Surgical treatment of acute endocarditis of the aortic valve with paravalvular abscess: considerations justifying the use of mechanical replacement devices

Abstract  **Objective.** Early recurrence after surgery for acute endocarditis is a life-threatening complication. Allograft valves are supposed to have a higher resistance to recurrent infection, thus several authors claim them to be the replacement device of choice in cases of aortic endocarditis. However, allografts have two major drawbacks: their availability is limited, and most of the patients require reoperation for graft calcification of degeneration. Until now there has been no prospective study analysing whether early recurrence after surgery of acute endocarditis is associated with the mechanical valve per se or with factors related to the surgical technique or postoperative care.

**Patients and methods.** We present a prospective study on 36 consecutive patients with acute endocarditis of the aortic valve with paravalvular abscesses. In this series, there were 5 women and 31 men with a mean age of 50.3 years. All patients were operated before a course of antibiotic therapy was completed. Abscesses were radically resected and the cavities closed either with direct suture or, if not possible, with Dacron patches. For aortic valve replacement, a mechanical valve was used in every patient.

**Results.** The early mortality in this series was 14%, only one patient experienced recurrent endocarditis and underwent reoperation. The results compare well with those achieved after valve replacements with allograft valves.

**Conclusion.** We conclude that, even in cases of acute endocarditis, replacement of the aortic valve with a mechanical device is an acceptable alternative to the allograft, if radical surgical debridement and adequate antibiotic therapy are performed.

**Key words** Infectious endocarditis - Paravalvular abscess - Mechanical valve

Introduction

Infection of a prosthetic valve implanted during surgery for aortic endocarditis still has a low but not insignificant prevalence. This risk increases if the endocarditis has to be considered acute at the time of the operation, and if abscesses are present [19]. Abscesses are also considered to be an adverse predictor of hospital mortality, and the frequency of reoperation for any kind of complication is increased in these patients [18, 19], because the techniques of removing infected tissue and the secure fixation of the prosthesis are more complex if the aortic annulus is partially or completely destroyed by the infectious process.

To meet this challenge, several authors have suggested the use of allograft valves for replacement in the aortic po-
sition, because both the early and late risk of the occurrence of recurrent endocarditis is supposed to be lower when compared to replacement with mechanical or xenograft devices [11]. Moreover, it has been suggested that the use of an allograft valve decreases the risk of early death after the operation; thus it has been stated that the allograft valve should be the replacement device of choice in cases of the surgical treatment of acute infective endocarditis [16]. However, there are two major drawbacks to allograft valves:

1. Patients usually require reoperation for graft failure or calcification several years after the first intervention.
2. The availability of allograft valves is limited.

The purpose of the following prospective study was to determine the clinical outcome and the risk of early and late recurrent endocarditis after prosthetic valve replacement in a group of patients presumably at highest risk, i.e. patients suffering from acute endocarditis of the aortic valve complicated by aortic root or myocardial abscesses. In particular, the question was addressed as to whether the frequency of recurrent endocarditis after surgery can also be kept low by a radical surgical approach and thorough postoperative care, even if mechanical valves are used as replacement devices. Indication for surgery, surgical approach and perioperative and postoperative management were standardized as far as possible in this collective of patients.

### Patients and methods

#### Patient data

Between 1988 and 1993, 86 consecutive patients were admitted with acute infective endocarditis of the aortic valve. Thirty-six of them had abscesses of the aortic root or annulus and/or adjacent myocardium at the time of operation. Among these 36 patients, 31 were men and 5 women with a mean age of 50.3 years. Additional involvement of the mitral valve was present in eight patients, one patient had aortic and tricuspid valve endocarditis and in two patients aortic, mitral and tricuspid valve were infected. Patients were only included if the endocarditis was considered to be "definite" according to the criteria proposed by Von Reyn [24], i.e. if the active phase of the infection was proved by histologic staining of the excised valve leaflets. Among the causative infecting microorganisms Staphylococcus aureus was involved in ten of the cases, coagulase-negative Staphylococcus in ten cases. In four patients no microorganisms could be isolated (Fig. 1).

