Right-sided infective endocarditis: surgical management

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Summary

Right-sided infective endocarditis (RSIE) accounts for 5–10% of all cases of infective endocarditis and is predominantly encountered among injecting drug users (IDUs). RSIE diagnosis requires a high index of suspicion as respiratory symptoms predominate. Prognosis of isolated RSIE is favourable, and most cases (70–80%) resolve following antibiotic administration. Surgical intervention is indicated in patients with persistent infection that does not respond to antibiotic therapy, recurrent pulmonary emboli, intractable heart failure and if the size of a vegetation increases or persists at >1 cm. Techniques can be divided into ‘prosthetic’ (valve replacement or prosthetic annular implantation) or ‘non-prosthetic’ ones (Kay’s or De Vega’s annuloplasty, bicuspidalization or valvectomy). In IDUs who run a high risk of complications, vegetectomy and valve repair, avoiding artificial material should be considered as the first line of surgical management as is associated with better late survival.

Keywords: Right-sided infective endocarditis • Pacemaker endocarditis • Implantable cardioverter-defibrillator endocarditis • Tricuspid valve replacement • Tricuspid valvulectomy • Tricuspid valve repair

INTRODUCTION

Right-sided infective endocarditis (RSIE) accounts for only 5–10% of cases of infective endocarditis (IE) [1, 2], the majority of which involves the tricuspid valve and occurs especially among injecting drug users (IDUs) and where intravenous lines and wires (e.g. pacemakers) are used [3, 4]. The reasons for the low incidence of RSIE in comparison to that of left-sided infective endocarditis (LSIE) could be attributed to: (a) low incidence of congenital heart disease on the right side of the heart. In a previous retrospective study of 28 patients suffering from congenital heart defects, Alexiou et al. [5] reported only 16 patients presenting with endocarditis; among whom, only six exhibited tricuspid valve disease. Of note, relapse rates requiring reoperation also remained low, since freedom from recurrent infection at 10 and 20 years was 100 and 87.5%, respectively [5]; (b) lack of strain to the tricuspid and pulmonary valves due to low haemodynamic pressure and (c) low oxygen saturation [1, 6].

The diagnostic and therapeutic management of RSIE in the context of drug abuse poses a significant challenge, particularly when combined with human immunodeficiency virus (HIV) or hepatitis C virus infection. Even though RSIE prognosis is more favourable than LSIE, ~5–16% of cases will eventually require surgical intervention [7–9]. Indications of surgery remain not well defined in RSIE population, whereas intra- and postoperative procedures are challenging, due to poor postoperative compliance and high relapse rate especially among IDU.

EPIDEMIOLOGY, MICROBIOLOGY AND PATHOGENESIS

RSIE accounts for 5–10% of all cases of IE [1, 2, 6] mostly involving the tricuspid valve, while isolated pulmonary valve involvement is rare [10]. Isolated cases of RSIE involving the eustachian valve, interventricular septum or right ventricular free wall have also been reported [1, 11].

IDU is the leading predisposing factor and accounts for the increasing incidence in developed countries, while in underdeveloped world, septic abortion and intra-abdominal sepsis remain important predisposing factors [1, 12, 13]. Up to 86% of IE among IDUs is right-sided, involving the tricuspid valve in the vast majority (90%) of cases with RSIE [11]. RSIE in non-IDU accounts for only 9% of all cases of IE, where intravascular catheters, pacemaker wires and intracardiac devices (catheters for haemodialysis or tricuspid prosthetic valve) are the commonest predisposing factors [4, 8, 13–15]. Nonetheless, even among kidney patients who carry an increased risk of endocarditis due to intracardiac haemodialysis catheters entering the right atrium or distal arteriovenous (A-V) shunts, tricuspid valve endocarditis...
occurs in only 20% of cases. According to Society of Thoracic Surgery data, between January 1994 and December 2003, including a total of 1862 valvular procedures in dialysis patients with endocarditis, isolated tricuspid valve was recorded in 55 cases (3%) [16, 17].

