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BRAIN PROTECTION STRATEGY IN PATIENTS WITH AORTIC ARCH REPLACEMENT USING COMPARISON OF ANTEROGRADE AND RETROGRADE CEREBRAL PERFUSION

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ABSTRACT

Objective: To compare the effect of brain protection using two cerebral perfusion methods in patients with aortic arch replacement, and to optimize the brain safety strategy of active arc surgery. A retrospective analysis was performed for anterograde brain perfusion at Second Affiliated Hospital of University of South China from September 2017 to December 2018.

Methods: Clinical data from patients undergoing aortic arch replacement surgery (37 cases) and retrograde cerebral perfusion (24 cases) were compared with monitoring brain oxygen saturation and detecting markers of brain injury.

Results: After aortic arch replacement, temporary neurological dysfunction occurred in the anterior and reverse irrigation groups, respectively. There were 1 case, 1 case of permanent brain injury, and 2 and 3 deaths in both groups, respectively. With the exception of near-infrared ($P>0$) cerebral oxygen saturation monitoring data, there was no significant comparison of other observational indices in the anterograde cerebral perfusion group and the retrograde cerebral perfusion group.

Conclusion: Anterograde cerebral perfusion and retrograde cerebral perfusion have similar effects on brain protection in patients with deep hypothermic aortic arch replacement.

Keywords: aortic arch replacement; brain protection; infusion mode; markers of brain injury; near-infrared spectroscopy; cerebral oxygen saturation

INTRODUCTION

With the advancements in medical technology, brain protection methods during surgical aortic arch replacement for aortic dissection patients have greatly improved. However, the issue of temporary or permanent central nervous system dysfunction still remains unresolved, as the quality of brain protection directly affects patient survival rates and diagnosis of neurological disease [1]. In 1975, Gripe et al. first introduced the application of deep cycle and low-temperature preventing technology to clinical practice, and since then, efforts have been made to improve brain protection techniques [2]. Different brain protection strategies may affect outcomes and reduce risk differently, and while there is no measurable difference in early mortality or stroke between antegrade cerebral perfusion (PCA) and CPR strategies in ascending/hemiark patients, the limited choice of brain protection in a minimally invasive approach should not prevent surgeons from using PCR in applied cases [3].

Acute aortic type A dissection repair is a complex and high-risk surgery associated with high mortality, ranging from 2.8% to 30%, often attributed to the emergent nature of the procedure, an elderly patient population, severe comorbidities, and often a large aortic area requiring replacement [1-9]. Brain damage after aortic surgery is the most common complication [1-12]. Efforts to reduce this risk range from deep hypothermic circulation arrest (AGHD) alone, to retrograde cerebral perfusion (RCP) and finally to ACHD. Unilateral or bilateral antegrade has evolved to moderate hypothermic circulatory arrest (SCMA) with cerebral perfusion (PCA) [1,13].

In this study, we aim to compare the effectiveness of brain protection strategies in patients after repairing acute aortic type A dissection, specifically comparing early and late outcomes between CPAP, PCR, and AGHD as neuroprotective strategies during the repair of type A aortic dissection.

An aneurysm is a bulge in the wall of an artery that can cause dangerous bleeding or death if it bursts. Aneurysms can occur in different parts of the body, with most occurring in the aorta, the main artery that carries oxygenated blood from the heart to other parts of the body. Early detection through imaging tests and prompt treatment can prevent aneurysms from bursting. Medications and surgery are the two main treatments for aneurysms.

Deep hypothermic cardiac arrest (DHCA) is a surgical technique used to achieve optimal operating conditions and protect the brain during surgery. DHCA involves cooling the body to temperatures between 68-77°F and stopping blood flow and brain function for a period of time. This technique is used during delicate surgeries in the brain or large blood vessels originating from the brain. DHCA provides a better field of vision during surgery due to the cessation of blood flow. It is a carefully managed form of clinical death in which the heart rate and all brain activity are stopped.