Preoperatively, 20 patients were in class IV according to the NYHA classification, 12 were in class III and only one patient was in class II. Three patients entered the operating room in a state of cardiogenic shock. Seven patients had undergone previous cardiac surgery, four of them aortic and three of them aortic and mitral valve replacement, all of them for non-infectious reasons. In eight (22%) patients an additional coronary heart disease with significant stenoses of one or two main vessels was present (Table 1).

All patients but two were on antibiotic treatment at admission. The duration of antibiotic therapy ranged from 2 days to 6 weeks, the mean duration was 3 weeks. Thirteen patients had received more than two antibiotic agents during the history of the disease. In the two patients without antibiotic therapy no signs of systemic infection were present before the operation and acute endocarditis was an intraoperative diagnosis. One of them arrived in a severe state of cardiogenic shock, the other patient had been on chronic dialysis for several years before surgery. Sixteen of the 34 patients (47%) with antibiotic pretreatment presented themselves with persisting temperatures, despite adequate antibiotic regimens. Possible or definite infective foci, as far as diagnosed preoperatively, were cured before the intervention, whenever the patient's cardiac condition allowed these procedures.

#### Diagnostic procedures and indications for surgery

The diagnosis was made by the combination of typical clinical symptoms and echocardiographic examinations in each patient. The abscess could be detected preoperatively in 40% of the overall population, however, correct diagnosis of paravalvular involvement was possible in 10 of 12 patients who underwent transesophageal

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**Fig. 1** Infective microorganisms isolated from preoperative blood cultures. (Staph. aureus, Staphylococcus aureus, Staph. coag. neg.: coagulase-negative Staphylococcus). Findings in %

**Table 1 Preoperative patient characteristics (NVE native valve endocarditis, PVE prosthetic valve endocarditis, New York Heart Association (NYHA) class V means cardiogenic shock)**

<table>
<thead>
<tr>
<th>Mean age</th>
<th>50.3 years</th>
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<tbody>
<tr>
<td>Female/male ratio</td>
<td>5/31</td>
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<table>
<thead>
<tr>
<th>NYHA</th>
<th>n</th>
<th>%</th>
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<tbody>
<tr>
<td>II</td>
<td>1</td>
<td>(3%)</td>
</tr>
<tr>
<td>III</td>
<td>12</td>
<td>(33%)</td>
</tr>
<tr>
<td>IV</td>
<td>20</td>
<td>(55%)</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
<td>(9%)</td>
</tr>
</tbody>
</table>

| NVE | 30 | (83%) |
| PVE | 6  | (17%) |

<table>
<thead>
<tr>
<th>Fever on admission</th>
<th>n</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>16</td>
<td>(44%)</td>
</tr>
<tr>
<td>Preop. antibiotic treatment</td>
<td>34</td>
<td>(94%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Single valve disease</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>(69%)</td>
</tr>
<tr>
<td>Double valve disease</td>
<td>9</td>
<td>(25%)</td>
</tr>
<tr>
<td>Triple valve disease</td>
<td>2</td>
<td>(6%)</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>8</td>
<td>(22%)</td>
</tr>
</tbody>
</table>
echocardiography. All patients underwent preoperative cardiac catheterization and, as far as the endocarditis was concerned, angiography did not provide additional information in this series but detected coronary heart disease in a considerable percentage as mentioned above.

In our institution, absolute indications for surgical intervention during the active phase of infective endocarditis before the course of antibiotic treatment is completed, are the following: progressive cardiac failure, uncontrollable infection despite adequate antibiotic therapy, recurrent emboli, acute renal failure and prosthetic valve endocarditis caused by staphylococci. Each patient in this series met at least one of these criteria. The main indication for surgery was progressive cardiac failure in more than 90% of the patients; acute aortic valve insufficiency leading to a clinical picture of NYHA III or higher was considered an indication for urgent surgical intervention.

