

Surgical Management of Patients with Aortic Root Abscess: An Interventional Study

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ABSTRACT

Background: It is still challenging for cardiovascular surgeons to treat aortic root abscess, a severe type of infective endocarditis (IE) of the aortic valve and the surrounding tissues.

Objectives: We aimed to assess the proper timing for surgical intervention, the rate of hospital mortality and recurrence, and mid-term survival in patients with active IE of the aortic valve.

Patients and Methods: Thirty patients with aortic root abscesses were subjected to isolated aortic root surgery between March 2016 and September 2017 at the Department of Cardio-thoracic Surgery at Kasr El-Ainy hospital, Cairo University, Egypt.

Results: Out of the 30 patients, 19 were females (63.33%), and 11 were males (36.67%), with a mean age of 39.5 ± 15.5 years. The mean diameter of the abscess cavities was 1.85 ± 0.82 cm, most commonly located in the non-coronary sinus (63.33%). The common causative microorganisms were *Staphylococcus spp.* (36.67%), followed by *Streptococcus spp.* (23.33%), *Pseudomonas aeruginosa* (16.67%), and *Candida sake* (6.67%). The mortality rate was 23.33% and 16.67% were early, and 6.67% were late. Patients with prosthetic valve endocarditis (PVE) were associated with larger vegetation size, the abundance of Staphylococcus infection, a higher proportion of AV dehiscence, longer operative, aortic cross-clamp and bypass times, and longer ICU stay. The overall recurrence rate was 16.67%.

Conclusion: Early outcomes of AIE of the aortic valve could be enhanced through proper diagnosis, earlier referral to surgery, radical excision of infected tissue, at least a one-month course of intravenous antibiotics according to the culture and sensitivity, or broad-spectrum empirical agents in culture-negative cases.

Keywords: Infective endocarditis, Prosthetic valve endocarditis, Aortic root abscess, Native valve endocarditis.

INTRODUCTION

Infective endocarditis (IE) is a disease characterized by high morbidity and mortality⁽¹⁾. Among those who have had a prosthetic valve implanted, the incidence of IE is between 0.3% and 1.2% annually, accounting for between 1% and 5% of all IE cases⁽²⁾.

Treatment mostly consists of antibiotics. However, surgery is required for around a third of patients with active IE and a much higher percentage of patients with prosthetic valve endocarditis⁽³⁾. Prosthetic valve endocarditis (PVE) is more likely to cause periannular problems than native valve endocarditis (NVE), while Staphylococcal infections are more likely to cause periannular complications than infections caused by other species⁽⁴⁾. Patients with total aortic root destruction and involvement of the intervalvular fibrous body and mitral valve provide a special surgical challenge because they lack clarity around their present risk and long-term prognosis⁽⁵⁾.

It is still challenging for cardiovascular surgeons to treat aortic root abscess, a severe type of IE of the aortic valve and the surrounding tissues. When left untreated, an aortic root abscess may cause cardiac arrhythmias, pseudoaneurysms, cardiac fistulas, and burrowing abscesses⁽⁶⁾. However, antibiotics alone is frequently insufficient to prevent the damaging impact of a severe

aortic root abscess, making early and extensive surgical reconstruction of the aortic root mandatory⁽⁷⁾.

There is a high risk of serious tissue damage if surgery is delayed.

A paravalvular abscess should raise red flags for physicians to send patients for emergency surgery. Debridement of diseased and necrotic tissues around the aortic root is a standard part of surgical therapy, as is aortic root reconstruction by patching or plicating the resected region and aortic valve replacement (AVR) with a prosthesis⁽⁸⁾. Aortic root replacement (ARR) is accomplished via radical debridement and the implantation of a biological or prosthetic composite graft into the aortic root⁽⁹⁾. Our study aimed to assess the proper timing for surgical intervention, the rate of hospital mortality and recurrence, and mid-term survival in patients consecutively referred to Kasr Al Aini Hospitals for surgical treatment of active IE (AIE).

