Management with Closed Irrigation for Post-Sternotomy Mediastinitis

Experience with the Use of Electrolyzed Strong Acid Aqueous Solution

Objective: **The aim of this study was to assess the adequacy of our treatment strategy for patients with post-sternotomy mediastinitis.** *Methods:* **Between May 1997 and December 2000, 1,045 consecutive adult cardiac operations were performed at our center. Mediastinitis occurred in 8 patients (0.77%) and as treatment, they underwent (1) aggressive debridement, (2) closed irrigation and drainage, and (3) transvenous administration of antibiotics. We irrigated the mediastinum with 0.1–1.0% povidone-iodine solution, alternating with electrolyzed strong acid aqueous solution. We subsequently reviewed the outcome after the closed irrigation treatment for patients with post-sternotomy mediastinitis.** *Results:* **In four of the 8 patients, the culture specimen grew Methicillin-resistant Staphylococcus aureus. In the others,** ***Serratia marcescens, Staphylococcus epidermidis, Pseudomonas aeruginosa*** **and Gram-negative rods were cultured. The mean period between primary surgery and the diagnosis of mediastinitis was 16.3 (8–57) days. The mean period between diagnosis of mediastinitis and the start of the irrigation treatment was 0.8 (0–3) days. The mean irrigation period was 30.0 (14–47) days. The irrigation complications were mild hepatic dysfunction in 2 patients, hyponatremia in 2 and protracted wound infection in 1. The hospital mortality was 1/8 (12.5%). Seven survivors are free from recurrent mediastinitis.** *Conclusions:* **Our experience of closed irrigation and drainage suggests that it can yield satisfactory results after post-sternotomy mediastinitis, comparable to other reported results with or without muscle flaps.**
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Key words: cardiac surgery, closed irrigation, electrolyzed strong acid aqueous solution, mediastinitis

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Mediastinitis following cardiac surgery is a severe complication for which no definite therapy has been established. However, conventional open treatment is shifting to closed irrigation, omental transfer, and muscle-flap coverage. For post-sternotomy mediastinitis, our treatment policy consists of (1) aggressive mediastinal debridement, (2) closed irrigation and drainage, and (3) transvenous administration of antibiotics. We treated 8 patients with mediastinitis following cardiac surgery chiefly by closed irrigation with povidone-iodine solution and electrolyzed strong acid aqueous solution (ESAAS). ESAAS is produced by electrolyzing sodium chloride solution, utilizing an ion exchange membrane that separates the positive and negative elements. We achieved relatively good results with this method. Here in, we report our experience with the use of this closed irrigation.

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Subjects and Methods

Between May 1997 and December 2000, we performed adult cardiac surgery in 1,045 patients. Of these 1,045 patients, eight patients (0.77%) developed mediastinitis. If clinical or microbiologic evidence of

Table I. *Patients' data*

case	*age (y)*	*sex*	*disease*	*diabetes*	*obesity*	*steroid*	*MRSA carrier*	*operation time (m)*	*CPB time (m)*
1	73	M	IHD	yes	–	yes	yes	435	135
2	69	F	IHD	yes	yes	–	–	385	162
3	42	M	VD	–	–	–	–	455	192
4	76	M	IHD	yes	–	–	yes	405	141
5	71	F	IHD	yes	yes	–	–	495	88
6	57	M	IHD	yes	yes	–	–	290	76
7	15	M	VD	–	–	–	–	460	143
8	76	M	IHD	–	–	–	–	435	121

IHD, Ischemic heart disease; *VD,* valvular disease.

infected presternal tissue and sternal osteomyelitis occured, with or without mediastinal sepsis or an unstable sternum, we performed re-sternotomy. The 8 patients, 6 men and 2 women, ranged in age from 15 to 76 years (mean 59.9 years) (Table I). Six of them had ischemic heart disease (IHD), and 2 had valvular disease. Bilateral internal thoracic arteries were used for coronary revascularization in 4 of the 6 IHD patients. The risk factors were diabetes mellitus in 5 patients, obesity in 3, steroid administration in 1, and *Methicillin-resistant Staphylococcus aureus* (MRSA) carrier state in 2 patients in the nasal cavity. The mean duration of the primary operation was 420.0 ± 62.4 min, and the mean duration of cardiopulmonary bypass was 132.3 ± 37.6 min. These 8 patients with mediastinitis underwent closed irrigation. In this study, we did not use omental transfer or muscle flap.

