Evaluation of Operative Imaging Techniques in Surgical Education

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ABSTRACT

Background: Certain open surgical procedures are difficult to observe, and poor visualization of the surgical field results in a compromised teaching environment for residents and medical students. In an attempt to improve the visualization of the open surgical field, we performed an open surgical procedure while viewing it via a laparoscope mounted to the side of the operating room table with an alpha port. These images were then compared in a blinded fashion with images from a boom-mounted camera positioned above the surgical field and a head-mounted camera positioned on the operating surgeon.

Methods: Participants viewed all 3 images from a remote location in a blinded, random fashion. All participants then completed a Likert questionnaire evaluating each image.

Results: Fourteen participants were in the study. The alpha port/laparoscope image was superior to the headcam image in all 8 categories. The alpha port/laparoscope image was superior to the sky-cam image in 4 of 8 categories. All 14 participants felt the alpha port/laparoscope image would benefit surgical education.

Conclusions: Use of a laparoscope mounted via an alpha port to an operating room table provides superior images during open surgery. This provides a unique and affordable way to teach residents and medical students operative procedures that are otherwise difficult to view.

Key Words: Surgical education, Laparoscopy.

INTRODUCTION

One advantage laparoscopy has over traditional open surgery is an excellent view of the operative field that can be shared by all persons involved in the surgical procedure. Often, open procedures provide suboptimal visualization for surgical residents in training because of the size of the skin incision or its location. Often this translates into a poor operative educational experience for the more junior members of the surgical team. We chose to perform an open surgical procedure while viewing it via a laparoscope mounted to the side of the operating room table with an alpha port. These images were then compared in a blinded fashion with those from a boom-mounted camera positioned above the surgical field and a head-mounted camera positioned on the operating surgeon.

METHODS

Participants viewed either a thyroidectomy or a parathyroidectomy performed by the same surgeon and resident. All 3 camera systems were positioned identically for each procedure. During the procedures, all 3 video images (see inset) were transmitted via an internet protocol line at 1.5 megabytes to a remote videoconference center. From this location, all participants viewed either surgical procedure in real time and critiqued the images in a blinded, random fashion. All participants evaluated each image and completed a Likert questionnaire (Figure 1).

Boom-Mounted Image: Sky-Eye Camera (Overhead Camera Systems Inc., Wichita, Kansas)

A Hitachi 3CCC HVC-20 camera is mounted on a large hydraulic-powered boom that is controlled by a joystick and connected to a JVC video monitor (Figure 2). The sky-cam was positioned over the operative field for the duration of the study.

Head-Cam Image: Wehmerlite Headlite/Video Camera System (BFW-Louisville, Kentucky)

A 24-mm camera lens is attached to a cable with 200 Lux illumination with 110 volt input. It produces 460+ lines of horizontal resolution. The camera was mounted on the
operating resident throughout the procedure. Prior to the procedures, this image was centered on the operative field (Figure 3).

**Alpha-Port Image**

A 45-degree laparoscope was positioned in a low-profile angle facing the operative field. It was held in place by the Alpha-port (Computer Motion, Inc, Goleta, CA), which is a device mounted on the right side of the patient’s bed and through which the laparoscope is passed to stabilize it and provide a pivot point (Figure 4). The telescope was attached proximally to an Aesop robot (Computer Motion, Inc, Goleta, CA) affixed to the operating table on the patient’s right side (Figure 5). Aesop was controlled by the surgeon’s voice throughout the procedure. The laparoscope was attached to standard laparoscopic video equipment (Stryker Endoscopy, Santa Clara, CA) and visualized on a 20-inch Sony medical color video monitor model PVM-20M2MDU (Sony Corporation, Tokyo, Japan).

**Statistical Analysis**

Means were assessed using analysis of variance, and Fisher’s exact test was used for analysis of frequency data.

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| Color of the image         | Poor color | 1 2 3 4 5 6 7 8 9 10 | Excellent color |
| Clarity of the image       | Poor clarity | 1 2 3 4 5 6 7 8 9 10 | Excellent clarity |
| Amount of motion artifact  | Significant amount | 1 2 3 4 5 6 7 8 9 10 | Negligible amount |
| Overall quality of the image | Poor quality | 1 2 3 4 5 6 7 8 9 10 | Excellent quality |
| Ability to visualize the surgical field | Poor visualization | 1 2 3 4 5 6 7 8 9 10 | Excellent visualization |
| Ability to understand the surgical orientation | Difficult | 1 2 3 4 5 6 7 8 9 10 | Easy |
| Ability to identify the anatomy | Difficult | 1 2 3 4 5 6 7 8 9 10 | Easy |
| Ability to follow the operation | Difficult to follow | 1 2 3 4 5 6 7 8 9 10 | Easy to follow |
| Do you feel this image would benefit surgical education? | Yes No (circle one) |

**RESULTS**

The study included 14 participants, 9 females and 5 males. Mean age was 34. Eight had a medical background (ie, medical student or resident); 6 had no medical background. The results of the questionnaire are listed in Table 1. The alpha port/laparoscope image was significantly better than the head-cam image in all categories ($P<0.001$). The alpha port/laparoscope image was superior to the sky-cam image in 4 categories: color of image, clarity of image, overall quality of image, and visualization of the operative field ($P<0.009$). The alpha port/laparoscope image was equivalent to the sky-cam image for the remaining 4 categories: amount of motion artifact, ability to understand the surgical orientation, ability to identify the anatomy, and ability to follow the operation ($P>0.05$).

