Laparoscopic Fixation And Guiding Devices

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Since the new advances in video technology in the mid 1980's and the coupling of the video camera to the laparoscope the surgeon no longer needs to control the laparoscope with his own hands. The advantage of this new development in laparoscopic surgery is that (1) it is not as tiring to perform (i.e., he no longer had to bend over the patient to look through the laparoscope's ocular), (2) the whole operating team could follow the progress of the surgery (for better or worse), and (3) that the surgeon is then enabled to operate with two hands, a new skill which must be learned since it is one of the keys to being more effective and efficient under the laparoscope. One of these advanced skills, intracorporeal suturing,[1] is an especially demanding skill and requires a well-centered, and steady camera support for the technique to be performed efficiently. The disadvantage is that he must give oral commands to the individual who is now charged with guiding the laparoscope within the operative field and this disadvantage alone is sometimes thought the tip the balance in the wrong direction.

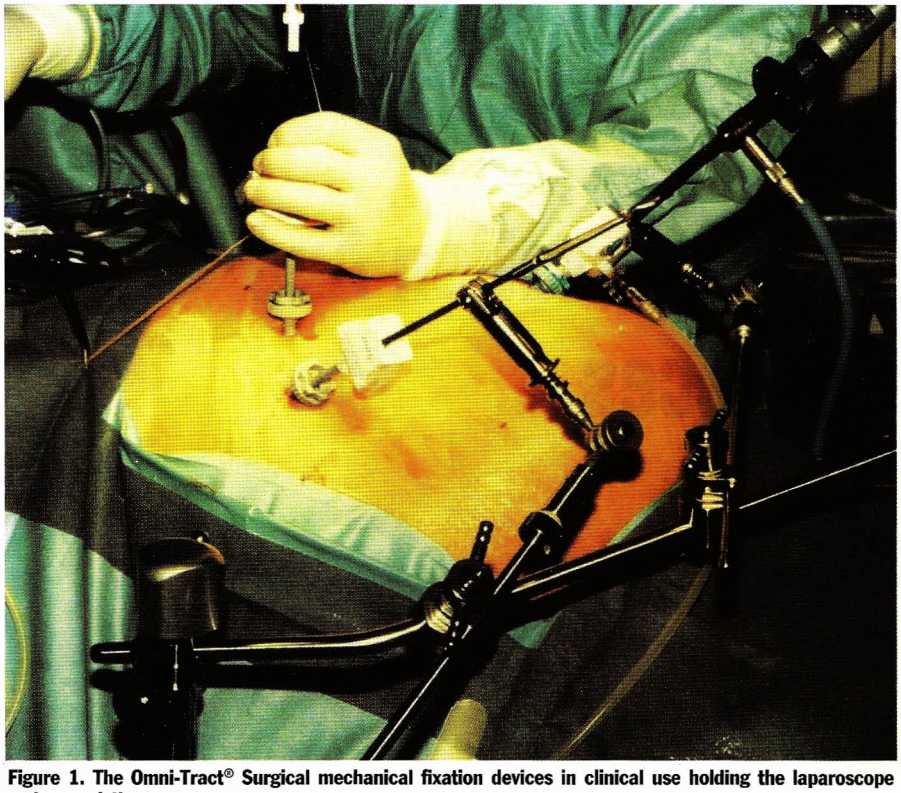

Figure 1. The Omni-Tract® Surgical mechanical fixation devices in clinical use holding the laparoscope and an assisting grasper.

