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Outcomes after aortic arch reconstruction for infants: deep hypothermic circulatory arrest versus moderate hypothermia with selective antegrade cerebral perfusion

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Abstract

OBJECTIVES: Optimal cerebral and visceral protection is crucial in aortic arch surgery. The main method for this protection has traditionally been deep hypothermic circulatory arrest (DHCA). Recently, antegrade cerebral perfusion with moderate hypothermia has become the preferred strategy for adult patients and some children undergoing aortic arch surgery. Continuous cerebral perfusion should reduce the incidence of neurological complications, but the degree of damage to organs and systems resulting from the lack of blood flow distal to the aortic arch remains unclear. Here, we aimed to evaluate the efficacy and safety of methods of protecting the brain and internal organs during aortic arch surgery in infants.

METHODS: We performed a retrospective review of 62 patients who underwent aortic arch reconstruction to assess their neurological status and internal injuries after different methods of cerebral protection.

RESULTS: Surgical correction of aortic arch congenital abnormalities was performed under DHCA in 27 patients (Group I), and unilateral selective antegrade cerebral perfusion (SACP) was performed in 35 patients (Group II). In Group I, 30.8% of patients had neurological complications, whereas in Group II 5.9% had neurological complications. The odds ratio for a neurological event was significantly lower in Group II compared with Group I—0.14 [(95% CI 0.02–0.63), $P = 0.02$]. However, incidence of renal dysfunction was significantly higher in the second group than the first: 21 (61.2%) vs 5 (19.2%) cases, respectively [odds ratio 6.49 (95% CI 1.41–38.26), $P = 0.02$].

CONCLUSIONS: Aortic arch reconstruction accompanied by SACP has a lower risk of neurological complications compared with DHCA. However, the high incidence of renal complications with SACP requires further study.

Keywords: Aortic arch surgery • Infants • Deep hypothermic circulatory arrest • Antegrade cerebral perfusion • Renal dysfunction

INTRODUCTION

Surgery on the aortic arch is challenging because of the need to ensure a bloodless surgical field and adequate cerebral protection. The optimal strategy for cerebral protection could be crucial. The main method for cerebral protection has traditionally been deep hypothermic circulatory arrest (DHCA) to reduce metabolic demands and oxygen consumption and thus increase tolerance to hypoxia [1, 2]. DHCA, although indeed sufficient to reduce cerebral metabolism [2, 3], is associated with adverse systemic effects such as coagulopathy, respiratory and renal failure, and an increased inflammatory response [4, 5]. In 1996, Asou *et al*. proposed a method of antegrade cerebral perfusion for aortic arch surgery in neonates [6]. Cerebral perfusion allows residual cerebral metabolism, so antegrade cerebral perfusion with moderate hypothermia has become the preferred strategy for adult aortic arch surgery patients and has also been utilized in some clinics for children [7, 8]. The many different methods of continuous cerebral perfusion have reduced the incidence of neurological complications [9, 10], but the degree of organ and system damage resulting from the lack of blood flow distal to the aortic arch remains unclear. A systemic inflammatory response after ischaemia–reperfusion injuries may cause kidney, liver and intestinal dysfunction, causing serious problems postoperatively, including mortality [11]. Additional research on methods to protect visceral organs during arch surgery is needed. The optimal temperature for DHCA during arch surgery in children remains unclear. A general consensus on a variety of other clinical variables, such as how temperature is monitored, the cannulation site, perfusion flow, speed of cooling and rewarming, pharmaceuticals to be utilized and more, has not been reached.

The purpose of this study was to evaluate the efficacy and safety of methods to protect the brain and internal organs during aortic arch surgery in infants and newborns in our clinic.

PATIENTS AND METHODS

Design

Institutional ethics committee approval was obtained for the study. The retrospective study included 62 patients (44 boys and 18 girls) aged 55 ± 14 (mean ± standard deviation) days (from 1 to 98 days), who required aortic arch reconstruction under cardiopulmonary bypass at the Center of Pediatric Cardiac Surgery in the Novosibirsk Research Institute of Circulation Pathology, Novosibirsk, Russia, between January 2004 and January 2014. Patients with hypoplastic left heart syndrome were excluded from the study. All patients underwent surgical correction of aortic arch congenital abnormalities under cardiopulmonary bypass and DHCA (Group I, 27 patients) or unilateral selective antegrade cerebral perfusion (SACP) with moderate hypothermia (Group II, 35 patients). The method for brain protection was selected by the surgeon.