Hypothermia is the main method of brain protection during DHCA, and other neuroprotective strategies include pharmacological methods, glucose control, hemodialysis, and acid-base management. Surgical techniques like selective antegrade cerebral perfusion can be used to increase the safe duration of DHCA. Infants tolerate DHCA longer than adults, and it is used for repairing aortic arch, large vessels of the head and neck, cerebral aneurysms, arteriovenous malignancies, pulmonary thromboendarterectomy, and resection of tumors that have invaded the vena cava. DHCA is a technique that provides excellent operating conditions while minimizing the consequences of limb ischemia.

Hypothermia has been used for medical purposes for centuries, with Hippocrates advocating for the use of ice and snow to reduce bleeding. In the 1940s and 1950s, Canadian surgeon Wilfred Bigelow conducted pioneering experiments that showed how cooling could extend the safe duration of cerebral ischemia from 3 to 10 minutes, allowing for rapid surgery. The first cardiac surgery using hypothermia was performed in 1952, and the advent of cardiopulmonary bypass surgery in the 1950s made it possible to stop the heart for surgery without stopping circulation to the rest of the body.

Deep hypothermic circulatory arrest (DHCA) remains a key technique for brain protection in complex cardiac, vascular, neurological, and urological procedures. However, it also poses risks, including dysrhythmia, coagulopathy, cerebral microembolism, and altered drug delivery and elimination. These risks are compounded by the adverse consequences of hypothermia, such as increased plasma viscosity, impaired coagulation, and decreased glomerular filtration rate.

Despite these challenges, DHCA continues to be a valuable tool in medical practice. Its historical roots can be traced back to the use of cold to extend the safe duration of cerebral ischemia, and its development was enabled by the advent of cardiopulmonary bypass devices. Today, DHCA remains a critical technique for brain protection in a wide range of medical procedures.

We describe the different strategies used for brain protection during aortic arch surgery. One of the most common and effective techniques is deep hypothermic circulatory arrest (DHCA), which involves stopping the blood flow and cooling the body to reduce the metabolic rate of cells and preserve energy reserves. During DHCA, the brain is also cooled to reduce the demand for brain metabolism and protect it from ischemic injury. ASF (antegrade selective cerebral perfusion) remains the gold standard for brain protection during aortic arch surgery, but DBS (deep brain selective cerebral perfusion) and CPR (continuous retrograde cerebral perfusion) may also be used in some cases.

Hybrid procedures, which combine endovascular stenting and surgery, are becoming a more popular option for patients who are not candidates for open surgery due to comorbidities or high surgical risk. However, hybrid procedures may not provide the same level of brain protection as ASF, DBS, or CPR.

Importance of carefully monitoring temperature and cerebral perfusion pressure to reduce the risk of neurological complications. Acid-base management is also essential during hypothermia, and two strategies can be used: the unmodified alpha-state strategy and the pH-state strategy.

MATERIALS AND METHODS

General information:

The Second Affiliated Hospital of University of South China conducted a study on the diagnosis and treatment of aortic dissection and Stanford type A aneurysms in patients who underwent aortic arch replacement surgery. The study included 73 patients who had an aneurysm or aortic arch dissection and underwent aortic arch replacement surgery, of which 51 were men and 10 were women, with a mean age of 56.2 years. Chest pain was the most common symptom, followed by dyspnea, syncope, and neurological symptoms. Hypertension was the most common comorbidity. The surgery was performed by experienced cardiovascular surgeons using various techniques, and the average duration of surgery was 331.6 minutes, with the median duration of communication arrest being 28.5 minutes.

Postoperative complications occurred in 13 patients, including neurological, respiratory, and renal complications, with an overall in-hospital mortality rate of 2.7%. The study suggests that surgery using different techniques may be effective in treating aortic dissection and type A aneurysms from Stanford, with an overall low mortality rate. However, postoperative complications can occur and should be monitored and managed carefully to ensure the best possible outcome for patients. The study provides valuable information on the diagnosis and treatment of these conditions.

