Institutional report - Cardiac general

Omental transfer for deep sternal wound infection after coronary artery bypass grafting with the right gastroepiploic artery

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Abstract

We have applied omental transfer in cases of deep sternal wound infection (DSWI) that occurred after the right gastroepiploic artery was used as a coronary artery bypass graft. Study subjects were 7 patients (mean age was 66 years) who underwent coronary artery bypass grafting with the right gastroepiploic artery during the period January 1990–March 2004, then suffered DSWI and underwent single-stage treatment consisting of debridement and omental transfer 33 days on average (range 12–93 days) after the primary surgery. Patients were followed-up, and the following data were collected in retrospect: clinical presentation and in-hospital and long-term results. Three of the 7 patients underwent omental transfer based on the left gastroepiploic artery alone, 3 underwent omental transfer based on blood supply from a branch of the right gastroepiploic artery, and 1 underwent omental transfer based on blood supply from both branches. The hospital mortality rate was 14% (1 of 7 patients); death was caused by recurrent mediastinitis. Postoperative hospitalization was 47 days (range 21–83 days). Two patients died of cardiac failure, and 1 patient suffered abdominal wall hernia during the follow-up period. Even after harvesting of the right gastroepiploic artery, omental transfer was effective for the treatment of DSWI.

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Keywords: Right gastroepiploic artery graft; Deep sternal wound infection; Omental transfer

1. Introduction

Deep sternal wound infection (DSWI) remains a dreaded complication of cardiac surgery. Omental transfer is reported to be an effective plastic reconstructive procedure for the treatment of DSWI [1,2]. Generally, it is believed that this procedure should be avoided in patients after right gastroepiploic artery (GEA) harvesting because of decreased blood flow in the axis vessels in this flap. However, usefulness of the remnant omentum in such situations has been reported recently [3,4]. We performed omental transfer as the initial surgical treatment in seven patients who suffered DSWI after coronary artery bypass grafting (CABG) with the right GEA. We conducted a retrospective study evaluating the usefulness of omental transfer in these patients. We report our findings and discuss specific indications for use of the remnant omentum as a reconstructive flap.

2. Materials and methods

Subjects were 7 patients (4 men and 3 women; mean age 66.5 ± 15.5 years, range 36–80 years) who underwent CABG with the right GEA during the period January 1990–March 2004, then suffered a major sternal/mediastinal wound infection and underwent single-stage treatment consisting of debridement and omental transfer. All procedures were conducted at Omiya Medical Center, Jichi Medical School, Saitama, Japan. The seven study patients were from an original 1816 patients who underwent CABG via complete median sternotomy. The right GEA was harvested as a graft in 243 of the 1816 patients (14%). The incidence of DSWI after CABG was 1.1% (21/1816), and the incidence of DSWI after CABG with the right GEA was 2.8% (7/243). Characteristics of the seven study patients are given in Table 1. Six patients underwent CABG alone, and one patient underwent CABG and concomitant aortic valve replacement. Four patients had diabetes, and two patients had chronic renal failure.

DSWI was defined according to the guidelines of the Center for Disease Control and Prevention [5]. The mean interval between the primary CABG operation and diagnosis of DSWI was 25 ± 18 days (range 6–57 days). The pathogens were Staphylococcus epidermidis in 2 patients, methicillin-resistant Staphylococcus aureus (MRSA) in 2, methicillin-sensitive Staphylococcus aureus in 1, Enterobacter cloacae in 1. The pathogen was not identified in one case.

