SURGICAL MANAGEMENT OF INFECTIVE ENDOCARDITIS IN PATIENTS WITH NON-VALVULAR CONGENITAL HEART DISEASES

UDC 616.12–007.2–053.1+616.126–002–089
Received 19.12.2012

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The aim of the investigation was to develop the surgical management of infective endocarditis in patients with non-valvular congenital heart diseases.

Materials and Methods. 31 patients with non-valvular congenital heart diseases complicated by infective endocartitis were operated in Nizhny Novgorod Specialized Cardiological Clinical Hospital from 1993 till 2011. The patients' age varied from 4 months to 37 years. Among non-valvular defects there were vegetations of mural endocardium and endothelium of major arteries, infected erosions, thrombi; and most frequently they developed in patients with ventricular septal defect (19 patients), valvular and infundibular pulmonary artery stenosis (3 patients), coronaro-right-ventricular fistula (3 patients), Fallot's tetrad (2 patients), a patent arterial duct (2 patients). In two cases infection developed in patients with the previous plasty of septal defects and was accompanied by their recanalization.

Results. Four patients died in early postoperative period. The mortality rate was 12.9%. Three patients died of progressive acute heart failure, and one — of major postoperative bleeding. 19 patients managed to avoid heart valve replacement due to a timely surgery performed before gross destructive cardiac valve damage developed. In 12 patients one of cardiac valves was replaced due to a late operation and a highly active infectious process.

Conclusion. Early surgery enables to improve treatment results and save the cardiac valvular apparatus. Recanalization of septal defect against the background of the developed infective endocarditis is to be considered an indication for surgical sanitation of cardiac chambers and repeated plasty of congenital heart disease. Surgical approach to different types of congenital malformations against the background of infective endocarditis is patient-centered, though the general principle is the maximum correction of turbulent blood flows contributing to endocardial damage and persistent infection, with minimal use of synthetic materials and conduits.

Key words: infective endocarditis; congenital heart disease; heart defect correction; heart valve replacement; cardiac chamber sanitation.

The urgency of infective endocarditis (IE) problem in patients with congenital heart disease (CHD) is due to the improvement of diagnostic quality and medical care, the increase of diagnostic and treatment procedures, and the rise in primary and secondary immunodeficiency rate. CHD is one of the most significant IE risk factor [1]. In CHD patients the risk of endocarditis is 0.1–0.2% per patient a year and decreases up to 0.02% after the correction [2]. Endocarditis risk depends on the defect type, and the maximum risk is in patients with complex cyanotic CHD, it reaching 1.5% per year [3–5]. After definite repair of Fallot's tetrad there still remains an increased risk of endocarditis (0.9% per patient a year) due to relatively common residual ventricular septal defect (VSD) and right ventricular outflow tract obstruction [4–6]. The patients with surgically closed VSD have moderate risk. The increased risk of IE development remains within 6 months after non-valvular CHD correction [7, 8].

There are some peculiarities of IE pathogenesis in non-valvular CHD. Some authors indicate the regularity in vegetation development [7–9]. Turbulent blood flow is created when blood passes through the narrow opening (stenosis, or valvular insufficiency, septal defect, vascular prosthesis) resulting in endocardium trauma immediately after passing through the narrowed opening. Further, due to endocardium trauma vegetation develops. In small high VSD a thin blood stream damages the septal cusp of the tricuspidal valve (TV). If there is a patent arterial duct (PAD), endocardial surface of the pulmonary artery is injured. CHD with left-right shunt is characterized by the development

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of the right cardiac chamber IE [3, 10]. The features of the right chamber involvement include the involvement of the lungs due to pulmonary embolism, the intensity of septic manifestations, early development of multi-organ failure [10–13].

Thus, the presence of non-valvular congenital defect is an extremely unfavorable factor promoting the persisting endocardial infection. The result is that conservative treatment is followed by high mortality rate (60–80%). Unreasonable delay of the surgery has a negative effect on the outcome as well. The use of modern antibacterial agents fails to solve the problem successfully [14].

The aim of the investigation was to develop the surgical management of infective endocarditis in patients with non-valvular congenital heart diseases. The research tasks were: 1) to assess short- and long-term results of IE surgical correction in patients with non-valvular CHD; 2) to specify the indications for IE surgical correction in non-valvular CHD; 3) to choose optimal surgical correction modality of the most common non-valvular CHD in endocardial infections.

