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CLINICAL REPORT

Ventral Hernias in Morbidly Obese Patients: A Suggested Algorithm for Operative Repair

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Abstract With the rise in prevalence of obesity, most general surgeons will have to face the problem of the obese patient with an abdominal wall defect. Treatment of these bariatric patients raises unique challenges, and at this time there is still no consensus on the best treatment option. This study was performed in a high-volume bariatric and minimally invasive surgery center at a tertiary care facility in the USA. Twenty-eight morbidly obese patients treated at our facility between 2003 and 2008 were separated into four groups according to anatomic features and symptoms. Patients with the following characteristics were classified as having a favorable anatomy: body mass index not exceeding 50 kg/m^2, gynecoid body habitus, reducible hernias found in a central location, abdominal wall thickness less than 4 cm, and the defect's largest diameter not exceeding 8 cm. All other patients were classified as having an unfavorable anatomy. In this study, we report a systematic treatment approach for the morbidly obese patient presenting with a ventral hernia based on whether the hernia is symptomatic or asymptomatic, as well as the distinct characteristics of the hernia and body habitus features. We followed up on these patients postoperatively for at least 2 years, with a mean follow-up period of 30 months. Only a total of three hernia recurrences were observed. Successful treatment of ventral hernias in morbidly obese patients should be individualized based on the patient's symptoms and defined hernia characteristics.

Keywords Ventral hernia · Laparoscopic ventral hernia repair · Bariatric surgery · Morbid obesity

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Introduction

Ventral hernia repair is one of the most common procedures performed by a general surgeon. The Center for Disease Control estimates that approximately five million Americans live with abdominal wall defects,[1] which include incisional, umbilical, and other hernias. Furthermore, morbidly obese patients are thought to be at a particularly high risk for the development and progression of abdominal wall defects because of increased intra-abdominal pressure and poor wound healing potential. [3]

An epidemic of obesity and morbid obesity is spreading throughout the USA and the world. Approximately 31 % of the American population is considered obese, including 5 % who are classified as morbidly obese[2]. As the obesity problem continues to expand, general surgeons can expect to see an increasing number of obese patients with anterior abdominal wall defects in their practice. Repair of a ventral hernia in the morbidly obese patient can be a challenging problem for any surgeon to face and, if not handled appropriately, can be complicated by high recurrence rates. In some of these cases, weight loss surgery can be an important adjunct strategy in the management of the morbidly obese patient and should be strongly considered.[13]

There is also the question of the appropriate approach to a patient presenting for bariatric surgery with history of anterior abdominal wall defect, whether symptomatic or asymptomatic. At this time, there is no consensus on the optimal timing or method of ventral hernia repair in this patient population. One dilemma the surgeon faces is whether to place a permanent synthetic mesh into a clean–contaminated field encountered during bariatric procedures, such as laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic sleeve gastrectomy (LSG), that violate the gastrointestinal tract as opposed to performing a primary hernia

repair. On the other hand, failure to address the hernia defect during bariatric procedures carries the risk of bowel obstruction secondary to incarceration and strangulation.[13]

There is also no consensus found in the literature as to the long-term effectiveness and durability of laparoscopic ventral hernia repair (LVHR) in morbidly obese patients. Some authors report low recurrence rates,[2, 4, 5] while others found relatively higher rates of hernia relapses.[6–8] A careful dissection of these reports reveals the variability of patient populations described in various studies, likely accounting for this discrepancy in the results. This shows that not all hernias are created equal, and every bariatric patient with an abdominal wall defect should be approached individually. Certain factors, such as the patient's past medical history, body mass index (BMI), body habitus, defect size and location, level of operative field contamination, and presence or absence of symptoms, should always be taken into consideration while developing a surgical plan. Based on our experience, we hereby propose an algorithm to appropriately classify and treat patients based on their anatomy and symptoms.