Staphylococcus aureus is the major microbiological cause of RSIE in both IDUs and non-addicts [2, 14]. Other causes of RSIE include coagulase-negative staphylococci and streptococci [14]. Lactobacillus spp., HACEK organisms (Haemophilus aphrophilus, Actinobacillus actinomycetemcomitans, Cardiobacterium hominis, Eikenella corrodens and Kingella kingae), Enterococci spp. cases and fungi have also been reported as infrequent causes of RSIE [1, 2, 11, 18]. Fungi are responsible for relatively few (~3%) of all cases of IE, but only rarely (7%) located to the right side of the heart [19]. IDU as a risk factor for fungal IE is only described in a minority (4–13%) of cases, caused by Candida spp. or in a few cases by Aspergillus spp., occasionally seen in the presence of HIV [20].

Although the microbiologic profile of RSIE matches LSIE, its pathogenesis remains unclear. Direct inoculation of the pathogen into the veins can be responsible for the increased prevalence of RSIE among IDUs; nevertheless, the pathophysiology in RSIE seems to be complicated by unique endothelial characteristics and immunologic responses found in IDUs, as well as specific characteristics of the microorganisms and the injected substances [2].

**CLINICAL MANIFESTATIONS AND DIAGNOSIS**

History, clinical examination and high-suspicion index remain the cornerstones of diagnosis, while advanced diagnostic modalities enhance our understanding of the natural history of RSIE.

Respiratory symptoms accompanied by fever, anaemia and microscopic haematuria predominate [21]. Although typical Duke criteria do not distinguish between LSIE and RSIE, diagnosis can be dramatically delayed, since right-sided murmurs often go undetected, while peripheral stigmata are absent. In contrast to left-sided endocarditis, pulmonary embolism occurs in 75–100% especially in the cases of tricuspid valve IE [6].

RSIE should be distinguished from other febrile illnesses accompanied by pulmonary symptoms including pulmonary embolism/infarction, chemical-induced pneumonitis (e.g. following aspiration), hypersensitivity pneumonitis, pulmonary tumour and interstitial or lobar pneumonia of any cause [6, 22].

As in LSIE, a positive blood culture, in combination with the clinical and echocardiography findings, establishes the diagnosis. Nevertheless, fastidious pathogens or prior administration of antibiotics can result in negative blood cultures, in IDU or HIV-positive patients [23]. Electrocardiogram and routine blood tests are non-specific; however, chest X-ray can reveal findings of pulmonary embolism due to septic emboli from the right heart [11]. However, chest computed tomography demonstrates multiple infiltrates with cavities in both lung fields, which suggests the presence of multiple pulmonary embolisms and lung abscesses [6, 8].

Contrary to LSIE, transthoracic echocardiography (TTE) may be sufficient for diagnosis since transoesophageal echocardiography (TOE) has been reported by some not to improve diagnostic accuracy of TTE in the detection of vegetations associated with RSIE in IDUs [24] (Fig. 1). However, TOE may prove more sensitive in detecting vegetations on pulmonary valves, central intravenous catheters and devices (e.g. defibrillators), prosthetic valve endocarditis, foreign bodies, unusual locations of RSIE and complications (e.g. perivalvular abscesses) after failure to respond to therapy [24]. The diagnosis of endocarditis of pacemaker or ICD endocarditis is based on the finding of lead and/or valvar vegetations through the TEE and has been identified in 18–23% of the cases [3, 8, 25].

Finally, the ventilation/perfusion scan of the lungs may be useful in detecting the septic pulmonary emboli in some cases [8]. Table 1 briefly summarizes the main differences between RSIE and LSIE.

**MEDICAL MANAGEMENT**

Initiation of antimicrobial therapy for suspected RSIE is targeted at the most likely causative organisms and should be initiated immediately after adequate blood cultures have been obtained. Empirical therapy should consist of a combination of an antistaphylococcal agent with activity against methicillin-resistant S. aureus (MRSA) such as the combination of vancomycin and gentamicin, or dapтомycin alone. Once culture and sensitivity results of an identified microorganism are known, antibiotic therapy can be appropriately modified, lasting up to 6 weeks [18]. Medical management of RSIE extends beyond the scope of this article and will not be further discussed.