All patients had a standard preoperative examination and underwent computed tomography to assess the aortic arch segment sizes and to plan interventions. Neurological status was assessed postoperatively. A neurological event was defined as any new, temporary or permanent focal or global neurological dysfunction after surgery. A seizure was defined as paroxysmal, stereotypic, repetitive motor behaviours (tonic, clonic or myoclonic). In a paralyzed and intubated child whose movements would be impossible to observe, a seizure was defined as a sudden and paroxysmal increase in blood pressure, heart rate or pupil size, unexplained by medication changes, pain or haemodynamic modifications. Patients were classified as having postoperative clinical seizures if the intensivist or cardiologist witnessed the seizure. A computed tomography of the brain was performed in cases of suspected gross neurological complications (coma, palsy, prolonged awakening or recurrent seizures). The duration of SACP, DHCA, cardiopulmonary bypass and myocardial ischaemia were retrieved from operative records. The postoperative fluid balance, urine output, duration of mechanical ventilation and other outcomes were obtained from intensive care unit bedside charts. The degree of renal dysfunction was assessed by the risk, injury, failure, loss and end-stage renal disease (RIFLE) classification [12]. Inotropic agent scores were calculated for 48 h after the operation [13]. Discharged patients were followed up to 3 years.

Surgical technique

All patients underwent similar anaesthesia protocols using sevoflurane and fentanyl. Blood pressure monitoring was performed using the right radial and femoral arteries. Cerebral oxygen saturation was assessed using an INVOS 5100 (Somanetics, IL, USA) throughout the procedure. The Dideco Lilliput I (Sorin Group, Mirandola, Italy) was used for cardiopulmonary bypass. The extracorporeal circuit was primed using 200–220 ml of solution that included donor red blood cells (to maintain a haematocrit of at least 30%), fresh frozen plasma, 20% albumin, sodium bicarbonate, mannitol and heparin. Median sternotomy was used to access the heart and great vessels. For perfusion, we used three methods of cannulation: cannulation only of the ascending aorta (11 [17.5%] cases), an arterial cannula that was secured within a Gore-Tex tube graft (W.L. Gore & Assoc, Flagstaff, AZ, USA) sutured to the innominate artery (29 [46.8%] cases), or double cannulation where the first cannula was placed directly into the ascending aorta or through a tube graft to the innominate artery and a second cannula was carried out through the ductus arteriosus into the descending aorta for perfusion of the lower half of the body during cooling (22 [35.5%] cases). In all cases, bicaval venous cannulation was performed. Drainage of the left ventricle was adjusted through the right upper pulmonary vein if necessary. Cardiopulmonary bypass was performed with a flow of 150 ml/kg with at least 20 min of prior cooling to a rectal temperature of 18–27°C with a temperature gradient not exceeding 10°C. The blood gases were maintained in an alpha stat with a target pCO_2 of 40 mmHg. Following occlusion of the aorta in the aortic root for myocardial protection, Bretschneider's antegrade crystalloid cardioplegic solution (Custodiol HTK, Koehler Chemie, Germany) was administered at a dosage of 40 ml/kg.

DHCA was carried out when the rectal temperature reached 20° C. SACP with a flow of 30 ml/kg/min was performed through the Gore-Tex graft anastomosed with the innominate artery. The left common carotid artery, the left subclavian artery and the descending aorta were clamped after the start of unilateral SACP. Depending on the individual anatomy, the aortic arch reconstruction was performed by one of the two methods: extension of the narrowed area with patches of xeno pericardium or forming a direct anastomosis between the descending and ascending aorta 'end to side' using only native tissues. This technique was proposed by Fraser and Mee [14] and modified by Rajasinghe *et al.* [15]. After aortic arch reconstruction, renewal of cardiopulmonary bypass and intracardiac defects repair, rewarming the patient was carried out with a gradient between the blood and body temperature of not more than 5°C. Modified ultrafiltration was performed after weaning from cardiopulmonary bypass using BC20 haemoconcentrators (Maquet, Solna, Sweden).

Statistical analysis

Continuous variables are presented as median (25; 75 percentile) unless stated otherwise. Categorical variables are presented as number (%). Mann–Whitney, χ^2 or Fisher's exact tests were used for between-group comparisons as appropriate. Binary logistic regression was employed to investigate the odds of developing neurological or renal complications in the two groups. Ordinal logistic regression was used to assess an association between the severity of renal dysfunction according to the RIFLE score and the type of perfusion. For the multivariable logistic regression analysis, a forward step-wise procedure with a cut-off *P*-value of 0.20 was used for formulating a final regression model. Otherwise, a two-tailed *P*-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using R statistical programming language [16].