Methods

This study included morbidly obese patients with ventral hernias who were consecutively treated at a tertiary care center between 2003 and 2008. Each patient was evaluated for body habitus based on fat distribution (android versus gynecoid), BMI, and hernia location and reducibility. Hernia anatomy was further assessed with the use of an abdominal computed tomography (CT) scan, which allows for a precise evaluation of the defect size, contents, and abdominal wall thickness. It is important to mention that an abdominal CT scan is an extremely helpful tool in the obese population as physical examination of the hernia is quite unreliable due to abdominal wall thickness. Based on the cited criteria, patients were divided into favorable and unfavorable anatomy groups (Table 1). The defect was considered to have a favorable anatomy if it was located centrally or in the upper half of the abdomen as it allows easier accessibility and laparoscopic port placement. It was considered unfavorable if it was located in the lower abdomen. Android body habitus is considered unfavorable due to less compliant abdominal wall and intra-abdominal fat distribution causing increased technical difficulty as opposed to favorable gynecoid fat distribution. In addition, we considered an abdominal wall thickness of more than 4 cm as an unfavorable anatomical feature. A thicker abdominal wall tends to cause greater torque on laparoscopic instruments, leading to increased surgical difficulty of hernia repair. In our experience, this is more commonly seen in patients with an abdominal wall thickness of over 4 cm. Patients with a thinner abdominal wall were considered to have favorable anatomy. Hernia reducibility is considered a favorable feature as incarcerated contents may be more difficult to reduce intra-operatively. Hernias of 8 cm or less in greatest diameter were also considered favorable because they allow the surgeon the ability to approximate the edges of the defect with primary sutures under reduced pneumoperitoneum pressures, whereas larger defects would be harder to repair primarily. Finally, a BMI of 50 kg/m^2 or greater was considered unfavorable due to the elevated operative risks associated with super-obese patients[14].

Table 1 Unfavorable and favorable anatomic ventral hernia characteristics

Characteristics	Anatomy	
	Favorable	Unfavorable
Body habitus	Gynecoid	Android
Hernia location	Central	Peripheral
Hernia size	<8 cm	>8 cm
Body mass index (kg/m^2)	<50	>50
Body wall thickness	<4 cm	>4 cm
Reducibility	Reducible	Irreducible

One of the key elements in selecting appropriate treatment modality for obese patients with an abdominal wall defect is to evaluate their symptoms. Unfortunately, the assessment of these complaints could be quite subjective. In this study, patients who presented with symptoms of partial or complete bowel obstruction, as well as those who presented with at least two episodes of severe abdominal pain requiring hospitalization, were classified as symptomatic. Complaints such as constipation, vague and chronic abdominal pain, or unsightly appearance of the hernia were not considered in the symptomatic group. Based on the cited considerations, patients were divided into four treatment groups as follows (Fig. 1):

1. *Symptomatic patients with favorable anatomy* underwent LVRH as an initial and separate procedure, followed by bariatric surgery of choice at a later date. Hernias were repaired using a modified Rives–Stoppa technique with intra-abdominal placement of permanent mesh (Dual Gortex Mesh was used at our institution) with at least 4-cm overlap of the defect, using both permanent suture fixation and circumferential tack placement[9]. Based on our experience, the level of adhesion formation encountered during the bariatric procedure is very manageable and does not increase the risk of converting to an open approach. While all study patients treated with this approach underwent LRYGB, a foregut bariatric procedure (such as LAGB or LSG) should be

