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Clinical outcomes of open heart surgery in patients with atopic dermatitis

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Abstract

Atopic dermatitis is a skin condition often complicated by colonization with *Staphylococcus aureus*, which increases the risk of infective endocarditis, skin cellulitis and osteomyelitis. Positive cultures for *Staphylococcus aureus* are obtained from 70% to 80% of wounds in patients with mediastinitis. Thus sternotomy carries increased risk of mediastinitis in patients with atopic dermatitis. We retrospectively reviewed 25 patients with atopic dermatitis who underwent cardiac surgery via a median sternotomy or thoracotomy from January 1997 to September 2010 at our institution. Postoperative mediastinitis due to methicillin-resistant *Staphylococcus aureus* was found in 3 patients who had a median sternotomy. They were ultimately discharged in good condition. No mediastinitis occurred in patients undergoing thoracotomy. Mediastinitis may occur due to direct exposure of the bone marrow to methicillin-resistant *Staphylococcus aureus* in patients with atopic dermatitis whose skin is colonized with such bacteria. Thoracotomy may be a better surgical approach in patients with atopic dermatitis who require thoracic surgery.

Keywords

dermatitis, atopic, endocarditis, bacterial, mediastinitis, sternum, surgical wound infection

Introduction

Atopic dermatitis (AD) is a skin condition often complicated by colonization with *Staphylococcus aureus* (S. aureus), which increases the risk of skin cellulitis and osteomyelitis in cardiac surgery.¹ In addition, Onoda and colleagues² reported that colonization with such bacteria is a risk factor for infective endocarditis (IE), which is consistent with the fact that native valve IE is often caused by S. aureus. This can be a particularly aggressive pathogen, and the incidence of neurological complications of IE, including septic emboli, tends to be higher with S. aureus infection than with other pathogens.³ Surgery via a conventional median sternotomy approach may be complicated by mediastinitis that carries a high mortality rate and requires both medical and surgical management.⁴ Positive cultures of S. aureus are obtained from 70% to 80% of wounds in patients with mediastinitis, and may be associated with cutaneous bacterial colonization with this pathogen. The purpose of this study was to analyze clinical outcomes with respect to mediastinitis in patients with AD undergoing thoracic surgery.

Patients and Methods

There were 4,111 cardiovascular operations with cardiopulmonary bypass performed at our institution from January 1997 to September 2010. Twenty-five (0.61%) of these were on patients with AD who were retrospectively reviewed for this study, using their medical records. Patient age ranged from 4 to 75 years (mean age, 31 ± 32 years). There were 20 (80%) males and 5 (20%) females. Among the 25 patients, 3 were emergency cases: 1 had IE complicated by tricuspid valve regurgitation, disseminated intravascular coagulopathy, and lung infarction; 1 had IE complicated by mitral valve regurgitation (MR), disseminated intravascular coagulopathy, and multiorgan infarction; and

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1 had aortic valve regurgitation and MR. There were 2 urgent cases: 1 with unstable angina pectoris; and 1 with IE complicated by MR. Preoperative characteristics and diagnoses are summarized in Tables 1 and 2. Preoperatively, healed IE was recorded in 8 patients. Causative pathogens were *S. viridans* in one case, methicillin-sensitive *S. aureus* in 6, and methicillin-resistant *S. aureus* (MRSA) in one. Overall, *S. aureus* was confirmed in 7 of 8 cases. In the context of IE, preoperative stroke was recognized in 7 patients. Renal dysfunction was present in only 5 patients in the sternotomy group. Details of the surgical procedures are summarized in Table 2.

Patients were under routine skin care for AD by dermatologists before surgery, except in some cases in which surgery was performed on an emergency basis. Patients underwent either a conventional median

sternotomy or a thoracotomy, at the discretion of attending surgeons, based on the type of surgical procedure and the condition of the patient's skin. The incidence of postoperative mediastinitis in patients with AD was compared according to the surgical approach utilized.

