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Educational Video Recording and Editing for The Hand Surgeon

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Abstract

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 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 with equipment preparation, video recording, editing and archiving as well as guidance for the choice of suitable hardware and software equipment.

Keywords

Equipment; Video Editing; Video Recording/instrumentation; Software

Video recordings are essential for scientific presentations, research, and patient education. (1-3) Video illustrations also facilitate effective physician-to-physician communication, enhance teaching and maximize audience's attention and retention. In hand surgery, capturing dynamic images has added advantages over standard still photography. Video footage can help to identify changes of patients' range of motion before and after surgery and facilitate documentation of patients' examination over time. For the hand surgeon, video recording and editing offers a good opportunity (especially the junior surgeon) to review critical steps of the surgical procedure and reflect on what he or she could improve the next time. (4).

Over the past decades, recording a surgical video was considered to be a difficult task that often required hiring professional personnel and the use of large and heavy equipments. Additionally, captured videos were stored on analog VHS tapes before they were converted to digital files then transferred to computers thus creating numerous quality and compatibility issues. Currently these equipment and technical issues are becoming less of a

concern. The availability of smart pocket-sized camcorders allows surgeons to capture their own videos and provide an economic and more practical alternative to using archaic expensive and large equipment. Furthermore, digital files can now be easily transferred directly from the camera to computer for further video processing by using small sized memory cards with high storage capacity.

The purpose of this article is to provide a step-by-step approach of how to create professional surgical videos recorded in the clinic and the operating room (OR) that can be effectively integrated into the hand surgeon's day-to-day practice.

Creating a surgical video involves 4 sequential and reproducible steps, these include: 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, one must first acquire the equipment that he/she needs to record then edit the procedure of interest (Table 1). The camera used for video recording is one of the most important equipment for this process. Several types of cameras are suitable for recording surgical videos, these may include: operating room light-handles with built-in cameras, remote-controlled cameras mounted on metal tripods or new generation wearable devices such as head-mounted cameras, among others. (1, 3-6) In our institution, we prefer to use high definition hand-held camcorder without any special lenses or accessories because they are easy to operate and provide a quick and consistent method of video recording both in the clinic and operation room settings. (6) We use a point-and-shoot camcorder Sony Handycam HDR-CX160 (Sony, Minato, Tokyo), 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, with the average price of a modern handheld video camera ranges between \$300-\$700. However the disadvantage of hand-held cameras is the need for a dedicated person to operate the camera steadily without tremor.

Although most camcorders are calibrated (i.e. default settings) to automatically capture the highest quality images, it is important that the operator has 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. (7) 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. The aperture of the lens opens and closes to adjust light exposure of the image so that it is neither too dark nor too bright. The depth of field (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) keep 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. (7-8)

Video recording

Following the assembly of equipments needed to record a surgical video; an informed consent should be obtained to seek patients' permission to use the recorded material for purposes of academic publications in order to comply with Health Insurance Portability and Accountability Act regulations (HIPAA). One must make sure not to show the patient's face while recording a hand procedure or any other patient identifiers such as name, address or hospital number. (8-9).

Recording a good video does not only rely 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. A 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). (8,10-11) Frequent change of view from the surgeon and the assistant's perspectives is disruptive to the viewers in understanding the anatomic features of the operation. During recording, the surgical field should be cleared of equipment not in use (e.g. retractors, scissors, metal forceps, cotton gauze etc.) or surgeons and assistants obstructing the view. The surgical field should also be cleaned of any bloodstains and debris as much as possible so that the viewers' attention is not detracted (Fig. 2). Prolonged shooting should be avoided because 15-30 seconds 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 the video operator should have a constant communication during the operation to capture critical steps of an operation. The camera operator should therefore be familiar with the procedure performed and prepare a storyline beforehand so that the recorded video illustrates concise and coherent sequence that includes all of the important steps of the procedure.

Other factors should also be considered when filming surgical videos, such as image centration, zooming, light and sound and the use of a suitable background material. (12) 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 wide screen aspect ratio of 16:9. Playing back a video recorded as 4:3 ratio on a wide screen of 16:9 is not recommended because this will leave dead zones on both sides of the screen, while the opposite is also true. The 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). (7,12). For example, when recording a hand procedure, the hand should lie in the center of the image with its 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 recording small details of surgical procedures. Recording fine anatomical details requires utilization of different types of image magnification such as camera zoom and macro mode. Camcorders typically have two types of zooming properties, a digital zoom and an optical zoom. The digital zoom is not considered a true zoom because it enlarges recorded image electronically by cropping and magnifying existing pixels without adjustment of camera optics that may result in 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. The optical zoom on the other hand, brings the object closer by adjusting lens optics without altering image resolution. It should also be stated that when bringing the field of view closer using digital or optical zoom or a combination of both, you lose much of the background area and other adjacent relevant details. In this case a macro mode (usually designated 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 use excessive zoom so that it keeps the image in focus. A common mistake when recording surgical procedures is the frequent use of zoom in and out, which causes visual disturbance and should be avoided.

The OR headlights may also affect recorded image quality. Too much light may cause over exposure of images. A slightly under-exposed image is preferred. If possible avoid using OR yellow lights because a non-uniform light may create shadows and lowers image quality. Instead ambient OR fluorescent light or surgical LED (light emitting diode) lights currently available in newly equipped OR(s) should be used. Regarding audio, the surgeon may record the voiceover during surgery or after video editing. If voice is recorded during surgery, it is best that the surgeon use a hard-wired lava-microphone as using 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. Either a sky-blue or a green-colored 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 cm × 40 cm green surgical towels both in the clinic and the operating room.

