

Surgical Treatment of Isolated Right-Sided Infective Endocarditis

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We reviewed our department's experience with the perioperative features and surgical treatment of isolated right-sided infective endocarditis. From January 2000 through July 2010, 35 patients underwent surgery for isolated right-sided infective endocarditis in our department. The mean pathologic course was 3.6 months. Preoperative transthoracic echocardiography had revealed intracardiac vegetations in all 35 patients: the tricuspid valve was involved in 28, and preoperative cultures were positive in 31. The median follow-up time was 5.8 years, and the follow-up rate was 85.3%. All the operations were performed with the patients on cardiopulmonary bypass, with or without cardiac arrest. All concomitant congenital heart defects were repaired, and vegetations and foreign materials were removed as part of intensive débridement of the infected area. After vegetation removal, 4 tricuspid valve replacements with tissue valves and 24 tricuspid valve reconstructions were performed.

One patient who underwent tricuspid valve replacement died of uncontrollable infection and multiple-organ failure. Two patients required mechanical ventilation for more than 1 week, and 3 needed dialysis for acute renal failure. Of the excised vegetations, 31.4% were positive for microorganisms. Of the patients who underwent tricuspid valvuloplasty, 23 had no valvular incompetence and 11 had mild or moderate regurgitation before discharge from the hospital. During follow-up, no patient needed reoperation because of reinfection, and 1 underwent reoperation for severe tricuspid regurgitation. We conclude that surgery can yield satisfactory immediate and midterm results in the treatment of isolated right-sided infective endocarditis. (*Tex Heart Inst J* 2011;38(6):639-42)

Key words: Cardiac surgical procedures; endocarditis, bacterial/etiology/pathology/prevention & control/therapy; heart valve diseases/surgery; prosthesis-related infections/microbiology/pathology/surgery; risk factors; treatment outcome; tricuspid valve/surgery

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Since endocarditis was first described, both the spectrum of causative organisms and the patients easily affected have changed.¹ New groups are at risk of endocarditis, such as elderly populations with degenerative valvular disease, patients with prosthetic materials in the heart, patients on hemodialysis, and abusers of intravenous drugs.^{2,3} Right-sided infective endocarditis (IE) constitutes 5% to 10% of all cases of endocarditis.⁴

From January 2000 through July 2010, 412 patients with endocarditis had been operated on in our department; of these, 35 patients (8.5%) had isolated right-sided IE. Herein, we report our experience with the surgical treatment of right-sided IE.

Patients and Methods

Upon review of the clinical data, the characteristics of the 22 male and 13 female patients conformed with the Duke criteria for IE. The patients' ages ranged from 10 to 72 years (mean age, 38.2 yr). All were admitted because of persistent fever, intractable right-sided heart failure, uncontrollable sepsis, or large vegetations. Table I shows the preoperative characteristics of the patients.

From the appearance of clinical symptoms to the diagnosis of right-sided IE, the duration of the disease process ranged from 1 month to 4 years (mean, 3.6 mo). The predisposing factors for endocarditis were congenital heart defects (in 19 patients), pacemaker infection (in 6), drug abuse (4), right-sided heart catheterization (3), surgical procedures for congenital heart disease (2), and dialysis (1). Preoperatively, 20 patients were in New York Heart Association (NYHA) functional class II, 13 were in class III, and 2 were in class IV.

Active IE was diagnosed when echocardiograms revealed vegetations or abscess formation and blood cultures were positive.⁴ In accordance with this definition, 31 of

the patients (88.6%) had active IE. Of these, 6 had an implanted pacemaker, 9 had recurrent pulmonary embolism, 2 developed infection after atrial septal defect repair or tricuspid valvuloplasty, and 2 had intractable right-sided heart failure.

Preoperative chest radiographs showed pulmonary infections in 28 patients, and computed tomography revealed pulmonary embolism in 11. Preoperative trans-thoracic echocardiography (TTE) revealed vegetations in all 35 patients (Table II). The vegetation diameter in 11 patients exceeded 20 mm, and in 5 patients it exceeded 30 mm. Four patients had severe tricuspid regurgitation, 21 had mild-to-moderate regurgitation, and the others had trivial or no regurgitation.