**SURGICAL MANAGEMENT**

Indications

RSIE is conservatively resolved in 70–85% of cases, and the remaining being surgically managed [26, 27]. According to
Sohail et al. [8], only 9 out of 34 patients (16%) with infected permanent pacemakers or implantable cardioverter defibrillators underwent surgical lead extraction by median sternotomy. Due to lack of official guidelines regarding indications of surgical management and small number of operated cases, current recommendations vary. According to most studies, indications can be summarized as follows [3, 4, 6, 8, 9, 15, 22, 26–28] (Fig. 2): (a) patients with persistent infection who do not respond to antibiotic therapy beyond 2 weeks, except for specific pathogens that aggressive treatment should be considered early in the course of the disease (e.g. S. aureus, Gram-negative fungi); (b) patients with recurrent septic pulmonary emboli, confirmed by computed tomography pulmonary angiogram; (c) patients with massive or worsening tricuspid regurgitation (>2+/4+) contributing to deteriorating right (and subsequently impending left) ventricular heart failure; (d) patients in septic shock and documented RSIE (indication for emergency operation); (e) when the size of a vegetation increases or persists in spite of antibiotic management at >1 cm; (f) new-onset acute or worsening renal and/or hepatic failure; (g) patients with RSIE who develop a secondary (right- or left-sided) valve endocarditis (multivalvular involvement); and (h) following failure or complications of percutaneous removal of device components in nearly all patients, even when lead vegetation diameters are >10 mm [8] (Fig. 3).

Timing of surgical management depends on the following factors: (a) cause of endocarditis (urgent in pacemaker, ICD endocarditis or prosthetic tricuspid endocarditis), (b) the causative infective factors (fungal, pseudomonas, MRSA, etc.), (c) coexistence with LSIE, (e) response to antibiotic treatment, (f) toxicity of antibiotics (renal and/or hepatic failure) and (g) complications of disease (abscess, increased vegetation’s size, etc.) (Fig. 3) [3, 8, 25, 29, 30].

Early surgery should be considered early if S. aureus is suspected. S. aureus infections are often complicated infections with large vegetations, aggressive valve destruction and embolic manifestations resulting in an increased risk of mortality [31]. In a relatively recent meta-analysis, medical therapy of staphylococcal endocarditis was associated with higher mortality (39 of 76; 51%) than combined medical/surgical therapy (24 of 77; 31%) [32]. Especially, if multi-resistant S. aureus is detected, surgery is the only conclusive therapy and is always indicated [33]. A fungal cause often marks a complex case of IE whose diagnosis is delayed due to recurring negative blood cultures. Once IE is established, medical therapy with antifungals is frequently unsatisfactory, resulting in the need for a surgery in a large percentage of patients. Of note, overall survival with medical therapy alone barely reaches 25%, whereas a combination of medical/surgical management can be up to 58% [34]. Several other microorganisms such as Brucella, Q fever and Pseudomonas aeruginosa indicate surgical intervention, especially due to the comorbidities they are related to, but are rare in presentation [35–37].

In the absence of LSIE coexistence, early surgery should be considered in the presence of life-threatening complications such as development of severe congestive heart failure, abscess formation or massive pulmonary emboli which reduce gas exchange. Large tricuspid valve vegetations (>2 cm), especially in the context of mycotic endocarditis, are related to valve insufficiency and pulmonary embolization that predict a poor outcome [10, 21, 38].

Persistent sepsis despite antibiotic treatment demands surgical intervention [39]. However, a persistent fever together with pulmonary symptoms may continue for weeks despite appropriate antibiotic management, but does ultimately respond [10, 40].

**General principles of surgical management**

The main principles of surgical management include [41–51]: (a) radical debridement of vegetations and infected tissue, (b)
avoidance of implantation of prosthetic material after debridement, especially in IDU, and (c) elimination of valve regurgitation.

Hence, surgical techniques can be divided into those that utilize prosthetic material for repair or replacement and those that use native or autologous material.

In IDUs who run a high risk of complications, e.g. heart block, prosthetic thrombosis due to low compliance with anticoagulant therapy and reinfection related to resumption of drug abuse [41, 42], vegetectomy and valve repair avoiding artificial material should be considered the first line of surgical management [7]. If this is not technically feasible, then tricuspid valve replacement should be performed [43].

‘Non-prosthetic’ surgical techniques

Non-prosthetic techniques on the background of tricuspid endocarditis mainly involve two surgical procedures: (a) complete removal of existing vegetations (vegetectomy) and (b) complete removal of valve leaflets and chordate lendinae (valvulectomy). They both bear the advantage of not using prosthetic material. If, following excision, there remains significant degree of valve regurgitation (>2+/4+), vegetectomy should be complemented by valve repair [6]. Even though, contrary to valvectomy, relapse rates are higher following vegetectomy, both methods are preferable in IDU in whom compliance is poor [27, 43].