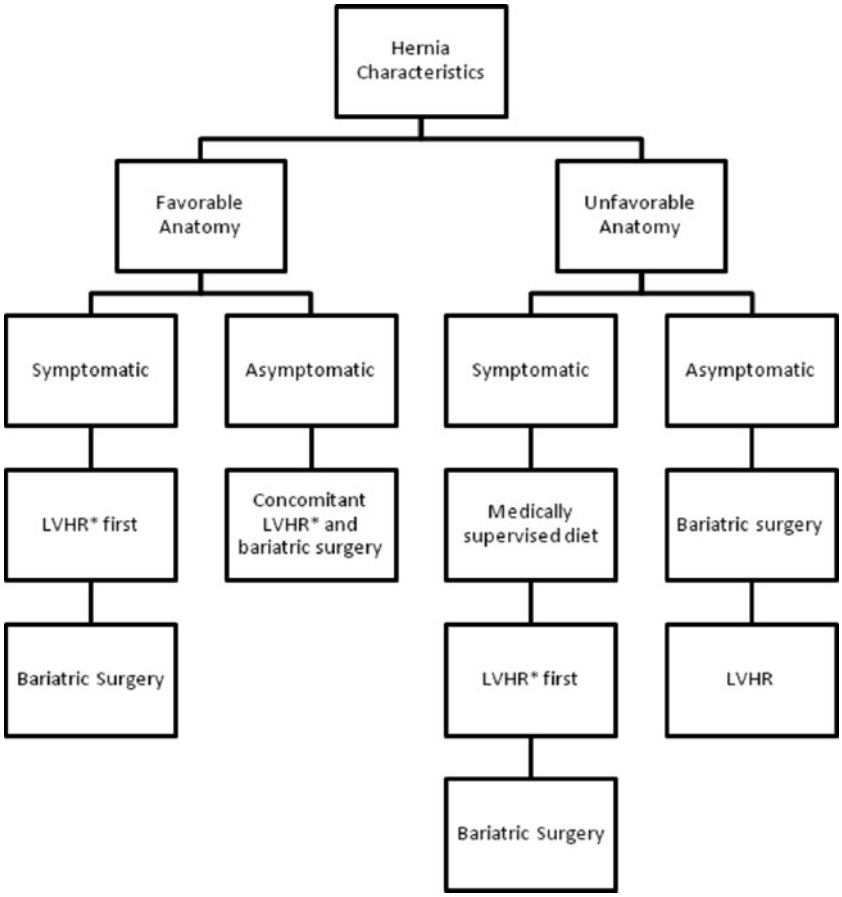

Fig. 1 Algorithm for ventral hernia repair in the morbidly obese patient. *LVHR* laparoscopic ventral hernia repair

considered if thick adhesions involving loops of small bowel loops are encountered.

2. *Asymptomatic patients with favorable anatomy* underwent concomitant bariatric surgery and LVHR. In the group of patients who underwent LRYGB or LSG, the hernia defect was repaired primarily with the placement of non-absorbable sutures using a suture-passing device through the abdominal wall and fascia (Fig. 2a). The approximated defect was then reinforced using biologic mesh (porcine intestinal submucosa was used at our institution; Fig. 2b). The mesh was introduced through the abdomen via one of the port sites and secured in place with both sutures and circumferential tacks. In these cases, biologic mesh was chosen with the intent to re-enforce our repair given the high recurrence rate of primary suture repair alone, while avoiding the risk of potential permanent mesh infection. Figure 2c shows the anterior abdominal wall of one of the patients who underwent a concomitant repair of a ventral hernia and LRYGB. This photo was taken during an unrelated abdominal procedure at about 24 months after the hernia repair. The patients who chose LAGB placement underwent traditional LVHR with permanent mesh using the modified Rives–Stoppa technique previously described. LAGB placement is not as time-consuming as LRYGB and does not necessitate field contamination by division of the alimentary tract. However, the choice of bariatric procedure offered to this patient population should be balanced against long-term outcomes of weight loss and co-morbidity resolution rather than the management of the abdominal wall hernia alone.
3. *Symptomatic patients with unfavorable anatomy* initially underwent a medically supervised very low calorie diet (800-cal liquid diet) for up to 12 weeks. The main goal of placing these patients on an aggressive weight loss regimen was to mitigate their risk profile as preoperative weight loss can help to control co-morbidities. It is also important to mention that some of these patients, as a direct result of their anatomical features, are at higher risk of conversion to open surgery. Rapid weight loss can improve these unfavorable features, decreasing their risk of open surgery. This group also received dietary supplements, including daily multivitamins as well as ursodiol treatment to prevent gallstone formation during rapid weight loss. All patients were required to follow up with medical staff on a weekly basis for physical examinations as well as laboratory analysis to ensure no adverse health changes. Additionally, they were enrolled in a support group with a registered dietitian and received behavioral modification. Failure