Results

A conventional median sternotomy was performed in 20 patients, and 5 had a right thoracotomy. Postoperative mediastinitis occurred in 3 (15%) patients undergoing conventional median sternotomy, and in none who had a thoracotomy. Details of the 3 patients who developed mediastinitis are summarized in Table 3. The causative pathogen was MRSA, which grew in blood cultures in all cases. In 2 of these cases, healed IE was present preoperatively; however, as the infection had been treated with antibiotics, the relationship between IE and mediastinitis was unclear. Mediastinitis did not occur in patients undergoing surgery on an emergency or urgent basis. The 3 patients with mediastinitis were treated with debridement, partial resection of the sternum, omentoplasty, and intravenous antibiotics. All 3 were ultimately discharged in good condition.

Discussion

Approximately 1% to 3% of the population is affected by AD, which is associated with a high rate of cutaneous colonization with *S. aureus*.¹ In fact, the density of *S. aureus* in AD lesions without any active infection can be up to 10^7 colony-forming units per square centimeter.⁵ The mechanism underlying the increased susceptibility to colonization with *S. aureus* is a deficiency in the expression of inflammation-induced antimicrobial, antifungal, and the antiviral peptides, cathelicidin LL-37 and β -defensin 2, in patients with AD.^{1,5} Mediastinitis can be a devastating complication in patients undergoing thoracic surgery. *S. aureus* can induce aggressive infection and can be cultured from 70% to 80% of wounds in patients with postoperative mediastinitis. Similarly, *S. aureus* is the most common cause of IE;⁶ and AD is a risk factor for IE, most likely because of its association with *S. aureus* colonization due to impaired expression of cutaneous antimicrobial peptides.²

This is the first study to describe the link between AD and postoperative mediastinitis. Thus it is unlikely that thoracic surgeons recognize the high risk of postoperative mediastinitis in patients with AD. Of the 25 patients, Postoperative mediastinitis in this study occurred only in those who had undergone surgery via a median sternotomy approach. This corresponds

Table 1. Clinical characteristics of atopic dermatitis patients

Variables	Sternotomy (n = 20)	Thoracotomy (n = 5)
Age (years)	33 $\pm$ 25	31 $\pm$ 8
Female sex	4	1
Hypertension	5	0
Diabetes mellitus	0	0
Hyperlipidemia	3	0
COPD	0	0
Stroke	5	2
Infective endocarditis	5	2
Renal failure	5	0
Hemodialysis	0	0
Peripheral vascular disease	1	0
Ejection fraction >60%	7	3
Ejection fraction 40%–60%	13	2
Ejection fraction <40%	0	0
NYHA class		
Class I	14	3
Class II	2	2
Class III	3	0
Class IV	1	0
Congestive heart failure	1	0
Angina pectoris	5	0
Myocardial infarction	0	0
Urgency of surgery		
Elective	16	4
Urgent/emergency	4	1
Redo surgery	0	0
Atrial fibrillation	1	0

COPD = chronic obstructive pulmonary disease, NYHA = New York Heart Association.

with an incidence of 15%, which is higher than the rate of postoperative mediastinitis in the general population (1% to 2%).⁴ In contrast, mediastinitis does not typically occur when minimally invasive techniques are utilized in the context of mitral valve surgery or redo cases, for example.⁷ Risk factors for dehiscence or mediastinitis include sternal instability, diabetes mellitus, age >75 years, chronic obstructive pulmonary disease, obesity, and heart failure.^{4,8} Diabetes mellitus and chronic obstructive pulmonary disease were not present in the 25 cases reviewed in this study. It is possible that sternal instability accounted for the higher incidence of mediastinitis in the sternotomy group. On the other hand, sternal stability is preserved in the context of thoracotomy, which does not require sternal division, and thus may be associated with a lower incidence of mediastinitis. Division of the sternum can facilitate invasion of *S. aureus* into the blood stream through the exposed bone marrow, leading to deep sternal infection.⁸ In fact, this may be the mechanism that disposes patients with AD undergoing open-heart surgery to develop mediastinitis.