TABLE I. Clinical Characteristics of the 35 Patients

Characteristic	Value
Male sex	22 (62.9)
Female sex	13 (37.1)
Age, yr	38.2 ± 6.1
Pathologic course, mo	3.6 ± 1.2
Predisposing Factor	
Congenital heart defect	19 (54.2)
Ventricular septal defect	9
Atrial septal defect	5
Trilogy of Fallot	1
Patent ductus arteriosus	2
Sinus of Valsalva aneurysm	2
Pacemaker	6 (17.1)
Drug abuse	4 (11.4)
Catheterization	3 (8.6)
Surgical procedure	2 (5.7)
Dialysis	1 (2.9)

Data are presented as mean ± SD or as number and percentage.

TABLE II. Infections in the 35 Patients

Infection	No. (%)
Vegetation Location	
Tricuspid leaflet	28 (80.0)
Right ventricle	12 (34.3)
Right atrium	8 (22.9)
Pulmonary leaflet	2 (5.7)
Microbiologic Epidemiology	
Staphylococci	19 (54.3)
Coagulase-negative staphylococci	13
<i>S. epidermidis</i>	5
<i>S. lentus</i>	1
<i>Streptococcus viridans</i>	10 (28.6)
<i>Enterococcus</i>	1 (2.9)
<i>Kocuria kristinae</i>	1 (2.9)
Culture-negative	4 (11.4)

Laboratory examination showed that the erythrocyte sedimentation rate was elevated to some extent in every patient, as was the C-reactive protein level in 24 patients; 26 patients had mild-to-moderate anemia. Upon routine preoperative microorganism cultivation, 31 cultures (88.6%) showed a positive result (Table II). Staphylococci predominated and were the causative microorganisms in 19 patients; however, no patient presented with methicillin-resistant *Staphylococcus aureus* (MRSA). Streptococci were reported in 10 patients, followed by *Enterococcus* and *Kocuria kristinae*. Four patients had negative cultures preoperatively.

Operations Performed

Each patient underwent median sternotomy, and cardiopulmonary bypass was instituted with aortic and bicaval cannulation. Twenty-one operations were performed on the beating heart, and the others were with the use of cold crystalloid cardioplegic solution with or without blood. Every concomitant congenital heart defect was repaired. The pacemaker probes and vegetations were removed completely, with intensive débridement of the infected area. Of the patients with tricuspid valve endocarditis, 4 were given a new tissue valve, and the other 24 underwent reconstruction directly or with autologous pericardium, to avoid the use of artificial materials after vegetation removal. To ensure leaflet coaptation, annuloplasty was performed in some patients (Table III). In the 2 patients with pulmonary valve endocarditis, a pericardial patch was used to reconstruct the valve after vegetation removal.

After surgery, massive doses of broad-spectrum antibiotics were administered for 4 to 6 weeks, in accordance with the pharmacologic sensitivity of each patient's infection. Cases of hypoproteinemia and anemia were treated promptly. Dialysis was performed when there was evidence of acute renal dysfunction.

Each patient underwent follow-up examination 6 months after surgery, and echocardiography was performed to evaluate cardiac function and establish NYHA status. Follow-up examinations were then performed once yearly.

TABLE III. Techniques Used for Tricuspid Valve Reconstruction

Technique	No. Procedures
Leaflet-plasty	24
Leaflet-plasty with pericardium	11
Annuloplasty	21
Commissuroplasty	3
De Vega annuloplasty	17
Other	1

Results

Only 11 samples of excised vegetation were positive for microorganisms (31.4%). One patient whose blood culture was negative preoperatively was diagnosed by microscopy to have *Aspergillus* infection. Despite aggressive antifungal treatment, this patient died of uncontrollable infection and multiple-organ failure 12 days after tricuspid valve replacement. In all instances, histopathologic results confirmed the diagnosis of IE.

The in-hospital mortality rate was 2.86%. Sequelae included 1 case of reoperation for bleeding, 2 cases of ventilation assistance for more than 1 week because of respiratory insufficiency, and 3 cases of dialysis due to acute renal failure. The mean length of stay in the intensive care unit was 4.6 days. In 4 patients who had to rely upon pacemakers, temporary units were used during the early postoperative period, and permanent pacemakers were implanted 2 or 3 weeks later.

Before hospital discharge, 23 patients had no tricuspid incompetence on TTE. Of 11 who had undergone tricuspid valvuloplasty, 8 had mild regurgitation and 3 had moderate regurgitation. One patient with severe valvular regurgitation underwent successful tricuspid valve replacement with a tissue valve 7 years after the first operation. Of 27 patients who were reexamined with use of TTE, 19 had trivial or no tricuspid regurgitation, 5 had a mild degree, 2 had a moderate degree, and 1 had severe regurgitation. The follow-up period was 5 months to 10 years (mean, 5.8 yr); 5 patients were lost to follow-up (follow-up rate, 85.3%). One patient died of small-cell lung cancer 5 years postoperatively. None required reoperation because of reinfection.