2.1. Treatment strategy

Our treatment strategy for DSWI after cardiac surgery is aggressive single-stage surgery consisting of debridement and omental transfer. When DSWI is suspected, we begin intravenous administration of a broad-spectrum antibiotic...
Table 1
Clinical characteristics of patients treated by remnant omental transfer for deep sternal wound infection after CABG with a right gastroepiploic artery graft

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Primary operation</th>
<th>ITA • graft</th>
<th>Operation time (min)</th>
<th>Diabetes</th>
<th>CRF b</th>
<th>BMI c (kg/m²)</th>
<th>Interval between CABG a and transfer (days)</th>
<th>Bacteriology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36/M</td>
<td></td>
<td>CABG×3</td>
<td>LITA, RITA*</td>
<td>415</td>
<td>Yes</td>
<td>No</td>
<td>26.7</td>
<td>26</td>
<td>Staphylococcus aureus (MRSA*)</td>
</tr>
<tr>
<td>2</td>
<td>58/F</td>
<td></td>
<td>OPCAB*×3</td>
<td>LITA, RITA</td>
<td>303</td>
<td>No</td>
<td>No</td>
<td>24.0</td>
<td>6</td>
<td>Enterobacter cloaceae</td>
</tr>
<tr>
<td>3</td>
<td>65/M</td>
<td></td>
<td>OPCAB×3</td>
<td>LITA</td>
<td>295</td>
<td>Yes</td>
<td>Yes</td>
<td>21.8</td>
<td>9</td>
<td>Staphylococcus epidermidis</td>
</tr>
<tr>
<td>4</td>
<td>74/F</td>
<td></td>
<td>OPCAB×3</td>
<td>LITA</td>
<td>330</td>
<td>Yes</td>
<td>No</td>
<td>15.9</td>
<td>20</td>
<td>Staphylococcus aureus (MSSA*)</td>
</tr>
<tr>
<td>5</td>
<td>75/M</td>
<td></td>
<td>CABG×4 + AVR</td>
<td>LITA</td>
<td>450</td>
<td>No</td>
<td>No</td>
<td>18.7</td>
<td>37</td>
<td>Staphylococcus aureus (MRSA*)</td>
</tr>
<tr>
<td>6</td>
<td>78/M</td>
<td></td>
<td>OPCAB×4</td>
<td>LITA, RITA</td>
<td>380</td>
<td>No</td>
<td>Yes</td>
<td>14.7</td>
<td>57</td>
<td>Staphylococcus epidermidis</td>
</tr>
<tr>
<td>7*</td>
<td>80/F</td>
<td></td>
<td>OPCAB×2</td>
<td>LITA</td>
<td>250</td>
<td>Yes</td>
<td>No</td>
<td>21.4</td>
<td>18</td>
<td>Not identified</td>
</tr>
</tbody>
</table>

* ITA, internal thoracic artery. • CRF, chronic renal failure. • BMI, body mass index. • CABG, coronary artery bypass grafting. • LITA (RITA), left (right) internal thoracic artery. * MRSA, methicillin-resistant staphylococcus aureus. * OPCAB, off-pump coronary artery bypass grafting. * MSSA, methicillin-sensitive staphylococcus aureus.

and perform open wound drainage at bedside. Irrigation with povidone-iodine solution and frequent dressing changes are performed for a few days to reduce local infection. Urgent removal of wires, wide sternal wound debridement, and omental transfer are performed simultaneously in the operating room.

2.2. Surgical technique

In each of the 7 patients included in the study, sternal wires and fascial or subcutaneous sutures were removed, and samples of mediastinal fluid were taken for culture. Wide sternal wound debridement was performed until fresh blood was obtained from the edge of the wound. The mediastinal wound was then irrigated with povidone-iodine solution. The upper abdomen was reopened via the previous midline incision, and laparotomy was performed. In cases in which severe intra-abdominal adhesion developed, careful dissection of the remnant omentum from the peritoneal wall and adjacent tissue was performed. Before construction of the omental pedicle flap, the remnant omentum and the right GEA were evaluated. A natural yellow color and palpable blood flow indicated that the remnant omentum could be used as a pedicle flap. After the omentum was separated from the transverse colon, the left GEA and/or the right omental artery (branch of the right GEA) was selected and used as an axis vessel for the omental pedicle flap. In cases in which the left GEA was normal and sufficient blood flow was confirmed, the omental pedicle flap was created based on blood supply from the left GEA (Fig. 1A). However, if the left GEA was not well developed and more reliable blood flow was confirmed in the right omental artery, the omental pedicle flap was created based on the right omental artery (Fig. 1B and Fig. 2). Usually, the right omental artery was preserved, and the vessel network within the omentum was maintained. In addition to these two procedures, the omentum was divided in one patient with widespread infection to the retrosternal space (Fig. 1C). That is, one pedicle was transferred to the anterior mediastinum and another pedicle was transferred to the subcutaneous space after debridement [6]. In all cases, after sufficient blood supply to the distal end of the pedicle flap was confirmed, the flap was transferred to the mediastinum or the subcutaneous dead space through a wide diaphragmatic opening. Subsequently, two underwater seal drains were left in the subcutaneous space; one was...
placed on the anterior surface of the omental pedicle flap, and the other was placed on the posterior surface. The subcutaneous tissue and skin were then closed with knot sutures. Closure was achieved as a single-stage procedure. After the mediastinal drainage samples were shown to be sterile, the suction drains were removed, generally 7–10 days after omental transfer. Antibiotics were given intravenously for 2–4 weeks after the operation.

