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HEMODYNAMIC PARAMETERS IN CHILDREN AFTER ENDOVASCULAR AND SURGICAL CORRECTION OF INTERATRIAL SEPTAL DEFECTS

SUMMARY

Comparison between endovascular and surgical correction of interatrial septal defects. In conclusion, degree of reduction systolic blood pressure in the right ventricle is same between children who underwent surgical correction of IASD and endovascular closure of interatrial septal defects. However, endovascular correction of interatrial septal defects is less traumatic surgery, is not accompanied with dysfunction of cardiac rhythm and conduction, and does not reduce the contractile function indicators of right ventricle.

Key words: interatrial septal defects, endovascular and surgical correction.

Secundum atrial septal defects (ASDs) account for 10 % of congenital heart disease in neonates at birth and as much as 30 % to 40 % in adults [1]. In the adults, the incidence of late complications (for example, rhythm disturbances) increases. Surgical repair of ASDs is a well-established procedure and is very safe, with a negligible mortality rate [2]. King and colleagues first described Tran's catheter occlusion of an ASD in 1976 [3].

Surgical correction is the standard of care for other types of ASD such as ostium primum and sinus venosus ASD with low mortality rate (<1 %). It has an intra- and postoperative complications that accompany not only the discomfort and cosmetic defect and postoperative complications such as "postpericardiotomy syndrome", supraventricular arrhythmias, intracardiac blocks. Air embolism is not a rare complication, especially in cardiothoracic surgeries where we use artificial blood circulation system. Long term postoperative complications are seen after surgical repair of ASD [4]. Right ventricular dilatation may appear even after 5 years of surgical repair. The risks still remain in terms of surgical treatment while using an artificial blood circulation device in patients with congenital heart disease therefore, nowadays transcatheter treatment of

CHD's is widely used. Transcatheter closure of secundum atrial septal defects with the closure device has the advantage of fewer complications, shorter hospitalization, and reduced need of blood products. Nonetheless, the surgeon's ability to close any atrial septal defect regardless of its size or location remains an important advantage of surgery. Only a few studies have compared transcatheter occlusion with surgical repair, and these have included both children and adults [4-6].

The aim of our study was to monitor the hemodynamic parameters in pediatric population after transcatheter and surgical treatment of atrial septal defect.

Material and methods: From 2010 through 2015, 81 consecutive children from 4 to ≤ 14 years of age with ASD, surgical correction was performed in patients who had ASDs that were unsuitable for transcatheter closure, at the Syzganov National scientific centre of surgery, Almaty, Kazakhstan. In all children, evaluation performed by standard transthoracic echocardiography (TTE). The ASDs were hemodynamically significant in all patients, with a pulmonary-to-systemic flow ratio (Qp/Qs ratio) 1,8±0,6. Mild pulmonary hypertension observed in all cases. At the same center from 2014 to 2016, 85 pediatric patients underwent transcatheter

closure by an occluder device. Generally, for percutaneous closure, an adequate rim of the ASD is necessary and all patients presented were of no less than five millimeters of free septal edge. Standard transesophageal echocardiography (TEE) or TTE were used to evaluate positioning of the occluding device and hemodynamic changes during the procedure, following day and 7 days after the procedure.

Results: In five cases, the next day after the procedure a small left to right shunt was seen, but a decrease in Qp/Qs ratio was observed from 1.6 to 1.2. A week later there was no shunt observed at all. In any of the cases no signs of valve dysfunction were observed despite the fact that in some cases the distal edge of occluder was approaching the atrioventricular valves. Only in one case with multiple defects despite the implantation of two occluders in the long-term follow-up showed small residual shunt from the edge.

The analysis shows that the surgical correction and endovascular/transcatheter closure of the defect are both equivalent highly effective method of correction of intracardiac hemodynamics in children with septal defects. The absence of surgical incision improves the effectiveness of the patient treatment both physically and morally. According to our study there is a reduction of right ventricular cavity and pulmonary artery pressure, a compensatory improvement in both systolic and diastolic function of the left ventricle is observed.

The advantage of endovascular correction in compare to the surgical treatment of ASD is moral satisfaction, absence of complications, non-traumatic and beneficial effect on the systolic function of the right ventricle.

In the early postoperative period after open-heart surgery in children different types of arrhythmias and conduction problems were found. In 3 cases during a week a wandering pacemaker, in one case AV dissociation was observed, which were recovered. In one case, sick sinus syndrome and in one case, supraventricular arrhythmia observed. Complete right bundle branch block was observed in 7 operated patients.