Inclusion criteria:

Patients included in the study met the following criteria: (1) diagnosis of active Stanford type A dissection or aortic arc aneurysm; (2) age between 14 and 65 years old; and (3) signed an informed consent form for surgery.

Exclusion criteria:

Patients were excluded from the study if they met any of the following criteria: (1) had a history of cerebral infarction; (2) had systolic blood pressure above 200 mmHg; (3) had a nasopharyngeal temperature below 28°C; (4) had a Montreal Preoperative Cognitive Score of 10-15 mL (/10); (5) had an American Society of Anesthesiologists (ASA) rating of 5; (6) had prefrontal skin rupture infection that affected cerebral oxygen monitoring; (7) had cerebral perfusion time exceeding 40 million; (8) had a brain oxygen saturation reference value less than 30%; and (9) experienced prolonged hypotension after surgery (systolic blood pressure less than 80 mmHg).

Before surgery, the surgeon determined the method of cerebral perfusion based on the patient's age, expected traffic downtime, and vascular conditions, and placed an ice cap on the head to reduce flow. Patients with medical history, Montreal Preoperative Cognitive Score of 10-15 mL (/10), and ASA rating of 5 were excluded from the study. The study included a total of 61 patients who met the inclusion criteria. Clinical data were collected from 61 patients, including 37 cases in the anterograde infusion group and 24 cases in the retrograde infusion group. Of these patients, 33 were men and 4 were women who underwent anterograde infusion surgery, while 18 were men and 6 were women who underwent retrograde infusion surgery. The routine preoperative examination of the entire group included three main blood routines, biochemistry, coagulation function, echocardiography, and computed tomography (CT) scans, as well as preoperative biomarkers of brain injury, such as specific neuronal anolase (NSE), interleukin-6 (IL-6), S100 calcium-binding protein B (S100B), transforming growth factor-β (TGF-β), and tumor necrosis factor α (TNF-α).

Methods of anesthesia and surgery:

It is a complex surgical procedure used to treat certain conditions affecting the aorta, such as aneurysms, amputations, or other types of abnormalities that can affect blood flow to the rest of the body. This procedure, known as aortic arch replacement, is performed by a team of highly skilled surgeons specializing in cardiovascular surgery.

Aortic arch replacement is a major surgical procedure that requires careful planning, preparation, and execution. Before the procedure, lorazepam is given to help the patient relax and calm down for the operation. The patient is then taken to the operating room where they are closely monitored with oxygen, percutaneous oxygen saturation monitoring and ECG monitoring to ensure their safety throughout the procedure.

During the procedure, the surgical team uses pulse-blocking forces to stop blood flow to the aorta, and they induce deep hypothermia cerebral perfusion to protect the brain from injury while blood flow stops. They then use a cannula to introduce a special fluid into the aorta that helps cool the body to a temperature of about 20-22 degrees Celsius. This procedure is known as circulation arrest and allows surgeons to work on the aortic arch without blood flow to the brain for a short period of time.

In some cases, retrograde infusion may be used instead of circulation arrest. In this technique, the surgeon inserts a cannula into the superior vena cava and uses it to introduce the coolant into the body. This technique allows more accurate control of the cooling process and is less invasive than communication arrest.

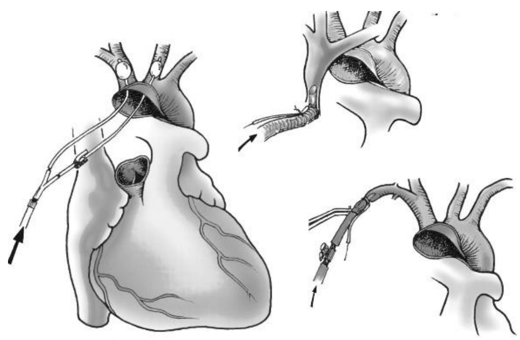

Figure 1: Bilateral antegrade cerebral perfusion is achieved by normal innominate and selective penetration of the left carotid artery. Top right: retrograde cerebral perfusion through superior vena cava. Bottom right: regional cerebral perfusion (unilateral antegrade perfusion) by the cannula of the right subclavian artery.