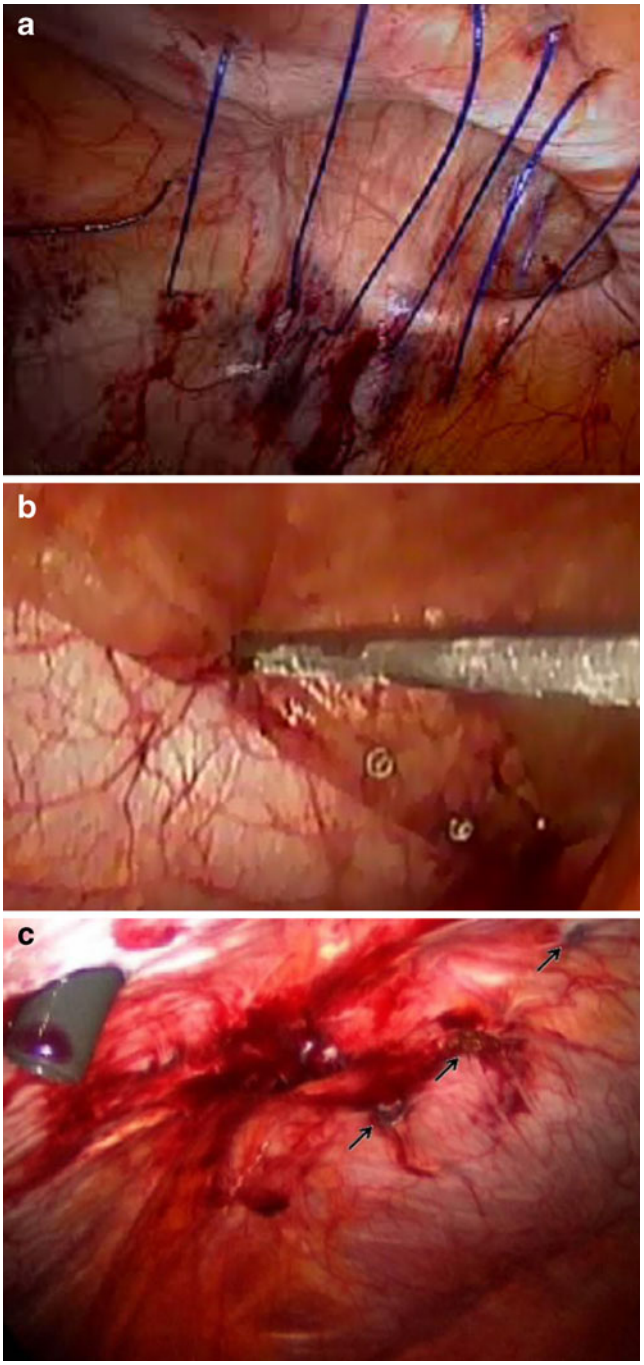

Fig. 2 Ventral hernia repair at time of bariatric surgery with follow-up laparoscopy at 1 year later. **a** Suture repair of the hernia defect at the time of laparoscopic Roux-en-y gastric bypass (step #1). **b** Subsequent placement of biologic mesh as a re-enforcement of the primary suture repair during laparoscopic Roux-en-y gastric bypass (step #2). **c** Anterior abdominal wall of the same patient who was undergoing an elective laparoscopic cholecystectomy at the 24-month time mark. Note the absence of the hernia defect and visible partially peritonized surgical tacks

to comply with the cited weight loss program requirements resulted in either delay or denial of surgery. Patients lost an average of 4 to 5 lb/week; most lost 10–20 % of their excess body weight. After appropriate weight loss was attained, patients underwent LVHR followed by concomitant or deferred bariatric surgery.

4. *Asymptomatic patients with unfavorable anatomy* were first treated with bariatric surgery, followed by LVHR at a later date after significant weight loss had occurred. The weight loss surgical options offered by our institution focused on foregut procedures such as LAGB placement or LSG. LSG is the preferred and recommended procedure at our institution given the more likely early rapid weight loss. This would allow a timely repair of the abdominal wall hernia. Nevertheless, the decision for which procedure to perform was made jointly by the patient and the surgeon after thorough discussion and counseling.

Results

A total of 28 patients were enrolled in our study. These patients were followed up for at least 2 years and were seen and examined in our surgical clinic to assess for hernia recurrence. It was noted that, as a result of the bariatric procedures, most of our patient population achieved adequate weight loss, allowing us to effectively assess the abdominal wall on physical examination. Some patients required CT scan for unrelated reasons where the abdominal wall was evaluated as well. The largest group consisted of 20 asymptomatic patients with favorable anatomy who underwent a concomitant LRYGB and hernia repair as described earlier. Only two recurrences (10 % of this subgroup and 7 % of the entire study group) were noted during the follow-up period.

Three patients were classified as symptomatic with favorable anatomy. They all underwent LVHR, followed by LRYGB as a separate procedure. The average time interval between the two procedures was around 6 months. No hernia recurrences were noted in this subgroup.

