What Alternatives Has Minimally Invasive Surgery Provided the Surgeon?

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When a new technology bursts on the horizon and reenergizes a field that has seemed to be flagging, as minimally invasive surgery has done for the field of general surgery, many enthusiasts rapidly embrace the discipline. Questions should arise, however, as to what novelty has really been introduced, where it should fit in our treatment of patients, and, when the dust settles, what alternatives truly have been provided to the advantage of our patients. This article provides information and data about some of these procedures, while trying to address these issues and answer some questions that new technology raises.

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In the nearly 150 years since the urinary bladder was first inspected telescopically, technical progress and therapeutic alternatives have been limited. Until the last 2 decades, interventions using endoscopy included only a slightly more extended view of existing spaces, but alternatives in therapy were not a reality. With the advent of the video endoscope, allowing cooperative and assisted procedures, high-energy light sources, and high-flow insufflation of distending gases, the stage was set to provide alternative access for complex abdominal surgical procedures. Thereafter followed an enthusiastic explosion of "new" endoscopic procedures, the limit of which was now only the imagination.

This era of laparoscopy has raised new questions: For what procedures do these new methods provide alternatives for access and in which do new strategies for treatment exist? For what surgical procedures does equipoise exist? For which procedures does the "conduct by less invasive methods involve a departure from (or synergism to) time-tested anatomic solutions accompanied (or unaccompanied) by patient benefit?"[1] When do these novel methods become the gold standard and when should traditional options be maintained? Have new treatment patterns emerged that alter the patient population to whom surgery is offered or should we be rigorous about maintaining standard criteria for surgery? Should we develop new education methods for these new procedures and in what ways do new methods of training pertain to standard education? For what procedures and in what aspects of surgery do true novel alternatives exist?

Herein we will examine some of these questions as they relate to specific new laparoendoscopic procedures.

EDUCATION

When laparoscopic cholecystectomy was introduced, established surgeons needed to rapidly learn new skills. These then needed to be transferred to surgical trainees and residents. Various alternatives for teaching new surgical techniques have therefore developed. The most prevalent change has been taking surgical training back into the animal laboratory as the first step in teaching new skills. Studies have shown that "practice in animal models can help overcome some of the handicaps of working in the two dimensional environment of angulated scopes."[2] It has also been demonstrated that hands-on training in the laboratory is effective in teaching the 2-handed skills necessary for complex endoscopic techniques.[3,4]

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These skills can be taught in a course, improve steadily, and are maintained. This training can be brought to the operating room incrementally[5] or as a fully developed clinical procedure. If the latter, it seems clear that the newly trained animal laparoscopic surgeon should be supervised and monitored for new procedures.[6] The learning curve has been well studied and can be objectively evaluated.[4,7,8] While initially cumbersome, this stepwise training model can be integrated into residency programs and, as senior, then junior, residents learn the "new" techniques, they become the standard, taught in traditional ways.[9] This technology is also ideally suited to digital dissemination and the Internet can be employed to train, assess, discuss, and disseminate new techniques.[10]

As this alternate paradigm for teaching surgical residents has become accepted during the last 5 years and shown to be effective in teaching skills, the question can be raised: Should "traditional" surgery be taught the same way? We have now developed models for skill training and evaluation.[3,8] Is there a reason not to expand this as an alternative approach for teaching central line placement, cyst removal, hernia repair, and gastrectomies? As operating room time, surgical inpatient days, and all clinical resources become more scarce and expensive, should our residents be learning their skills in the traditional clinical settings or should we take all these procedures back to the animal and inanimate laboratory? An alternative education model needs to be considered.

