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Mediastinitis after aorto-coronary bypass surgery[1]

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Abstract

Objectives: To identify risk factors in 60 cases of mediastinitis amongst 2512 patients (2.3%) subjected to isolated coronary bypass surgery from March 1988 through December 1995, treated by a closed irrigation/drainage system. **Patients and methods:** The mean age of the 60 patients was 56.9 ± 6.8 years (45–81 years) and 55 (91.6%) were male. Early mediastinal reexploration was performed in all cases immediately after the diagnosis of mediastinitis, with debridement of necrosed tissues, followed by implantation of a closed-circuit irrigation system of the mediastinum constituted by irrigation catheter and drain, closure of the sternum and skin, and specific systemic antibiotic therapy. The mean interval between the original surgery and reexploration was 9.4 days (range 6–14 days). No patient required more extensive procedures, namely omental or muscular flaps. Twenty potential risk factors in patients with mediastinitis, including diabetes mellitus, obesity, coexistence of peripheral vascular disease, decreased LV function, use of inotropes, mediastinal blood drainage and utilization of double IMA, were compared with the group without mediastinitis. **Results:** Mean cardiopulmonary bypass time was 74.1 ± 8.1 min, anesthetic time 3.5 ± 0.8 h and postoperative mechanical ventilation 18 ± 3 h. A total of 23 patients (38.3%) received one IMA and 35 (58.3%) two IMAs. In the postoperative period, 7 of the 60 patients (11.6%) had required inotropes because of low output. Mediastinal blood loss was 1112cc ± 452cc and 9 patients (15%) were transfused. Cultures were positive in 40 cases (66.6%) and the most frequent infecting agent was the *Staph. epidermidis* in 25 cases (62.5%), followed by *Candida albicans* and *Enterobacter* and *Serratia* species (7.5% each); 1 patient (1.7%) died and 9 (15%) had renal failure. The irrigation/drainage was maintained for a mean of 9.1 days (5–83 days). Patients with mediastinitis had a significantly higher prevalence of diabetes (41.6% vs. 18.8%; $P < 0.01$), obesity (48.3% vs. 15.2%; $P < 0.001$), peripheral vascular disease (11.6% vs. 4.0%; $P < 0.05$), but a lower incidence of poor LV function (18.3% vs. 32.7%; $P < 0.05$). A double IMA was used more frequently in patients who had mediastinitis (58.3% vs. 23.5%; $P < 0.001$) **Conclusions:** Diabetes mellitus, obesity, co-existence of peripheral vascular disease and use of double IMA are risk factors for mediastinitis after coronary artery surgery. The efficacy of the closed method of treatment with a mediastinal irrigation/drainage system was increased with early diagnosis and reintervention. © 1997 Elsevier Science B.V.

Keywords: Mediastinitis; Risk factors; Complications; Coronary surgery; Sternotomy

1. Introduction

Infection of the mediastinum and/or dehiscence of the sternum are life-threatening complications after coronary artery bypass surgery. In a review article, Oakley and Wright [19] found a reported incidence varying from 0.4 to 5%. The exposure of the anterior mediastinum to bacterial contamination in the operating table is the triggering factor and the *Staphylococci epidermidis* or *aureus* are the most common pathogens involved [5,11,15].

Several technical and patient related factors may influence the occurrence of mediastinitis. The use of the internal mammary artery (IMA) as a conduit for myocardial revascularization, obesity and diabetes melli-

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tus, which is prevalent in coronary artery patients, are the most important risk factors [3,6,12]. Other factors which may play a significant role include age, older patients being more susceptible to mediastinitis, and the coexistence of peripheral vascular disease, an indication of the generalized nature of the arterial pathology. Finally, significant periods of low cardiac output markedly increase the risk of infection [3,24,25].

Several methods of treatment have been recommended, including the use of muscle and omental flaps to fill the infected space [1,10,14,21], but we prefer to use a closed irrigation/drainage system, implanted as soon as the diagnosis of mediastinitis is made. We believe that early diagnosis and reintervention is a key for successful treatment of this complication, with a significant decrease in the mortality rate.