The infective process was not controllable by medical therapy alone in 45% of the patients, major embolic events occurred in nine patients. In five patients prosthetic valve endocarditis was caused by staphylococci. Due to the severity of the illness, the patients suffered from a variety of endocarditis-related preoperative complications: five patients were admittend with acute renal failure, six patients experienced stroke during the preoperative course of the disease. Minor or major septic embolization was frequent, occurring in 14 patients (38%). In three patients, extension of the abscess had led to a ventricular septal defect (VSD), in two of them complete atrioventricular block was present. Routinely, each patient underwent abdominal sonography or computed tomography (CT) scan for diagnosis of metastatic extracardiac organ manifestations; if neurologic symptoms were present, CT scan of the brain was performed additionally.

Surgical technique

The interventions were carried out during cardiopulmonary bypass with mild hypothermia. A low-flow, low-pressure perfusion regimen was performed (mean flow 1.1 l/min per m², mean pressure 30–50 mm Hg at 26 °C), for myocardial protection cold crystalloid cardioplegia was used. In all cases, the aortic valve was resected first and the annulus inspected. Details on the intraoperative findings are given in Fig. 2. Care was taken to examine all adjacent structures to determine whether the infection had spread beyond the valve. Infected tissue was radically excised in sano, irrespective of whether the conduction system was jeopardized or if larger defects in the aortic wall, the annulus or the myocardium were created. Abscesses were removed and even the wall of the abscess cavity was resected as completely as possible. Then the whole site was gently rinsed with antibiotic solution [5].

Defects were subsequently closed by direct suture in 27 of the patients; in nine patients Dacron patches were required for tension-free closure (among them there were three patients with VSDs caused by the abscess). Abscess cavities were filled with fibrin glue or, more recently, with gentamycin-swabs ("Sulmycin-implant") as proposed by Watanabe [25], and closed the same way. The same strategy was applied, if the mitral valve was involved in the infectious process. The left-sided valves were implanted using single, Teflon-coated sutures. After closure of the aorta (and left atrium in cases of mitral involvement), the right atrium was opened if additional tricuspid endocarditis was suspected. Again, all infected structures were resected and tricuspid repair or replacement was performed.

In all patients, mechanical valves were used for replacement of the aortic valve. Mechanical prostheses were inserted in ten patients for additional mitral valve replacement, while in one patient mitral valve repair was possible. The tricuspid valve was replaced in one and repaired in two patients. In nine patients aortocoronary bypass grafting was necessary for one- or two-vessel coronary artery disease. In three patients splenic abscesses were diagnosed preoperatively; these patients underwent simultaneous splenectomy.

Fig. 2 Intraoperative pathology. Findings in %

Data sampling

As in every patient operated in our institution, more than 5000 items describing the preoperative, perioperative and postoperative course were sampled and fed into the database of the department's network [23]. As a standard procedure, each patient and his home physician received a questionnaire automatically generated by the computer every 6 months following the operation. Follow-up was 100% complete. The mean follow-up period was 42 months.

Results

Survival

Five patients (14%) died within 30 days after the operation. The reasons for death were uncontrollable bleeding in two patients; one of them, with Staphylococcus aureus endocarditis, was treated antibiotically for 6 weeks, until the source of infection was found. At surgery, the whole heart, aortic root and ascending aorta appeared to be involved in the infectious process. After replacement of the valve and closure of several abscess cavities, bleeding resulted from rupture of the ascending aorta from the cannulation site into the aortic arch after extracorporeal circula-
tion had been terminated. The other patient had undergone the third cardiac reoperation; he presented himself with a severe prosthetic valve endocarditis of aortic, mitral and tricuspid valves with large abscesses and purulent pericarditis. Large parts of the pulmonary trunk, the walls of the atria and the right ventricle were destroyed by the infection, so that reconstruction with Dacron patches had to be performed. Friable tissue conditions of the whole heart together with pre-existing disturbances of the clotting system, disseminated intravascular coagulation and a long period of extracorporeal circulation were causative for fatal bleeding mainly from the suture lines at the left atrium and right ventricle.