Three patients were included in the asymptomatic and unfavorable anatomy group. These patients underwent LSG (n=2) and LAGB (n=1) followed by LVHR as a separate procedure. Hernia repairs were delayed for 9 months in the LSG patients and 18 months in the LAGB patient due to slower weight loss. The last patient presented with hernia incarceration and required emergent laparoscopic repair using the modified Rives–Stoppa technique with intra-abdominal placement of permanent mesh. A recurrence was seen at a subsequent laparoscopic procedure. It was addressed at a later time during a panniculectomy.

Two patients fit the criteria of the symptomatic hernia with unfavorable anatomy group. After attaining acceptable weight loss with a medically supervised very low calorie diet, both patients underwent a LSG and a concomitant

LVHR using primary suture repair with bio-absorbable mesh re-enforcement. There was one recurrence in this group. Table 2 shows the recurrence incidence in all groups. No operative deaths or wound infections occurred and no patients required conversion to an open procedure.

Discussion

Ventral hernia repair has evolved in recent years. Traditional open primary suture repair was associated with recurrence rates as high as 52 %[4]. Tension-free mesh repair was later introduced, significantly reducing recurrence rates to roughly 20–30 %. However, large abdominal incisions in the morbidly obese with wide tissue dissection for creation of flaps resulted in a high incidence of postoperative morbidity and wound complications (12 % or higher)[4]. All these factors promoted the search for other modalities in tackling abdominal wall defects in the morbidly obese population.

Laparoscopic ventral hernia repair was first reported in 1992. This technique has been associated with lower recurrence rates, fewer complications, and faster recovery, although true randomized trials with open techniques are lacking[2, 4, 5, 11]. It appears that this advance in hernia repair might benefit the bariatric patient as well, just as recent studies have demonstrated an advantage of the laparoscopic approach over open bariatric surgery. National Surgical Quality Improvement Program data reported by Hutter and colleagues clearly reveal the advantages of minimally invasive surgery when comparing LRYGB to open surgery[12]. Similarly, shorter hospital stays, decreased pain, lower wound complications, lower recurrence rates, and quicker return to work are reported for LVHR patients[1, 2, 4, 5, 11]. The cited evidence supporting the laparoscopic approach should be favored when dealing with the unique challenges of abdominal wall defects in the morbidly obese patient. The current literature still lacks guidance concerning optimal timing of hernia repair in relation to the bariatric procedure and the choice of hernia repair method. Furthermore, the literature contains a wide spectrum of outcomes on ventral hernia repair in obese patients, which further complicates the surgeon's decision-making process.

Review of the current literature shows only fair outcomes in reports including higher BMI patients. Raftopolous et al. reported hernia repairs on 27 morbidly obese patients with an average BMI of 46.9 kg/m^2. These patients were followed over 15 months and the recurrence rate was reported at 18.5 % (8). Similar results were reported by Shuster's group, who performed LVHR on 12 patients with average BMI 50.4 kg/m^2 and a recurrence rate of 17 %. (10) In contrast, much better outcomes are seen in obese patients with lower BMIs. Novitsky et al. and Heniford et al. both report recurrence rates of around 5 % in patients with BMI of 38 and 32 kg/m^2, respectively. Their patients were followed for at least 20 months.[2, 4] All of the mentioned reports demonstrate an acceptable recurrence rate when LVHR is used in the obese patient, but clearly there is a correlation between the patient's BMI and hernia recurrence rates. This, in conjunction with the known fact that patients with BMI over 50 kg/m^2 pose increased surgical risk, led us to seek a more complex algorithm to treat bariatric patients with abdominal wall defects.