In this paper, we review our experience with 60 cases of mediastinitis after coronary artery bypass surgery and describe the methods used in the treatment. The different patient risk factors are analyzed to assess their potential impact in the occurrence of the infection.

2. Material and methods

The records of 2512 consecutive patients who underwent isolated coronary artery bypass grafting (CABG) from March 1988 through December 1995 were reviewed. Acute mediastinitis, defined as the presence of pus, classified as such by the surgeon, or bacterial growth in the mediastinal tissues sampled during surgical reexploration, occurred in 60 patients (2.3%). The indication for reoperation was sternal dehiscence with or without external purulent drainage.

2.1. Perioperative management

Electivly operated patients and most of the urgent ones were admitted to hospital the day before or the day of surgery. Skin preparation included a povidone-iodine (Betadine®) shower in the evening. Electrical clipping of the hair was performed on the operating table in all cases, followed by a Betadine scrub. The skin was then dried out and painted with two layers of alcoholic tincture of iodine. The perineum and borders of the operative sites were isolated with cotton towels and transparent plastic sheets were applied to all exposed surfaces. The mediastinum was not irrigated before sternal closure. Bone wax was usually used to control venous oozing from the cut sternal edges. Closure of the sternum was performed with 7–9 steel wires. Overlying soft tissues were closed in layers with continuous absorbable sutures.

In all cases prophylactic antibiotic therapy, with either Vancomycin or Flucloxacilin plus Netilmicin or Aztreonam, had been routinely employed before induction of anesthesia and continued until the removal of the drains, usually in the second postoperative day.

2.2. Infection surveillance and surgical treatment

During the postoperative period, wounds were examined twice a day by the surgical team. Only cases of deep wound infection were included in this series. Superficial wound cellulitis and subcutaneous wound infection that only required simple drainage and treatment with antibiotics were not included and 17 patients who were not considered infected had simple refixation of the sternum without irrigation system or prolonged antibiotic therapy, and were also not included.

Early mediastinal reexploration was performed in all cases immediately after the diagnosis of deep wound infection had been confirmed or strongly suspected. The mediastinum was reopened in the operating room under general anesthesia. All sternal wires and other suture material were removed. Multiple specimens were obtained for bacterial culture and antibiotic sensitivity analysis. All necrotic and grossly infected tissues were debrided. The edges of the bone were cleaned by curettage.

The wound and mediastinum were then copiously irrigated with antiseptic solution. In all cases a closed-circuit irrigation system of the mediastinum was used. To this end, one size 32 or 36 Fr drain and one size 10 Fr catheter, for infusion of the irrigation solutions, were inserted in the retrosternal space. The sternum was reapproximated with wires, taking care to avoid involvement of the cartilages. Subcutaneous tissues and skin were usually closed in one layer with heavy mattress nylon sutures.

Postoperatively, the mediastinum was continuously irrigated with a 1% povidone-iodine or, occasionally, a dilute antibiotic solution, at a mean rate of 125 cc/h, and drained freely without suction. Irrigation fluid input and output were measured three times a day to detect eventual fluid retention.

Broad intravenous antibiotic coverage was routinely started before surgical debridement, and continued until appropriate antibiotic sensitivities became available. Initial treatment usually combined Vancomycin and an aminoglycoside (Netilmicin) or Aztreonam, which were then replaced or not, depending on the bacteriologic data. Intravenous antibiotics were usually continued until the irrigation was stopped and/or local and systemic evolution was judged to be good. Thereafter, they were usually administered orally and continued for 1–3 months. During the irrigation period repeated cultures of the effluent were performed to detect new infecting agents and/or the development of drug resistance. Irrigation was continued until the effluent was sterile and, more important, the patient did not show any sign of

systemic or local infection. This required the irrigation to be continued for periods of 1–3 weeks. After the irrigation was stopped, the retrosternal tube was progressively removed (2–3 cm in alternate days), to avoid residual space. The volume of the residual spaces was regularly measured by the quantity of fluid that they admitted and by contrasted X-Ray pictures.