All 14 participants felt the alpha port/laparoscope image would benefit surgical education ($P=0.0002$) (Table 2). Upon fractionating the results of the medical versus the nonmedical participants, the only categories in which the medical participants scored significantly higher than the nonmedical participants were in ability to understand the surgical orientation ($P=0.03$) and ability to follow the operation ($P=0.02$).
DISCUSSION

Since the time of Halsted, surgery has been taught in a mentoring fashion between surgeon and trainee. One of the problems associated with the classic Halstedian teaching method is the lack of visualization of the operative field to more junior members of the surgical team. Particularly for procedures with a limited exposure, this can result in a compromised experience for junior residents, medical students, and other trainees.

As a result, various imaging modalities have emerged to overcome the inability to see the operative field. One such modality is the head-cam, in which the operating surgeon wears a camera mounted to his or her head with the camera focused on the operative field. The obvious drawback to such a system is that any movement away from the operative field translates into motion artifact for the viewer.

A second imaging modality is the sky-cam in which a camera fixed to a boom is lowered over the surgical field. Although excellent images can be obtained with such a device, the drawback is that the operating surgeon and...
assistants often block the field of view resulting in an obscured image.

With the advent of laparoscopy, many of the above-stated problems associated with traditional open surgery have been eliminated. A significant achievement occurred in 1986 with the introduction of the solid state camera. This allowed a laparoscopic image to be transmitted electronically to a video monitor, allowing the entire surgical team to view the operative field.

We applied the optical principles of the laparoscopic image to an open surgical procedure, in essence, obtaining all of the visual advantages of laparoscopy in an open surgical procedure.

Thyroidectomy and parathyroidectomy were chosen as typical for 2 major problems often encountered while attempting to teach surgical residents and medical students: visualization through a small incision, and secondly, the location of an operative field that is difficult to visualize because it is often obscured by the surgeon and assistant.

In this study, all participants felt the alpha port/laparoscope image would benefit surgical education. Although we chose to control the laparoscope with the use of the Aesop robotic arm (Computer Motion Inc, Goleta, GA), this is not essential to accomplish the goals of projecting a high-resolution image onto a monitor for residents/students to view. The laparoscope can simply be mounted onto the side of the operating room table with the alpha port and the scope manually positioned as seen fit by the operating surgeon. The ready availability of laparoscopic equipment in most operating rooms makes this unique approach of teaching very affordable for surgical training programs.

In this study, we chose to transmit the images to a computer-generated video monitor, allowing the entire surgical team to view the operative field.

Table 1.

|                        | Alpha Port/Laparoscope | Sky-Cam | Head-Cam |
|------------------------|------------------------|---------|----------|
| Clarity of image       | 9.1±.8                 | 5.6±1.8 | 6.5±2.7  |
| Amount of motion artifact | 8.9±.6               | 6.2±2.6 | 5.7±3.0  |
| Overall quality of image | 7.7±1.6             | 7.1±2.2 | 4.1±2.3  |
| Ability to visualize operative field | 8.7±.8              | 5.9±2.8 | 4.6±3.0  |
| Ability to understand surgical orientation | 8.0±1.4             | 5.2±3.0 | 3.3±2.8  |
| Ability to identify anatomy | 6.7±3.1            | 5.8±3.2 | 3.2±3.1  |
| Ability to follow operation | 6.8±3.2             | 5.4±2.9 | 3.2±2.9  |

Table 2.

|                        | Alpha Port/Laparoscope | Sky-Cam | Head-Cam |
|------------------------|------------------------|---------|----------|
| Do You Feel This Image Would Benefit Surgical Education? | No 0 | 4 | 9 |
|                        | Yes 14 (P=.0002)       | 10      | 4 |

Figure 5. Laparoscopic telescope attached proximally to an Aesop robot affixed to the operating table on the patient’s right side.
ference center so that the participants would remain blinded as to which image they were evaluating.

This is not necessary to enhance the operative educational experience of residents and medical students. A video monitor placed in the operating room will suffice and provide a teaching environment in which the surgeon can instruct, point out pertinent anatomy, and answer questions with minimal disturbance to the flow of the operation.

CONCLUSION

Use of a laparoscope mounted via an alpha port to an operating table provides superior images during open surgery when compared with images from the sky-cam or head-cam systems. The alpha port/laparoscope combination provides a unique and affordable way to teach residents and medical students operative procedures that are otherwise difficult to view due to the location or the size of the incision, or both.

References:

1. Kerr B, O’Leary J. The training of the surgeon: Dr. Halstead’s greatest legacy. *Am Surg.* 1999;65:1101–1102.
2. Rutkow I. Moments in surgical history: William Stewart Halstead. *Arch Surg.* 2000;135:1478.
3. Allhoff E, Bading R, Hoene E, et al. The chip camera: perfect imaging in endourology. *Endoscopy.* 1998;6:6–7.
4. Melotti G, Meinero M, Bonilauri S, Baro G. Technical equipment and instrumentation. In: Meinero M, Melotti G, Mouret P, eds. *Laparoscopic Surgery: The Nineties.* Milano, France: Masson; 1994:45–75.
5. Nagy A. History and development of laparoscopic surgery. In: Eubanks S, ed. *Mastery of Endoscopic and Laparoscopic Surgery.* Philadelphia, PA: Lippincott Williams and Wilkins; 2000–2011.

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