Two patients died of cardiac failure, both of them had a long history of aortic valve disease with severely impaired left ventricular function. In one patient, the reason for death was septic multiorgan failure on the 17th postoperative day. At necropsy, metastatic infection of the liver, kidneys, spleen and lungs were found together with purulent pericarditis. Macroscopically and microscopically the aortic valve prosthesis did not show signs of recurrent or persistent infection.

Preoperative conditions, such as high NYHA classification, type of infecting microorganisms or prosthetic valve endocarditis, were not shown to have had significant influence on the surgical outcome (Table 2) among this limited number of patients.

Another four patients died in the later postoperative course: one from pneumonia, two patients from cardiac failure and the fourth patient died suddenly 2 years after triple valve replacement. None of these patients underwent necropsy, but there was no clinical evidence that death could have been related to persistent or recurrent endocarditis.

Table 2  Early mortality related to preoperative patient characteristics. Univariate analysis (NVE native valve endocarditis, PVE prosthetic valve endocarditis)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Deaths (n/%)</th>
<th>P value</th>
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<tbody>
<tr>
<td>NYHA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>12</td>
<td>1 (8%)</td>
<td>NS</td>
</tr>
<tr>
<td>IV and V</td>
<td>23</td>
<td>4 (17%)</td>
<td>NS</td>
</tr>
<tr>
<td>Microorganism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcus</td>
<td>10</td>
<td>1 (10%)</td>
<td>NS</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>18</td>
<td>4 (22%)</td>
<td>NS</td>
</tr>
<tr>
<td>Type of endocarditis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NVE</td>
<td>30</td>
<td>4 (13%)</td>
<td>NS</td>
</tr>
<tr>
<td>PVE</td>
<td>6</td>
<td>1 (16%)</td>
<td>NS</td>
</tr>
<tr>
<td>Valves involved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>25</td>
<td>4 (16%)</td>
<td>NS</td>
</tr>
<tr>
<td>Double/multiple</td>
<td>11</td>
<td>1 (9%)</td>
<td>NS</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>5 (14%)</td>
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</table>

Twenty-six of the 27 surviving patients are in functional NYHA class I or II, only one patient was considered to be in NYHA class III without any sign of prosthetic valve dysfunction.

Major complications

After surgery seven patients had complete AV block: in two of these the block had already been present preoperatively and was caused by the extent of the abscess. Thus, performing the radical surgical approach, we created AV blocks in five patients. These seven patients had permanent pacemaker implantation 2–3 weeks after valve surgery. Five patients were mechanically ventilated for more than 4 days, two patients had to be reoperated for bleeding. Two patients experienced transient psychological problems.

Recurrent endocarditis

Only one case of recurrent endocarditis complicated this series, in a patient initially operated for Streptococcus sanguis endocarditis of the aortic valve. The diagnosis of recurrence was based on transesophageal echocardiography, were a small amount of vegetation and a paravalvular leak were seen at the prosthesis. Additionally, the patient presented persistent septic temperatures and leukocytosis despite adequate antibiotic therapy. Reoperation was performed 12 days after the initial valve replacement and Staphylococcus epidermidis was found causative for the prosthetic valve endocarditis. The patient survived the second intervention and recovered well. All the other patients remained free from recurrence or reoperations for paraprosthetic leak or valve dysfunction after the intervention.

