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Laparoscopic Harvest of Omental Flaps for Reconstruction of Complex Mediastinal Wounds

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ABSTRACT

Background: Omental harvest for complex poststernotomy mediastinal wounds has traditionally required a formal laparotomy in often high-risk patients, thus making it the procedure of last resort.

Methods: The charts of all patients who underwent a laparoscopic omental harvest at the Texas Endosurgery Institute were retrospectively reviewed.

Results: Seven patients, 4 males and 3 females with an average age of 65.1±6.3 years, with complex mediastinal wounds following coronary artery bypass grafting were studied. All patients underwent laparoscopic harvest of omental flaps based on the right gastroepiploic artery (3), the left gastroepiploic artery (1) or both (3), along with pectoralis major myocutaneous advancement flaps in 5 patients and partial-thickness skin graft and a vacuum-assisted closure device in 2 patients. The average operative time for the entire procedure was 196±54 minutes. Enteric feedings could be tolerated early postoperatively with a mean of 3.8 days. One death (14.2%) occurred. All surviving patients had excellent wound healing results at a mean follow-up of 19.1 months.

Conclusion: Laparoscopic harvest of omental flaps for the reconstruction of complex mediastinal wounds is a valid and potentially less morbid alternative for the treatment of this infrequent but disastrous complication of open heart surgery.

Key Words: Laparoscopy, Omentum, Mediastinitis.

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INTRODUCTION

Chest wall defects result from trauma, radiation injury, radical surgery, and massive infections following surgical procedures and in fact constitute hernias of the chest wall. These defects can result in exposure of anatomical structures normally protected by the chest wall, varying from soft tissue, cartilage, and bone to more vital organs, such as the heart, lungs, and great vessels. The potential for involvement of these vital structures by the infectious process may lead to life-threatening complications, such as major cardiovascular hemorrhage.[1]

Reconstruction of the chest wall has been a challenge for surgeons. To accomplish the best functional and aesthetic results, reconstruction of the defect in the chest wall may require a skin graft, a local pedicle flap, or both of these, for superficial defects or more complex flap reconstruction for larger and deeper areas of tissue loss. Various muscle flaps commonly used for chest wall reconstruction are usually readily available and include pectoralis major, latissimus dorsi, rectus abdominis, trapezius, serratus anterior, and paraspinous muscle groups. Omentum with an intact vascular supply based on the right or left gastroepiploic vessels has also been used as a flap for chest wall reconstruction, due to its supple texture and flexible consistency to fill open spaces and its ability to adapt to different sizes or shapes.[2] However, omental harvest has traditionally required a formal laparotomy often in a high-risk debilitated patient, thus increasing the morbidity and mortality of the procedure and making it the procedure of last resort when no other flaps are suitable.

Laparoscopic omental harvest has been previously described[3] but has not gained widespread adoption. The laparoscopic approach has the potential to decrease the physiological stress of laparotomy and the very high risk of abdominal wound infection and to make the omental flap option more available to seriously ill patients when needed. In this article, we report our initial experience with laparoscopically harvested omental flaps in the reconstruction of infected sternotomy wounds.

METHODS

The charts of all patients who underwent a laparoscopic omental harvest at the Texas Endosurgery Institute were retrospectively reviewed. Demographic data were noted including age, and sex. Preoperative data noted included comorbidities, American Society of Anesthesiology (ASA) class, preoperative hematocrit, white blood cell count, creatinine, and albumin. The organisms cultured from the sternal wound were recorded as were the local and systemic treatments preceding the omental flap reconstruction. The operative time for the entire procedure, which included the laparoscopic harvest, was recorded. In addition, the estimated blood loss, any intraoperative or postoperative complications, the length of postoperative mechanical ventilation, time to resumption of enteral feeding, and length of postoperative stay as well as the status of the wound on follow-up were noted.