Weight loss surgery may be an important adjunct treatment in the management of ventral hernia. LRYGB and LAGB are the two most popular bariatric procedures performed. LSG is rapidly gaining momentum as a stand-alone bariatric procedure and may be favored in morbidly obese patients with large ventral hernias as the surgery is limited to the foregut and can be approached through a small window of clear adhesion-free abdomen. Additionally, this novel procedure results in faster weight loss than LAGB, similar to what is observed in a LRYGB. However, both LRYGB and LSG require division of the gastrointestinal tract, which results in field contamination. In such cases, there is a general lack of acceptance within the surgical community of concomitant bariatric surgery and hernia repair with permanent mesh due to risk of mesh infection. Limited data demonstrating the feasibility of such an approach, however, have been reported. Schuster and colleagues reported concomitant LRYGB and ventral hernia repair in 12 patients using polyester/collagen or polypropylene/cellulose with no mesh infections and two recurrences[10]. While such data do exist, it is by no means considered a standard of care as it only involves a small series with lack of long-term follow-up. Mesh infection, necessitating subsequent mesh removal, is a very

Table 2 Recurrence of ventral hernia by treatment subgroups

Surgical Approach	Patients	Recurrences
Favorable asymptomatic subgroup (LVHR followed by bariatric procedure)	3	0
Favorable symptomatic subgroup (concomitant bariatric procedure LVHR)	20	2
Unfavorable symptomatic subgroup (medically supervised very low calorie diet followed by LVHR and then bariatric surgery)	2	0
Unfavorable asymptomatic subgroup (bariatric procedure followed by LVHR at a later date)	3	1

morbid and costly problem in an already high-risk bariatric patient population, not to mention the high recurrence rates associated with mesh infections and the potential medical–legal implications. For those reasons, we do not favor this approach.

In our experience, an unacceptably high recurrence rate has been encountered when bio-absorbable mesh is used as a bridge to close the hernia defect in a similar fashion to permanent mesh. Our initial data reported zero recurrence rates at 13-month follow-up using this technique concomitantly with LRYGB. Unfortunately, with longer-term follow-up rates (mean of 30 months and 50 % follow-up), all patients who presented back to our practice had developed hernia recurrences. While some surgeons routinely use the above technique as a temporary fix with the main goal of avoiding bowel strangulation, clearly it cannot be considered a permanent repair. The reasoning behind this is that deferring repair of the defect carries a significant risk of bowel incarceration and possibly even strangulation, especially when the surgeon reduces an omental incarceration without addressing the underlying hernia [13]. Based on our experience, we believe that the use of bio-absorbable mesh with concomitant LRYGB can only be effectively utilized as reinforcement for suture repair. On the other hand, concomitant bariatric surgery and hernia repair in patients with unfavorable hernia and body habitus characteristics as described in our study can be very challenging and time-consuming. Performing LRYGB at the time of hernia repair not only adds considerable operation time and risk but also introduces contamination with subsequent risk for mesh infection as previously mentioned.

A fairly large number of bariatric patients present with small hernias with greatest diameter of less than 2 cm. These defects are most often asymptomatic and are incidental findings during laparoscopic bariatric surgery. Those defects can be repaired primarily with the use of permanent sutures. It is also important to mention here that these defects need to be addressed as failure to perform a repair can lead to potential bowel strangulation, requiring emergent surgery with potentially poor outcomes [13].

The main limitation of this study is the small number of patients in each individual treatment subgroup. The reason for this is that only a small percentage of candidates for bariatric surgery present with larger hernias diagnosed prior to the procedure, and most of these patients are asymptomatic with favorable anatomy features. Candidates for bariatric surgery who fall in the other groups are not as common. As only a small number of patients present with these complex issues, adequate power cannot be established and valid statistical analysis is not possible. In addition, blind randomizations would also be virtually impossible given the wide variation in the types of hernias. Another important limitation that we need to mention is the fact that the anatomic criteria used to divide patients into groups are entirely subjective. The criteria and guidelines we have developed are based on our vast experience with the bariatric patient population. This manuscript provides an algorithm which is not a rigid guideline but is aimed at guiding surgeons in the decision-making process, and not all patients will fit into our criteria exactly as not all hernias are created equal.

Conclusion

In summary, as the prevalence of obesity increases, so does the incidence of ventral hernias in the obese population; most general surgeons will eventually face this problem in their practice. It is clear that bariatric patients with abdominal wall defects present a unique challenge to the surgical community, requiring a complex and thought-out approach. Based on our center's experience, we propose an individualized treatment approach that takes into consideration a patient's symptoms and anatomical considerations.

Conflict of Interest Dr. Eid would like to disclose that he has been a speaker for Covidien and a consultant for Cooper Surgical and Apollo Surgical. Dr. Wikiel, Dr. Entabi, and Dr. Saleem have no conflicts of interest to disclose.

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