Table 2. Preoperative diagnoses and details of surgery

Diagnosis	Sternotomy	Thoracotomy
Atrial septal defect	4	1
Ventricular septal defect	2	0
Kawasaki disease	1	0
Angina pectoris	4	0
Aortic regurgitation	2	1
Aortic stenosis	1	0
Mitral regurgitation	6	4
Tricuspid regurgitation	1	0
Procedure		
Atrial septal defect closure	4	1
Ventricular septal defect closure	2	0
Coronary artery bypass	5	0
Aortic valve plasty	1	1
Aortic valve replacement	2	0
Mitral valve plasty	6	4
Tricuspid annuloplasty	1	0

These data suggest that it may be appropriate to avoid a median sternotomy when risk factors for mediastinitis are present. We previously described a patient with uncontrolled diabetes mellitus who had mitral valve replacement via a right thoracotomy to avoid a median sternotomy and mediastinitis.⁹ Further, the deficiency of antimicrobial peptides against *S. aureus* in the skin of patients with AD may represent another contraindication to median sternotomy because we cannot correct this deficiency preoperatively.⁵ Not all surgical procedures can be performed via thoracotomy, so several preoperative measures should be undertaken when considering surgery in patients with AD. First, if surgery is non-urgent, patients should receive treatment from a dermatologist to optimize skin condition before surgery. The guidelines for management of AD recommend care for dry skin with decreased barrier function and even slight skin eruptions, to prevent the recurrence of inflammation and reduce symptoms.¹⁰ If skin care is neglected, inflammation can easily recur. Second, bacterial contamination of the surgical site is an important factor that contributes to the risk of surgical site infection, and efficient preoperative skin preparation is essential to reduce this risk.^{11,12} Microbial sealant prevents migration of potential pathogens from the skin into the incision site, and application of a cyanoacrylate-based microbial sealant after disinfection prior to cardiac surgery can reduce surgical site contamination significantly when used in conjunction with 10% povidone-iodine skin preparation.¹¹ Indeed, in in-vitro studies, recovery of MRSA was reduced by 99.9% after application of a microbial sealant.¹¹ While we cannot achieve total sterilization even with optimal skin preparation, these measures seem appropriate for reducing the risk of *S. aureus* in the incision site in patients with AD and cutaneous bacterial colonization who are undergoing thoracic surgery.¹¹ Further studies on the efficacy of these measures in patients with AD would be of benefit. In our experience, after introduction of a microbial sealant, we applied it in sternotomy and thoracotomy, and no mediastinitis was detected; the 3 cases of mediastinitis occurred before its introduction.

Based on the observations in this study, we propose that thoracotomy should be used rather than median

Table 3. Summary of patients with postoperative mediastinitis

No.	Age (years)	Sex	Diagnosis	Skin Status	Procedure	Pathogen	Treatment	Outcome
1	31	Male	MR, IE	Erythema	MVP	MRSA	Surgery, antibiotics	Alive
2	20	Male	MR, IE	Dry skin	MVP	MRSA	Surgery, antibiotics	Alive
3	75	Male	AP	Dry skin	CABG	MRSA	Surgery, antibiotics	Alive

AP = angina pectoris, CABG = coronary artery bypass grafting, IE = infective endocarditis, MR = mitral regurgitation, MRSA = methicillin-resistant *Staphylococcus aureus*, MVP = mitral valve plasty.

sternotomy whenever possible in patients with AD who require thoracic surgery. Patients should undergo preoperative consultation with a dermatologist to improve skin condition when possible, and a cyanoacrylate-based microbial sealant should be used after ordinary preoperative disinfection.

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Conflicts of interest statement

None declared.

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