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Original Article

# Omental flap harvested through transdiaphragmatic approach at the same sternotomy incision for poststernotomy mediastinitis: a new approach

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## Abstract

**Background**
The surgical treatment of poststernotomy mediastinitis is still a challenge and associated with high mortality. Conservative treatment and various surgical procedures are sometimes inadequate and need more aggressive treatment. Omental flap improves control of infection and prognosis, but harvesting is an additional procedure with its associated morbidity and trauma.

**Patients and methods**
A total of 14 patients had omental flap, which was harvested through a diaphragmatic opening at the lower part of the same sternotomy incision, without additional laparotomy incision or extension of sternotomy incision into the upper abdomen or even laparoscopically. The mean age of the patients was 59.5 ± 15.5 years. There were nine females and five males. Coronary artery bypass grafting was done in 12 patients and two patients had mitral valve replacement.

**Results**
There were no complications related to the omentoplasty. No herniation of abdominal organ occurred. Reoperation was performed at an interval of 15 days (7–23 days). Wound debridement was done in four patients, and wound was opened in five patients. Two patients had vacuum suction. Tissue cultures revealed staphylococci in eight patients. Omental flap was performed alone in 10 and combined with pectoralis flap in four patients. The operative mortality was one patient. Prolonged ICU stay (±pneumonia) was seen in four patients and prolonged ventilation in four patients. Septicemia was seen in two patients, and one of them died with septic shock. No early or late flap failure occurred. Incisional hernia occurred in one patient and lymphorrhea in one patient.

**Conclusion**
Transdiaphragmatic approach which allows harvesting of omental flap safely through the same sternotomy incision is a new era of minimally invasive surgery without the need of additional laparotomy or extension of the sternotomy incision to the upper abdomen or even laparoscopic surgery and provides excellent results for the treatment of poststernotomy mediastinitis through the same sternal incision.

**Keywords:** Omental flap, poststernotomy mediastinitis, the same sternotomy incision, transdiaphragmatic approach

## Introduction

The incidence rate of mediastinitis is 0.5–4%, with a mortality rate up to 50%. Poststernotomy mediastinitis is a rare but devastating complication following cardiac surgery. The presence of infection and compromised perfusion of the sternum makes the bone weak, and the sternal wires get ripped out of the bone by the permanent motion of the two sternal halves and then an open thorax results [1,2].

The omentum is known as 'policeman of the abdomen' and has since been described for the treatment of a variety of infective cardiothoracic complications. It is an excellent choice for repairing a wide range of thoracic defects. Various approaches

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include laparotomy (upper midline abdominal incision), laparoscopy, and transdiaphragmatic through thoracotomy [3].

The greatest disadvantages of the omentum for treating postoperative sternal osteomyelitis are related to the laparotomy, which is responsible for postoperative ileus (delayed oral nutrition) and postoperative pain (impairment of ventilatory dynamics, mucus retention, and possible respiratory infections) [4].

Harvesting the omental flap by laparoscopy is a technically easy procedure. It takes advantages of the favorable properties of the omentum without further significant surgical trauma that allows the use of such procedure even in severely compromised patients [4].

Although the transdiaphragmatic approach through thoracotomy avoids an abdominal incision, it is difficult to harvest the whole greater omentum with this technique omentum through with this technique, as it is not recommended when a large bulk of omentum is needed [5].

Thoracic use of omental flap includes treating poststernotomy mediastinitis, bronchopleural fistula, space defects associated with empyema, threatened airway anastomoses, esophagogastrostomy after esophagogastrectomy, and tracheoesophageal fistulas [3].

Contraindications for omental flaps include previous major abdominal infection, cirrhosis with portal hypertension, and omental disorders. In patients with cachexia, omental bulk may be insufficient to overlap large defects [3].

Complications associated with omental harvest are rare and include ileus, bowel obstruction, gastric outlet obstruction, diaphragmatic herniation, omental necrosis, and abdominal fascial dehiscence [3].

## Patients and Methods

Fourteen patients had omental flap harvested with transdiaphragmatic approach through the same sternotomy incision at the National Heart Institute from June 2009 to December 2018. There were nine females and five males.