Irrigation techniques. When mediastinitis was diagnosed, we immediately performed re-sternotomy. After aggressive debridement, the irrigation tube was placed. The infusion tube (16–18 Fr) was placed anteriorly and 2–4 drainage tubes (24–28 Fr) were placed in the retrosternal space and inferior pericardial space. Closed irrigation was performed in 8 patients: intermittent irrigation in the first patient, and continuous irrigation in the remaining 7 patients. In the first patient (Case 1), intermittent irrigation was performed after povidone-iodine soaked sponge packing of 3 days duration. To irrigate the mediastinum, 1,000 ml of povidone-iodine solution was used 3 times daily. In the remaining 7 patients, continuous irrigation was performed immediately after open mediastinal debridement, using 0.1–1.0% povidone-iodine solution, alternating with ESAAS every 4–5 hours. The infusion speed was 100–250 ml/h, and the drain was opened and closed every hour. If signs of cardiac tamponade were noted, the speed of infusion was reduced, or the drain was left open.

Antibiotics. As a rule, antibiotics were administered transvenously, but, in the first 3 cases, diluted antibiotics were added to the irrigating fluid.

Results

Seven of the 8 patients survived, and one died (mortality rate, 12.5%) (Table II). In Case 4, the patient developed mediastinitis after coronary artery bypass grafting and died of hemorrhagic shock from saphenous vein graft rupture and subsequent septic shock. The etiologic agents in the 8 patients were MRSA in 4, *Serratia marcescens* in 1, *Staphylococcus epidermidis* in 1, *Pseudomonas aeruginosa* in 1, and unidentified gram-negative rods in 1. Arterial blood cultures were positive (bacteremia) for MRSA in 2 patients (Cases 1 and 4), who were MRSA carriers in the nasal cavity on admission. The diagnosis of mediastinitis was made on the 8–57th day after primary surgery (mean 16.3 postoperative day). Mediastinal irrigation was begun 0–3 days after diagnosis (mean 0.8 days) and was continued for 14–47 days (mean 30.0 days).

As a rule, irrigation was discontinued when the disappearance of bacteria from drainage fluid was confirmed. However, in 1 patient (Case 4), it was discontinued when the saphenous vein graft started to bleed. In 2 patients (Cases 1 and 6), the drains were withdrawn when bacteria disappeared from drainage fluid but bacteria were detected from extubated drainage catheter tip. In Case 7, we re-opened the sternum to place new irrigation tubes. However, the wound had no signs of infection and we stopped the irrigation. The bacterial cultures of the mediastinum and pericardial cavity were negative. The tip of the inserted drain was contaminated, and cultures of the contaminant confirmed a small amount of *Pseudomonas aeruginosa*. In the above 3 cases, drainage tubes themselves became a culture medium.

Table II. *Postoperative data*

case	*microorganism*	*blood culture*	*time of diagnosis (POD)*	*diagnosis to irrigation (days)*	*irrigation techniques*	*irrigation periods (days)*	*outcome*
1	MRSA	+	57	0	intermittent	28	alive
2	MRSA	–	11	0	continuous	47	alive
3	MRSA	–	9	0	continuous	31	alive
4	MRSA	+	8	0	continuous	14	death
5	Serratia marcescens	–	12	1	continuous	36	alive
6	Staphylococcus epidermidis	–	9	3	continuous	41	alive
7	Pseudomonas aeruginosa	–	13	1	continuous	29	alive
8	Gram (–) rods	–	11	1	continuous	14	alive

MRSA, Methicillin-resistant Staphylococcus aureus; *POD,* postoperative days.