Once the aortic arch is exposed, the surgeon will make an incision in the arch and remove the diseased or damaged part of the aorta. They will then replace it with a synthetic graft or a piece of the patient's blood vessel. The surgeon will then restore blood flow to the aorta and restore systemic circulation through the four branches of the blood vessels.

After aortic arch replacement, the surgical team will closely monitor the patient's vital signs to make sure they are stable. They will then proceed with surgical repair by opening four branches of the left subclavian artery, left common carotid artery, unnamed artery, and artificial blood vessels to restore cerebral circulation. Finally, a four-branched descending blood vessel will be anastomous with the ascending aorta to open the cardiac circulation.

The use of advanced medical technologies and techniques can help improve patient outcomes and reduce the risk of complications during and after surgery. For example, some surgical teams may use minimally invasive techniques, such as thoracoscopic aortic arch replacement, which can reduce the risk of bleeding, infection, and other complications associated with open-heart surgery.

Finally, aortic arch replacement is a complex surgical procedure used to treat certain conditions affecting the aorta. This procedure requires a team of highly skilled surgeons who specialize in cardiovascular surgery and use advanced medical technologies and techniques to ensure positive outcomes for patients. Although this procedure is associated with certain risks and complications, the benefits of this procedure, such as improving blood circulation and reducing the risk of stroke, may outweigh the risks for some patients.

Equipment used during surgery, experimental materials for perioperative testing:

Intraoperative brain oxygen monitoring uses the INVOS 5100C brain and regional oximetry system manufactured by COVID. Bilateral oxygen saturation of the frontal cerebral lobe is systematically monitored intraoperatively. The brain oxygen monitor is monitored in operating room mode, and the bilateral brain oxygen data recorded before anesthesia is set as the baseline value, and the cerebral oxygen saturation data is recorded in real time during manual surgery, and the special is marked manually.

Events such as aortic obstruction, stopping circulation at low and low temperatures and other time points, in addition, depend on changes in cerebral oxygen saturation data by anesthesia and adjustment of extracorporeal circulation to maintain a relatively stable state of cerebral oxygen, and record baseline values before stopping circulation at low deep and low temperatures and stopping circulation for 10 minutes. Recovery of cerebral circulation for 10 min brain oxygen saturation data at three time points. Brain injury markers S100B, TGF-β, TNF-α protein tests were detected using Wuhan Huamei Bioengineering Co., Ltd.

Postoperative follow-up indicators:

The patient returned to the intensive care unit after surgery, including regular respiratory support, ECG and oxygen saturation monitoring, central venous pressure monitoring to regulate volume load, recording of hourly urine output, observation of patient's mental changes, student size and light reflexes during postoperative resuscitation, observation of changes in organ activity and muscle strength. Brain assessment: Glasgow Coma Rating Scale and Richmond Movement-Sedation Scale (RAS). Pleural fluid drainage was observed dynamically at the beginning of surgery, and dynamic blood gas management was performed to assess the internal environment and oxidation state. S100b, TGF-β and TNF-α concentrations were measured 12 hours later, 12 postoperative concentrations of NSE and IL-6 were measured at 48 hours, and postoperative ventilator-assisted ventilation times and ICU stays were recorded.

spy	Anterograde Infusion Group	Retrograde infusion group	*p value*
n	37	24	
Age (years).	48. 76±11. 45	49. 42±10. 12	0.819
Start time (H).	151. 92±77. 84	258. 72±90. 24	0.137
Body mass (kg).	74. 01±10. 64	70. 60±12. 10	0.242
NSE (ng/mL)	13. 78±3. 33	13. 24±4. 19	0.278
IL-6 (pg/mL)	65. 85±12. 08	56. 35±16. 81	0.238
Hematocrit (%).	0. 40±0. 04	0. 38±0. 04	0.221
S100b (pg/mL)	81. 91±45. 20	85. 59±30. 24	0.407
TGF-β (NG/NG)	0. 35±0. 25	0. 39±0. 30	0.748
TNF-α (pg/mL)	58. 24±27. 44	48. 52±35. 54	0.034

Table 1: Comparison of baseline preoperative clinical data between the two groups [*x*±*s*].