RESULTS

Demographic characteristics of the cohort are presented in Table 1. The median age was similar in both groups: 20.0 (7.5;

Table 1: Characteristics of the cohort

	Group I ($n = 27$)		Group II ($n = 35$)		P-value†
	Male	Female	Male	Female	
Age, days	23 (15; 43)	29 (5; 116)	21 (8; 36)	9 (7; 44)*	0.65
Weight, kg	3.5 (1.9; 6.5)	3.5 (3.0; 6.5)	3.4 (2.9; 4.0)	3.4 (2.9; 3.9)	0.27
Body surface area, m^2	0.21 (0.19; 0.24)	0.21 (0.20; 0.32)	0.21 (0.19; 0.24)	0.21 (0.20; 0.23)	0.58
LV EF, %	73 (66; 80)	77 (72; 78)	73 (69; 79)	74 (70; 85)	0.89
LV EDV, ml	14.5 (9.7; 22.8)	10 (5.2; 24.0)	14 (7.0; 15.3)	8 (6.3; 11.5)	0.39
Haemoglobin, g/l	132 (122; 142)	140 (117; 142)	137 (127; 152)	131 (118; 149)	0.36
Hydrocephaly	1 (3.7%)	0 (0%)	0 (0%)	1 (2.9%)	1.00
Aristotle basic score	13.5 (13.0; 16.2)	13.0 (13.0; 14.5)	13.0 (13.0; 17.0)	13.0 (13.0; 14.9)	0.62
Univentricular repairs	1 (3.7%)	0 (0%)	5 (14.3%)	1 (2.9%)	0.26

Data are median (25; 75 percentile) or number (%).
LV: left ventricle; EF: ejection fraction; EDV: end-diastolic volume.
*$P < 0.05$ when compared with all other subgroups.
†Based on pooled analysis.

Table 2: Cardiac diagnoses

	Group I ($n = 27$)	Group II ($n = 35$)
VSD	9 (33.3%)	16 (45.7%)
ASD	5 (18.5%)	2 (5.7%)
TGA	4 (14.8%)	9 (25.7%)
TAPVC	3 (11.1%)	0 (0%)
DORV	1 (3.7%)	0 (0%)
Mitral atresia	1 (3.7%)	1 (2.9%)
Double-inlet left ventricle	0 (0%)	5 (14.3%)
Aortic valve stenosis	4 (14.8%)	2 (5.7%)

Data are number (%).
VSD: ventricular septal defect; ASD: atrial septal defect; TGA: transposition of great arteries; TAPVC: total anomalous pulmonary venous connection; DORV: double-outlet right ventricle.

33.5) days in Group I and 20.0 (12.0; 28.5) days in Group II. When analysed by gender subgroup, females in Group II were significantly younger than males in the same group and patients of both sexes in Groups I. The two groups had comparable left ventricular ejection fractions and end-diastolic volumes. There was no difference in the Aristotle basic score between the two groups. Cardiac diagnoses are reported in Table 2.

None of the 62 patients died intraoperatively, but 9 deaths occurred postoperatively; 5 (18.5%) in Group I, of which 3 (11.1%) were the result of a combination of multiorgan failure and sepsis and 2 (7.4%) were caused by multiorgan failure alone and 4 (11.4%) in Group II, which resulted from either multiorgan failure and sepsis (2 [5.7%]) or multiorgan failure alone (2 [5.7%]). Additionally, 2 patients (5.7%) in Group II died within 3 years after hospital discharge due to cardiorespiratory failure accompanied by pneumonia, whereas no patients in Group I died during the follow-up period. Mortality rates were not significantly different between the two groups (Table 3). Two of the patients who died in the postoperative period (1 in each group) had been admitted to the hospital in critical condition due to severe circulatory failure and required cardiopulmonary resuscitation (CPR) before emergency surgery. Due to an inability to rule out CPR as a cause of organ failure observed postoperatively, these 2 patients were excluded from the analysis for neurological complications and renal failure. There were 1 (3.7%) and 6 (17.2%) patients with univentricular correction in Groups I and II, respectively ($P = 0.26$). Hospital mortality among patients with univentricular correction was 2 (28.6%) when compared with 7 (12.7%) in those without the trait (OR 2.68, 95% CI 0.22–21.00, $P = 0.26$). Perioperative data are presented in Table 3.