Discussion

Isolated right-sided IE is often found in patients with intracardiac lesions and in those with artificial materials that have been inserted in the right side of the heart.⁵ In Western populations, it is predominantly a disease of intravenous-drug abusers,⁶ and *S. aureus* is the chief pathogen.⁷ Of note, although *Staphylococcus* was the main pathogen in our study population, no MRSA was found. Vegetations are common in patients with right-sided IE because of the lower pressure of those heart chambers, which may be the source of septic pulmonary embolism.⁸ Patients who have preoperative pulmonary complications are vulnerable to respiratory dysfunction, which extends their stays in the intensive care unit.

Many patients with right-sided IE benefit from conservative therapy with antibiotics; however, approximately 20% require surgery.⁹ If surgery is necessary, the goal is to eradicate the infection and achieve hemodynamic correction.² The operative indications for right-sided IE are 1) uncontrolled septicemia, or fever that

persists longer than 3 weeks despite antibiotic therapy⁴; 2) intractable right-sided heart failure despite appropriate medical therapy; 3) perivalvular abscess formation; 4) right-sided fungal IE; 5) the repeated occurrence of pulmonary embolism; 6) concomitant left-sided IE; and 7) vegetation diameters that exceed 20 mm.¹⁰ The prognosis is better before cardiac function deteriorates and when the outcome will not be affected by the duration and intensity of preoperative antibiotic therapy.¹¹ Accordingly, for patients with right-sided IE—even those in the active phase—earlier surgery is advised in order to achieve satisfying mid- and long-term results.⁴

Regarding patients with concomitant congenital heart disease, the timing of surgery is a matter of controversy. Some authors advocate performing surgery only when the infection is fully controlled.¹² The reasoning is that if surgery is performed during the active infectious phase, especially if artificial materials need to be inserted to repair malformations, the recurrence of infection is more likely. Niwa and colleagues¹³ reported an operative mortality rate of 8.8% during the active phase in patients with IE and congenital heart disease. In our study, 16 patients had IE and congenital heart disease, and 12 were in the active phase. Among those 12, one developed patch infection after the initial repair of an atrial septal defect. All recovered uneventfully, and no reinfection or repair failure was detected upon follow-up examination.

Pacemaker probes can also induce right-sided IE. The therapeutic principle is the removal of all infected implanted materials.¹⁴ Artificial materials that have been implanted within the preceding 12 months may be removed directly; however, those implanted for longer than 1 year should be removed surgically because of the tight adhesions between the probe and the ventricular muscles, especially when the diameter of the vegetation exceeds 20 mm.¹⁵ In one study, it was found that right-sided IE related to implanted probes could be controlled satisfactorily by surgically removing the probes with the use of cardiopulmonary bypass and subsequent antibiotic therapy; however, the mortality rate was still as high as 12.5%.¹⁶ In our group, 6 patients underwent surgical removal of an infected probe and vegetation, without recurrence or death.

The tricuspid valve is usually involved in right-sided IE because of the vegetation. Although different techniques of valve reconstruction can be chosen according to the degree of damage, the following basic principles should be followed⁴: 1) Aggressive and extensive débridement is required to prevent further access of the infection to the circulation, and if the infection is confined to the valve, the vegetation can be removed. 2) Defects that have developed, such as fistulae and perforations, should be repaired with homologous or autologous pericardial patches. 3) Whenever valve repair is attempted, the use of artificial material should be avoided. 4) If

valve replacement is unavoidable because of extensive endocarditic destruction of the valve, a biological prosthesis is preferred, and as little foreign material as possible should be used in the infected area (although whether a mechanical or a tissue valve should be used in patients with active IE is still a matter of debate¹⁷). By following these principles, we achieved satisfactory immediate and midterm results.

Complex reconstructive techniques can yield satisfying long-term outcomes, and tricuspid valve replacement with a tissue prosthesis can benefit patients in whom more than 2 leaflets are damaged.^{18,19} When anuloplasty is performed, it should be reinforced with pericardium to ensure leaflet coaptation. Conversely, if the pulmonary valve is involved, repair can be handled by simple removal of the damaged leaflet and repair with a pericardial patch.⁴

Conclusion

The surgical treatment of active right-sided IE can yield good early and midterm results through thorough débridement of vegetations, minimizing the presence of foreign materials in the infected area, and implementing aggressive antibiotic therapy postoperatively. Treatment and therapy should be tailored to the needs of each patient.

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