PATIENTS AND METHODS

Study Design

Between March 2016 and September 2017, ARR and AVR with patch repair of the aortic root were performed for patients who had aortic root abscess at the "Department of Cardio-thoracic Surgery, Kasr El-Ainy hospital, Faculty of Medicine, Cairo University, Egypt."

Patients

A total of 30 patients were surgically treated for aortic valve AIE complicated with aortic root abscess. Patients with AIE who needed surgery before completing a conventional course of antibiotics were included, regardless of whether or not they were showing indications of sepsis or their valve and blood cultures were positive for the infecting microbe. Modified Duke's criteria were used to make the IE diagnosis⁽¹⁰⁾. Aortic root abscess was defined as a perivalvular region with necrosis and purulent material as shown by echocardiography and doubtlessly confirmed on surgical intervention^(11,12). Patients with a neurological insult, irreversible septic shock with failed medical treatment, and those with ischemic heart disease necessitating CABG were excluded.

Data collection

All patients were diagnosed and initially treated at the Department of Cardiology and then referred to our surgical department. The following data were collected from each patient: Age, sex, ECG findings (NSR, AV block, arrhythmias, and AF), Echocardiography findings (PVE, NVE, abscess, location, size, extension, and complications, vegetations, LVEDD, LVESD, and LVEF), clinical state (NYHA class, embolic events, neurological state, renal dysfunction, and hepatic dysfunction), the timing of surgical interference (emergent, urgent, or elective), and positive culture study.

Surgical technique

During the procedures, aorto-bicaval cannulation was used to establish cardiopulmonary bypass in all patients who underwent median sternotomy. A combination of cold blood selective antegrade cardioplegia and ice slush, and systemic hypothermia to 28° were used to induce myocardial protection. Surgical procedures, if required, would be performed after six weeks on antibiotics customised to each patient's blood and tissue cultures. Whenever a PVE was complicated by an aortic root abscess, the affected prosthetic aortic valve was extracted initially, and then the annulus and abscess were examined for location and perforation. Culture samples were taken from all surgically removed tissues or prosthetic valves, and then the antibiotic solution (Gentamycin) was irrigated into the sewing ring of the prosthetic valve and abscess cavities. Dacron patches or autologous pericardium were used to repair the underlying defects

(redo cases). When the damage reached the coronary ostia, the Bentall operation was performed to replace the aortic root with "a double velour Dacron graft" linked to the valve with "4/0 running polypropylene sutures". Running 5/0 polypropylene sutures were used to reimplant the coronary ostia, which were then stabilized with native pericardial strips. 4-0 Teflon pledgets simple or running polypropylene sutures were used to reconnect the endocardium of the LVOT with the aortic intima at the level of the original annulus in patients with Aorto-ventricular disruption, therefore restoring ventricular-aortic continuity. Concomitant mitral valve replacement (MVR) and aorto-mitral continuity reconstruction were performed when the posterior IVF was involved.

Ethical approval: The study was approved by the Ethics Board of Cairo University and an informed written consent was taken from every participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association.

Statistical Analysis:

Data were presented as mean \pm SD in case of parametric continuous data, whereas numbers and percentages were used in case of categorical data. The Pearson Chi-Square test for independence was used to examine the relationships between categorical variables. To be statistically significant, the p-value has to be equal or less than 0.05. We used SPSS (Version 22, 2011) and Microsoft® Office Excel 2010 to conduct our statistical analysis.

RESULTS

Characteristics of all patients

Demographic and clinical characteristics: Out of the 30 patients, 19 were females (63.33%), and 11 were males (36.67%), with a mean age of 39.5 ± 15.5 years. Patients had comorbidities, including cerebral embolism 13.3%, renal dysfunction 20%, and impaired liver function 16.67%. Most cases (70%) showed normal sinus rhythm, 23.33% of cases experienced arrhythmias preoperatively in the form of atrial fibrillation, and 6.67% suffered from acute atrioventricular block (AVB), complicating the extension of infection to the AVN that renders intervention more emergent. Prosthetic valves were infected in half of the patients. Large vegetations (>10 mm) with recurrent systemic emboli were found in 60% of the patients, mainly with PVE (55.56%) (Table 1).