Omental flap was harvested through transdiaphragmatic approach at the same sternotomy incision without additional laparotomy incision or extension of sternotomy incision into the upper abdomen or even laparoscopically. Previous abdominal intervention is the only contraindication to this procedure.

### Operative technique

A median sternotomy incision over the existing scar was done if the wound (or part of it) is still closed. Inspection of the sternal bone edges after removal of the sternal wires was done. A mediastinal debridement was performed with Volkmann's spoon until a well-perfused and vascularized tissue had been exposed. This includes partial or near-total resection of the sternum when needed. The bilateral pectoral flaps were prepared if the sternal remnants were too small, to add additional stability and stiffness to the wound.

Incision is performed at the subxiphoid anterior insertion of the diaphragm with a diathermy at the lower part of sternotomy incision (Fig. 1).

The length of the incision at the diaphragmatic opening is tailored (longitudinally and transversely if needed) without extension to the upper abdomen (Fig. 2), to allow the surgeon's hand to slide through the diaphragm to enter the abdominal cavity over the left lobe of the liver, which is seen once the incision is made (Fig. 3). The greater omentum is identified by gentle palpation. When the most distal portion of the omentum is identified and recognized to be free of adhesions, it is gently retracted through the diaphragm into the chest between the two sternal edges in the sternotomy incision until a sufficient pedicle is enough to fill the space up to the suprasternal notch (Fig. 4).

In sternotomy incision, there is no need for a very long pedicle as in the thorax. During the maneuver, the transverse colon is identified and its omental insertion is divided as extensively as possible if needed. If the pedicle is not long enough, it is mobilized from the transverse colon. The mobilization is begun by dissecting the omentum along the avascular embryologic fusion plane along the transverse colon with blunt dissection and ligation of blood vessels with silk sutures. After the omentum is mobilized from the transverse colon, a small rim of omentum is left behind, and then a reflection maneuver of the omentum is done from below upward associated with mobilization from both sides until a long pedicle is reflected through the diaphragmatic opening with care not to twist the transverse colon or angulate the pedicle of omentum to preserve its vascular blood supply by avoiding obstruction of its blood vessels and necrosis.

After ensuring that the flap reaches the suprasternal notch with no traction on the transverse colon or stomach, the omentum is fixed to the surrounding structures (remnant of the sternal wall and muscles) with interrupted absorbable sutures. The diaphragmatic incision is then narrowed with heavy interrupted silk sutures leaving an opening without tightness to the pedicle

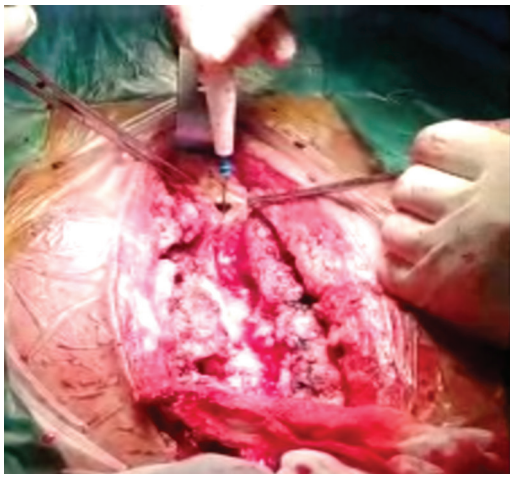

**Figure 1:** Incision is performed at the subxiphoid anterior insertion of the diaphragm with a diathermy at the lower part of sternotomy incision.

to prevent strangulation of the omentum. Tension on the omental flap is further relieved by fixing it to the diaphragmatic opening with fine interrupted sutures.

The subxiphoid muscles are closed over the flap to prevent hernia but not tightly over the pedicle to avoid squeezing of the omentum. No skin grafts were used to reconstruct the sternal wound over the omentum. Closure of the skin was done with interrupted tension sutures after drainage (Fig. 5).

### Ethics

All the cases in this study were the author's own patients with no need for approval by the Ethical Committee of the National Heart Institute.

### Consent

The study data and information were taken after approval by patients. Informed consent was obtained from patients to do this procedure and for data publication.