Materials and Methods. 31 patients with non-valvular CHD complicated by IE were operated in Specialized Cardiological Clinical Hospital (Nizhny Novgorod, Russia) from 1993 till 2011. The patients' age varied from 4 months to 37 years. The spectrum and frequency of the congenital abnormalities is given in Table 1.

A successful correction of non-valvular CHD complicated by IE requires complete preoperative diagnostics that enables to perform an accurate assessment of the severity of endocardial pathology and infectious process, and plan the extent of the surgery. In patients with non-valvular CHD, the disease frequently began with cardiac wall endocardium damage in the place of septal defect localization, pathological stenoses along the blood flow, followed by valve pathology. Due to this, we consider invasive surgical approach in these patients to have been reasonable, since it enabled to prevent the infective process spreading to cardiac valvular apparatus avoiding the development of thromboembolic complications and multi-organ failure.

We pursued the twofold aim when operating on the patients with CHD complicated by IE: the correction of intracardiac hemodynamics failure, and sanitation of surgical foci of infection in a patient's body.

The surgical management characteristics of IE in this group of patients relates to a variety of CHD anatomy, the types of infectious process spreading and possible damage of intracardiac structures. The character of damages was variable, for this reason the operative technique was nonstandard.

All operative interventions (Table 2) were median-approach procedures. We carried out cannulation of ascending aorta, and separately — vena cava. The left cardiac parts were drained through interatrial septum.

The required element of all operations for IE was mechanical and chemical sanitation of the cardiac chambers. Mechanical sanitation meant maximum vegetation removal by the resection of intracardiac structures affected by infectious process (valves, mural endocardium, infected thrombi and calcium conglomerates), and abscessectomy. Chemical sanitation included the treatment of cardiac chambers by antiseptic solutions. Intraoperatively we checked all valves with perspective evaluation of their function, as well as examined the cardiac chambers aiming to reveal and eliminate possible sites of infection.

Non-valvular defects included vegetations of mural

Table 1

The distribution of patients according to nosologies

Defect type	Number
VSD	13
VSD + atrial septal defect (ASD)	4
Fallot's tetrad	1
Partial atrioventricular canal	2
Aortic coarctation + VSD	1
PAD with pulmonary artery stenosis	1
Partial anomalous drainage of pulmonary veins to the right atrium with pulmonary artery stenosis	1
Coronary right ventricular fistula and bicuspid aortic valve	1
Coronary right ventricular fistula + VSD	1
Fallot's tetrad + ASD + PAD	1
Coronary right ventricular fistula + condition after definitive repair of Fallot's tetrad	1
ASD	1
Pulmonary artery stenosis	1
Condition after VSD plasty + aneurysm of ascending aorta	1
Condition after the correction of partial atrioventricular communication	1
Total	31

Table 2

Surgical procedures performed in patients with non-valvular congenital heart diseases complicated by infective endocarditis

Surgical procedures (n=31)	Number
Aortic valve replacement with sanitation of cardiac cavities:	6
with VSD plasty	4
with VSD suture and aortic root plasty	1
with Dittrich's stenosis resection, anterior tricuspid leaflet plasty, tricuspid valvuloplasty by the De Vega technique	1
Mitral valve replacement with cardiac cavities sanitation:	4
with primary ASD plasty	3
with VSD suture	1
Aortic valve replacement + mitral valve replacement with cardiac cavities sanitation:	2
with coronary right ventricular fistula suturing	1
with indirect isthmoplasty of aortic coarctation, VSD suturing	1
VSD plasty with sanitations of right cardiac chambers:	10
with ASD suturing	3
with tricuspid valve replacement	1
with tricuspid valvuloplasty by the De Vega technique	1
Radical surgery of Fallot's tetrad:	2
with infundibular pulmonary artery stenosis resection, the plasty of exit pathway of the right ventricle by Gore-Tex patch, PAD suturing, and ASD suturing	1
with tricuspidal valve replacement	1
VSD suturing with sanitation of the right cardiac chambers	1
Coronary right ventricular fistula suturing with tricuspid valve sanitation	1
Open pulmonary valvuloplasty + removal of vegetations from the main pulmonary artery + PAD ligation	1
ASD suturing + tricuspid valve replacement + cardiac cavities sanitation	1
Correction of partial anomalous drainage of pulmonary veins + pulmonary valvuloplasty + tricuspid valve sanitation	1
Coronary right ventricular fistula plasty with tricuspid valve sanitation	1
Resection of ascending aorta aneurysm with patchplasty, thrombus removal from the right atrium	1

endocardium and endothelium of great vessels (Fig. 1), infected erosions, thrombi. These defects were found most frequently in patients with ventricular septal defect (19 patients), valvular and infundibular stenosis (3 patients), coronary right-ventricular fistula (3 patients), Fallot's tetrad (2 patients), patent arterial duct (2 patients). In two cases the infection developed in patients with previous plasty of septal defects and accompanied by their recanalization. The most patients operated for non-valvular congenital heart diseases complicated by IE were school-aged children. It results in an increasing IE risk in non-operated children in the course of time.