Table (1): Demographic and clinical characteristics

Variables		Total Patients (n=30)	Deceased patients (n=7)	P-value
Age (years)		39.5±15.5	37.2±12.5	>0.05
Gender	Male	11 (33.67%)	3 (42.86%)	>0.05
	Female	19 (66.33%)	4 (57.14%)	
Rhythm	Normal sinus rhythm	21 (70%)	4 (57.14%)	>0.05
	Atrial fibrillation	7 (23.33%)	2 (28.57%)	
	Atrio-ventricular block	2 (6.67%)	1 (14.29%)	
Type of infected valve	PVE	15 (50%)	6 (85.71%)	0.031
	NVE	15 (50%)	1 (14.29%)	
Vegetation size	> 10 mm	18 (60%)	7 (100%)	0.014
	< 10 mm	12 (40%)	0 (0%)	
LVEF	< 50%	10 (33.33%)	4 (57.14%)	>0.05
	> 50%	20 (66.66%)	3 (42.86%)	
NYHA clas	I	0 (0%)	0 (0%)	0.023
	II	6 (20%)	0 (0%)	
	III	16 (53.33%)	3 (42.86%)	
	IV	8 (26.67%)	4 (57.14%)	

Echocardiographic data: The mean diameter of the abscess cavities was 1.85 ± 0.82 cm. The abscess cavities were most commonly located in the non-coronary sinus (63.33%). Pseudoaneurysm affected only 6.67% of the patients, fistula formation between the aorta and RA occurred in 3.33%, and aortoventricular dehiscence affected 23.33%. Coronary ostia were involved in 10%. The mean LVEDD was 6.65 ± 1.45, and LVESD was 4.8 ± 1.4. Preoperative mean left ventricular function (LVEF) was 50 ± 20%. The predominant patient functional class (FC) was III in 53.33%, IV in 26.67%, and II in 20%.

Timing of surgical intervention: The percentage of emergency surgeries (within 24 hrs.) was 26.67%, urgent surgery (a few days after admission) was 70%, and only one patient (3.33%) was stable enough to receive one week of wide spectrum antibiotics prior to intervention and was operated on elective (1-2 weeks of antibiotics prior to intervention) basis.

Type of the causative organism: The common causative microorganisms were *Staphylococcus spp.* (36.67%), followed by *Streptococcus spp.* (23.33%), *Pseudomonas aeruginosa* (16.67%), and *Candida sake* (6.67%). Culture-negative endocarditis affected 16.67% of patients. Infections caused by staphylococci were found to be substantially higher in PVE patients than in NVE patients (p= 0.008).

Characteristics of deceased patients

Out of the 30 patients, the mortality rate was 23.33%; of them, 16.67% were early (30 days postoperatively) mortality, and 6.67% were late (>31 days postoperatively) mortality. There was no significant (p>0.05) difference between deceased patients and all patients regarding age, gender, or preoperative cardiac rhythm. On the other hand, in terms of the type of infected AV, 85.71% of the deceased patients had infected PVE compared to 50% in all patients (p=0.031). Similarly, all deceased patients had vegetations larger than 10 mm compared to 60% of all patients (p=0.014). Deceased patients were associated with a higher NYHA class than all patients (p=0.023). In terms of echocardiographic parameters, there was no statistically significant difference between the deceased and all patients regarding abscess cavities diameter, incidence of pseudoaneurysm, aortoventricular dehiscence, coronary ostia involvement, LVEDD, LVESD, and LVEF. The prevalence of comorbidities was comparable in both deceased and all patients. Regarding the timing of surgical intervention, 71.4% of the deceased patients underwent emergent surgery compared to 26.67% of all patients, with a statistically significant difference (p=0.022). There was no significant difference between the deceased and all patients considering the causative organisms.