Data divided by brain oxygen saturation before stopping circulation compared to 0.8, less than 0.8 for risk of injury) the proportion of patients was lower than in the retrograde infusion group [4.2% (1/37) vs. 40% (8/24), p = 0. 006; 0 vs. 25% (6/24), p = 0. 1005], the difference was statistically significant; A comparison of other intraoperative indices of extracorporeal circulation and cerebral oxygen monitoring in the two groups of patients is presented in Table 2.

spy	Anterograde Infusion Group	Retrograde infusion group	*p* value
n	37	24	
Minimum stopping cycle temperature (°C).	22. 40±2. 00	21. 58±2. 13	0.129
Cerebral perfusion time (minutes).	23. 11±6. 36	23. 04±5. 03	0.964
Cerebral perfusion rate (L/L)	0. 64±0. 17	0. 51±0. 15	0.005

Table 2: Comparison of intraoperative cardiopulmonary bypass and cerebral oxygen monitoring indices in the two groups [*X*± S].

If signs of neuro-localization are present, a CT scan of the head is performed to identify myocardial infarction or bleeding, and if the muscle strength of the lower limbs is grade 0, a clinical lumbar puncture is performed to measure CSF pressure and release CSF for low BP. The analysis summarized the causes of death in deceased patients.

Statistical analysis:

The data is analyzed using IBM SPSS 20.0 software. General conformity distribution measurement data are represented as (X ± S), using an independent sample t-test and anOVA for comparison between multiple means; Not positive.

State distribution measurement data are expressed as [M(P25~P75)], and non-parametric testing is used. The calculated data are expressed in [n(%)] and tested using Fisher's exact probability method. Take p <005 statistically significant for the difference.

RESULTS

Comparison of baseline preoperative data between the two groups:

Sex ratio between the anterograde infusion group and the retrograde infusion group [male: 89.]. 2% (33/37) vs. 75% (18/24), p = 0.171, patients with primary hypertension. 9% (24/37) vs. 70. 8% (17/24), p = 0. Compared to the proportion of diabetic patients (non-diabetic patients in both groups), the difference was not statistically significant; A comparison of other baseline data between the two groups of patients is presented in Table 3.

Intraoperative follow-up indicators compared between the two groups

Risk of left and right brain injury during surgery in the anterograde infusion group (results of intraoperative monitoring of cerebral oxygen saturation are based on cerebral oxygen saturation at a distance of 10 min from the circulation).

Difference (Postoperative)	Antegrade Infusion Group	Retrograde infusion group	*p* value
12:00 S100b (PG/PG) ml)	58.85±24.73	60.64±33.84	0.309
12:00 pm TGF-β (NG/NG) ml)	2.30±1.31	0.29±0.22	0.984
12:00 pm TNF-α (PG/PG) mL)	83.56±50.40	54.20±21.55	0.4
12:00 pm IL-6 (PG/PG) ml)	269.42±72.66	355.75±29.05	0.318
48h IL-6 (PG/PG) ml)	30.59±21.68	31.28±30.62	0.413
12 h NSE (NG/NG) ml)	41.63±11.76	44.81±17.06	0.392
48 H NSE (NG/NG) ml)	22.64±7.61	22.84±10.22	0.931

Table 3: Concentration of brain injury biomarkers at different times after surgery in two groups of patients

Postoperative outcomes were compared for both groups:

The surgical procedure of the entire group went smoothly and a total of 5 patients died after surgery, including 3 cases in the retrograde infusion group and the anterograde infusion group.

