Editorial

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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Robotics

Minimal access surgery has been a great advance in surgical management both for the surgeon and for the patient. It has resulted in less pain for the patient, a shorter hospital stay, and a quicker return to work. However, these advances have come at considerable cost to the operating room and its personnel in the form of more equipment in the operating room—both in the sterile field and in the nonsterile field around the operating table. The instruments are fragile and need considerable upkeep for them to function efficiently. The equipment in the nonsterile field around the table needs constant adjusting during the procedure. As laparoscopic procedures have advanced over the last decade, becoming more complicated and intricate, the amount of equipment has extended well beyond simply a light source and insufflator. It now often consists of two light sources, high flow insufflators, harmonic scalpels, Bovie generators, Ligasures instruments, and ultrasound equipment. The equipment is bulky and invariably freestanding, being placed all around the operating table, cluttering the floor space, and making it difficult for the circulating nurse to get from once piece of equipment to the next and to keep it adjusted to the requirements of the operating surgeon. This is time consuming and keeps the circulating nurse from performing his or her other duties in the room, and it can also add considerably to the length of an operation.

In an attempt to reduce the number of assistants needed to perform laparoscopic procedures, there was an effort made to replace the camera holder by a mechanical holder. These early mechanical holders held the image stable and avoided the normal movement of the image when the camera is held by hand. This freed operating personnel to perform other jobs in the operating room, but it meant that the camera could only be moved by the surgeon, who had to put down instruments so that he or she could reposition the camera holder manually. This interrupted the flow of the operation. Other methods of controlling the camera are now in use; some are voice activated, controlled by head movements, or there are even those that follow the laparoscopic instrument tips. The last variety have not been as successful and the other two types. Camera controllers, regardless of their control systems, are likely to take a prominent place in laparoscopy in the future. Newer and improved systems will emerge with time.

Another issue that is arising as operations become more complicated are the constraints placed on the surgeon by current laparoscopic instruments, which are straight and nonergonomic. In an open operation, the surgeon alters the position of his or her hand so that the straight instruments can be placed in the exact position that is required for optimal performance of a task. However, the mobility and placement of laparoscopic instruments are restricted by the fixed placement of the port sites. These fixed positions often prevent the tips of the instruments from being placed at the most optimal angle to the tissue so that a task can be performed efficiently and quickly. Another problem that the laparoscopist faces is the scaling up or scaling down of the movement of the tip of an instrument in relationship to hand movements; these are changes that occur in as a result of alterations of the length of the instrument that is inside the peritoneal cavity compared to the amount of the instrument outside the peritoneal cavity. This scaling up or down is constantly changing, and may even be different between a laparoscopist's right and left hand depending on the relationship of the site of dissection to the port sites used by each hand. As a result of technological advances, these problems facing the laparoscopic surgeon are being addressed, and change is on the way, as shown in several articles in this issue of *Surgical Endoscopy and Other Interventional Techniques.*

Two articles explain differing technologies for the control by the surgeon from the sterile operating field of the nonsterile laparoscopic equipment that surrounds the operating table, with control by trained operating room personnel circulating in the nonsterile field. One article deals solely with control of the camera by the EndoAssist (Armstrong Healthcare Ltd., High Wycombe, Buck, United Kingdom) during the performance of a laparoscopic cholecystectomy. The unit is freestanding and is placed beside the operating table with an arm that holds the laparoscope and camera. The surgeon wears a head device that permits his head to be tracked by an infrared sensor. Head movements by the surgeon, pan, tilt, and zoom the camera, leaving his hands free for manipulation of the laparoscopic instruments. This system was compared with a trained human camera holder. The results showed that the EndoAssist was safe, and subjectively the operating surgeons found the image to be "stable and equivalent to or better than that provided by a skilled human camera holder." The operative time for the EndoAssist and the human camera holder were 66 minutes and 74 minutes, respectively, this being statistically different. The time difference was small, and since the study has a small number of patients in each arm, this difference could be explained by the normal variation of times taken to perform laparoscopic cholecystectomy on a series of patients. Certainly the important

fact is that the EndoAssist did not prolong the operative time. Setup and takedown for the EndoAsssit was found to be short, not interfering with or prolonging the operation.