Intra-operative findings: Regarding the precise localization of the abscess after debridement of the whole of the infected tissue, patients with PVE were more likely to have significant aortic root destruction with aortic-ventricular dehiscence (p=0.040), whereas those with NVE were more likely to have well-circumscribed and confined abscess development. No significant difference was found regarding the effect of abscess location and extent on the mortality rate. In all patients, infected valves were replaced with AV prosthesis, and abscess cavities were closed by direct suturing in 6.67% and by pericardial patch in 93.33%. Annular reconstruction was needed in 86.66% of the patients with PVE compared to only 26.67% with NVE (p= 0.01). Bentall procedure was performed in 10%. Concomitant MVR was performed in 10% due to extensive destruction of the AML. Neither type of procedure performed nor adding MVR significantly affected post-operative mortality. Regarding operative time, it was significantly longer in the PVE

group compared to the NVE group (260 ± 100 min vs. 210 ± 80 min; p=0.033). Likewise, both ACC and CPB times were longer in the PVE group than in the NVE group (p=0.021 and 0.016), respectively (Table 2).

Table 2: Surgical data

Variables		PVE (n= 15)	NVE (n= 15)	P-value
Type of the infected organism	Staph. Spp	9 (60%)	2 (13.33%)	0.008
	Strept. Spp	1 (6.67%)	6 (40%)	0.031
	Pseudomonas A.	3 (20%)	2 (13.33%)	>0.05
	Candida	1 (6.67%)	1 (6.67%)	>0.05
	Negative culture	1 (6.67%)	4 (26.67%)	>0.05
AOR destruction	Pseudo-aneurysm	1 (6.67%)	1 (6.67%)	>0.05
	Fistula (to RA)	1 (6.67%)	0 (0%)	>0.05
	AV dehiscence	6 (40%)	1 (6.67%)	0.04
Operative Abscess location	Annulus	4 (26.67%)	3 (20%)	>0.05
	LVOT	6 (40%)	9 (60%)	>0.05
	Fibrous trigone	4 (26.67%)	1 (6.67%)	>0.05
	Mitral Annulus	1 (6.67%)	2 (13.33%)	>0.05
Surgical Procedures	AVR	15 (100%)	15 (100%)	>0.05
	Direct suturing	0 (0%)	2 (13.33%)	>0.05
	Patch Reconstruction	15 (100%)	13 (86.67%)	>0.05
	Annular Reconstruction	14 (93.33%)	3 (20%)	0.01
	Bentall procedure	2 (13.33%)	1 (6.67%)	>0.05
	Concomitant MVR	2 (13.33%)	1 (6.67%)	>0.05
Operation time (min)	260±100	210±80	0.033	
ACC time (min)	177.4±20.2	151.4±17.5	0.021	
CPB time (min)	210.4±105.3	191.1±21.2	0.016	

Post-operative parameters

Complications: The most prevalent early sequela was low cardiac output syndrome (LCOS), and inotropic support was used in 63.33%, 10% died due to intractable LCOS. Two patients (6.67%) were re-operated for post-operative bleeding, and one of them died of surgically

uncontrolled bleeding. Post-operative sepsis in the form of leukocytosis and persistent fever affected four patients (13.33%), and one of them died of severe sepsis and multi-organ failure. Pneumonia affected two patients (6.67%) with no mortality. The acute post-operative renal failure affected one patient (3.33%), and renal dialysis was mandatory to save his life. Transient atrioventricular block occurred in four patients (13.33%) postoperatively, however, a permanent pacemaker was implanted in only one.

Mechanical ventilation time: Overall mean mechanical ventilation time was 42.2 ± 30.2 hours, and prolonged mechanical ventilation (>24 hrs.) was recorded in 13 patients (43.33%) with no statistically proven effect on mortality. Mechanical ventilation time among PVE patients (22.3 ± 15.4 hrs.) was longer than that in NVE (18.4 ± 14.1 hrs.), with no statistically significant difference (p>0.05).

Intensive care unit stay: Overall ICU stay time was 8.3 ± 6.2 days, and prolonged ICU stay (> 72 hrs.) was observed in 14 patients (46.67%); six of them died, denoting a statistically significant effect on mortality (p=0.018). The mean ICU stay was statistically (p=0.038) longer in PVE patients (5.9 ± 4.1 days) compared to that in NVE patients (4.8 ± 3.5 days), (Table 3).