The group of patients under discussion is the most complex among other IE patients, since each congenital defect requires individual surgical approach. We started the operation in VSD patients with cardiac chambers sanitation, then resected fibrous rim along the defect margin, which in most cases was affected by vegetations. And only after these procedures we performed VSD plasty by a patch or suturing (in restrictive type of a defect).

If a patient had pulmonary valve artery stenosis complicated by IE, the only reasonable correction technique

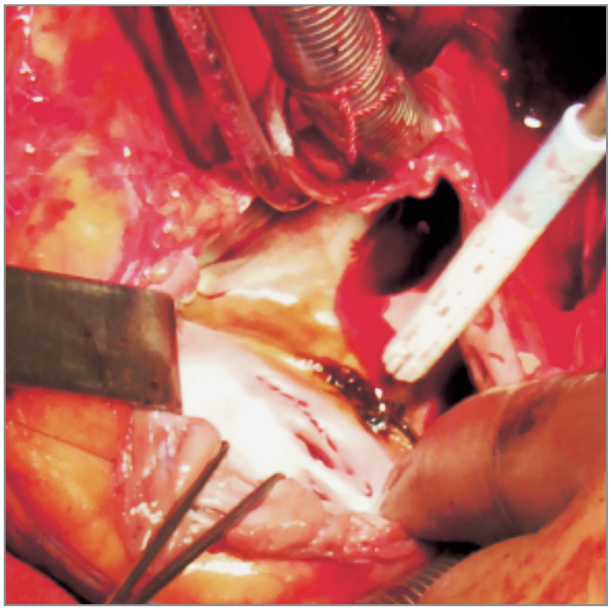

Fig. 1. Mechanical and chemical sanitation of the right atrium. The vegetations on the right atrial wall are seen

was considered to be open pulmonary valvuloplasty with the transaction of cups adhesion in commissure area under artificial circulation (AC) on a working heart, with sanitation of the valve and pulmonary artery walls. In case of infundibular stenosis we resected its fibrous and muscular components, with sanitation of the right ventricle and pulmonary artery under parallel perfusion conditions. If it was necessary, we performed the plasty of the exit pathway of the right ventricle by xenopericardial patch. The adequacy of defect correction was assessed according to age standarts using the measurement of exit pathway of the right ventricle.

Botallitis was treated under AC conditions, since a standard ligation of a duct was accompanied by an increased risk of its rupture and hemorrhage development. Moreover, a standard PAD ligation does not provide the infected area sanitation and results in recurrent infection. Median sternotomy was used as a surgical approach in botallitis treatment. CPB pump was used according to "aorta-vena cava" scheme. After cardioplegic solution administration and cardiac activity cessation, we incised a pulmonary artery longwise, found the duct entrance, removed vegetations from a pulmonary artery and performed chemical sanitation, followed by PAD entrance suture. This approach enabled to produce positive results.

Coronary right ventricular fistulas were corrected under AC and cardioplegia conditions using the right atrial approach. We used retrograde administration of cardioplegic solution through coronary sinus. After physical and chemical sanitation of the right ventricular cavity, in two patients we sutured fistula, and in three patients — performed patchplasty.

Surgical management of patients with Fallot's tertrad complicated by IE deserves special attention. The radical surgery under AC conditions is considered to be an optimal modality in this case, and we used it in two patients. However, it is not always possible to use radical surgery.

