UDC 616.131−089.843

**Estimation of the impact of an additional source of blood flow into the pulmonary artery in the early and late postoperative period after bidirectional cavopulmonary anastomosis**

Fylypchuk V.V., Truba Y.P., Golovenko O.S., Prokopovych L.M.,

Boyko S.M., Dziurii I.V., Lazorishinetz V.V.

*Amosov National Institute of Cardiovascular Surgery (Kyiv)*

The current work analyzes the results of the impact of an additional source of blood flow into the pulmonary artery to the outcome of the bidirectional cavopulmonary anastomosis, and the experience resulting from the improved pulmonary blood flow in patients after bidirectional cavopulmonary anastomosis (BCPA). During this work 66 patients were divided into two experimental groups: the first group consists of those patients with an additional source of pulmonary blood flow (ASPBF), the second group consists of patients without the ASPBF after BCPA. It was established that long-term results in the second group were better according to the following parameters: lower exudation frequency and lower pulmonary artery pressure, which resulted in a shorter period of hospital stay, better overall survival in the early and late postoperative periods, and better functional status of the cardiovascular system.

**Key words:** *single ventricle, bidirectional cavopulmonary anastomosis, additional source of pulmonary blood flow, total cavopulmonary anastomosis.*

Surgical treatment of patients with functional single ventricle of the heart (SVH) is an actual problem of children's heart surgery. The terms of BCPA application, and also the optimum interval between BCPA and performance of total cavopulmonary anastomosis (TCPA) are still undefined [1,2]. Besides, there is a disagreement concerning the conservation of an auxiliary source of pulmonary blood flow during the BCPA [3]. A part of cardiac clinics around the world adheres to the concept of a double source of pulmonary blood flow which allows better indicators of arterial blood oxygen saturation, but another part of clinics are opponents of ASPBF and consider that the additional source of blood supply of the pulmonary artery increases the load on the functional single ventricle of the heart (FSVH) [4, 5]. In this research a retrospective analysis of the influence of ASPBF on the results after BCPA was carried out.

**Objective.** Improve the results of treatment of patients with bidirectional Glenn anastomosis by a retrospective analysis of the influence of ASPBF on the results after BCPA.

**Materials and methods.** Since December of 2006 to May of 2016 in the Amosov National Institute of Cardiovascular Surgery of NAMS of Ukraine an optimization of the pulmonary blood flow was performed in 66 patients by application of the bidirectional cavopulmonary anastomosis. Considering the presence or the absence of an additional source of pulmonary blood flow two groups of patients were created. Aortopulmonary collaterals as an auxiliary source of pulmonary blood flow were excluded from our research.

The first group consisted of 32 patients (48,5%), they were left with an additional source of blood supply and the BCPA was applied on them. The age of patients at the time of operation varied from 11 to 185 months, the average – 37,5 ± 2,6 months. The weight of patients varied from 4,9 to 47 kg, the average – 16,4 ± 3,1 kg. In 29 of 32 patients (91,0%) previous operative manipulations were performed (tab. 1).

**Table 1**

**Distribution of patients after BCPA with an additional source of a blood flow by the type of previous operative manipulation**

|  |  |  |
| --- | --- | --- |
| **Type of operative manipulation** | **n** | **%** |
| Modified Blalock-Taussig anastomosis | 11 | 34,0 |
| Pulmonary artery banding | 8 | 25,0 |
| Balloon dilatation of the PA valve | 7 | 22,0 |
| CоАо removal  | 2 | 6,3 |
| Damus Kay Stаnsel operation  | 1 | 3,1 |

Note: PA – pulmonary artery, CoAo – aorta coarctation.

The second group consisted of 34 patients (51,5%), who had no auxiliary pulmonary blood flow after BCPA. The average age was 8,6 ± 4,3 months (from 4,2 to 46 months), the average weight was 7,9 ± 2,8 kg, (from 4,9 kg to 15,8 kg). In 32 patients (94,0%) previous operative manipulations were performed, which are presented in table 2.

**Table 2**

**Distribution of patients after BCPA without additional source of blood flow by the type of previous operative manipulation**

|  |  |  |
| --- | --- | --- |
| **Type of operative manipulation** | **n** | **%** |
| Modified Blalock-Taussig anastomosis | 10 | 31,0 |
| Pulmonary artery banding | 9 | 28,0 |
| Norwood I operation | 4 | 12,5 |
| Balloon dilatation of the PA valve | 4 | 12,5 |
| CоАо removal  | 2 | 6,2 |
| Repair of MV, TV | 2 | 6,2 |
| Implantation of CP  | 1 | 3,1 |

Note: MV – mitral valve, TV - tricuspid valve, CP – cardiac pacemaker

**Results and discussion.**

The early postoperative mortality in a cohort of 66 patients was 4,5% (n = 3): in the I group it was 6,2% (n = 2), in the II group it was 3% (n = 1).