Discussion

The incidence of paravalvular destruction in patients with acute endocarditis of the aortic valve has increased in recent years [25]. The reasons for this finding are difficult to define, a role may be played by more aggressive and potent antibiotic therapy, which selects microorganisms prone to form abscesses, like Staphylococcus aureus or coagulase-negative Staphylococcus. Adequate treatment remains a challenge to the surgeon whenever the infectious process has spread beyond the limits of the valve, because the techniques required for repair are more complex and the paravalvular tissue is friable. Difficulties result from the need for extended debridement of the infected tissue, the closing of abscess cavities and secure fixation of the prosthesis and lead to a high risk of postoperative valve dysfunction, paraprosthetic leak and recurrent endocarditis [6, 19].
As reconstruction of the valve is usually no treatment option in these severe cases and the valve has to be replaced, one of the currently discussed questions is which replacement device to use to meet the challenge of repairing a destroyed aortic root while avoiding reoperation for early recurrent endocarditis. The suggestion of several authors, to use homograft valves for replacement, sounds promising as the homograft valve is supposed to avoid several problems in these critically ill patients. The implantation may be technically easier, because the biologic tissue is more flexible than a mechanical prosthesis and so it can cope better with the problems of a destroyed aortic root [10, 14]; perioperative mortality is considered to be lower after allograft replacement as compared to prosthetic devices [11, 16, 21]. Concerning the question of whether the resistance of allografts towards recurrent or persisting infection is higher, Haydock and McGiffin published two comparative clinical studies with large patient collectives in 1992. Both demonstrated that allografts appear to involve a lower immediate risk of the development of recurrence than mechanical valves or xenografts: Haydock reported an overall incidence of recurrent endocarditis of 10% for allografts versus 17% for xenografts or mechanical prostheses, McGiffin of 0% versus 17%, respectively. These studies, however, were not randomized and were carried out over a 20-year period and differences in the outcome may not only be due to the replacement device, but may also reflect differences in patient selection, surgical approach and perioperative management during the observation period.

The higher resistance of allografts to recurrent infection is attributed to the content of viable cells [9], which, in turn, seems to be dependent on the preservation technique; best results were achieved with fresh-cryopreserved homografts from living donors, the worst with cold wet stored, antibiotic sterilized ones [4]. This, however, is one of the drawbacks of the method: fresh cryopreserved allografts require an extraordinary expenditure for storage and stringent bacteriological control, therefore this kind of allograft will hardly be available in most centers if a patient is admitted for urgent operation. Another major drawback of allograft valves, besides the fact that their availability is limited, is the need to reoperate many of these patients for calcification or graft failure. The incidence of tissue failure in allografts has decreased in the last years, as new methods of preservation have been invented, but O'Brien et al. still reported 50% reoperations within 15 years after valve replacement [20] and Barratt-Boyes et al. described an actuarial freedom of only 42% from valve replacement 14 years after homograft implantation [2]. Regarding the fact that patients with acute endocarditis are usually younger at the time of surgery than patients with non-infectious acquired valve diseases [13], this means that most patients in whom the aortic valve was replaced with an allograft will undergo reoperation for graft failure. As Blackstone and Kirklin pointed out, the risk after second valve procedures evidently increases, and therefore every effort should be made to make the first valve procedure a lasting one [3].

Until today there has been no controlled randomized trial comparing allograft and mechanical valves for the treatment of acute endocarditis and there will probably never be one, due to the heterogenous patient populations requiring surgery, different surgical techniques for repair and differences in perioperative and postoperative medical care.

In an attempt to analyze whether mechanical valve replacement is still justified during active endocarditis, we performed a prospective study on patients presumably at highest risk of dying and early recurrent endocarditis: patients suffering from acute endocarditis of the aortic valve with paravalvular abscesses. All patients were selected according to the same criteria concerning the indication for surgery; the management of extracorporeal circulation and myocardial protection were standardized and the same radical surgery strategy was applied to each patient. Special care was taken to identify and eradicate infectious foci preoperatively and in the application of adequate antibiotic therapy perioperatively and postoperatively [1]. Apart from the fact that each case of endocarditis in our series was in the active phase and had paravalvular involvement, there were several other conditions determining the high operative risk of this collective: 20 patients were in NYHA class IV, and three patients arrived mechanically ventilated and dependent on inotropics in high dosage in a state of cardiogenic shock. *Staphylococci* contributed to a higher percentage of infections as compared to other series, where the infection was limited to the valve leaflets [5]; this finding supports the advice of Watanabe and others [13, 17, 25] to undertake early surgical interventions on patients presenting themselves with staphylococcal endocarditis to prevent the development of paravalvular involvement.