Table 3: Postoperative outcomes

Variables		Total Patients (n=30)	Deceased patients (n=7)	P-value
Mechanical Ventilation time	> 12 hours	13 (43.33%)	5 (71.43%)	>0.05
	< 12 hours	17 (56.66%)	2 (28.57%)	
ICU stay	> 72 hours	14 (46.67%)	6 (85.71%)	0.018
	< 72 hours	16 (53.33%)	1 (14.29%)	

Recurrence of infection: AVE reoccurred in five patients (16.67%) postoperatively within 1-4 months. All of them were readmitted and received antibiotic therapy regarding culture and sensitivity. One patient died shortly after admission due to septicemia. One patient was re-operated for valve dehiscence but died soon after the operation due to intractable LCOS. No statistical evidence connects the prevalence of mortality among patients with recurrence and no connection between the type of the infected valve prior to intervention to recurrence. Culture and sensitivity were positive for *Pseudomonas Aeruginosa* in three patients, *Staph spp.* In one patient and

negative in one patient with statistically prevalent organism implication for recurrence.

Follow-up echocardiography

The LVEF significantly dropped after surgery from 50.2% to 40.8% ($p < 0.05$). But the LVED size has increased dramatically from 6.65 ± 1.45 mm to 52.6 ± 8.2 mm ($p < 0.05$). After a mean duration of 6.7 ± 2.4 months, follow-up echocardiography showed progressive regain of LV function and normal dimension. Three patients among the 23 survivors (13.04%) showed progressive mitral regurgitation with a mean MR gradient of 2.1 ± 1.2 (mild to moderate). One of these patients is scheduled for MVR.

DISCUSSION

There is still a high mortality rate linked with surgery, despite improvements in pre- and post-operative care. Mortality rates vary widely from 5% to 32%.⁽¹³⁻¹⁶⁾ In our study, the overall early mortality was 16.67%. Similar to our findings, **David et al.**⁽¹⁷⁾ reported an early mortality rate of 15.5%, only 11% were observed by **Nakatani et al.**⁽¹³⁾, whereas **Adademir et al.**⁽¹⁸⁾ documented 15.5%. The total mortality rate was 38%, as reported by **Nagvi et al.**⁽¹⁹⁾, 7% of patients died during the procedure, and 31% of patients died preoperative. Early mortality was observed by **Leontyev et al.**⁽²⁰⁾ to be 25%, while total in-hospital mortality was reported by **Mahia et al.**⁽²¹⁾ to be 29%. Patients in these studies waited longer than expected before surgery, lending support to the idea that, if a peri-annular extension is identified, immediate action is necessary to avoid further tissue destruction and the spread of infection.

Regarding late mortality, our study showed that 6.67% of the patients died following the recurrence of infection. One patient died shortly after admission due to septicemia. One patient was re-operated for valve dehiscence but died soon after the operation due to intractable LCOS. Similarly, **Yankah et al.**⁽²²⁾ and **Adademir et al.**⁽¹⁸⁾ reported comparable rates (7.3% and 8% respectively). On the other hand, some studies reported higher late mortality rates than those reported by **David et al.**⁽¹⁷⁾ (25%), **Nakatani et al.**⁽¹³⁾ (23%), and **Kirali et al.**⁽²³⁾ (23.8%). The presence of a greater proportion of patients with staphylococcal infection or other more virulent organisms associated with increased mortality and recurrence rate is a remarkable frequent finding across studies with high late mortality rates^(24,25). The lack of late mortality from cardiac causes was reported by **Lee et al.**⁽²⁶⁾. Variation in mortality rates has been linked to factors such as PVE prevalence, microorganism type, patient health at the time of surgery, delay in intervention, and the presence of concomitant lesions.