2.3. Risk factors for mediastinitis

We selected 20 clinical, angiographic, operative and postoperative variables among the 2512 consecutive isolated coronary bypass patients and subjected them to univariate analysis, comparing the population of patients who developed mediastinitis with those who did not.

The clinical variables selected were: age, sex, obesity (>15% of normal table values) diabetes mellitus (whether insulin-dependent or not), smoking, hypertension (systolic and/or diastolic, requiring medication), peripheral arterial disease (symptomatic or asymptomatic obstruction >50% in the iliac-femoral-popliteal distribution). Urgent / emergent operation, angina pectoris (CCS class III or IV), family history and history of myocardial infarction. The angiographic and operative variables included the number of vessels involved, left main disease, left ventricular dysfunction, use of double internal mammary artery and perfusion time. Post-operative respiratory failure (need for prolonged ventilatory support or need of reintubation), a stroke (with transient or permanent neurologic dysfunction), reoperation for bleeding and perioperative myocardial infarction were also considered. Additionally, we also analised the effect of the IMA graft type (one versus two) in patients with diabetes mellitus.

Statistical significance for the continuous variables was assessed using Student's t-test; χ^2 analysis was used for non-continuous data.

3. Results

3.1. Patients data: clinical, angiographic and operative

The mean age of the 60 patients who developed mediastinitis was 56.9 ± 6.8 years (range 45–81 years) and 55 (91.6%) were male; 25 (41.6%) patients were diabetic, 29 (48.3%) obese, 40 (66.6%) smokers, and 7 (11.6%) had peripheral vascular disease. The primary operation had been done on an emergency basis in 7 (11.6%) patients. A total of 40 (56.6%) and 20 (33.4%) patients were in class I/II and III/IV of the CCS, respectively. There were no cases of CABG reoperation among these patients. The involvement of one, two or three vessels was, respectively, 3.3, 11.6 and 85.1% and 9 patients (15.4%) had left main disease. Left ventricular dysfunction (based on angiographic evidence) was classified, as normal/mild in 76.6% and moderate/severe in 23.4%. Among the patients 23 (38.3%) had received one IMA and 35 (58.3%) two IMAs. Mean cardiopulmonary bypass time was 74.1 ± 8.1 min, anesthetic time was 3.5–0.8 h and postoperative mechanical ventilation 18 ± 3 h, and only 1 patient required ventilation for more than 24 h (31 h). In the postoperative period, 7 patients (11.6%) had required inotropic support; 2 patients (3.3%) required reoperation for bleeding; 2 had a stroke; 1 (1.7%) had a perioperative MI and 3 (5.0%) developed renal insufficiency (creatinine > 2.5 mg/dl). Mediastinal blood loss was 1, 112 ± 452 cc and 9 patients (15%) were transfused; 2 patients (3.3%) subsequently had the diagnosis of pulmonary infection, which required reintubation and ventilator support, before the diagnosis of mediastinitis.

3.2. Clinical and bacteriological findings

The diagnosis of mediastinitis was made 6–14 days postoperatively (average 9.4 days). The most frequent early findings were fever in 34 patients (56.6%), purulent wound drainage in 26 patients (43.3%), and leucocytosis in 24 patients (40.0%). Additionally, all patients had sternal instability.

Cultures were positive in 40 cases (66.6%) and the most commonly isolated pathogen was the *Staphylococcus epidermidis* which caused 25 (62.5%) infections. Gram-negative organisms, more frequently *Enterobacter* or *Serratia*, were the responsible pathogens in 12 (30.0%) cases. Fungal (*Candida albicans*) infections occurred in 3 (7.5%) patients. There were no polymicrobial infections (Table 1).