Operative Technique

After satisfactory induction of general endotracheal anesthesia, the patient is secured to the operative table and placed in a modified lithotomy position. A nasogastric tube and Foley catheter are inserted. The abdomen and chest are prepared and draped in the usual manner. The chest wound is initially debrided and pulse lavaged with a solution containing an antibiotic, then covered with Betadine-soaked gauze so it does not contaminate the abdominal wounds and cavity. This is frequently completed at the same time as the abdominal procedure using 2 separate teams and sets of instruments. The abdomen is insufflated with a Veress needle up to 14 mm Hg, usually away from the midline, followed by placement of a 5-mm trocar lateral to the left rectus sheath and a 5-mm camera. Three additional trocars are then placed under direct vision as illustrated in **Figure 1**. Supplementary trocars are added as needed. After exploration of the abdomen and completion of any adhesiolysis, the omentum is suspended to allow better exposure for detachment of the omentum from the transverse colon, from the hepatic flexure to the splenic flexure. Depending on the amount of mobilization needed, the omentum may be left attached to the entire greater curvature of the stomach (bipedicled omental flap), or separated from the stomach in the plane between the gastroepiploic arcade and the stomach wall by using the ultrasonic dissector and the left or right gastroepiploic vessels then ligated and divided. Once the omentum is

completely freed, an incision is made in the upper anterior abdominal wall near the xiphoid through the median sternotomy wound and the omentum delivered from the abdominal cavity into the sternal wound without tension on the stomach. Care must be taken to avoid torsion of the blood supply to the omental flap. For deep mediastinal wounds, the omentum is brought up to the mediastinum through an opening in the diaphragm and pericardium. The omentum is fashioned into position to provide maximal coverage of the chest wall defect. The wound is then closed with bilateral pectoralis major musculocutaneous advancement flaps if available, or a partial thickness skin graft placed over the omentum followed by a vacuum-assisted closure (VAC) device. Hemostasis is secured in the abdominal cavity, the flap rechecked, and the trocar sites closed.

RESULTS

At the time of the study, 7 patients had undergone a laparoscopic harvest of an omental flap for coverage of sternal and mediastinal wounds. Patients comprised 4 males and 3 females with an average age of 65.1 ± 6.3 years (range, 54 to 71). Four patients had diabetes, and 4 had chronic obstructive pulmonary disease (COPD). Three patients had chronic renal insufficiency with 2 requiring hemodialysis prior to the omental flap due to superimposed acute renal failure. The mean ASA was
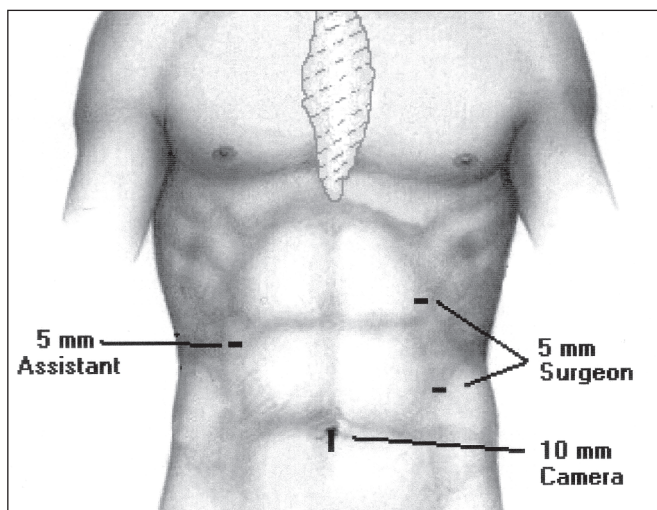

Figure 1. Trocar sites for laparoscopic harvest of omental flaps.

3.8, ranging from 3 to 5. The mean preoperative serum albumin level was 2.6 (range, 1.8 to 3.5). Four patients had prior open abdominal surgeries, which included cholecystectomy (3) and hysterectomy (2). All median sternotomy incisions were for coronary artery bypass grafting, one of them being a reoperation; the left internal mammary artery was used for coronary revascularization in all patients, and the right internal mammary artery was used in 1 patient as well. In all patients, the sternal wound infection occurred 6 to 18 days postoperatively, except for in 1 patient who developed it about 3 months after the median sternotomy. The sternal wound cultures grew methicillin-resistant *Staphylococcus aureus* (MRSA) in 3 patients (42.8%) and methicillin-resistant *Staphylococcus epidermidis* (MRSE) in 2 patients. All cultures were negative in 2 patients. All patients were placed on systemic antibiotics and underwent multiple debridements (range, 1 to 5 debridements) prior to the omental flap. One patient had pectoralis major advancement flaps that failed.

