unwanted portions of the original video are excluded. Video segments moved to the storyboard should include only relevant and important steps of the surgical procedure and the total video length should be substantially shorter than the original video (rough editing). The total duration of the final video should be no longer than 3 to 5 minutes. Adjustments are made by advancing selected clips frame by frame, allowing the editor to cut, trim, rearrange, and choose the best image with which to start and end each sequence. Further fine-tuning of the edited video is made by adjusting exposure, saturation, contrast, and brightness of selected images as necessary (Fig. 5). This creates a homogeneous video stream that is easier and more comfortable for the viewer’s eye to follow. In addition, video images can be cropped to exclude undesired territories or rotated and aligned for an optimum view. A precision editor, an editing tool, allows further tuning of the speed of each segment in seconds or milliseconds according to the editor’s discretion. Moreover, text, titles, annotations, and transitions can be added to the

FIGURE 4: iMovie (Apple Computer), an easy-to-use interface that provides basic and advanced nonlinear editing capabilities. As shown here, most video editing software programs have 3 workspaces: a timeline track that shows the whole video footage, a storyboard that consists of edited video clips, and a preview screen.
video as required. Transitions inserted between clips are particularly useful in creating a smooth flow of the video stream. Finally, for high-quality display, we add the video stabilizer option for the entire length of the video to produce a smooth clip motion and reduce motion distortions (see Video 1, available on the Journal’s Web site at www.jhandsurg.org).4,6,16

A voiceover is added after splitting the audio from the visual component of the video. It is best to record voiceovers in a sound studio if it is affordable. If it is not possible to record the voiceover in a sound studio, the audio narration can be recorded in a quiet room after turning off all electronic equipment such as pagers, mobile phones, and air conditioning, to minimize background noise. Furthermore, voiceovers are best added after editing is completed, rather than during surgery, because as cuts are made during video editing the narration may become discontinuous. The length of each video clip should fit its corresponding commentary or narration.11

**TABLE 3. Digital Video File Formats Supported by Windows and Mac Computers**

<table>
<thead>
<tr>
<th>Video File Extension</th>
<th>Description</th>
<th>Windows Computers</th>
<th>Mac Computers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVI</td>
<td>Creates large uncompressed files; despite large file size remains a popular option.</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>MPEG-1</td>
<td>Most compressed, resolution of 352 × 288 pixels. Suitable for PowerPoint presentations. Newer versions of PowerPoint support higher resolutions.</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>MPEG-2 and MPEG-4</td>
<td>High resolution, 720 × 480 pixels (DVD quality). MPEG-4 is a newer version that takes smaller storage space and is suitable for portable devices.</td>
<td>√,†</td>
<td>√</td>
</tr>
<tr>
<td>WMV</td>
<td>High-definition resolution: 1,280 × 720 pixels (720 p) or 1,920 × 1,080 (1,080 p) pixels</td>
<td>√</td>
<td>–</td>
</tr>
<tr>
<td>MOV</td>
<td>High-definition resolution: 1,280 × 720 pixels (720 p) or 1,920 × 1,080 (1,080 p) pixels</td>
<td>√,†</td>
<td>√</td>
</tr>
</tbody>
</table>

*Mac OS X v10.6.x or later.
†MPEG-4 and Apple Quick Time Mov. extensions are supported only on the latest version of Windows Media Player 12 on Windows devices.

**VIDEO PREPARATION FOR PUBLICATION/PRESENTATION AND ARCHIVING**

Once the video material is fully edited and audio narration is added, the video can be rendered (process of
finalizing video product from source files in an edited project) and saved as a movie file. The duration and quality of edited videos files should be formatted to best serve the purpose of their intended use. Surgical videos can be generally disseminated through podium presentations, on-line Web streaming, or podcasts or submitted to journals for publication along with scientific manuscripts. For submitting videos with manuscripts, authors are encouraged to check individual journal requirements beforehand. For example, videos submitted to the Journal of Hand Surgery should comply with the journal’s formatting and image quality requirements (www.jhandsurg.org).17

Several video compression formats can be used to save and export finalized videos, including audio video interlaced, one of the oldest uncompressed formats with high resolution and largest file size. The Moving Picture Experts Group (MPEG-1, MPEG-2, MPEG-4 file compression formats) was formed by the International Organization for Standardization and International Electrotechnical Commission to set the standards for coding of audio and moving pictures. Other video compression formats include Windows Media Video and MOV. (Apple QuickTime Player) (Table 3).12,15,18–20 The Journal of Hand Surgery accepts QuickTime and MPEG formats for video submission and XML file extensions for on-line Web streaming.17

The importance of regularly backing up and archiving cannot be overemphasized. A single hard drive crash can cost hours of work and loss of precious material. Moreover, as the video library expands, it becomes more problematic to manage and store edited videos on traditional hard disks or DVDs. For these reasons, we use an external hard drive with a storage capacity that reaches up to 20 terabytes (Drobo, Inc, San Jose, CA) and consists of multiple replaceable hard drives. Using several hard drives for storage protects the data. If one drive fails, data can be retrieved from other hard drives. The final step is tagging and arranging videos thumbnails so that they can be easily retrieved by typing into the search box patient name, hospital number, or name of the procedure.15

High-quality video recordings are essential for documenting patient care and teaching, and for scientific publications and presentations. Digital video recording, editing, and archiving are now easily achieved within a reasonable budget. Basic knowledge of hardware and software equipment is essential to enable consistent production of high-quality videos. To improve the learning curve, it is advisable to seek help from colleagues who have more experience in the video editing process, read literature, watch training DVDs, or attend an instructional course such as those organized by professional bodies such as the American Society for Surgery of the Hand.

REFERENCES