3.3. Risk factors for mediastinitis

Patients with mediastinitis had a significantly higher incidence of diabetes mellitus (41.6 vs. 18.8%;

Table 1
Bacteriology of mediastinal fluid and tissues

Organism	N	%[a]
Gram-positive		
Staphylococcus epidermidis	25	(62.5)
Gram-negative		
Enterobacter	3	(7.5)
Serratia	3	(7.5)
Escherichia coli	1	(2.5)
Pseudomonas	2	(5.0)
Nocardia	1	(2.5)
Proteus	2	(5.0)
Fungus		
Candida albicans	3	(7.5)

[a] % of 40 patients with positive cultures.

Table 2
Factors predisposing to mediastinitis after isolated coronary artery bypass grafting

Variable	Patients with mediastinitis	Patients without mediastinitis	*P*-value
Mean age (years)	56.9 ± 6.8	59.8 ± 3.6	NS
Sex female (%)	8.4	11.8	NS
Obesity (%)	48.3	15.2	<0.001
Diabetes mellitus (%)	41.6	18.8	<0.001
Smoking (%)	66.6	59.9	NS
Hypertension (%)	43.3	45.4	NS
Family history of CAD (%)	20.0	22.3	NS
History of MI (%)	55.0	53.0	NS
Peripheral vascular disease (%)	11.6	4.0	<0.05
Emergency/urgent operation (%)	11.6	10.6	NS
Angina (CCS III/IV) (%)	33.4	41.6	NS
Extent of disease (%)			
One vessel	3.3	8.1	NS
Two vessels	11.6	20.5	NS
Three vessels	85.1	71.4	NS
Left main disease (%)	15.4	13.5	NS
Left ventricular dysfunction (%)			
Moderate/severe	23.4	17.9	NS
Arterial conduit type (%)			
Bilateral IMA	58.3	25.6	<0.001
Perfusion time (min)	74.1 ± 7.8	69.9 ± 6.8	NS
Postoperative respiratory failure (%)	3.3	1.4	NS
Reoperation for bleeding (%)	3.3	2.7	NS
Perioperative MI (%)	1.7	2.6	NS
Postoperative stroke (%)	3.3	3.2	NS

$P < 0.001$), obesity (48.3 vs. 15.2%; $P < 0.001$) and peripheral vascular disease (11.6 vs. 4.0%; $P < 0.05$). A double internal mammary artery was used more frequently in patients who developed mediastinitis (58.3 vs. 25.6%; $P < 0.001$). The prevalence of mediastinitis in patients with single IMA grafts was 0.9% and in patients with diabetes mellitus was 4.8%. Diabetic patients who received a double IMA had an incidence of 9.1%, while in those who received one IMA graft the prevalence of this complication was only 1.6% ($P < 0.01$). None of the other factors studied, including sex and age, came as a significant risk factor in this study (Table 2).

3.4. Mortality and morbidity of mediastinitis

The irrigation was maintained for a mean of 9.1 days (5–83 days). The mean duration of treatment with intravenous antibiotics was 33 days. Mean length of hospital stay was 35 days (14–105 days) and all patients were considered cured from the infection at the time of discharge.

No patient died during the treatment phase but 1 patient (1.7%) died late of as a consequence of cervical vertebral osteomielitis. This patient was readmitted with a neck abscess which was drained. Neurological signs led to the diagnosis of vertebral body collapse and successful surgery for spinal stabilization was undertaken. However, he died 2 days later, apparently due to food aspiration.

Iatrogenic renal insufficiency, which occurred in 9 patients (15.0%), disappeared after discontinuation of intravenous antibiotics. Early in the series, two (3.3%) patients had persistent infections that required reoperation for re-establishment of the closed-circuit irrigation system of the mediastinum, and this second procedure was successful. In some cases of very soft and fragmented sterni, rewiring was done with the construction of a 'mesh' of wires tightened around the costal cartilages. Infected cutaneous fistulae were developed by 8 (13.3%) patients and they were treated surgically by removal of infected tissues and, in some cases, of one or more sternal wires. None of these had evidence of recurrent mediastinitis. Rewiring of unstable but sterile sternum was required in 7 patients.