The other study on the control of equipment in the nonsterile field compared the use of Hermes (Computer Motion, Inc., Goleta, CA, USA), a voice activated system that is controlled by the surgeon vs controlled by a circulating nurse. This system controls the camera, light source, insufflators, and telephone during laparoscopic Nissen fundoplication. The time that the nurse took to adjust the equipment was greater than the time taken for Hermes to perform similar adjustments. The surgeon and nurse satisfaction scores were significantly greater in the Hermes arm of the study than the circulating nurse control arm. Although these two articles address different issues in the laparoscopic operation, they do seem suggest that there may be an advantage to mechanical adjustment from the operative field, in both time and satisfaction. These types of control systems also free operating room personnel for the performance of other important tasks in the operating room. This technology needs to be studied further in this age of operating room personnel shortages and increasing demands for timeliness and efficiency.

A third article in this issue of *Surgical Endoscopy* reports the use of a computer-enhanced laparoscopic instrument in eleven cases of laparoscopic hysterectomy. The instrument used was the da Vinci Computer-Enhanced Laparoscopic Surgical System (Intuitive Surgical, Inc., Mountain View, CA, USA). This is one of two such systems that are currently being used clinically. This instrument has a wrist action that facilitates dissection, manipulations, and makes knot tying easier than when performed with normal laparoscopic instruments. It also is equipped with 3-D visualization system. The authors report that the ease of manipulation of the instrument made tasks easier, and the 3-D vision gave them the feel of an open operation. They also reported that the learning curve for the instrument was shorter than for regular laparoscopic instruments. However they reported several problems with the instrument, and the operations took significantly longer than a standard laparoscopic operation, ranging from 4½ to 10 hours. The reason for the increase in length of the operation was mainly the long time it took to set up the instrument, however, the amount of time decreased as the operating staff became more familiar with the instrument. Another reason for the increase in time was because of moving the instrument from the position of working in the pelvis to working in the upper abdomen to perform an omentectomy. The instrument is large, bulky, and heavy, and it is not easy to move and set up again. Another problem with the instrument was the limitation of instruments that could be used. However, as the authors point out, this issue is being addressed with the development of new and more versatile tips.

These instruments do seem to improve the dexterity of the operating surgeon because of the damping of the natural tremor of the surgeon, the wrist of the instrument having the ability to perform manipulations more easily, and the ability to control the scaling of the movement of the tips of the instrument. This equipment, at the moment, has considerable limitations. The instruments are too large, too cumbersome, too intricate, require too much tuning and maintenance, and are too expensive. One of the significant deficiencies at the moment that surgeons complain about is the loss of tactile sensation, or even feedback to the hands of the surgeon. At the moment, all movements rely on complete visual control. This will shortly change, with the introduction of force feedback on this type of instrument, which will tell the surgeon how hard he is pulling on a suture or how hard he is pushing on a structure. It will be a long time before tactile sensation can be appreciated through these instruments. However, they are a major start in the improvement of laparoscopic instrumentation. Big improvements and lower cost are important before these instruments become part of routine laparoscopy. It should be remembered that the computer-enhanced instruments currently being used clinically are a magnificent start in this new era of laparoscopic instrumentation, which is in its infancy, and they will continue to develop over the years.

These technological advances in equipment control and computer-enhanced instrumentation are the start of a new era in laparoscopy. They are likely to alter significantly the way we perform minimal access surgical procedures in the future. They may make life easier for the surgeon and the operating room staff, and may result in shorter and safer operations in the future, as well as the performance of more complicated laparoscopic procedures than we perform today. However, it must be remembered, that these technologies are in an early phase of development, and they will change significantly over the next few years. The control systems will become more sophisticated, and the computer enhanced laparoscopic instruments will become small, easier to use, and more intuitive to the surgeon than these large instruments of today. We are on the edge of an exciting era in minimal access surgery. We are likely to see major technological changes over the next decade as instrumentation and control systems get smarter, smaller, cheaper, and more user friendly than even these new systems, which will, over the next decade, change the face of minimal access surgery as we know it today.

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