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 big investment in time and efficiency because subsequently the raw video footage will take less time and effort to edit.

Video editing

Non-linear 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 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). (4,6,15-16) The choice of computer and editing software is a matter of personal preference. For video editing, we use iMovie (Apple Computer, Cupertino, Calif) on Apple computers or Sony Vegas Studio (Sony, Minato, Tky) on Windows (Microsoft, Redmond, Wash.) 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/notebook. Video files can be imported directly and stored into the directory of the editing software. Alternatively a separate folder can be created on the computer to store video files. The latter is preferred in order to avoid damage of video content stored within the library of the editing program that may occur unexpectedly. Furthermore, still images of radiographs, computed topography or magnetic resonance angiography can also 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 of 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). (16) 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 only include 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 3-5 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. (4) 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 homogenous video stream that is easier and more comfortable for the viewer's eye to follow. Additionally, 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/milliseconds according to editor's discretion. Moreover, text, titles, annotations and transitions can also be added to the video as required. Transitions inserted in 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). (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 one can afford it. If it is not possible to record the voiceover in a sound studio, then the audio narration can be recorded in a quiet room after turning off all electronic equipments such as pagers, mobile phones and air conditioning in order to minimize the background noise. Furthermore, voiceovers are best added after editing is completed and not during the 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)

Video preparation for publication/presentation and archiving

Once the video material is fully edited and audio narration is added, the video can then 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 its intended use. Surgical videos can be generally disseminated through podium presentations, online web streaming, podcasts or submitted to journals for publication along with scientific manuscripts. For submitting videos with manuscripts, authors are encouraged to check individual journals' 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. These include; AVI. (Audio video interlaced) which is 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 ISO/IEC (International organization for standardization and International Electrotechnical commission) to set the standards for coding of audio and moving pictures. Other video compression formats include WMV (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 online web streaming. (17)

The importance of regular backup and archiving cannot be over emphasized. 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 San Jose, CA, Inc.) and consist of multiple replaceable hard drives. Storing on several hard drives 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 in the search box either patient name, hospital number or name of the procedure. (15)

In summary high quality video recordings are essential for documentation of patient care, teaching, scientific publications and presentations. Digital video recording, editing, and archiving are now easily achieved within a reasonable budget. A 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 video editing process, read literature, watch training DVDs or attend an instructional course such as those organized by professional bodies such as the ASSH (American Society for Surgery of the Hand).

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Figure 1.
A standard hand-held camcorder with a swivel LCD screen that allows the videographer to shoot from different directions. Note the best position of the camera operator is directly behind the surgeon to capture surgeon's view.

Figure 2. Shows an example of bad and good video shots. The left hand screen shot shows bloodstained gauze and unused surgical equipment that distracts viewers' attention. In contrast, the screen shot on the right hand side shows a 'clean' view after removing bloodstains and other unnecessary equipment so that the observer can concentrate on area of interest within the surgical field.

Figure 3.

An example of two screen shots demonstrating capture of a perspective shot of the entire surgical field (left) followed by a close-up view that focus on area of interest (right), which is important when filming surgical procedures so observers don't lose anatomical orientation.

Figure 4.
iMovie (Apple Computer, Cupertino, Calif) an easy to use interface that provides basic and advanced non-linear editing capabilities. As shown here most of video editing softwares have three workspaces, a timeline track that shows the whole video footage, a storyboard that consists of edited video clips and a preview screen.

Figure 5. Demonstrating tools for color grading and settings for exposure, brightness, contrast and saturation that can be manipulated to produce a high quality video.

Table 1

Necessary equipment for production of surgical videos.

1. Camera (e.g. hand-held camcorder)
2. Desktop or notebook computer
3. Video editing software
4. Storage devices (e.g. flash drive, external hard drive >1TB)
5. External/built-in microphone
6. Connectors, adaptors, cables and a spare fully charged battery

Table 2

Commercially available video editing softwares

Mac computers	Windows computers
Adobe Premiere Pro	Adobe Premiere Elements
Avid Xpress Pro	Adobe Premiere Pro
Avid Media Composer	Avid Liquid
iMovie	Avid Xpress Pro
Final Cut Pro	Avid Media Composer
Media 100 HDe	Corel Video Studio
Media 100 SDe	Movie Maker
	Pinnacle Studio
	Sony Vegas Movie Studio

Table 3

Digital video file formats supported by Windows and Mac computers

Video file extension	Description	Windows computers	Mac computers *
AVI.	Creates large uncompressed files despite large file size remains a popular option.		
MPEG-1	Most compressed, resolution of 352 pixels × 288 pixels. Suitable for PowerPoint presentations. Newer versions of PowerPoint support higher resolutions.		
MPEG-2 & MPEG-4	High resolution, 720 × 480 pixels (DVD quality). MPEG-4 is a newer version that takes smaller storage space and is suitable for portable devices.	[‡]	
WMV.	High definition resolution 1280×720 pixels (720p) or 1920×1080 (1080p) pixels		-
MOV.	High definition resolution 1280×720 pixels (720p) or 1920×1080 (1080p) pixels	[‡]	

[‡] MPEG-4 and Apple Quick Time Mov. Extensions are only supported on latest version of windows media player 12 on windows devices.

* Mac OS X v10.6.x or later