We did not find any significant difference between deceased patients and all patients regarding age and gender, which is supported by many studies^(18,19,23,26). However, **Pang and Sin**⁽²⁷⁾ defined increasing age as a risk factor for extensive paravalvular extension mortality, and lower survival rates. These results are consistent with those reported by other studies⁽²⁸⁻³⁰⁾. **Siniawski et al.**⁽³¹⁾ reported that the female gender is an independent factor of in-hospital mortality. **Rouzé et al.**⁽³²⁾ identified the male gender as a risk factor for increased long-term deaths. Other studies reported a higher incidence of mortality among PVE patients but with no statistically significant difference. **Wallace et al.**⁽³³⁾ reported 13.8% early mortality in the PVE group versus 6.9% of mortality in the NVE group.

The size and the location of the abscess were not associated with the mortality rate in our study, which was also observed by several studies^(16,23,26). Large vegetations (>10 mm) with recurrent systemic emboli were found to be a statistically significant risk factor for mortality, matching with results reported by many studies^(33,34). On the other hand, **Gotsman et al.**⁽³⁵⁾ and **Spiliopoulos et al.**⁽³⁶⁾ denied any significant association between vegetation size and in-hospital mortality in complicated cases of active IE.

The functional class was significantly associated with hospital mortality, all of the mortality cases in our study presented with F.C. III or IV. **Knosalla et al.**⁽³⁷⁾ reported NYHA functional class greater than F.C II and cardiogenic shock necessitating high doses of inotropes as the most important predictor of post-operative mortality. In addition, **Zhijie et al.**⁽³⁸⁾ reported that 7/9 mortality cases belonged to NYHA FC III-IV.

Regarding microbiology, Staphylococcal species dominated culture and sensitivity results among our patients is matching with studies accusing *Staph Aureus* as the commonest organism involved in the paravalvular extension of infection^(24, 34, 41). Among our patients, the type of organism had no statistically significant effect on mortality, which was also reported in other studies^(23, 42). However, **LaPar et al.**⁽⁴³⁾ reported that the involvement of staphylococcal species carries a higher risk of mortality and worse outcome.

As indicated in our findings, 13 patients with PVE (86.66%) required annular reconstruction compared to 4 patients (26.67%) with NVE, matching earlier studies^(23, 42). This is because a surgeon must often sacrifice the whole aortic annulus and 3–5 mm of surrounding tissue to ensure effective infection eradication, after which an ARR is the surgeon's only alternative. Similar to our findings, several studies demonstrated that operation, CPB, and aortic cross-clamp times were considerably longer in the PVE group but did not influence the total in-hospital mortality^(19, 23, 32).

Our findings, that the mean ICU stay for patients with PVE was statistically longer than that for patients with NVE ($p=0.038$). This is consistent with what reported by **Leontyev *et al.*** ⁽⁴²⁾ who concluded that patients who underwent ARR had a longer ICU stay than those who underwent AVR with patch reconstruction, though this difference did not reach statistical significance ($p=0.40$). Extended time in the intensive care unit was associated with an increased risk of death ($p=0.018$). Our findings are consistent with other studies ^(20,42,45). The only way to ensure complete and permanent recurrence-free is by completely removing all affected tissues. However, heart block was a predictable consequence because it was so close to the heart's electrical conduction system ^(27, 46, 47).

The recurrence rate in our study was 16.67%, which is comparable to several investigations ^(19, 27, 42). However, **Lee and his team** ⁽²⁶⁾ showed no recurrence of infection. The recurrence remains substantial in culture-negative individuals despite rigorous antibiotic therapy. Possible explanations include the fact that *P. aeruginosa* endocarditis is characterized by easy relapse and is significantly connected with prosthetic devices and the observation that culture and sensitivity findings were positive for *P. aeruginosa* in three individuals with recurrence ⁽⁴⁴⁾. Our study's survivors showed a considerable decline in LVEF on echocardiographic follow-up evaluation. However, the LVED dimension was significantly better than in previous investigations ^(17, 18, 42).

CONCLUSION

Our results suggest that early outcomes could be improved through proper diagnosis, earlier referral to surgery, radical excision of infected tissue, at least a 4-week course of intravenous antibiotics according to the culture and sensitivity, or broad-spectrum empirical agents in culture-negative cases.

Conflict of Interest: None

Funding source: None

Acknowledgment: None.

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