All patients underwent a laparoscopic harvest of an omental flap along with pectoralis major myocutaneous advancement flaps in 5 patients and partial-thickness skin graft and the VAC device in 2 patients. The omental flaps were based on the right gastroepiploic artery (3), the left gastroepiploic artery (1), or both (3). The average operative time for the entire procedure was 196±54 minutes (range, 117 to 292 min). Patients with prior abdominal surgeries had longer procedures as expected (223.7 min versus 160.7 min) due to lengthy lysis of adhesions. The average estimated blood loss was 364±154 cc (range, 100 to 500); the blood loss for the omental harvest was usually minimal. No intraoperative complications occurred. Enteric or oral feedings could be fully tolerated early postoperatively with a mean of 3.8 days (range, 2 to 9 days). Postoperative complications included 1 acute renal failure requiring hemodialysis and 1 rectovaginal fistula secondary to chronic fecal impaction requiring a laparoscopic diverting colostomy. Three patients had a prolonged intubation requiring tracheostomy; two of these patients had been intubated for a long duration (26 and 23 days) prior to the omental flap surgery. No intraabdominal or abdominal wound complications occurred. One death (14.2%) took place that occurred on postoperative day 18 secondary to enterococcal and MRSA sepsis with renal and respiratory failure. Only 1 small partial necrosis of 1 omental flap was noted based on the left gastroepiploic artery that healed

well. All surviving patients had excellent wound healing results at a mean follow-up of 19.1 months (range, 3 to 36 months).

DISCUSSION

Infection and dehiscence of a median sternotomy wound is a relatively infrequent but potentially devastating complication of open heart surgery and may eventually lead to anterior mediastinitis with osteomyelitis/chondritis and necrosis of the sternum with a high morbidity and mortality rate. Rates of sternal infection after cardiac surgery range from 0.4% to 5%,[4] increasing in diabetic patients. The increased number of elderly, diabetic, and critically ill patients who undergo an open heart procedure and the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) found in cultures of these wounds have made the management of these patients very difficult.

Multiple management strategies have been proposed to deal with this serious and challenging complication; the plethora of available treatment methods probably attests to the difficulty of the problem and the relatively poor outcome of most therapies. Conservative surgical options include debridement followed by sternal resuturing over an antibiotic irrigation system or open dressings and delayed primary closure or closure by secondary intention. Proponents of delayed primary closure suggest some criteria for its use including clean tissue surfaces without purulent debris, the absence of pockets of purulent drainage, and negative wound cultures obtained 24 hours before closure.[5] However, several disadvantages exist with this conservative approach mainly related to the morbidity associated with serial debridements and dressing changes with open packing until the wound is closed, as well as the potential morbidity and mortality associated with the shearing forces between the beating heart and the debrided sternal edges and the need to paralyze the patient during the period after the debridement.[6] Although this conservative approach may be an effective treatment for sternal wound infection in select patients, it often fails or is impossible when radical debridement results in large and complex mediastinal wounds. In addition, these techniques with either open packing or antibiotic irrigation have been associated with a mortality approaching 50% in some series.[7]

When compared with closed-catheter irrigation and open granulation techniques, flap closure is shown to result in a fourfold decrease in mortality, an increased success of

primary therapy, and a diminished length of hospitalization following treatment.[8] In fact, the main advantage of using autologous tissue flaps is the presence of healthy, well vascularized tissue, mobilized from an area away from the infected wound and that will assist in the control of local infection, promote wound healing, and provide adequate coverage of the mediastinal organs. Bilateral pectoralis major advancement myocutaneous flaps are the most common type of muscle flap used for this indication.[8-11] They have been used alone or in combination with pedicled rectus abdominis muscle flaps.[11,12] Other surgeons have used pedicled rectus abdominis,[13] free rectus abdominis,[4] or latissimus dorsi muscle flaps.[14] Muscle flap reconstruction for sternal infection can be expected to give good long-term functional results. In 1 study,[15] exercise tolerance and pulmonary function did not differ from that in a control group of cardiac surgical patients, despite the altered composition of the chest wall. Muscle flaps have been associated with a mortality of 8.1% to 15%[7,11] and complications including recurrence of infection, hematoma, hernia at the donor site, and others. Pectoralis major muscle may not be sufficient to obliterate the whole poststernotomy defect, especially inferiorly, may result in excessive tension on the closure in wide defects, and may leave a large dead space in deep mediastinal wounds. Pedicled rectus abdominis muscle flaps are often unavailable secondary to the routine use of one or both internal mammary arteries for coronary artery bypass grafting or secondary to the division of these arteries during extensive sternal wound debridements or prior open abdominal surgeries with subcostal incisions.