From Table 3, the median cardiopulmonary bypass time was considerably longer in Group I than in Group II, whereas the aortic cross-clamping time did not differ significantly between the two groups. The intraoperative fluid balance was generally negative in Group I, as opposed to Group II where a strong trend towards positive balance was observed. Whereas perioperative blood loss was similar in both groups, patients in Group II received more blood transfusions: 36.6 (24.2; 60.0) ml/kg in Group II vs 20 (12.3; 55.3) ml/kg in Group I, $P = 0.03$.

There were 8 (30.8%) neurological events in Group I and 2 (5.9%) in Group II. Seven Group I patients and 2 Group II patients had temporary neurological dysfunction—transient clinical seizures, which fully recovered within a month. One patient from the DHCA group had prolonged awakening and right-sided hemiparesis after surgery and continues rehabilitation for hemiparesis. The results of univariate and multivariate analyses for neurological events are presented in Table 4.

A total of 4 CT brain studies (3 in Group I and 1 in Group II) were performed postoperatively. In Group I, the clinical presentations and CT findings were as follows: a 30-day-old girl after correction of aortic arch hypoplasia with total anomalous pulmonary venous connection had prolonged awakening followed by right-sided hemiparesis; CT scan revealed multiple bilateral ischaemic foci; 2 more patients (a 25-day-old boy after aortic arch reconstruction with double-outlet right ventricle correction and a 15-day-old boy after aortic arch reconstruction with aortic valve stenosis correction) had recurrent seizures; CT scans revealed ischaemic focus in the left frontal lobe in the former and only signs of hydrocephaly in the latter. In Group II, a 24-day-old boy had recurrent seizures and intraparenchymal haemorrhage 4 × 5 mm in size in the right frontal lobe on CT scan after aortic arch reconstruction with correction of transposition of the great arteries. The odds for neurological events were significantly lower in Group II

Table 3: Perioperative characteristics of the cohort

	Group I ($n = 27$)	Group II ($n = 35$)	*P*-value
CPB, min	150 (132; 195)	130 (100; 156)	0.01
Aortic cross-clamping, min	70 (47; 94)	56 (42; 70)	0.20
Minimal rectal temperature, °C	20 (19; 20)	25 (24; 26)	<0.01
Circulatory arrest time, min	25 (21; 28)	–	–
SACP, min	–	21 (18; 31)	–
Intraoperative fluid balance, ml/kg	−4 (−23.3; 14.5)	26.5 (2.5; 59.7)	<0.01
Intraoperative blood loss, ml/kg	12.5 (7.2; 17.9)	15.9 (12; 20.5)	0.15
Postoperative blood loss (24 h), ml/kg	18.6 (10.7; 38.0)	21.2 (12.8; 38.5)	0.54
Blood transfusion, ml/kg	20 (12.3; 55.3)	36.6 (24.2; 60)	0.03
Ventilation, h	120 (60; 204)	144 (86; 348)	0.08
LV EF, %	73 (71; 80)	76 (70; 81)	0.70
LV EDV, ml	12 (8.5; 18)	8.3 (7; 1.5)	0.02
Maximal inotropic index			
24 h	6 (5; 7.5)	10 (5; 13.5)	0.06
48 h	5.3 (4.6; 7.6)	10 (5.6; 12)	0.04
Neurological event[a]	8 (30.8%)	2 (5.9%)	0.01
Acute kidney injury (RIFLE)[a]	5 (19.2%)	21 (61.2%)	<0.01
Risk	3 (11.5%)	3 (8.8%)	1.00
Injury	1 (3.9%)	5 (14.7%)	0.22
Failure	1 (3.9%)	13 (38.2%)	<0.01
Loss	0 (0%)	0 (0%)	–
ESRD	0 (0%)	0 (0%)	–
Peritoneal dialysis[a]	2 (7.7%)	14 (41.2%)	<0.01
Hospital mortality	5 (18.5%)	4 (11.4%)	0.48

Data are median (25; 75 percentile) or number (%).

CPB: cardiopulmonary bypass; SAPC: selective antegrade cerebral perfusion; LV: left ventricle; EF: ejection fraction; EDV: end-diastolic volume; ESRD: end-stage renal disease.

[a] Two patients (1 in each group) having had cardiopulmonary resuscitation prior to surgery were excluded.