4. Comment

Deep mediastinal infection is a serious complication after cardiac surgery, with financial costs that have been calculated as three times those of non complicated cases [15], and with a mortality rate that varied from 14 to 40% in recent reports from large series [9,13,15,20].

In our series of 2512 patients undergoing median sternotomy for coronary artery bypass grafting, 2.3% had deep sternal wound infection. This is in accordance with other recent reports where the overall incidence of this complication varied from 0.4 to 5% [19], less than

2% in most large series (see also Table 3), but our rate may have been overestimated by the strict criteria of inclusion in the series.

However, the main purpose of our retrospective study was to identify factors associated with an increased incidence of mediastinitis. Several technical and patient related factors have been identified which may predispose to mediastinitis after coronary surgery [6,8,11,12,15,16,28]. In our experience, diabetes mellitus, obesity, peripheral vascular disease and the use of bilateral internal mammary artery were significantly associated with an increased incidence of mediastinitis.

Although the use of IMA as a conduit for myocardial revascularization compromises the blood supply to the sternum and anterior mediastinal tissues (which appears to be particularly relevant with the use of both IMAs), different studies still provide conflicting evidence as to whether an increased risk of mediastinitis is associated with the use of double IMA [3,6,8,12,15,16]. While some have reported increased rates of deep sternal wound infection after double IMA grafting, others have denied such an association. Our data would support a significantly increased incidence of mediastinitis after use of double IMA.

Diabetes appears in our study as a risk factor for mediastinitis and the risk is even greater among patients who received bilateral IMAs. Other reports have also confirmed diabetes mellitus and obesity as risk factors [12,15,28].

There was no statistically significant difference in the age at operation between patients in whom mediastinitis developed and those who did not have such infections. Although the ratio of men to women was slightly higher among the patients with mediastinitis, the difference was not significant. These findings contrast with those of some studies who have found a higher prevalence of either male or female patients and older age among infected patients [2,17,24]. Some authors have also identified smoking, prolonged ventilatory support, and reoperation as important risk factors [3,25], but we could not confirm any of these factors to significantly increase the incidence of mediastinitis.

Table 3
Incidence of mediastinitis in some reported studies

Study	No. of patients	Incidence (%)
Grmoljez et al. (1975) [4]	1550	0.8
Culliford et al. (1976) [3]	2594	1.5
Serry et al. (1980) [26]	4124	0.9
Sarr et al. (1984) [25]	824	0.7
Ottinno et al. (1987) [20]	2579	2.0
Grossi et al. (1985) [5]	7949	0.9
Loop et al. (1990) [15]	6504	1.1
Ivert et al. (1991) [9]	6323	0.4

Intraoperative exposure of the mediastinum to bacterial contamination is probably the most important triggering factor of the infection. Similar to the findings of others, gram-positive bacteria (*Staphylococcus*) were the most commonly isolated organisms in this series (62.5%). By contrast, the incidence of other infecting organisms in this study, differ from those reported elsewhere. Namely, we have not identified cases of mixed infections, which in other reports often represent more than 40% of the cases [25].

Because of the high prevalence of infection by *Staphylococcus epidermidis*, it is probable that we are dealing with auto-infection. Hence, short preoperative hospitalization and showering with antiseptic solution before the operation are two important preventive maneuvers to reduce surgical wound infections. Also important is perioperative skin preparation, especially hair removal. Shaving with electrical clippers was found to be associated with a lower incidence of wound infection than razor shaving, not only in general but also with sternotomy wounds in the experience of Ko and associates [11].

Prophylactic antibiotic administration in cardiac operations is accepted today as a standard practice [22]. Most cardiac surgeons still use one or more broad spectrum antibiotics (usually a β-lactamase-resistant penicillin in combination with an aminoglycoside) for 2 to 3 days. We used a 2-day regimen of Vancomycin or Flucloxacilin plus Netilmicin or Aztreonam. Nevertheless, some studies appear to demonstrate that the administration of a single dose of a broad spectrum systemic antibiotic provides satisfactory prophylaxis against the development of wound infection [7]. However attractive this may be, we believe that it is appropriate to wait for a substantive body of evidence before abandoning standard antibiotic prophylactic regimens.