A significant increase in end-diastolic volume (EDV) of the left ventricle (LV) by 10.3 ml ($P < 0.01$). This increase in hemodynamic load is due to inter septal repair and partial shunt. Left ventricular systolic function was significantly increased: EF increased from $66,5 \pm 1,2$ % to $70,8 \pm$

$1,9$ % ($p < 0.001$). Arterio-venous shunt elimination contributed in normalizing the right ventricle function. Three months after surgery a statistic significant reduction observed in the cavity of the right ventricle and pulmonary artery diameter. As a result of the surgical correction of the defect the pumping function of the right ventricle was as same as the normal values. The systolic pressure of right ventricular in these patients before discharge from the hospital and for 3 months did not differ from the normal values and was about $25,5 \pm 0,8$ mmHg ($P < 0.001$). It is known that surgical stress resulting from operation, cardiopulmonary bypass has a negative influence on the functional capability of the myocardium of the right ventricle. One of the complications of heart surgery is a low cardiac output syndrome, according to various authors occurs in 35-50% of operated patients [4,5]. The main cause of myocardial damage during cardiac surgery with cardiopulmonary bypass is reperfusion. Because of surgical trauma, hypercatecholaminemia and electrolyte imbalance damages cardiomyocytes promoting deterioration of myocardial function and develop heart failure in the early postoperative period [6].

Thus, in the early postoperative period, the presence of myocardial insufficiency was typical for patients with mixed form of right ventricular myocardial hyperfunction due to the presence of shunt from left to right and moderate pulmonary hypertension. The basic reason of myocardial failure is diastolic dysfunction of the right ventricle, caused by a mismatch of relaxation speed during the intensive mode of heart function, because of which the Frank-Starling mechanism is not implemented.

According to our sources in the postoperative period there was an increase in total pulmonary resistance (TPR) to $540,6 \pm 65,8$ dynes-sec-cm⁻⁵. Perhaps this is due to a sharp drop in cardiac output of the right after surgery, which is consistent with data from other researchers [3].

In a one-year follow-up in these patients, a recovery of hemodynamics was observed. The heart rate decreased to $82,3 \pm 1,9$ beats per min. Systolic and diastolic blood pressure improved and did not differ from normal values ($104,3 \pm 1,9$ mmHg and $70,2 \pm 1,3$ P < 0.05). Hemodynamic values, a year after open-heart surgery in pediatric population with ASD did not change significantly and the average corresponded to those in the control group. In a follow-up the dimensions of

the right ventricle and the pulmonary artery diameter were reduced that seem to be associated with hemodynamic adjustment and improvement of myocardial contractility of the right ventricle. Compensatory improvement in the systolic function of the right ventricle normalized total pulmonary resistance, which was equal to $325,5 \pm 79,4$ dynes-sec-cm [6].

Similar moderate hemodynamic changes were observed in the group of children who underwent percutaneous closure of atrial septal defect. There were no rhythm and conduction disturbances recorded in any of the case after transcatheter closure of ASDs. Comparative analysis of the results showed that no changes were seen post-procedural major hemodynamic changes, left ventricular virtually unchanged. There was a tendency to increase the size and volume of the left ventricle cavity.

In patients with transcatheter closure, mild increase in systolic function of the left ventricle is probably due to initial moderate deviations in hemodynamics. Post occluder implantation with color Doppler revealed no shunts in any of the cases, in most of the cases the ratio of pulmonary and systemic circulation was normalized. In one month right ventricle systolic pressure decreased from $38,0 \pm 1,5$ mmHg to $25,5 \pm 1,3$ mmHg ($P < 0,05$), and up to $21,8 \pm 3,0$ a year after the intervention which did not differ from the normal values. A year after there was a moderate reduction in average pressure in the pulmonary artery, whereas TPR increased respectively to $21,8 \pm 3,0$ mmHg and $420,5 \pm 65,5$ dynes-sec-cm [6].

Discussion

Thus, in pediatric population children who underwent surgical and transcatheter treatment of atrial septal defect, there was an equal reduction of systolic blood pressure in the right ventricle in both procedures. However, transcatheter closure of ASD is less traumatic procedure, which do not develop arrhythmias, conduction problems and the systolic function of the right ventricle is also not impaired. Following the steps of occluder implantation, patient selection probably remains the key to achieving good results with both methods of treatment. The use of transesophageal echocardiography (TEE) with ASD in patients pre-hospital stage, can more accurately determine the size of the defect.