However, in the case of extensive damage in more than one leaflet of the valve, repair is not possible and complete excision of the valve (valvulectomy) should be considered [52]. This technique was first described 30 years ago by Arbulu et al. [52, 53] with good results. According to their study, actuarial survival among 53 IDUs 22 years following valvulectomy reached 64%. The subsequent severe tricuspid regurgitation is well tolerated by patients, especially if pulmonary artery pressure is normal [52]. However, in about one-third to one-fourth of the cases, it may lead to ascites, peripheral oedema and low-cardiac output syndrome due to right ventricular dilatation/dysfunction, requiring valve implantation in 6–9-month time [1, 6, 27, 43, 54, 55]. In some of these patients, right ventricular dysfunction may develop even earlier, due to pulmonary hypertension secondary to multiple pulmonary emboli [45]. Hence, tricuspid valve excision without replacement is contraindicated, in patients with left-sided endocarditis and high left atrial pressure [45]. Nonetheless, in contrast to above data, only 6 out of 49 (12.25%) patients following tricuspid valvulectomy required prosthetic valve implantation in due time [56].

In our opinion, tricuspid valve excision for RSIE should be considered in the following cases of RSIE: (a) in IDU, (b) if a normal (not elevated) pulmonary pressure is reported, (c) if the degree of destruction of the valve is high and (d) if a reoperation after a previous repair is required (recurrence of infection). After eradication of the infection, a second-stage operation with tricuspid valve replacement can be performed months or even years later (e.g. after rehabilitation) [52, 57, 58].

Following aggressive debridement of the infected valve tissue, repair will be implemented using autologous pericardial patch [41, 42] (Fig. 4A), artificial chordae [6, 44] and simple annuloplasty by using sutures and not prosthetic annulus (Kay’s or De Vega annuloplasty) (see below). Small defects localized to one leaflet can be repaired by direct closure by autologous pericardial patch, with or without annuloplasty [27, 45]. In addition, patch
repair is also performed when one major or two minor leaflets are widely excised and provide excellent restoration of valve competence [27]. Bicuspidalization annuloplasty is another option of ‘non-prosthetic repair’ after complete resection of the posterior (but not of the anterior or the septal) leaflet (Fig. 4B). In these cases, a De Vega annuloplasty is necessary to downsize the annulus [27, 45]. The combined technique using artificial chordae and autologous pericardial patch for partial replacement of a leaflet may satisfactorily restore valve competence without signs of progressive regurgitation in the next years [6, 59]. Valve repair after excision of one-half to three-fourths of the anterior tricuspid leaflet can be more complex than reconstruction after excision of redundant leaflet tissue in mitral valve repair [41]. Moderate tricuspid insufficiency (<2+/4+) after tricuspid repair is well tolerated, and valvular competence generally improves over time, with the resolution of right ventricular volume overload and ventricular remodelling [41]. Even complete excision of the posterior leaflet, or resection of almost the entire anterior leaflet, can be accomplished, while maintaining good valvular function [45]. In some patients, use of a rigid annular ring can achieve better valve competence [45]. Filsoufi et al. [46], in their study of 51 patients undergoing tricuspid valve repair for functional tricuspid regurgitation due to annular dilatation, report of no patient with more than mild tricuspid regurgitation after using prosthetic remodelling ring.

There are several valve repair techniques:

Kay’s annuloplasty is performed after almost complete excision of a leaflet (except that of septal, where the risk of postoperative atrio-ventricular block is high). It consists of the placement of a few sutures in the corresponding segment of the annulus [47]. The procedure not only significantly reduces the orifice area, but also transforms the tricuspid valve into a bicuspid one. However, if pulmonary hypertension exists, progressive dilatation of the anterior segment of the annulus may follow [46].