Indicators of the arterial blood oxygen saturation in the I group with pulsing blood flow in the pulmonary artery were higher, the average was 89,3 ± 4,8%, on the contrary the II group's saturation was 86,5 ± 9,2%. The duration of mechanical ventilation in the I group varied from 6,5 h to 32 h, (on average 10 ± 2,5 h), and was significantly (p < 0,05) lesser in comparison with the II group (from 5,5 h to 28 h, on average 6 ± 2,6 h).

The I group of patients with pulsing blood flow in the pulmonary artery after BCPA had higher values of venous pressure (16,2 ± 6 mmHg), in comparison with the II group of patients without BCPA (13,7 ± 3,9 mmHg).

The duration of exudation in the I group was from 5 to 19 days (on average 11,3 ± 4,5 days) and was higher than in the II group, were it lasted from 5 to 15 days (on average 9,3 ± 5,4 days). The intensity of exudation during the first 4 days in the I group (the average was 1,7 ± 0,4 ml/kg/h during 4 days) varied from 1,4 to 2,6 ml/kg/h, in the II group was significantly (p < 0,05) lower and it varied from 1,2 ml/kg/h to 2,1 ml/kg/hour, (on average 1,5 ± 0,3 ml/kg/h). The protein level in the blood during 5 days ranged from 52 g/l to 77 g/l (on average 59 ± 12 g/l) in the I group, and ranged from 58 g/l to 79 g/l (on average 62 ± 14 g/l) in the II group.

 Assessment of the BCPA efficiency in the remote period was carried out in 61 examined patients, which constituted 92,4% of all operated patients: the term of observations diverged from 3 months to 9 years (on average 54 ± 14 months).

During the remote period in the first group the general mortality of 28 (87,5%) operated patients was 10,7% (n = 3); 3,6% (n = 1) of them died from thrombosis of the BCPA, 7,1% (n = 2) of them died from unknown reasons at place of residence at different periods of time after performance of the BCPA. The functional condition of patients from the first group was more severe during the last examination: 14,3% (n = 4) of patients corresponded to the I class of NYHA, 25,0% (n = 7) belonged to the II class, 28,6% (n = 8) to the III class, 17,8% (n = 5) to the IV class. In 10,7% (n = 3) of them cardiomegaly was documented.

During the remote period in the II group of 33 (97%) patients after BCPA without the pulsing blood flow in the PA the mortality was on 4,7% lesser and constituted 6%; 2,3% (n = 1) of patients died from thromboembolism of the PA, 3,0% (n = 1) died from severe heart failure (III stage). The functional condition of patients in the II group was less severe during the last examination: 36,4% (n = 12) of patients belonged to the I class of NYHA, 18,2% (n = 6) to the II class, 12,1% (n = 4) to the III class, and the cardiomegaly developed in 6% (n = 2) patients from the IV class.

**Conclusions.**

The analysis of the results of treatment of our patients showed that patients who were after performance of the BCPA without sources of an auxiliary pulmonary blood flow had lower duration and amount of exudation and lower pressure in PA, which predetermined smaller terms of their stay in clinic, better general survival in the early and remote postoperative periods, and better functional state. The pulsing blood flow in the pulmonary artery promotes better oxygen saturation of blood, but in the remote period worsens the diastolic function of the single ventricle of the heart that leads to cardiomegaly, and also negatively influences on the change of resistance in pulmonary vessels and thus leads to deterioration of survival in early and remote postoperative the periods. Thus, decreasing the term of staying in hospital and improving the results of operations will be possible by realization of several conditions. The first condition is the application of full overlapping of blood course from ventricle into the pulmonary artery, or creation of a minimum as possible outlet opening. The second condition has a technical character: it is the improvement of the technology of operation, of the artificial circulation, the anesthesia support and intensive care, and the elimination of complications at all stages of the hospital period. And the third (main) condition consists in the individual approach in the choice of tactics and technique of surgical treatment of patients.

**References:**

1. Alghamdi A. A. Bidirectional Glenn With Additional Pulmonary Blood Flow: Systematic Review and Evidence-Based Recommendations / A. A. Alghamdi // J. Card. Surg. − 2015. − Vol. 9, № 30. − P. 724–730.

2. Fenestration improves clinical outcome of the Fontan procedure: a prospective, randomized study // M. S. Lemler, W. A.Scott, S. R. Leonard [et al.] // Circulation. – 2002. − Vol. 2, № 105. − P. 207–212.

3. Effects of controlled antegrade pulmonary blood flow on cardiac function after bidirectional cavopulmonary anastomos // J. Caspi, T. W. Pettitt, T. W. Ferguson [et al.] // Ann. Thorac. Surg. − 2003. − Vol. 76. − P. 1917–1921.

4. Effect of accessory pulmonary blood flow on survival after the bidirectional Glenn procedure / R. D. Mainwaring, J. J. Lamberti, K. Uzark [et al.] // Circulation. − 1999. − Vol. 100, № 9. − P. 51–56.

5. Appropriate additional pulmonary blood flow at the bidirectional Glenn procedure is useful for completion of total cavopulmonary connection // M. Yoshida. M. Yamaguchi, N. Yoshimura [et al.] // Ann. Thorac. Surg. − 2005. − Vol. 3, № 80. − P. 976–981.