Follow-up was performed in all patients. Follow-up time ranged from 3 to 35 months (median 7 months). The incidences of late death, late complications, and recurrent sternal wound infection were assessed. The 1-year survival rate was calculated by the Kaplan-Meier method. Statistical analyses were performed with SPSS 10.0 software (SPSS Japan Inc, Tokyo, Japan).

3. Results

The operative and postoperative details of the omental transfers are summarized in Table 2. Omental transfer was performed an average of 33 ± 28 days (range 12–93 days) after primary CABG. In 5 patients, infection was localized to the sternum (sternal osteomyelitis). In 2 patients, infection had spread to the anterior mediastinum. The omental pedicle flap was created based on the left GEA in 3 patients and on the right omental artery in 3 patients. In 1 patient (patient no. 1 in Table 2), both the left GEA and the right omental artery were used, yielding two pedicle flaps. Average operation time was 157 ± 66 min (range 80–290 min).

The hospital mortality rate was 14% (1 of 7 patients). This death was caused by multiple organ failure due to recurrent infection. The patient underwent an additional omental transfer 14 days after the initial transfer. The recurrence was probably due to incomplete coverage of the mediastinum with the remnant omentum (flap necrosis was not found at the time of the second omental transfer). Although the sternal wound infection resolved after re-operation, the patient died of multiple organ failure 82 days after the initial omental transfer. The other 6 patients were discharged without complication or recurrent angina. The average hospital stay after transfer of the remnant omentum was 47 days (range 22–83 days).

Two patients died of cardiac failure, one at 4 months and the other at 5 months after omental transfer. Abdominal wall hernia occurred in one patient. There were no other late complications related to omental transfer or recurrent sternal wound infection. The actual 1-year survival rate was 57%.

4. Discussion

DSWI remains one of the most serious complications after cardiac surgery, and the mortality rate is high. Commonly cited predictors of DSWI include diabetes, obesity, and use of both internal mammary arteries for CABG [7]. Although the incidence of DSWI among the patients with a GEA graft was higher than that of the whole cohort (1816) of CABG patients (2.8% vs. 1.1%) in our series, use of the GEA graft has not been reported as a risk factor for DSWI. Prolonged antibiotic therapy and open wound drainage are insufficient for controlling this dreaded condition. Although early debridement is essential in the treatment of DSWI, the ideal strategy for controlling the infection is controversial, and many procedures have been advocated to reduce the associated mortality and prolonged hospital stay. Efficacy of new closed irrigation-suction systems for the treatment of DSWI has been shown recently. Kirsch et al. [8] studied 72 patients who underwent closed drainage with a Redon catheter. They reported 15 cases of mediastinitis-related deaths (21%) and 9 cases of recurrent mediastinitis (13%) after this procedure. El Oakley et al. [7] recommended debridement and irrigation for DSWI occurring within 2 weeks after surgery in the absence of risk factors.