Table 4: Results of univariate and multivariate analyses of risk factors for neurological event and renal failure

	Unadjusted OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Neurological event				
SACP[a]	0.14 (0.02–0.63)	0.02	0.14 (0.02–0.63)	0.02
CPB (1 min increment)	1.01 (1.00–1.03)	0.06	–	–
Min rectal temperature (1°C increment)	0.76 (0.56–0.97)	0.04	–	-
Intraoperative infusion (1 ml/kg increment)	0.97 (0.94–0.99)	0.04	–	–
Male gender	0.58 (0.14–2.57)	0.45	0.56 (0.12–2.68)	0.45
Renal failure				
SACP[a]	6.78 (2.17–24.52)	<0.01	6.49 (1.41–38.26)	0.02
Baseline LV EDV (1 ml increment)	0.92 (0.84–0.98)	0.02	–	–
Postoperative LV EDV (1 ml increment)	0.86 (0.76–0.95)	0.01	–	–
Minimal rectal temperature (1°C increment)	1.22 (1.03–1.48)	0.02	–	–
24 h maximal inotropic index (10-unit increment)	3.22 (1.05–9.86)	0.04	–	–
48 h maximal inotropic index (10-unit increment)	44.34 (5.51–356.89)	<0.01	27.30 (3.47–214.63)	<0.01
Intraoperative infusion (1 ml/kg increment)	1.02 (1.01–1.08)	0.04	–	–
Male gender	0.35 (0.11–1.08)	0.07	0.30 (0.04–1.62)	0.17

Data are odds ratios (ORs) and associated 95% confidence intervals (95% CIs).

SACP: selective antegrade cerebral perfusion; CPB: cardiopulmonary bypass; LV EDV: left ventricular end-diastolic volume.

[a] When compared with deep hypothermic circulatory arrest.

than in Group I [OR (95% CI) 0.14 (0.02–0.63), $P = 0.02$]. It is worth noting that in the multivariable logistic regression analysis, group allocation was the only factor that significantly influenced the outcome. Other variables tested for neurological events but proved non-significant were age, body surface area, Aristotle score, intraoperative fluid balance, echocardiographic data, blood gas data, etc.

Five (19.2%) and 21 (61.2%) cases of acute kidney injury (AKI) were diagnosed in Groups I and II, respectively. Multivariable logistic regression analysis yielded an OR (95% CI) for developing AKI of 6.49 (1.41–38.26) for Group II, when compared with Group I, $P = 0.02$. The same set of variables was tested for AKI as for neurological event; the results are presented in Table 4. In the two groups, for every 10 units of increase in the maximal inotropic index in 48 h (ranging between 5 and 236 units), there was a dramatic increase in the odds of AKI (OR [95% CI] 27.30 [3.47–214.63], *P* < 0.01). To assess an effect of group allocation on the severity of AKI, ordinal logistic regression was employed. This analysis yielded an OR (95% CI) of 4.88 (1.61–17.20), *P* < 0.001, indicating that patients in Group II had an almost 5-fold increased risk of obtaining a higher RIFLE score versus all lower scores combined, when compared with Group I. Notably, a positive statistically significant correlation was established between minimal rectal temperature during surgery and blood lactate level after releasing the aortic cross-clamp (coefficient of correlation 0.27, 95% CI 0.02–0.49, *P* = 0.03). There were two main operating surgeons in the study; an association between the choice of cerebral protection technique and particular surgeon was not significant (*P* = 0.59). Incidence of neurological events was 5 (20.8%) and 5 (13.9%) for surgeons A and B, respectively (*P* = 0.50). Incidence of renal failure was 8 (33.3%) and 18 (50.0%) for surgeons A and B, respectively (*P* = 0.29). The duration of stay in the intensive care unit was not significantly different between Groups I and II.

DISCUSSION

Successful surgery using hypothermia in neonates and infants in the early 1970s laid an important foundation for the later use of DHCA in aortic arch surgery [17]. Griepp *et al.* [18] first described the use of hypothermic circulatory arrest in aortic arch surgery in 1975, which was later supplemented by first retrograde, and then antegrade brain perfusion. Asou *et al.* [6] used selective antegrade perfusion in neonates with aortic arch pathology in 1983.