**Figure 2:** The length of the incision at the diaphragmatic opening is tailored (longitudinally and transversely if needed) without extension to the upper abdomen.

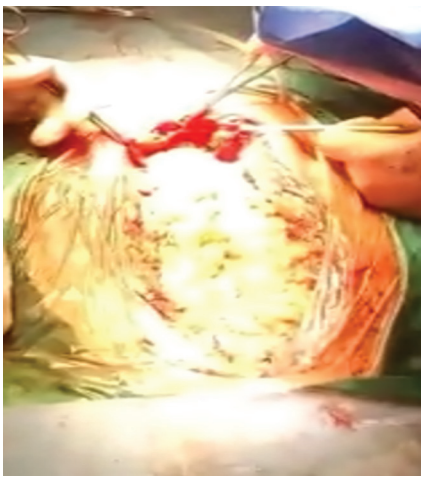

**Figure 4:** The greater omentum is identified by gentle palpation. When the most distal portion of the omentum is identified and recognized to be free of adhesions, it is gently retracted through the diaphragm into the chest between the two sternal edges in the sternotomy incision until a sufficient pedicle is enough to fill the space up to the suprasternal notch.

## Results

Fourteen patients had omental flap reconstruction of poststernotomy mediastinitis through transdiaphragmatic opening at the same sternotomy incision, as there were no fixed guidelines. The mean age of the patients was 59.5 ± 15.5 years. There were five (35.7%) males and nine (64.3%) females. There were no complications related to the omentoplasty procedure. None of the patients reported digestive or abdominal symptoms. No herniation of abdominal organs occurred in any patient. Reoperation for mediastinitis was performed in an average of 15 days (range: 7–23 days) after the initial operation. Before reconstruction surgery, wound debridement was performed in four (26.6%) patients. The wound was opened before the

**Figure 3:** To allow the surgeon's hand to slide through the diaphragm to enter the abdominal cavity over the left lobe of the liver, which is seen once the incision is made.

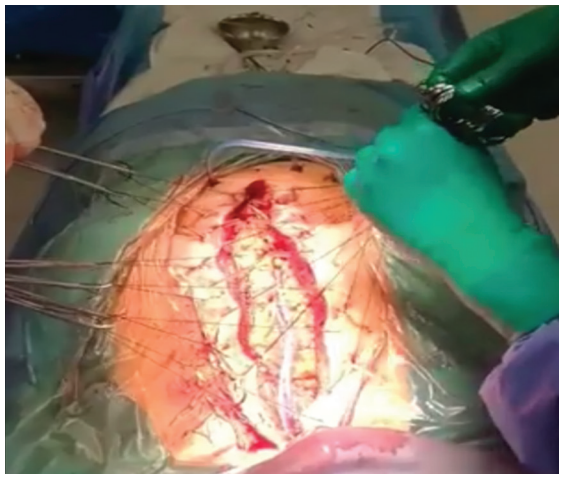

**Figure 5:** The subxiphoid muscles are closed over the flap to prevent hernia but not tightly over the pedicle to avoid squeezing of the omentum. No skin grafts were used to reconstruct the sternal wound over the omentum. Closure of the skin was done with interrupted tension sutures after drainage.