Taking these conditions into consideration, the lethality of this group of patients treated with mechanical valves is low and compares well with other reports in the literature, even if allograft valves were used for replacement. Two patients died intraoperatively from uncontrollable bleeding after the repair of extensive destruction of the aortic root and ascending aorta in one, and of the aortic and mitral annuli and the walls of the left atrium and right ventricle in the other patient. Bleeding in these patients was not dependent on the type of replacement device inserted, but on the friable tissue caused by large abscesses and the extension of the infectious process into the myocardium; it does not seem likely that an allograft could have solved this problem. The other cases of early death - two of them from cardiac failure and one resulting from septic multiorgan failure with extracardiac metastatic foci - were not dependent on the replacement device either. Interestingly, risk factors usually determining the early results of surgery [12] (high NYHA classification, staphylococcal infection, prosthetic valve endocarditis) did not significantly influ-
ence the prognosis of the patients. This finding may be due to the relatively small collective, but also to the fact that the presence of an abscess is considered to be a risk factor in itself, and selecting patients according to this criterion may diminish the influence of other risk factors.

The rate of recurrent infections was very low with only one patient experiencing this complication, but these results can only be achieved if a very radical surgical approach is used [8, 15, 22]. Infected tissue must be thoroughly removed, even if large defects are created or the conductance system is destroyed by this technique. In our series, the extensive surgical debridement resulted in five complete AV blocks postoperatively; this complication has to be taken into account, because leaving infected tissue in situ always carries a high risk of recurrent endocarditis, irrespective of the replacement device that is chosen [7, 18].

These guidelines may have a more serious impact on the outcome of these patients than the choice of the replacement device per se. Our data prove that, even in patients with acute infective endocarditis and aortic root abscess replacement of the valve, with a mechanical prosthesis together with extensive debridement and the closure of abscess cavities leads to results as satisfactory as those reported after allograft replacement, and usually no hazardous reoperation is required after some years.

The limitation of this study is a relatively short follow-up period ranging from 1–6.5 years with a mean of 42 months. Homograft valves are supposed to have a lower incidence of infection years after the operation [11], but this does not depend on whether the valve was replaced for endocarditis or non-infectious reasons. There is unanimous agreement that events occurring months after surgery for acute endocarditis cannot be related to the initial infectious process and to the surgical procedures performed. Based on this short-term analysis and taking into consideration the disadvantages of allograft valves, we conclude that a mechanical prosthesis is still an acceptable alternative to an allograft in patients undergoing urgent valve replacement for infective endocarditis.

References


Discussion

Dr. G. Petterssen (Copenhagen, Denmark): Just to make the picture complete I would like to update you on one use of a Ross operation for endocarditis. To date, we've operated on 16 patients and 15 of those had annular invasion, 6 of them having prosthetic valve endocarditis. We have one death, not related to the choice of procedure but to the type of patient.

What you are doing is difficult and it seems to me, being involved in homograft and Ross operations, that your operations are at least as difficult as our operations. I also noticed your high incidence of heart block. It is this mainly related to how radical you are in excising the pathology, or is it the placement of sutures deeper with pledgets that also contributes to a rather high frequency of heart block, which is higher than that we have.

Dr. Bauernschmitt: Two of these AV blocks were present already preoperatively as a result of the extent of the abscesses, and I think it's not avoidable to create some new AV blocks if you are really radical and really excise all the infected tissue. I think it's a result of excising and not of sutures.