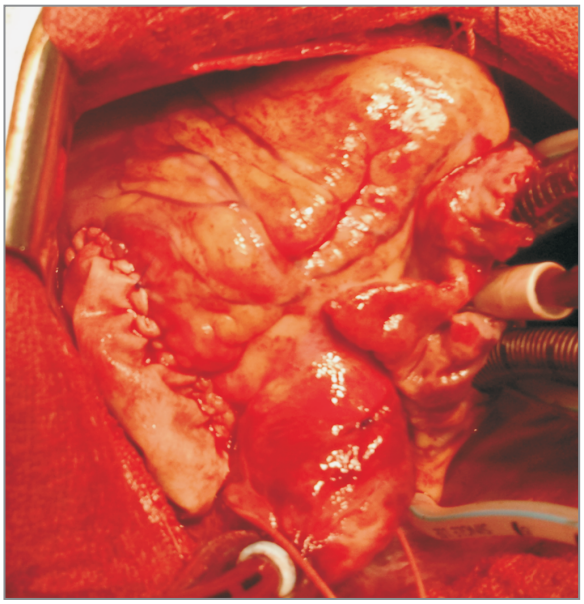

Fig. 2. Xenopericardial patch plasty of stenotic exit pathway of the right ventricle

The contradictions to one-stage treatment were pulmonary artery hypoplasia (aortopulmonary index <200 mm^2/m^2) and left ventricular hypoplasia (end-point diastolic volume <30 ml/m^2). If there are contradictions to radical surgery, the repair of the right ventricular drainage (Fig. 2) is considered to be the operation of choice, since it has a number of advantages over central and peripheral anastomoses, being the most hemodynamically physiological intervention. Firstly, it enables to carry out mechanical and chemical sanitation of the right ventricle and pulmonary artery. Secondly, this operation promotes the reduction of flow rate in the exit pathway of the right ventricle and pulmonary artery, as well as through ventricular septal defect reducing traumatic hemodynamic effect of turbulent blood flow on myocardium. Thirdly, no synthetic prostheses are used, since they produce turbulent blood flow and are risk factors of infection persistence.

The correction of ASD (6 patients) and partial anomalous drainage of pulmonary veins (1 patient) was performed according to standard techniques, and was completed by the sanitation of the right atrium and tricuspid valve. The partial anomalous drainage of pulmonary veins to superior vena cava was corrected by two-patch technique. In two cases the primary ASD plasty in patients with partial atrioventricular communication was combined with the replacement of infection damaged mitral valve.

Results and Discussion. 4 patients died in early postoperative period. The mortality was 12.9%. Three deaths were caused by progressive acute heart failure, one — by massive postoperative hemorrhage. In 19 patients we managed to avoid cardiac valve replacement due to timely performed surgery, and no destructive changes of valvular apparatus occurred. Due to late intervention and high activity of infectious process, 12 patients underwent the replacement of one of the valves, 6 patients — aortal valve replacement, 4 — mitral valve replacement, and the tricuspid valve was replaced by a tissue valve in 2 patients.

The infection recurred in a 20-year female patient with VSD 3 months after the operation. The complication was caused by *Acinetobacter*, an infectious agent, multi-resistant to antibacterial therapy. Three months later the patient underwent VSD re-plasty with its recanalization. However, in another three months there was a new episode of recurrent intracardial infection followed by consecutive VSD recanalization. The examination revealed splenelcosis. The patient was performed a single-stage replasty of the defect and splenectomy. There were no new recurrences.

We managed to assess long-term results in 22 patients (70.96%). 15 patients had good postoperative results, 5 patients — satisfactory, and 2 patients — poor. In one case a poor result was caused by infection-allergic myocarditis with chronic heart insufficiency 6 months after the discharge, and in another case — postoperative tricuspid insufficiency. The second patient underwent tricuspid valve replacement 6 years after the first operation. A year after the implantation of tissue valve the treatment result was assessed as good. And one female patient was reported to die of dysrhythmia a year after the operation.

Conclusion. We received good short- and long-term

results of surgical management of infective endocarditis (IE) that complicated the course of non-valvular congenital heart diseases. However, the lethality in this group of patients is higher than in other IE patients. We associate the findings with critical initial condition of patients due to a long latent course of the disease, marked intracardial hemodynamic abnormalities, the predominance of pathogenic agents resistant to therapy. Invasive surgical approach is the formula for successful treatment of IE in these patients. Early surgery enables to improve short- and long-term treatment results and save the cardiac valvular apparatus. Recanalization of septal defect against the background of the developed IE is to be considered an indication for surgical sanitation of cardiac chambers and repeated plasty of congenital heart disease. Surgical approach to different types of CHD against the background of IE is patient-centered, though the general principle is the maximum correction of turbulent blood flows contributing to endocardial damage and infection persistence, with minimal use of synthetic materials and conduits.

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