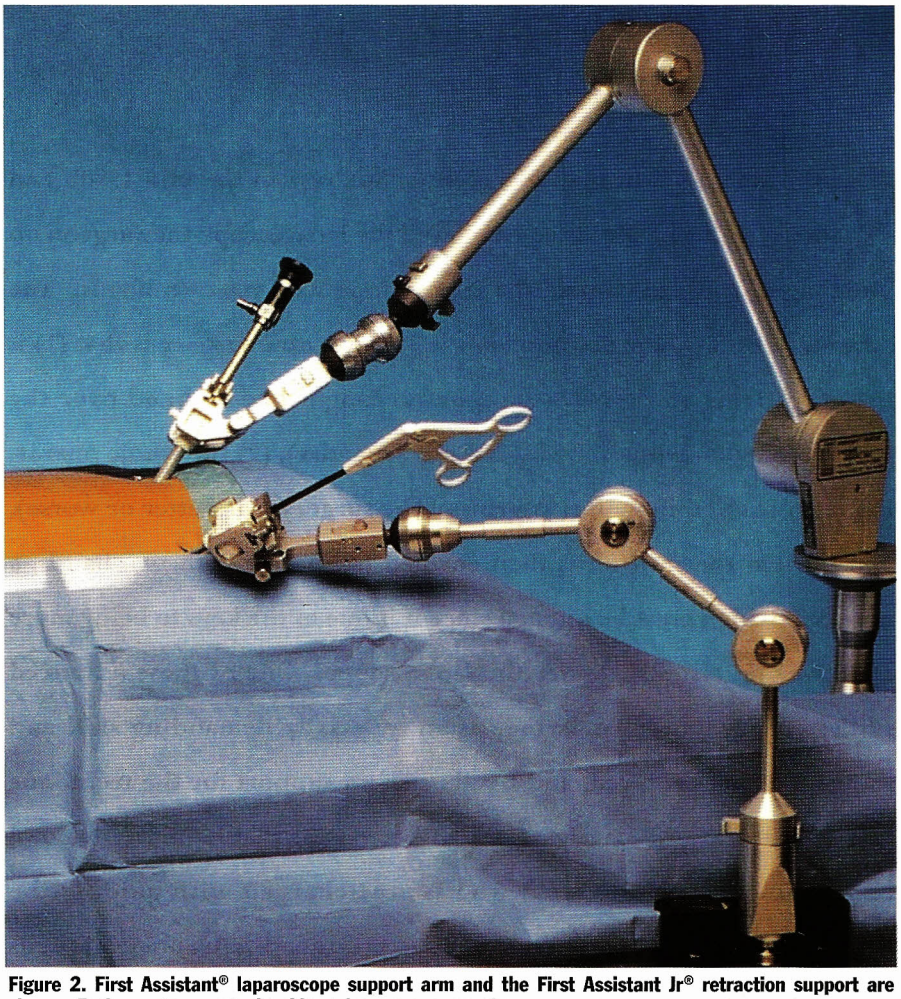

Figure 2. First Assistant® laparoscope support arm and the First Assistant Jr® retraction support are shown. Both are steam autoclavable and vacuum powered.

Most individuals, including surgeons, are not well trained in giving specific directions on how to find a specific point in space, therefore, the movement of a laparoscope requires a teamwork to develop between the surgeon and camera operator. A new concise form of communication or language for this task would be helpful, but this also takes considerable learning time and unless the surgeon can rely on the availability of such a trained individual for all of his surgeries, such communication training might not be practical. Considering the economic downturns facing healthcare providers, the likelihood of reimbursement to the surgical assistant is diminishing rapidly. The job of camera guiding must then turn to an operating room technician or nurse, or other individual (including other surgeons or surgeons-in-training), most of whom are inadequately trained for the critical requirements of the job.

Holding a camera steady or moving the view to accommodate the surgeon's needs are no simple tasks, as the camera operator must be as focused on the procedure at hand, and in nearly the same mental and physical condition, as the surgeon himself. Yet the camera operator's job is a tedious one and therefore it requires a special motivation or dedication to sustain focused concentration and rock solid steadiness that the job requires.

The camera operator must not only be able to follow the action of the operation, he must be able to anticipate the surgeon's needs, including following the instruments in and out of the ports, as well as following the instruments in the field, and understanding when to zoom in and when to pan out. If this function does not proceed smoothly frustration on the part of the surgeon, delays in the surgery, and an increased potential for iatrogenic injury results.

Furthermore, the constraints around the operating table or the necessary port positions, might ultimately require the camera operator to hold the laparoscope while standing in an awkward position for extended periods of time. Not very many humans are cut out for the role. A poorly performed job at camera holding results in surgery progressing in a halting fashion.

Laparoscope holders or retractors were designed to address the above problems. These devices can be easily attached to the side of standard operating room tables and most can be

applied intraoperatively. They typically reach up and over the surgical field through a series of mechanical linkages, but vary in the manner and ease in which they are operated. Laparoscope holders occupy less space than a human assistant, providing the surgeon more flexibility to maneuver around the patient. While these devices do not suffer human lackings, such as drifting attention or fatigue, they also do not anticipate the surgeon's needs.