De Vega annuloplasty consists of the placement of two semicircular purse string sutures, from the anteroseptal commissure to the posteroseptal commissure, to achieve an annular narrowing and resulting coaptation of the remaining two leaflets [48]. This technique produces a semicircular deformation of the tricuspid orifice and causes relative inward folding of the leaflets, impairing their motion. Further dilatation of the tricuspid orifice due to migration of the suture is common [60]. De Vega annuloplasty achieves leaflet coaptation while avoiding excessive tension on the repaired valve; thus, it is a useful adjunct to tricuspid valve repair. In the case of dilatation of the tricuspid

![Diagram of Proposed Choices of Surgical Management of RSIE](image-url)
annulus, it does not affect the different segments of the tricuspid annulus equally. The diameter of the anterior segment of the annulus can increase up to 40%, whereas its posterior segment can dilate up to 80% of its initial diameter. The dilatation of the septal segment is limited (maximum 10%) because of its close anatomical relationship with the fibrous skeleton of the heart.

Both techniques represent ‘non-prosthetic’ techniques and therefore should be the first-choice attempts for valve repair, especially in the IDU.

‘Prosthetic’ surgical techniques

These techniques should be performed in the case of resulting significant regurgitation after debridement and/or attempting repair and are essential in the case of coexistent pulmonary hypertension.

The most common prosthetic surgical technique is Carpentier’s remodelling annuloplasty [61]. Prosthetic rings of a suitable size are selected, based on the distance between the anteroseptal and the posteroseptal commissures as well as the surface area of the anterior leaflet (Fig. 4C). The remodelling annuloplasty restores the normal shape of the annulus, thereby allows both a normal orifice area and normal valve function. The goal of the reconstructive valve surgery is to reserve leaflet mobility and to create a large surface. Several clinical studies have demonstrated the superiority of the remodelling annuloplasty over suture-based techniques in terms of avoiding tricuspid regurgitation and reoperation [60, 62, 63]. Despite these excellent results, it has been suggested that this mismatch in configuration between the prosthetic ring and the tricuspid annulus has been at the origin of incidental reports of ring dehiscence [63].

Tricuspid replacement is another, but rare, surgical option in RSIE. Using the above-mentioned repair techniques, few cases of tricuspid endocarditis will eventually require valve replacement, due to good toleration of moderate valve regurgitation (<2+/4+) by the right ventricle. In a long series of cardiac valve replacement due to endocarditis, only 4% involved tricuspid valve [64]. Valve replacement requires absence of drug addiction during the time of surgery and certainty of non-relapse [65].

Initial replacement of the tricuspid valve has some drawbacks including: higher surgical mortality, risk of infection of the prosthesis and risk of A-V complete block (~25%) [66, 67]. However, the development of bileaflet valves and low-profile porcine valves has greatly improved the prognosis of patients after tricuspid valve replacement [52]. Transvalvular gradients are low when prostheses >31 mm are implanted; the incidence of prosthetic thrombosis is equally low even if mechanical valves are used; and calcific degeneration of the tricuspid bioprosthesis develops more slowly than it does in the mitral position [54]. Nevertheless, valve replacement with either a mechanical or a biological prosthesis does theoretically expose the patients to valve-related complications and to some risk of recurrent endocarditis especially in IDU [55]. Surprisingly though, the incidence of spontaneous recurrence of prosthetic endocarditis is very low in valves in the tricuspid position [41]. This finding can perhaps be explained by the propensity of the infection to involve the free margin of the valve more often than the annular region (due to its pure muscular and not fibro-muscular nature as on the left heart side, as well as the decreased haemodynamic pressure) [45]. In addition, local factors, such as differences in the blood supply to the annular area and the surrounding myocardium, may account for the different manifestations of endocarditis among the mitral, aortic and tricuspid valves [45].

Figure 4: (A) Repair using autologous pericardium. After radical debridement of the infected region of the AL of the valve, a piece of autologous pericardium is sutured in the ‘gap’. (B) Bicuspidalization of the repaired valve. In the case of profound destruction of one leaflet, and after its aggressive debridement, the remaining tissue is insufficient to restore the competence of the valve. Thus, the corresponding annulus of PL is obliterated by a few sutures, reinforced by pieces of autologous pericardium or pledges. Competence of the valve is re-obtained by cooptation (during systole) of the remaining AL and SL. (C) Restoration of valve’s competence using prosthetic annular ring. After extensive (>75%) debridement of the AL, the observed significant regurgitation of the valve may be eliminated by implantation of a prosthetic (or even pericardial) annular ring. PL: posterior leaflet; AL: anterior leaflet; SL: septal leaflet.
Homograft tissue valve is another choice following valvectomy. Indeed, tricuspid valve replacement by a cryopreserved mitral homograft is the latest introduction into clinical practice. It provides atrioventricular competence, thereby avoiding late right heart failure [68]. However, drawbacks include low availability and more difficult implantation.