Transcatheter closure of ASDs has the advantage of fewer complications, shorter hospitalizations, reduced need for blood products, less discomfort for patients, and no incisional scar. It is our opinion that, in selected children, surgical closure of ASDs is no longer necessary. The volume of data from studies regarding percutaneous closure and their safety and efficacy have long surpassed the surgical data in these age-groups. Patients of all ages experience reduction in PA pressure, RV size and an improvement in functional capacity after percutaneous device closure of ASD, and these improvements appear to be greater if the defect is closed earlier. Given the low rate of complications and virtual lack of mortality, isolated ASDs should be considered for percutaneous device closure regardless of symptoms or patient age.

REFERENCES

- 1 Hoffman J.I., Christianson R. Congenital heart disease in a cohort of 19,502 births with long-term follow-up // *Am J Cardiol.* 1978; 42:641-7.
- 2 Rigby M.L. The era of transcatheter closure of atrial septal defects // *Heart.* – 1999; 81:227-8.
- 3 King T.D., Thompson S.L., Steiner C., Mills N.L. Secundum atrial septal defect. Nonoperative closure during cardiac catheterization // *JAMA.* – 1976; 235:2506-9.
- 4 Bukharin B.A., Burakovsky V.Y., Podzolkov V.P. et al. Congenital heart diseases // *Cardiac surgery.* – M.: Medicine, 1996. – 768 p.
- 5 Berger F., Vogel M., Alexi-Meskishvili V., Lange P.E. Comparison of results and complications of surgical and Amplatzer device closure of atrial septal defects // *J Thorac Cardiovasc Surg.* – 1999; 118:674-80.
- 6 Durongpisitkul K., Soongswang J., Laohaprasitiporn D., Nana A., Sriyoschati S., Ponvilawan S. et al. Comparison of atrial septal defect closure using amplatzer septal occluder with surgery // *Pediatr Cardiol.* – 2002; 23:36-40.

7 *Thompson J.D., Aburawi E.H., Watterson K.G., Van Doorn C., Gibbs J.L.* Surgical and transcatheter (Amplatzer) closure of atrial septal defects: a prospective comparison of results and cost // *Heart*. – 2002; 87:466-9.

8 *Abzaliev K.B., Batalova K.S., Berdibek A.B., Toybaeva A.K., Bolatbekuly J.B., Nalibayev A.Sh., Alibayov A.N.* Causes of mortality after cardiac surgery in children under one year // *Proceedings XIX International Conference "Health family – 21" Sochi - 2015 April 27 4 мая. Page 4-5.* Published on the website of the electronic scientific journal "Family-21 Health Century" and are available at the following link:<http://fh-21.perm.ru/materials.php>

АННОТАЦИЯ

Проведено сравнение эндоваскулярной и хирургической коррекции дефекта межпредсердной перегородки. Выявлено, что у детей, перенесших оперативную коррекцию ДМПП и эндоваскулярное закрытие дефекта, степень уменьшения систолического давления в правом желудочке одинакова. Эндоваскулярная коррекция ДМПП является менее травматичной операцией, не сопровождается развитием нарушений сердечного ритма и проводимости, не приводит к снижению показателей сократительной функции правого желудочка сердца.

Ключевые слова: дефект, межпредсердная перегородка, эндоваскулярная и хирургическая коррекция.

ТҮЙІН

Жүрекаралық далданың эндоваскулярлық пен хирургиялық түзетулері салыстырылды. Жүрекаралық далданың ақаулығы (ЖАДА) жедел түзету және сондай ақаулығын эндоваскулярлық жабу отасын жасатқан балалардың жүрегінің оң жақ қарыншасында систола қысымы азаю деңгейі бірдей екендігіне көз жеткізіп, қорытындыға келдік. Дегенмен, ЖАДА-ның эндоваскулярлық түзетуі барынша аз жарақатты ота болып танылады, жүрек ырғағының бұзылуы және өткізілуі дамымайды, сондай-ақ жүректің оң жақтағы қарыншасының қысқартылу функциясын төмендетуге соқтырмайды.

Түйінді сөздер: жүрекаралық далданың ақаулығы, эндоваскулярлық пен хирургиялық түзетулер.