Mechanical Devices

Some mechanical systems may utilize frames that are already in use in the operating room. In this case adapters for laparoscopic application are all that would be needed. This represents the least expensive means to achieve stabilization of the laparoscope since other components of the system can be utilized, and cost shared, by other specialties, e.g. other general surgeons and neurosurgeons. Examples include OmniTract® (OmniTract® Surgical, St. Paul, MN), the Iron Intern® (Automated Medical Corp. Products, New York, NY), the Bookwalter™ retraction system (Codman, Somerville, NJ), and others. Each system has interchangeable parts with adapters for the laparoscope and various trocars. Simple instant-release mechanisms are of great importance as the surgeon must be able to regain immediate control of the laparoscope and retractors should an intraoperative incident occur.[2] The OmniTract™ (Figure 1) system has individually controlled joints at the shoulder, elbow, and wrist portions of the mechanical arm promoting a more gradual repositioning and a quick release of the endoscope grasper, an especially attractive feature. The Iron Intern® has a single release mechanism that controls three joints simultaneously, however the scope or retracting instrument holder is independently controlled.

Pneumatic Devices

These systems offer greater adaptation, responsiveness, and greater ease of use than mechanical arms.

The First Assistant™ (Leonard Medical, Huntingdon Valley, PA) is a steam autoclavable vacuum-powered articulating support arm (Figure 2). It contains three joints (shoulder, elbow, wrist) which are secured in place with wall suction (vacuum) and therefore has a wide range of motion. Anti-rotation clips prevent inadvertent camera rotation

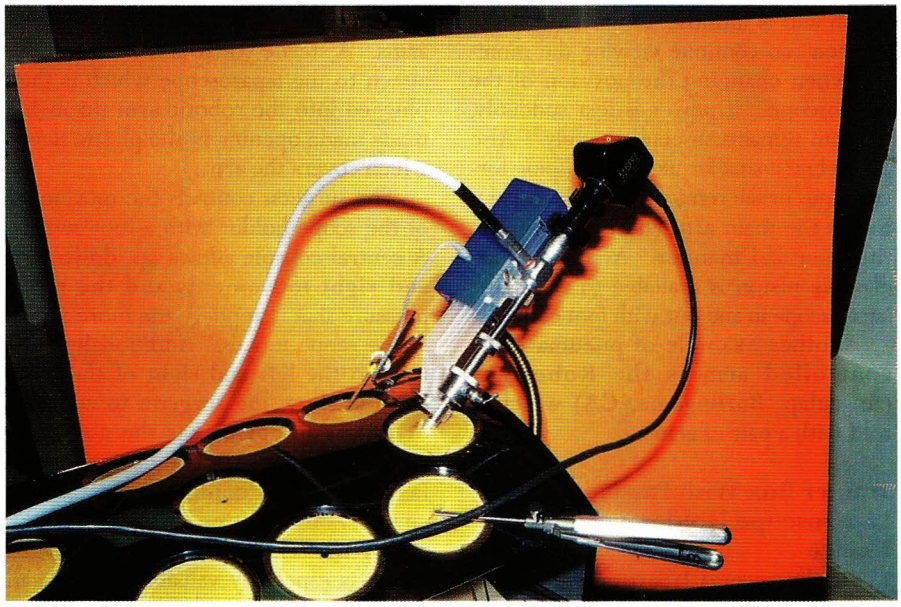

Figure 3. Laparoscope support arm that is a part of the Szabo-Berci Laparoscopic Suturing Trainer enables the surgeon to practice laparoscopic suturing without an camera person. Zooming device is also shown.

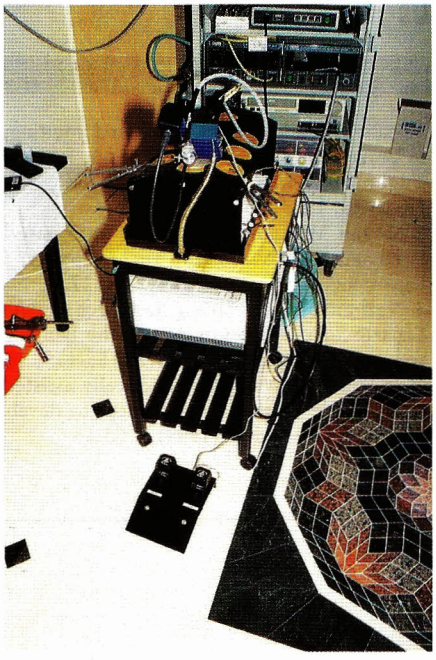

Figure 4. The laparoscopic training station with Laparoscopic Suturing Trainer, Zooming device, and foot controls.