Finally, implantation of a stentless aortic porcine valve—in an upside-down orientation—in the tricuspid position has been reported to be an effective alternative [69].

Postoperative outcomes

The reported surgical mortality rate for patients with infective endocarditis has improved from 30% in the 1970s to 7.4–9.9% in the 2000s [70]. Nonetheless, assessment of surgical outcomes following tricuspid valve endocarditis remains challenging due to (a) the small amount of cases, (b) heterogeneity in patient population (coexistence with LSIE, comorbidity) as well as (c) surgical technique applied.

Surgical treatment of RSIE, with or without involvement of the left heart, can be performed with good early, mid-term and long-term results [7, 57]. The 20-year survival rate after RSIE operation was 58%, falling to 36% for patients with left as well as the 2000s [70]. Nonetheless, assessment of surgical outcomes following tricuspid valve endocarditis remains challenging due to (a) the small amount of cases, (b) heterogeneity in patient population (coexistence with LSIE, comorbidity) as well as (c) surgical technique applied.

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Comparison of valve repair and replacement remains challenging. Undoubtedly, valve repair is recommended in mild cases, when compared with mass valve destruction and regurgitation, when replacement is more appropriate. In a recent study of 22 patients with tricuspid endocarditis, Gottardi et al. support that surgical mortality as well as complication rates (relapse, reoperation) are higher in the replacement group. According to these authors, valve replacement should be saved only in cases that repair is considered inappropriate [27, 72]. This comes in line with respective comparative results between repair and replacement of mitral valve [73], even though arguable by others [74]. In a recent review of literature including 24 studies of 470 and 724 patients with mitral valve endocarditis undergoing repair and replacement, respectively, Feringa et al. [73] showed: (a) significantly lower surgical mortality (2.3 versus 14.4%), (b) significantly lower long-term mortality (7.8 versus 40.5%), (c) the rates of early reoperation (2.2 versus 12.7%), early cerebrovascular events (4.7 versus 11.5%), late reoperation (4.7 versus 8.7%), late recurrent endocarditis (1.8 versus 7.3%) and late cerebrovascular events (1.6 versus 24.4%) were significantly lower after mitral valve repair. In a relative study involving the tricuspid valve, Guenther et al. [75] compared long-term results of replacement (106 patients) and repair (310 patients) in a total of 416 patients with tricuspid valve pathology. Their study showed that (a) surgical mortality was <50% in the repair versus the replacement group (13.9 versus 33%, respectively), (b) replacement represents an independent risk factor for operative mortality, (c) 10-year actuarial survival was significantly higher in the repair group (47 ± 3.5 versus 37.4.8%) and (d) the incidence of reoperation is low with no significant differences when the tricuspid valve has been repaired or replaced. Following these results, these authors recommend the use of a biological prosthesis following tricuspid valve replacement [75]. Singh et al. [76] compared midterm results following repair (178 patients) or replacement (78 patients) of tricuspid valve due to organic disease. Tricuspid valve repair is associated with better perioperative, midterm and event-free survival than tricuspid valve replacement in patients with organic tricuspid disease. Despite more tricuspid regurgitation in the repair group during follow-up, reoperation rates and functional class were similar [76]. These results disagree with a recent meta-analysis performed by Moraca et al. [77] comparing a matched cohort of patients undergoing repair versus replacement using propensity score analysis (68 patients in each group). In this study, no significant difference in surgical mortality and 10-year survival favouring tricuspid valve repair over replacement was observed. As a result, the authors of this study did not hesitate to recommend tricuspid valve replacement for patients in whom there is a reasonable chance for recurrence of regurgitation after repair [77].