operation in five (35.7%) of them. Two (14.2%) patients had vacuum drainage before surgery. Tissue cultures were obtained in all patients. Staphylococci were the predominant germ in eight patients [six (42.9%) with *Staphylococcus aureus* and two (14.2%) with *Staphylococcus epidermidis*]. Six (42.9%) patients had a nosocomial Gram-negative infection. No patient had mixed infection with two or more microorganisms. There were 10 (71.4%) patients with diabetes mellitus, of which six (42.9%) patients were insulin dependent; seven (50%) patients with obesity (BMI >32 kg/m$^2$); and five (35.7%) patients with chronic obstructive pulmonary disease. Simultaneous debridement and omental flap transposition only was performed in 10 (71.4%) patients. Combined transposition of omental flap and bilateral pectoralis flap to the midline was performed in four (26.6%) patients. No patients had partial sternotomy at the time of reconstruction. The operative mortality was one (7.1%) patient, which was a hospital mortality in a female patient who had septicemia and died from septic shock. There were four (26.6%) patients with prolonged ICU stay (±pneumonia), four (26.6%) patients with prolonged ventilation, two (14.2%) patients with septicemia, and one (7.1%) patient with septic shock. There were three (21.4%) patients who had low COP. There were no signs of recurrent infection or flap failure or necrosis in the surviving patients. No early or late flap failure occurred. One (7.1%) patient developed incisional hernia with incomplete healing of the sternal wound. One (7.1%) patient had prolonged discharge in the form of lymphorrhea for 2 months and then resolved. One (7.1%) patient was ventilated twice because of pneumonia with *Klebsiella pneumoniae* and improved after antibiotic according to culture taken. She was obese with chronic obstructive pulmonary disease and insulin-dependent diabetic and had both omental and pectoral flaps. No patients developed postoperative pleural infection. All median sternotomies were performed for cardiac diseases. Twelve patients underwent coronary artery bypass grafting as primary procedure, with 10 (71.4%) patients with one internal thoracic artery and two (14.2%) patients with double internal thoracic arteries, and there were two (14.2%) patients with mitral valve replacement (Table 1).

**Table 1: Omental flap reconstruction results**

| *N* | 14(100%) |
|---|---|
| Age (years) | 59.5±15.5 |
| Male | 5 (35.7) |
| Female | 9 (64.3) |
| Reoperation time (range) (days) | 15 (7-23) |
| Debridement before procedure | 4 (26.6) |
| Wound open | 5 (35.7) |
| Vacuum suction | 2 (14.2) |
| Culture | |
| *Staphylococcus* | 8 (57.1) |
| *Staphylococcus aureus* | 6 (42.9) |
| *Staphylococcus epidermidis* | 2 (14.2) |
| Gram negative | 6 (42.9) |
| *Pseudomonas aeruginosa* | 2 (14.2) |
| *Escherichia coli* | 2 (14.2) |
| *Klebsiella pneumoniae* | 2 (14.2) |
| Omental flap only | 10 (71.4) |
| Omental flap+pectoral flap | 4 (26.6) |
| Diabetes mellitus | 10 (71.4) |
| Insulin dependent | 6 (42.9) |
| COPD | 5 (35.7) |
| Obesity (BMI>32) | 7 (50) |
| Mortality | 1 (7.1) |
| Prolonged ICU stay (±pneumonia)>2 days | 4 (26.6) |
| Septicemia | 2 (14.2) |
| Septic shock | 1 (7.1) |
| Prolonged ventilation>24 h | 4 (26.6) |
| LCOP | 3 (21.4) |
| Incisional hernia | 1 (7.1) |
| Incomplete healing | 1 (7.1) |
| Lymphorrhea | 1 (7.1) |
| Primary procedure | |
| CABG | 12 (85.7) |
| 1 ITA | 10 (71.4) |
| 2 ITA | 2 (14.2) |
| MVR | 2 (14.2) |

CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; ITA, internal thoracic artery; LCOP, low cardiac output; MVR, mitral valve replacement.

## Discussion

Omental flap is preferred in the treatment of poststernotomy mediastinitis to muscle flap owing to the following factors: first, the omentum is rich of vascular supply that ensures adequate oxygen and antibiotic delivery, and second, the omentum has potent angiogenic factors [5]. Such factors have not been found in the muscle.

The use of vascularized tissue is needed for infection control, whereas flail chest is generally a minor problem for the mediastinal stiffness secondary to postinflammatory fibrosis. The omental flap shows superior resistance to infection and allows better filling of the deepest mediastinal recess [6,7].

The advantages of the greater omentum is immunologic action, which is also well known to increase local lymphocyte and other immunocompetent elements counts. Moreover, the omental transposition does not have the disadvantage of producing chest wall deformities and impairing the muscle function as seen with the use of major muscles flaps. Its amorphous shape and pliability allows perfect adaptation of the flap to close the defect. The disadvantage of omental flap transposition is extending the surgical procedure into the abdomen requiring additional laparotomic access (another upper midline incision) or elongation of the sternal incision into the upper abdomen [5].