Figure 5. The AESOP computer controlled robot is shown here with the laparoscope support arm, computer control unit, foot and hand controls.

which is especially practical when using angled laparoscopes. To change the position of the laparoscope, the "wrist" joint is disengaged by pushing a single push-pull lever (slip clutch) and resecured by activating the same lever. With practice it can be operated with hand pressure applied to the "wrist" and does not require the surgeon to look away from the video monitor to do so. The arm has grippers which attach to the trocar cannula rather than directly to the laparoscope body which avoids damage to the scope. Its mechanism has a smooth action and is intuitive to use so that the surgeon can continue viewing the monitor when changing the position of the laparoscope. If power is lost suddenly, the arm remains suspended safely.[3] Also available is a smaller unit for grasping forceps and/or fan retractors which complements the main arm and is operable in the identical manner. A steam autoclavable piston is available to zoom the laparoscope in and out with foot controls.

Another example of pneumatically controlled arm is the Robotrac® (Aesculap, Burlingame, CA) which is sold with a pair of arms.

Trainer Box With Passive Laparoscope Holder & Zooming Device

Of the several laparoscopic trainer boxes available, one has been designed specifically for learning intracorporeal suturing and knotting techniques (Szabo-Berci Laparoscopic Suturing Trainer, Karl Storz Endoscopy-America, Culver City, CA). This trainer contains a passive arm (Figure 3) to hold the laparoscope so that a surgeon can practice alone with the arm holding the image steady. It has a optional zooming attachment that moves the laparoscope along the vertical axis of the laparoscope (pistoning) so that the laparoscope can zoom in and pan out as needed during suturing and knotting by activating foot controls (Figure 4).

Computer Controlled Robotic Arm

A new system has been developed that is operated by foot and therefore does not require the surgeon to park his instruments in order to change the position of the laparoscope. The Automated Endoscope System for Optimal Positioning (AESOP) (Computer Motion, Inc. Santa Barbara, CA), allows the surgeon direct control without disrupting the procedure, thereby enhancing a safe and efficient process (Figure 5).

The mechanism consists of a computer into which is plugged a robotic arm and controlling hand piece and foot switch. The robotic arm is fastened to the operating table like other types of arms. A sterile collar and collar holder attach to the laparoscope which is then plugged into the robotic arm through a ready made opening in the plastic sleeve which covers the arm.

The surgeon controls the movement of the scope holder with a foot switch. A central console allows up, down, left and right movements and the more pressure that is applied, the more rapidly the scope moves. Additionally, buttons to the left and right of the main console allow the surgeon to zoom in or out. The device has the ability to remember the initial position of the laparoscope so orientation is always correct. In addition, AESOP has the ability to "remember" given positions which is especially valuable, such as an ideal panoramic view and an ideal close up.[4] Therefore, whenever an instrument is withdrawn or introduced, its movement can be followed in and out and then be commanded back to the original position. The hand controller provides the same utility and has six programmable positions.

CONCLUSION

With the increasing number and complexity of laparoscopic procedures being attempted, especially those that require suturing, the surgeon finds himself more and more in a handicapped operating environment. Therefore, in order to provide higher quality care he needs exacting assistance in the form a highly skilled camera operator and assistant surgeon. It has been found that a mechanical, pneumatic, or computer operated laparoscope support arm frees the surgeon and his assistant to use both hands in the operating field, and to have the camera in a completely stationary position without interference from human factors. However, when movement of the laparoscope is required, it should be a relatively simple matter for the surgeon or his assistant to change its position and resume surgery.

Mechanical devices offer the main advantage of low cost if the operating room already has the basic system and only needs the laparoscopic adapters. Robotic arms composed of servo-mechanisms provide ease of use, involving a slip-clutch mechanism for pneumatically assisted positioning. The First Assistant®, Robotrac® are two servo-assisted arms that are pneumatically operated; OmniTract® is a mechanical system that provides a quick release mechanism. The AESOP computer actuated robotic arm can be controlled by foot or hand controls that change the position of the laparoscope. This system has the ability to be programmed to remember a certain number of positions and when commanded will automatically return to the desired position. It also can be controlled manually. Costs are higher with robotic systems but the excellent quality of the assistance, and consequentially the possibility of performing more complex tasks are clearly evident and may be an argument in their favor. STI

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