The omentum has the advantage of adapting to large wounds, contains a rich vascular and lymphatic supply, and has angiogenic activity that may stimulate neovascularization in ischemic tissues.[16] In patients in whom a muscle flap cannot be used due to failed prior attempts at reconstruction or due to resection or damage at the time of radical debridement, the omentum becomes a valid alternative and allows containing infections, absorbing exudates, and furnishing a good base for skin grafts. In patients with mediastinitis, the omentum appears to provide adequate bulk for obliteration of the large dead space that remains after opening and debriding the median sternotomy wound.

The use of omentum as a coverage flap is not new. Jobet and Lambel[17] first described the clinical use of the omentum in 1826 for the treatment of intestinal wounds.

Kiricuta[18] popularized its use as a pedicle flap and was the first to describe it in reconstruction of the breast after breast cancer in 1963. Subsequently, omental flaps have found many indications in thoracic and reconstructive surgery. In 1976, Lee et al[19] proposed the transposition of the omentum to eliminate mediastinal dead space in cases of infected sternotomy wounds, with good results. Yasuura et al[20] reported their 10-year experience with 44 patients treated with omental flap transposition for deep sternal wound infection: methicillin-resistant *Staphylococcus aureus* was cultured from more than 50% of the wounds; 7 (16%) in-hospital deaths occurred with hemodialysis and ventilatory support at the time of omental flap transposition significantly associated with in-hospital mortality rates by univariate analysis; 2 patients with cultures positive for methicillin-resistant *Staphylococcus aureus* had recurrent sternal infections but all other survivors had good long-term results. Omental pedicle flaps have also been used to treat patients with acute and chronic empyema with bronchopleural fistula, with excellent results reported.[21-23]

Harvesting of the omental flap normally necessitates a formal laparotomy, which is associated with significant morbidity including wound complications along with pulmonary-related problems in patients who already have a significant limitation in their respiratory function. However, the laparoscopic approach has the potential to decrease the physiological stress of laparotomy and its potential complications thus making the omental flap option more available to seriously ill patients and reducing the rate of abdominal wound infection.

Laparoscopy was initially used preoperatively with patients under local anesthesia to check the extension and constitution of the greater omentum and assess its suitability for flap coverage.[24] Laparoscopic omental harvest was first reported by Saltz in 1993.[3] Originally, he described a complete exteriorization of omental tissue prior to ligation of vascular branches and isolation of the right gastroepiploic pedicle. Later, the dissection of the greater curvature of the stomach was performed intracorporeally.[17] In 1998, Domene et al[25] described 1 case of an omental flap harvest by laparoscopic surgery for the reconstruction of a large mediastinal wound, transposing the omentum based on the left gastroepiploic vessels without complications through the abdominal wall defect.

Recently, authors[26] have described the use of laparo-

scopically harvested omentum for immediate breast reconstruction in 10 patients. Their results suggest that the laparoscopically harvested omental flap may be extremely dependable in terms of vascular supply; 1 case of partial necrosis occurred that healed with local management alone. Cosmetic results were satisfactory and donor-site scars were minimal. No residual loss of function occurred, and no cases of incisional ventral hernias were noted.

Our series is the largest published series of laparoscopically harvested omental flaps for complex, postmedian sternotomy, mediastinal wounds. Our results in these patients with frequent comorbidities and ventilatory dependence show that this procedure is safe, allows early resumption of enteric feeding, and has virtually no wound-related complications. We did not encounter any recurrent chondritis or any flap loss. Our mortality (14.2%) is similar to that reported in the literature in open omental harvest for deep sternal wound infection after cardiovascular surgery;[20] it probably relates more to the nature of the patient population than to the procedure itself.

CONCLUSION

The use of omental flaps for reconstructing chest wall defects secondary to massive sternal wound infection has been described in the medical literature, traditionally requiring an abdominal incision in a high-risk group of patients. Laparoscopic techniques provide a minimally invasive approach and seem to offer a safe procedure. As with other laparoscopic procedures, surgeons must be familiar and comfortable with laparoscopic equipment and surgical techniques to avoid preventable complications, such as perforation of bowel, laceration of vessels, and other iatrogenic injuries. We believe that this new method is a valid and potentially less morbid alternative for treatment of this infrequent but disastrous complication of open heart surgery.

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