The surgical treatment of this complication varies from wound debridement and primary sternal closure with closed mediastinal irrigation and drainage, to open wound treatment, usually followed by reconstructive procedures using omental or muscle flaps [10,14,21]. Several studies have shown that both techniques are similarly effective in the treatment of mediastinitis after cardiac operations [10,23,27]. The treatment option depends on the particular experience of each surgical group and on the characteristics of the wound, as late and destructive infections more often need plastic procedures. Hence, the importance of early diagnosis and treatment. Our policy has been to follow the patients closely in the immediate postoperative period. As soon as the diagnosis of the infection is made, wound debridement is performed and closed mediastinal irrigation and drainage are established. With such strict policy some non-infected cases may have been diagnosed as mediastinitis and treated as such, thus contributing to an overestimated incidence. The mean time

delay between the cardiac operation and the beginning of the treatment of the mediastinal infection was 9.4 days, with all the patients being treated during the first 2 weeks after coronary surgery. This time compares favorably with those of other published works [18]. It shows our aggressive attitude toward this problem, in providing early treatment to an area which is not yet very deeply infected and to a bone which does not display frank osteomyelitis.

This simple technique takes a short operative time, can be performed by a less experienced surgeon and, depending on the condition of the patient, does not usually require admission in the intensive care unit. All our patients went back to the ward after surgery. The mortality of our group of patients was only 1.7% (one patient) which compares very favorably with the 14–40% previously published by others [9,15,20] but the difference to that refered to by more recent series is not as significant. Recentley, Oakley and Wright [19] propsed a new classification of mediastinitis and correlated early stages and abscence of multiple risk factors with lower mortality. We think that two major issues importantly contributed to our lower mortality rate. One was that all patients had been treated in a early stage, i.e. during the first 2 weeks after operation. The other concerns to the fact that we have no cases of mixed infections, which is considered as one of the main reasons of poor prognosis both for mortality and morbidity.

There were no serious complications in any of our surviving patients but 2 patients required placement of a new irrigation/drainage system because of resurgence of infection which probably resulted from premature withdrawal of the previous drainage. Sternal rewiring was required in 7 patients who had an unstable but already sterile bone. They all had a very fragile sternum which fractured during the original cardiac operation in most cases. Finally, simple excision of late cutaneous fistula was necessary in 8 patients, with eradication of the infection in all cases.

We can consider that there was an initial failure of the technique in the 2 patients who had re-infection, but this was solved with the second cycle of irrigation/drainage. No other surgical maneuver was necessary. Even if we consider also the 7 patients who required rewiring, the failure rate of 15% is similar to that reported by Loop et al in 1990 [15], using a similar method. However, it is inferior to that reported in most other series. We believe that early re-operation, the efficient irrigation and drainage system, constantly monitored to avoid retention of debris, and the long period of intravenous antibiotic treatment were influential for these results. Maintaining the mediastinal drain as long as there is any significant drainage and the radiological control with contrast media of any residual cavity along the drainage tract before retrieving the drain, seemed to be fundamental details which influenced the success of this technique.

In conclusion, mediastinitis is a serious complication following coronary artery revascularization. In this series, obesity, diabetes mellitus, coexistence of peripheral vascular disease and the use of double internal mammary artery were significant predictive factors for this complication. We believe that the closed irrigation/drainage method, as described, remains the method of choice for the treatment of early mediastinal infection. It is efficient, safe and relatively comfortable for the patient. Furthermore, in our experience it has avoided the need for more extensive operations, such as the use of omental or muscle flaps.