Wound debridement and closure with a muscle or omental flap were advocated mainly as second-line treatment after failure of the debridement and irrigation method. It has been said that these plastic surgery procedures greatly burden critically ill patients. However, many recent reports of patients treated with debridement and primary or delayed plastic reconstructive procedures have shown favorable results [1,2,9,10]. The pectoralis flap, which is the most commonly used reconstructive procedure, was used to achieve early closure and healing of the infected sternal wound, with mortality reported to be 8.1% [9].
However, this procedure can lead to late complications, such as persistent pain, chest wall instability, and shoulder weakness [7,11].

We have used the omentum as the first choice to fill the dead space after extensive debridement in treatment of DSWI. The omentum is widely used in the management of a variety of intra-abdominal infections. Many authors have shown the utility of this reconstructive procedure [1,2,12,13]. Krabatsch et al. [1] reported 40 patients who underwent omental transfer for DSWI after CABG, with an in-hospital mortality rate of 19%. Yasuura et al. [2] reported 84% survival in a group of 44 patients with DSWI treated by isolated omental transfer. Several advantages have been reported regarding omental transfer versus a muscle flap. For instance, the omentum contains high numbers of immunologically active cells, and abundant vascularization coupled with neovascularization potential [14] increases the blood supply in the infected area, leading to increased oxygen, nutrition, and delivery of antibiotics. Furthermore, the amorphous shape of the omentum and its capacity to absorb wound secretions allows more secure filling of dead space, preventing bacterial growth [10,12]. Although some early and late complications can be caused by abdominal contamination, the incidence of these complications is quite low [10,12,13]. Hultman et al. [15] studied long-term complications in 135 patients in whom the omentum was harvested for various reconstructive surgeries. Donor site complications occurred in 25 (19%) of these patients, mainly abdominal wall infection (n=9) and hernia (n=8).

DSWI after CABG with the right GEA has been considered a contraindication for omental transfer [7]. Usefulness of the remnant omentum after harvesting of the right GEA was first described by Sueda et al. [3]. They reported successful debridement and remnant omental transfer without postoperative irrigation in a case of DSWI caused by MRSA. Subsequently, Yokoyama et al. [4] reported two cases of DSWI treated by a procedure similar to the one proposed by Sueda. In both reports, the remnant omental pedicle was created based on the left GEA. Four of our patients underwent remnant omental transfer based on the left GEA, and the postoperative courses were uneventful. We feel that the left GEA is the important vessel for creation of the omental pedicle because it can provide sufficient blood supply to the whole pedicle flap, and it does not decrease blood flow of the right GEA graft. When the left GEA is not well developed, we use the right omental artery as the axis vessel of the remnant omental flap. Although it is difficult to analyze flow interactions between the right GEA graft and the right omental artery used in the remnant omental pedicle, use of the right omental artery could cause flow competition between the two vessels, leading to ischemia of the flap or the graft.

In conclusion, we evaluated outcomes in 7 cases of omental transfer for DSWI occurring after CABG with the right GEA. Despite the limitations of this study (small patient sample, short follow-up period, and lack of randomization), our findings point to the feasibility of remnant omental transfer for DSWI after harvesting of the right gastroepiploic artery. We believe one-stage omental transfer is useful for the treatment of DSWI even if the right GEA is used for grafting.

References


Appendix A. ICVTS on-line discussion

Authors: Hitoshi Hirose and Atsushi Amano (Juntendo University Hospital, Tokyo, Japan)

eComment: Mediastinitis is an important surgical complication after cardiac surgery. The risk increases with the presence of diabetes, osteoporosis, and use of bilateral internal mammary arteries. The patients with these risk factors may be considered to undergo prophylactic omentum transfer at the time of cardiac surgery. The omental transfer is not a complicated procedure, especially when the right gastroepiploic artery was used for a bypass conduit. Special attention should be paid for vascular injury of the graft. The transferred omentum occupied the mediastinal space with minimum dead space. The fatty tissue in the omentum is quickly absorbed and the volume of the transferred omentum also reduced over a small patient sample, short follow-up period, and lack of randomization, our findings point to the feasibility of remnant omental transfer for DSWI after harvesting of the right gastroepiploic artery. We believe one-stage omental transfer is useful for the treatment of DSWI even if the right GEA is used for grafting.