Complications of continuous irrigation were mild hepatic dysfunction in 2 patients (Cases 2 and 8), hyponatremia in 2 patients (Cases 2 and 3), and protracted wound infection in 1 patient (Case 1). No retrograde infection, microbial substitution, or recurrence of mediastinitis was observed. The hepatic dysfunction was attributable to the povidone-iodine solution, and was caused by 1.0% and 0.1% solutions in Cases 2 and 8, respectively. We measured the serum iodine level when Case 2 developed mild hepatic dysfunction. The result of iodine level was 922 μg/dl (normal range: 4.0–9.0 μg/dl). In both patients, hepatic function improved as soon as irrigation with povidone-iodine solution was discontinued. The hyponatremia was ascribed to ESAAS. In both patients, the serum Na^+ level fell below 130 mEq/L, which was corrected by administering NaCl solution. In the patient with protracted infection, who underwent povidone-iodine packing of 3 days duration followed by intermittent irrigation of 28 days duration, pus discharge stopped 40 days after irrigation was discontinued. The infection was localized to the subcutaneous tissue, and took approximately 3 months to heal after local treatment and antibiotic administration.

To examine the recurrence of mediastinitis, we interviewed all seven survivors. The mean follow up period was 22.3 months. All were alive and free from recurrence of mediastinitis.

Discussion

Mediastinitis is a serious complication of cardiac surgery and remains a problem. At one time, mortality rates of 30–40% were reported for this complication. However, researchers have recently reported lower mortality rates of 8.1–14.7%[1-5] (Table III). Various therapeutic modalities have been tried, such as conventional open treatment, closed irrigation, omental transfer, and muscle flap.

Although mortality rates do not significantly vary among the therapeutic modalities, many studies favor omental transfer and muscle flap rather than closed irrigation because of the advantage of a shorter hospital stay.[3,6] However, one of the risks of late morbidity is recurrence. Jones et al.,[3] who treated mediastinitis by omental transfer or muscle flap, achieved good results as indicated by the mortality rate of 8.1%, but reported a recurrence rate of 5.6%. Castello et al.[5] reported a recurrence rate of 12% from a 10-year experience with muscle flap, and stated that reducing this rate would decrease the mortality rate for mediastinitis. Omental transfer has been challenged with the disadvantage of intraperitoneal adhesions and decreased blood flow,[7] predicting difficulty with future upper abdominal surgery. On the other hand, with muscle flap coverage, postoperative pain and impairment of motor function are important complications.[8]

In contrast, closed irrigation is free from such complications and, since it is discontinued when the pathogens have disappeared, mediastinitis is unlikely to recur. The recent adoption of irrigation with ESAAS has been reported to produce good results in the treatment of mediastinitis and peritonitis.[9,10] Hayashi et al.[9] stated that ESAAS has several favorable features: first, the bactericidal effect covers a wide spectrum of microorganisms, including fungi; second, it can be applied to almost all kinds of tissues; third, it does not impede the healing process; and fourth, the solution promptly changes to weak acid solution leaving no residual toxicity. However, it is true that closed irrigation inevitably prolongs the duration of hospital stay. A survey of the literature shows that the median hospital stay after

Table III. *Procedure and outcome*

Author	*year*	*procedure*	*Number of cases*	*Recurrence rate (%)*	*Mean hospital stay (days)*	*Mortality rate (%)*
Heath BJ[1]	1987	OT	8	0	27	12.5
Loop FD[2]	1990	OT MF Open Closed	72	unknown	OT MF: 46 Open : 57 Closed: 42	13.9
Jones G[3]	1997	OT MF	409	5.6	12.4 (recent case)	8.1
Thomas K[4]	1999	Closed	34	0	unknown	11.8
Castello JR[5]	1999	MF	34	12	32	14.7
Our case	–	Closed	8	0	97.6	12.5

OT, Omental transfer; *MF,* muscle flap; *Open,* open treatment; *Closed,* closed irrigation.

omental transfer in a single operation is approximately 30 days,[1,6] whereas after closed irrigation is 56 days.[11]

The relative advantages of therapeutic modalities for mediastinitis cannot be judged by mortality rates alone; however, closed irrigation appears to be advantageous, in three respects. First, it is free from functional complications; second, additional therapeutic techniques such as omental transfer and muscle flap are feasible for intractable mediastinitis as additional treatment; third, a new treatment has been introduced, such as ES-AAS irrigation.

Conclusions

To treat mediastinitis, we performed continuous closed irrigation without omental transfer or muscle flap and obtained relatively good results comparable to the reported results with other therapeutic modalities for mediastinitis. Further study is needed to improve these results.

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