SYSTEMIC RESPONSE TO LAPAROSCOPIC SURGERY

Although we will evaluate specific procedures, it is helpful to assess minimally invasive surgery as a whole and assess its effects systemically to adequately judge its usefulness and viability as a surgical alternative for the future. Many studies have been done to evaluate the effect pneumoperitoneum and minimal-access surgery have on the cardiovascular and immunocompetence systems. Laparoscopic surgery has a reduced effect on postoperative cardiorespiratory and muscle performance and does not induce significant postoperative fatigue or pulmonary restrictions.[11-13] Intraoperatively, however, lactic acidosis and hypothermia can still result,[14,15] particularly with prolonged procedures. Alternative methods of insufflation and exposure may provide safer modalities for prolonged procedures or high-risk patients.[16]

Just as general cardiopulmonary effects are lessened, it is not surprising that stress responses, as measured by cortisol and catecholamine levels, are muted as compared with open surgery.[17-19] Cellular immune function is also measurable and preserved to a much greater degree following laparoscopic procedures.[19-22] Because of this decrease in inflammatory response, adhesion formation is lessened with laparoscopy.[23]

The implications of these findings on developing ways of modulating the immune response to surgery, in anticipation of chemotherapy or for improving the local environment for second looks at a later date, may provide far-reaching alternatives in cancer treatment in the near future.

GASTROINTESTINAL TRACT PROCEDURES

If an optimized inflammatory and immune response can be expected with minimally invasive surgery, gastrointestinal tract procedures, with their greater effects on recovery, can be expected to show some of the greatest benefits from laparoscopic alternatives. This can be seen with intestinal resections for benign disease. Improved recovery, as measured by analgesic requirements and return to normal function, is noted after laparoscopic and laparoscopic-assisted colectomies.[24,25] The microsurgical techniques of endoscopic resections have also improved access to higher rectal lesions, allowing local excision and avoidance of stomas.[26] The advisability of laparoscopic resections for cancer of the gastrointestinal tract remains controversial. Studies have shown similar specimen pathological characteristics, comparable morbidity and mortality, and enhanced recovery, even in a debilitated population with metastatic disease.[25,27,28] Concerns have arisen with reports of port site metastases, indicating that questions remain about the mechanisms of dissemination of malignant cells with laparoscopy.[24,29-31] Studies are currently being done to determine if aerosolization of cells, enhanced growth in a carbon dioxide environment, or shedding of cells on retrieval of the specimen are significant factors, and whether a laparoscopic colon resection for malignant neoplasms yields acceptable long-term results. It is possible that alternative methods of access, such as helium or air insufflation and gasless laparoscopy, may retain the benefits of recovery and immunocompetence while minimizing recurrence rates.[32,33] While there are indications for laparoscopy in malignant neoplasms, for staging purposes and for avoiding laparotomy in advanced disease, the role of laparoscopic resection of the colon is awaiting the results of current prospective randomized trials and, for this indication at least, minimally invasive surgery is not yet the gold standard.

When the procedure remains identical and only the access changes, such as with surgery for gastroesophageal reflux disease (GERD), identical results can be expected and more rapid progress toward gold standard status can be made. The evolution of the laparoscopic fundoplication serves as an interesting model and provides valuable lessons in minimally invasive surgery. Every general surgeon knows that a valuable treatment option for GERD lost its place with the advent of H_2 blockers and proton-pump blockers.[34] It seemed that GERD was no longer a surgical disease. When the advent of minimal-access surgery coincided with an understanding of the long-term cost—in both financial and lifestyle terms—of medical treatment, surgical options became more attractive. To make the argument of parity in treatment, the identical operation needed to be done showing outcomes similar to those obtained historically.[35,36] With respect to GERD surgery, laparoscopy has introduced some interesting alternatives in surgical indications, techniques, and evaluation, as well as dissemination of information. In an effort to avoid the implication and compromised outcome of inappropriate surgery, the evaluation of reflux has become more rigorous. Currently accepted practice includes broad use of pH monitoring and manometry, both preoperatively and in follow-up. This in turn has allowed a better understanding of the pathophysiology of reflux disease and the outcome of reflux surgery—a valuable evolution. This has led to a broader understanding of alternative surgical procedures for GERD, including partial wraps and a more tailored algorithm for each patient.[37-39] This complements findings that compromise in technique to fit the goal of minimal access compromises results.[40,41] The traditional lessons of adherence to strict surgical technique and patient selection maintain their value despite innovation.

A final innovation in the dissemination of minimal-access surgery for GERD has been the marketing of the technique directly to patients. Concurrent with similar techniques in pharmaceuticals, alternative paths for accruing patients have been tried with radio and television marketing directly to patients.[42] The efficacy and ethics to this approach have yet to be evaluated to determine if this is a valuable alternative.