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Appendix A. Conference discussion

Dr Jakob (*Heidelberg, Germany*): Congratulations on a nicely performed study and on your excellent results. We in Heidelberg did a prospective study last year encompassing 376 consecutive adult patients undergoing cardiac surgery. We studied those patients in detecting the usual clinical chemical parameters and in addition we obtained nasal cultures of all the patients preoperatively and of 147 persons treating the patients. The idea was to find a differentiation whether there is an endogenous or exogenous pathway of infection. To get those results a DNA fingerprint analysis in the case of *Staphylococcus aureus* infection was made. Our results were somewhat similar to yours. In the multivariate analysis, obesity and diabetes were the most prominent risk factors, but nasal carriage of *Staphylococcus aureus* was the most striking problem.

Dr de Oliveira: In the patients?

Dr Jakob: Yes, in the patients. So in 85% of deep sternal wound infection, which was in 4% of all the patients, an identical *Staphylococcus aureus* was found in the mediastinum as in the patient's nose. From these results we conclude that maybe if we could eradicate the *Staphylococcus* preoperatively we could lower our incidence of *Staphylococcus aureus* sternal wound infection. My question to you would be about the irrigation volume you are using. We have had the experience that, let's say 2 l per day, does not help that much, that the chest inside occludes and you just have little sheets of Betadine irrigation not reaching all septic foci. So we give a high volume of irrigation, let's say, 16–20 l per day. And this, even in case of pleural empyema, clears out the chest. My question is; what is your volume regime?

Dr de Oliveira: That is an important point. We usually run 3 l per day; we ask the nurses to control the fluid rate, delivering about 1 l every 8 h. It is certainly important to avoid clogging of the drains, which happens very easily in the first days. What we usually ask the nurses, and we do it ourselves, is to milk the drains, very often, during the day. And once in a while we just open the drainage system wide, milk the drains well, and make sure that the fluid is really running freely. And that also gives us some information about how much debris there is still inside. But it is very important to keep the fluid flowing permanently.

Mr Treasure (*London, UK*): I practise just as you do in cases such as these. I believe it is important that this is done because at present there is resistance on the part of our pharmacists and nurses to irrigation of wounds. This is a special situation and your results support it.

Dr de Oliveira: This is just a retrospective study. We thought that we were getting good results with this kind of patient and decided to study them.

Dr Jakob: But you had a couple of recurrences with your regime, and we don't see them anymore with our high volume regime.

Dr de Oliveira: Well, that is good information. However, I must tell you that what I can consider as real recurrences or reinfections were found in only 2 patients. Because the other 7 patients were just rewired. And most of them were patients with fragile sterni, and have just one simple rewiring. It may well be that if we had used other techniques such as Robicsek's, with better support of the sternum, we probably would not have that kind of problem.

Mr Lawrence (*Middlesex, UK*): Congratulations. I thought that was very well presented. I was just going to ask you about the risk factors. You put together the double IMA, obestity, diabetes, and peripheral vascular disease. Were these effective in combination or on their own?

Dr de Oliveira: On their own. There were independent risk factors. Of course, if you combine double IMA, plus obesity, or plus diabetes, the risk goes sky high.

Mr Lawrence: Sure. Because we presented some time ago some data on the use of double IMAs, it was in a particular series of patients age 70 and over, and we found that diabetes/obesity combined with double IMA worked together, but on its own we were not able to show that double IMAs did that.

Dr de Oliveira: In our study they were statistically significant on their own.

Dr Mestes (*Barcelona, Spain*): Just one more question. We agree that reoperative risk factors, I believe, is why we stopped double IMA in obese patients beyond 70 years of age and so on, but you mentioned something on the surgical technique at reoperation. My question is, were there any differences among surgeons at the time of closing the sternum at the initial operation? Have you seen any influence among different surgical techniques in the the postoperative outcome or not? Because I think in spite of the risk factors that you mentioned, the surgical technique is also pretty important in that setting.

Dr de Oliveira: I fully agree with you. I think, from that point of view, this series is quite homogenous because, at least during the period covered in this series, and that was until about 2 years ago, chest closure in all coronary procedures was done by either one of two surgeons, who used the same technique. They trained together, they used basically the same technique.