Direction-giving to Residents in Laparoscopic Surgery

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Abstract

Surgeons rely on laparoscopic images to perform surgical tasks in laparoscopic surgery. However, learning how to maneuver the laparoscope is often overlooked by current surgical training systems. In this study, we identify the explicit instructions made by surgeons to guide residents in making useful images in laparoscopic cholecystectomy. These instructions reflect the most common problems for residents maneuvering the laparoscope. Based on our findings, we discuss ways to support minimally invasive surgery and surgical training via technology.

Introduction

Minimally invasive surgery (MIS), where surgeons do not directly touch or see the structures on which they operate, has prompted a significant paradigm shift in the advancement of surgery. MIS procedures produce less post-operative pain, shorter recovery time, and less hemorrhaging compared to open surgery. Video captured by a laparoscope is oftentimes the only source for surgeons to see into the anatomy during the surgery. A recent study found that surgeons often guided residents’ hands in maneuvering the laparoscope. It was shown that maneuvering the laparoscope is not only a process to capture images, but also a way to perceive images.

However, most current MIS training models focus on surgical skills in manipulating instruments. The physical box trainers and virtual reality simulators usually fix a high-definition camera in the center of the trocar ports. Residents then passively watch what is presented instead of making their own useful images by moving and focusing the laparoscope while practicing surgical tasks. Given the importance of the laparoscope in the advancement of surgery, this limitation in training may inhibit residents’ overall performance in operating rooms.

The motivation for this study is to identify the explicit instructions made by surgeons to guide residents in making useful images. These instructions, in essence, identify the most common problems for residents maneuvering the laparoscope. From these findings, we discuss ways to support MIS and MIS training via technology.

Table 1. Frequency of Different Combinations among Ten Cases

<table>
<thead>
<tr>
<th>Attending</th>
<th>Resident</th>
<th>Frequency</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>2</td>
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<td>B</td>
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<td>A</td>
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<td>2</td>
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<tr>
<td>C</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>1</td>
</tr>
</tbody>
</table>

Methods

This study is based on videos recorded during fieldwork in the surgery department of a teaching hospital in the Northeast US. The field observations focused on the operations and the use of the images in laparoscopic cholecystectomy (gall-bladder removal). A total of ten cases were analyzed. The cases included three different surgeons and three different fourth-year residents in different combinations of the two groups (Table 1). The videos were in picture-in-picture format, including the external video captured on a handheld video camera and the internal video captured by laparoscopic recorder (Figure 1). The data analysis was focused on what instructions residents needed in making useful images and why they needed these instructions.
Findings

Of the 97 laparoscope-movement directions given in the 10 cases observed (mean 10 per case), the instructions for laparoscope movement are divided into five categories (Figure 2). These five categories included the common ways in controlling the camera – “zoom in/out”, “pan”, and “hold” as well as two unique instructions in maneuvering the laparoscope in laparoscopic cholecystectomy – “port in/out” and “change angle”. Attending surgeons often instructed the resident to take the laparoscope out of the port (“port in/out”) in order to perform a function such as turning over the gallbladder without the laparoscope getting in the way. The category “change angle” refers to the attending surgeons instructing residents change the laparoscopes internal mirror angle in order to take different views around a specific structure.

Based on these categorizations, we have identified three major problems for residents maneuvering the laparoscope. First, residents are accustomed to passively perceiving the images presented on the screen. For example, when working on a tiny structure, residents would attempt to stare at one spot in a distant view without moving the camera forward. In those instances, the attending surgeon would instruct the resident to zoom in to see the pertinent details. Another problem for residents is in stabilizing the laparoscope. The safety of every surgical task performance requires a still view of structures. However, residents usually paid great attention to surgical tasks with their primary hand and overlooked the laparoscope in their secondary hand. In these cases, the laparoscope would begin to drift and the attending surgeon would remind them to hold the laparoscope tight and center it on the structure of interest. Likewise, maneuvering the angle of the laparoscope is also a challenge to residents. Instructions of type “change angle” were necessary to encourage the residents to “see the tip” of the instrument when dissecting a plane that is not vertical to the laparoscope. Even with surgeons’ instruction and explanation for the movement, residents still found it difficult to understand the instruction and often attempted different movements before properly realizing the instruction they were given. Oftentimes the attending surgeon needed to put down his instruments and guide the residents’ hand to show them how to use the laparoscope.

Conclusion

Our findings present the major categories of laparoscope movement instructions and common problems for residents maneuvering a laparoscope. Our work indicates that residents, who have been trained by current MIS simulation systems, have limited skills in maneuvering the laparoscope. This limitation impedes their ability in performing surgical tasks and increases the likelihood of error. For MIS training system designers, it highlights the needs to train residents in how to maneuver a laparoscope, how to capture useful images, and how to perform relevant tasks with both hands simultaneously. Further, our work also indicates that there are physical and mental challenges in maneuvering the laparoscope that could be supported through robotic camera control systems thus freeing surgeons’ hand from maneuvering the laparoscope. However, the approaches thus far have had some deficiencies that prevent it from being fully integrated in the operating rooms. For example, many systems still require a surgeon to put down his surgical instrument to adjust the angle manually during the surgery, which may influence the efficiency of the surgery. For MIS robotic camera control designers, our work provides a comprehensive collection of the laparoscope movements and suggests the needs to support surgeons in accessing these laparoscope movements through voice or gesture control.

References