The need for an additional surgical access into the abdomen and the concern for the potentially related additional complications (ileus, laparotomic dehiscence, and herniation) have limited the proliferation of the omentoplasty among surgeons as well as its acceptance by the patients [5].

Our technique allows harvesting of a sufficient amount of vascularized omental tissue without the need of an additional

laparotomy incision or extending the sternotomy incision into the upper abdomen or even laparoscopically with the advantages of better acceptance by patients and reduces operative time and trauma without increased morbidity. No associated abdominal and gastrointestinal complications or diaphragmatic herniation have been observed in our patients. The most effective ways to prevent potential intrathoracic herniation of abdominal organs are fixing the omentum to the diaphragmatic opening and narrowing the opening without tightness [5].

Muscle flap can be insufficient, in case of persistent or recurrent infection as well as remaining potentially infected artificial material. Re-inflammation, segregation of pus, and urgent revision will follow. The following attempt to cover the defect by the already existing flap will become more difficult. Reason for that is the fact that muscle flaps will lose their flexibility soon after its transplantation and transform to a firm scar-like structure. In that sense, a muscle flap will bring strong stability to the thorax wall; in case of revision for mediastinitis, it has been more and more difficult to replace it in the defect zone. Therefore, a tissue is needed, which will be an active aggressor against remaining infection [8].

Milano *et al.* [9] compared the omental flap and pectoralis flap for poststernotomy mediastinitis with specific regard to obtain a healed wound. They found that omental flap had a lower mortality rate and improved the early outcome; it seemed to be a more effective therapy with no flap failure or local recurrence.

Omentum is our best choice to obliterate the mediastinal gap after radical debridement. It can be used to cover the ascending aorta prosthesis in infected patients [4]. It contains high amounts of immunologically active cells, which seems to be responsible for its high anti-infective activity. Extensive vascularization as well as its neovascularization potential increases the blood supply leading to higher concentration of antibiotics at the infection site. Furthermore, by absorbing wound secretion, it eliminates substrates for bacterial growth. Pectoralis muscle is used to cover any remaining bony structure and to provide a stable and uniform surface underneath the skin.

In case of sternotomy, usually the midline incision is extended to the upper abdomen or a separate upper midline incision is done, and then the omentum is mobilized through that incision and transposed into the chest through anterior transdiaphragmatic or substernal route.

Although laparoscopically prepared omental flap allows to take the advantage of harvesting the omentum without further significant surgical trauma [4], and has the advantage of a technically easy procedure that allows its usage in compromised patients [10], it is still an additional procedure with all its complications.

The technique simply allows harvesting the omentum from the same sternotomy incision through anterior diaphragmatic opening without extension of the sternotomy incision or another separate upper abdominal incision or even by laparoscopically. It allows harvesting of a sufficient amount of vascularized omental tissue without the need of laparotomy incision by simply performing a cruciate incision in the anterior diaphragm at the lower part of the same sternotomy incision, access to the abdomen, and reflection of a sufficient omental pedicle to fill the space of sternotomy, with the advantages over all techniques described before by reducing operative time, trauma, morbidity, and avoiding all the disadvantages of all other techniques described before.

D'Andrilli *et al.* [5] had no associated gastrointestinal complications or diaphragmatic herniation, as they believed that fixing the omental pedicle to the diaphragmatic opening prevents further intrathoracic herniation of abdominal organs. In this study, the omental flap is fixed to the diaphragmatic opening as well as to the surrounding tissues (pectoral muscles and remnants of sternum) up to the soft tissues of suprasternal notch with reduction of the diaphragmatic opening without tightness, and there was no diaphragmatic herniation of intra-abdominal organs.

## Conclusion

Early results of transdiaphragmatic approach are excellent for the treatment of poststernotomy mediastinitis. It allows harvesting of omental flap safely through the same sternotomy incision, which is a new era of minimally invasive surgery without the need of additional laparotomy or extension of sternotomy incision into the upper abdomen or even laparoscopic surgery.

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### Conflicts of interest

There are no conflicts of interest.

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