Currently, there is no single approach to protecting the brain during aortic arch surgery. The role of deep hypothermia has been questioned, and the need to maintain an extremely low cerebral metabolism has already been partially negated by implementation of SACP. There are many retrospective studies of aortic arch surgery, but few conclusive randomized controlled trials directly comparing the results of DHCA and SACP. However, a recent meta-analysis of adult patients indicates that SACP improves the neurological outcomes in patients with aortic arch reconstruction [19]. On the other hand, a recent randomized controlled trial of DHCA and SACP in neonates with aortic arch obstructions demonstrated no significant difference between these perfusion techniques with regard to new cerebral lesions as evident on MRI [20]. Controversy remains concerning the influence of perfusion temperature on the incidence of renal dysfunction. Temperatures used during circulatory arrest in the lower body may impact protection against visceral ischaemia, coagulation and the inflammatory response, which leads to differences in blood loss, renal blood flow, and kidney, liver and intestine function, among others.

The neurological complications remain a problem in aortic arch reconstruction in neonates and infants using DHCA. Our results confirm these data. In particular, a significantly lower rate of neurological complications was demonstrated in patients with the use of SACP compared with DHCA, as evidenced by the corresponding OR (95% CI) of 0.19 (0.04–0.72). Seven patients from Group I and 2 patients from Group II had temporary seizures, which fully resolved within 30 days. Similar transient neurological disorders are common after surgery of complex congenital defects, especially in cases of prolonged DHCA [21, 22]. One patient from Group I continues rehabilitation for right-sided hemiparesis. In our opinion, the cause of neurological complications may be hypoxic brain damage. One of the possible factors affecting the subtle neurological deficit after DHCA may be the alpha-stat strategy used. Studies show a decline in the number of neurological complications when using the pH-stat [23]. One possible factor affecting the subtle neurological complications in Group II may be that an SACP flow of 30 ml/kg/min was inadequate for some of the patients, as demonstrated in some studies [24]. In a randomized study by Algra *et al.* [20], no significant difference in the incidence of perioperative cerebral injury after SACP compared with DHCA was demonstrated; furthermore, SACP may be more harmful because more focal infarcts in central regions of the brain were found. Notably, deep hypothermia was used for all patients by the authors. In contrast, only a moderate hypothermia was utilized for SACP patients in the present study. In the DHCA group, 2 cases of ischaemic foci were revealed by CT imaging, whereas 1 patient had intraparenchymal haemorrhage in the SACP group. Unfortunately, the small number of postoperative CT data precludes the drawing of definitive conclusions on the difference in cerebral injury in our study.

Another frequent complication after aortic arch surgery is AKI. According to our data, the incidence of acute renal injury was significantly higher in the SACP group (21 [61.2%] cases) compared with the DHCA group (5 [19.2%] cases). Moreover, the RIFLE scale for severity of injury was significantly higher in the SACP group. The risk of developing more severe renal dysfunction was, on average, 4.88 times higher among SACP patients compared with DHCA patients. There was also a higher frequency of peritoneal dialysis in the SACP group (14 [40%]), compared with the DHCA group (2 [7.4%]). Multivariable analysis revealed that the maximum inotropic index within 48 h is an independent predictor of renal dysfunction. Our study also revealed a significant positive correlation between the rectal temperature and intraoperative lactate. Similar data exist in studies by Salazar *et al.* [25] and Roerick *et al.* [26]. These data may indicate more pronounced hypoxic damage to the lower half of the body, including the kidneys, with a higher temperature. Deep hypothermia was used for all patients in the recent study of Algra *et al.* [20], and the incidence of peritoneal dialysis was not different between the two approaches. To solve the problem of internal organ damage, some authors suggest multisite perfusion, allowing perfusion of the viscera during aortic arch reconstruction [8, 11]. A direct comparison of different temperatures and modes of perfusion is needed to understand the correlation with risk of renal dysfunction.

This report has several limitations. First, the retrospective, non-randomized nature of the study requires caution when interpreting the results. Some important information is unavailable, such as baseline renal function, gestational age etc., often due to the urgent nature of the surgery and imperfect methods of record collection and storage during the initial period of the study. Second, the relatively small sample size may have limited statistical power of the analyses. Additionally, diagnosis of neurological event in this category of patients is often subjective, which may have introduced a detection bias into the study. A prospective, randomized study is planned that will determine the effect of temperature on renal dysfunction in aortic arch surgery for infants.

CONCLUSIONS

Aortic arch reconstruction with SACP for neonates and infants is accompanied by a lower risk of neurological complications compared with DHCA. However, a higher incidence of renal complications with SACP and moderate hypothermia warrants a further prospective, randomized study.

Conflict of interest: none declared.

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