Dr. M. O'Brien (Brisbane, Australia): I would like to comment this morning that we really are hearing a new gospel, namely that a mechanical valve for active endocarditis is just as good, and perhaps some might even say superior, to an allograft. We have looked at the freedom from endocarditis with over 3,000 aortic valve replacements. The percentage freedom over time was exactly the same whether it was a mechanical, a xenograft or an allograft valve.

But if we focus only on the 206 patients who had aortic valve replacement for endocarditis, the hazard function analysis for recurrent endocarditis was constant and low for the allografts and the early recurrence of endocarditis with a mechanical and xenograft was a greater hazard. Our study was confirmed by both the Auckland and Alabama groups. It is from these analyses that we learned or believed that the allograft was the valve of choice for active endocarditis. Perhaps this may not be right, for this study goes back some 20 years and perhaps now, in this present era, some are doing the surgery better. We have just heard there is a more radical excision of infective tissue. Consequently, the hazard is lower on recurrent endocarditis may show different results. It may be that the hazard for recurrent or persisting endocarditis of the mechanical valve will not have a flat line if the surgery is done in the present era of radical excision. We need to relook prospectively at all of this again. I would like to thank you for a very important presentation.

Dr. C. Yankah (Berlin, Germany): If you look at your analysis regarding the morbid events, comparing the homograft to that of a mechanical valve, of course you know that the homograft patients have fewer AV blocks post-operatively and therefore a lower incidence of pacemaker implantation and also of late death. In your series, with mechanical valves the incidence of AV block was higher, if you compare it to many series of homografts. Did you add in your analysis all those morbid events as risk factors for the mechanical valves?

Dr. Bauernschmitt: I think our late deaths were not related to the valve implanted. If you look at large series where homograft valves were implanted, patients used to be a little bit younger and there series extended over a very long period of time. These four late deaths were cardiac but not valve-related; they are related to problems of the myocardium. As you saw, these patients had coronary heart disease to a considerable extent, and some of them had severely impaired left ventricular function because of long-standing aortic valve disease. So I think the homograft wouldn't have helped us in the later outcome.

Dr. M. Irarrazaval (Santiago, Chile): I noticed that some of your patients had strokes before surgery. Was that a risk factor, did they all recover? What is your current thinking about the patient with a stroke before surgery and acute endocarditis?

Dr. Bauernschmitt: Fortunately these patients recovered well. We try to have an interval of at least 2 weeks before we perform surgery on a patient who has had a stroke, but that was not possible in this collective. We had to operate on four of these six patients earlier because of cardiac deterioration and, as I said, fortunately none of these patients had worsening of his symptoms after surgery. Of course we did a CT scan of the brain before we went to the operating theater and made sure that there was no bleeding in any patient.

Dr. B. Messmer (Aachen, Germany): Just a question that came to me already in the first paper from Dr. Langely. He said that shock is a strong predictor for early mortality. You have patients with stroke before, you have patients in cardiogenic shock. Do you think there are patients that should not undergo operation anymore, and what are your criteria not to operate anymore?

Dr. Bauernschmitt: It is difficult to answer the question in this collective because we had only three patients who were actually in shock and one of these patients died after being resuscitated in the operating theater. We did an analysis on these patients, whether New York Heart Association Class IV or V was a predictor for a higher mortality, and there was a tendency towards a higher mortality, but I think with 36 patients it's impossible to perform a meaningful statistical analysis. So I would answer the question at the moment in this way: each patient with acute endocarditis and acute cardiac deterioration can be operated with good results.

Dr. G. Petterssen (Copenhagen, Denmark): Just to comment on when these patients should be operated on. I attended a meeting on endocarditis in Boston recently and was exposed to figures from medical people showing mortalities higher than what we have seen today. The conclusion there was that more of these patients should be operated on and that they should be operated on earlier than today. We should not see so many of these late patients.