Even though no significant difference in early survival was observed after reconstruction compared with replacement of the tricuspid valve, a tendency towards better late survival (at and after 7–10 years) following tricuspid valve reconstruction was noted [7]. This is mainly attributed to the inevitable degeneration of the biological valve that is implanted in the position of the tricuspid valve, despite low haemodynamic pressures applied to the right ventricle. According to a comparative study of Ohata et al. [78] in 37 patients undergoing simultaneous replacement of mitral and tricuspid valve with biologic valve, the actuarial freedom from structural valve deterioration and reoperation in the mitral and tricuspid positions were 78 ± 22 and 100 and 70 ± 30 and 90 ± 10% (P = 0.03), respectively. No patient had systemic or pulmonary thromboembolism, or complications associated with fatal arrhythmia. In conclusion, the bioprostheses in the tricuspid position yield significantly better long-term results than those in the mitral position after simultaneous mitral valve replacement and tricuspid valve supraannular implantation [78]. However, despite the long durability of bioprosthetic valve in the tricuspid position, in approximately one-third of the cases following 5 years of operation, a gradual gradient due to pannus formation on the ventricular side of the pericardial cusps seems to be developed [79].

According to Shemin [58], the choice of type of prosthetic valve is dependent on several factors, including age, anticoagulation parameters, sex (woman in child-bearing age), coexistence with another prosthetic valve, history of thromboembolic complications, existence of chronic atrial fibrillation. If a mechanical valve prosthesis should be chosen, a bileaflet with homoxial flow (e.g. St Jude M, or ON-X) could be the valve of first choice. However, comparative results derived from various studies demonstrate no significant differences concerning the operative mortality, survival rate as well as rate of freedom from reoperation [80–82]. Finally, in a recent meta-analysis, Rizzoli et al. [83] showed that there is no survival benefit between a bioprosthetic or a mechanical valve in the tricuspid position.

RSIE endocarditis rates following lead infection of pacemakers or ICDs are currently increasing, whereas its outcomes depend on respective management (Algorithms I and II). The management of pacemaker and ICD endocarditis is both medical and
surgical, mainly based on the extraction of the device (see Algorithm I). The reported mortality rates for ICD endocarditis without device extraction ranges from 31 to 66%, compared with 18% in patients in whom the hardware is extracted, followed by prolonged antibiotic therapy [3, 8, 30]. According to Margery et al. [25], in their study with 39 patients suffering from endocarditis, complete device extraction was undertaken in 82%. Of these patients, none had a subsequent relapse, and their mortality rate was 7.4%. In contrast, patients managed with partial removal or conservative therapy, relapse occurred in 67% with mortality occurring in 8.4% of them. In pacemaker-dependent patients, a temporary transvenous pacing wire may be implanted to allow at least 7 days until another permanent system is implanted (see Algorithm II). Of note, in about 88–90% of patients undergoing device extraction, percutaneous removal is performed, while only in 10–12% of cases, a median sternotomy and use of extracorporeal circulation is required [3, 8, 25].

Postoperative antibiotic administration

The duration of postoperative antibiotic administration is unresolved. Currently, there is no systematic evaluation of outcomes after surgery for IE (or RSIE) with respect to duration of antibiotic treatment. Four to six weeks of the preoperatively selected antibiotic, irrespective of aetiologic factors, has been suggested [32]. Nevertheless, shorter duration of postoperative treatment does not necessarily lead to a higher incidence of relapse, if certain criteria are fulfilled (i.e. negative valve cultures, adequate compliance) making a 2-week scheme of postoperative treatment acceptable [84].

In the opinion of these authors, the maximum period of anti-biotic administration (4–6 weeks) should be considered in cases of: (a) presence of annular involvement, (b) implantation of prosthetic material (ring or non-homograft valve), (c) postoperative presence of significant regurgitation, (d) IDUs, (e) cases of suspected ‘non-radical’ debridement, (f) presence of preoperative extracardiac foci of septic emboli, (g) positive culture of extracted material and/or valve and (h) aetiology of staphylococci or fungi. In non-IDUs with none of the above criteria, 2 weeks of postoperative antibiotic therapy should be sufficient.

CONCLUSIONS

RSIE remains common among IDUs. Despite the relatively benign prognosis of RSIE that can be mostly conservatively managed, RSIE can also present a great challenge to the cardiac surgeon, due to poor postoperative compliance and high relapse rate. Hence, surgical management of RSIE prompts for a multispecialist approach including cardiologists, cardiac surgeons and infectious disease specialists so that the best possible outcome is achieved, in the context of drug abuse and related comorbidities.

Conflict of interest: none declared.

REFERENCES