BILIARY DISEASE

Gallbladder surgery led the way for all of the aforementioned minimally invasive abdominal surgical procedures. Because it has the longest history, several lessons can be learned from gallbladder surgery regarding evaluating the alternatives minimal-access surgery provides. Clearly, a learning curve exists for new technologies[43,44] but, with the new education techniques and preceptorships, this can be scaled and comparable results can be obtained.[45] As comfort with the "no longer new" technique is gained, previously relative contraindications can then be waived, such as laparoscopy in obesity, acute cholecystitis, or during pregnancy.[46,47] More questions will and should continue to be asked as to the preferable means of treatment,[48] but when safety is maintained and advantages pertain, the gold standard can be said to be achieved.

HERNIA SURGERY

The laparoscopic approach to hernia surgery has had difficulty becoming the gold standard for several reasons. This may be an example of too many alternatives hindering the achievement of a satisfactory technique for a common procedure. The results of reconstructive surgery seem to be more difficult to optimize than those of ablative surgery. When the variables, such as analgesia and return to preoperative function, are quantified, results are more nebulous and consensus is harder to obtain. Studies abound on either side of the debate, showing both that laparoscopic herniorrhaphy has clear advantages in analgesia, length of stay, and time off from work[49-52] and that laparoscopic herniorrhaphy takes longer, costs more, has higher recurrence rates, results in no better postoperative disability, and has not been standardized as a technique.[52-54] As any first-year resident knows, if there are too many alternatives, the right procedure has not yet been found.

LAPAROSCOPY IN THE ACUTE ABDOMEN

Coming full circle from laparoscopy as an instrument of observation, minimally invasive surgery has found a new role in the evaluation and management of the acute abdomen. The usefulness of laparoscopy varies with the indication; the diagnostic benefit obtained for the acute abdomen was found to be 100%, with a change in management found in 80% of patients.[55] Laparoscopy can also be useful in the evaluation and management of trauma, small-bowel obstruction, and perforated ulcer.[56,57] While there is a report of a higher incidence of septic shock and increased mortality following laparoscopy for gastric perforation in animals,[58] diagnostic laparoscopy can be a valuable adjunct in the management of the acute abdomen.

Then there is the category of procedures for which the questions still need to be formulated. Are procedures for which there is anecdotal reporting from a single group "experimental" or "emerging technology"? If a procedure is feasible, does it necessarily become an alternative? Many are describing the use of laparoscopy in splenectomy, showing decreased operating room time, shorter length of stay, and decreased hospital costs.[59] Minimally invasive techniques have been used for retroperitoneal procedures such as lumbar sympathectomy, spine surgery, lymphadenectomy, and adrenalectomy, with reports showing feasibility and safety if not yet superiority.[60-63] Vascular surgery has also not been immune from the advent of minimal access, with reports of minimally invasive infrainguinal bypass showing a longer operating room time, a trend toward decreased lengths of stay, and decreased hospital costs, with no significant differences in morbidity, generally concluding that "more study is needed."[64,65] Left hepatic lobectomy has been deemed feasible in the animal model[66] and endoscopic parathyroidectomy has been described.[2] Then there are the proponents of a new level of minimal-access surgery using "needlescopic" approaches. How far should we go for improved cosmesis if morbidity and outcomes are comparable?[67] One can ask if the "level of enthusiasm with these can-do procedures is appropriate."[68]

Perhaps the best legacy of minimal-access surgery—not to imply that an epitaph is being written—is an alternative way of thinking. Surgery at the beginning of this century maintained that more is better. Whether in radical mastectomies or regional colectomies, the more resected, the better the cure. We have seen the upheaval of this paradigm in the latter part of the century, for which minimal-access surgery can be considered the logical extension. With the movement toward "less is more," the door is open to an alternative school of surgery. Sentinel node biopsy for breast surgery and gamma knife neurosurgery, to name some procedures, can be seen showing the way through this door to an understanding that less invasion, less upheaval, and less intervention to obtain the same outcome is, in itself, a goal to be pursued.

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