In 2 cases, the leading cause of death was gastrointestinal appearance or septic shock. After surgery, patients with temporary brain dysfunction were identified by RASS scores, 1 case in the retrograde infusion group and 7 cases in the retrograde infusion group, manifested primarily by irritability and personality changes, but gradually scores of 12 or higher are available in the Glasgow intensive care unit. Subdural bleeding occurred in 1 postoperative patient with antiaerograde infusion; 1 patient with retrograde infusion had lacuner cerebral infarction. Comparing postoperative recovery time, postoperative hypoxia incidence, NSE changes, IL-6 changes, S100B changes, TGF-β changes, TNF-α variation, ventilation duration and ICU time of stay), the difference was not statistically significant (p >0.). 05. All surviving patients discharged.

Infusion is effective in both directions, but due to the complexity of aortic arch surgery, only 2 prospective studies have been published on brain protection strategies for aortic arch replacement, [14]. Especially after an infusion time of more than 50 minutes, but there was no clear difference in the incidence of neurological dysfunction in terms of malignancy and durability.

spy	Anterograde Infusion Group	Retrograde infusion group	p value
n	37	24	
Amount of NSE Variation	30.22	32.21	0.669
Variation of IL-6	29.97	32.58	0.575
Variation of S100b	24.52	21.1	0.385
Amount of variation of TGF	21.09	24.05	0.445
Changes to TNF	29.07	21.95	0.091

Table 4: Comparison of changes in brain injury biomarker concentration in the two groups [average rank].

spy	Anterograde Infusion Group	Retrograde infusion group	p value
n	37	24	
Postoperative recovery time (H).	4. 80±3. 51	7. 61±6. 60	0.438
Temporal brain dysfunction [n (%)].	7（18. 9）	1（4. 2）	0.132
Postoperative hypoxia [n (%)]	13（35. 1）	10（41. 7）	0.609
Duration of ventilation (H).	100. 22±92. 57	129. 17±57. 24	0.965

Table 5: Comparison of ICU postoperative clinical data in 2 groups [x±s, n (%)].

Replacement of aortic arch Are currently aortic dissection, aortic arch aneurysms and other surgical procedures in which the aortic arch is involved in the most difficult and complex surgical method, although it knows decades of discovery by laboratory and clinical experts, many advanced monitoring tools have also appeared with the development of science and technology. But there has never been brain protection technology that can provide very real, effective, and safe results. Insufficient cerebral perfusion, during deep circulation and at low temperatures, is likely to cause postoperative cerebral edema; If the canula leads to the peeling of vascular plaque and dissection thrombus, it is easier to separate.

First, brain tissue metabolism was reduced by reduced and deep temperature shutdown technology, brain damage caused by ischemia was reduced, and EEG devices were used to monitor EEG waves to judge the effect of cooling on low brain metabolism. The exact mechanism by which low temperatures protect the brain is not fully understood. It is widely accepted that cryoprotection is at least partly caused by metabolic inhibition. The brain is the largest organ of the human body, the oxygen consumption of the bloodstream is very important, metabolism mainly depends on aerobic glycolysis, measuring the basal metabolic rate of oxygen of brain tissue can provide useful information for the metabolic state of the brain. However, the process of high and low temperatures has a great effect on the state of systemic coagulation and inflammatory response, and leads to many complications. Studies have shown that the incidence of temporal neurological dysfunction was significantly increased with a deep and low temperature cycle time of more than 25 minutes, and this was positively correlated with cycle downtime, and cycle downtime was 40 minutes [15,16].

In the early 90s, due to the uncertainties of the simple low temperature stop circulation technique, the combination of clinical abandonment and perfusion blood flow and the brain protective effect of deep low temperature stop circulation was improved, the anterograde and retrograde cerebral perfusion techniques appeared sequentially. But the benefits and disadvantages of enterograde and retrograde infusion are clear, and there is no clear evidence of which effect is best. In this study, clinical data from 61 patients were retrospectively analyzed, and this group of patients used near-infrared brain oxygen saturation monitoring techniques and multiple brain injury marker detection techniques, which reduced the intervening factors and made the results more accurate. In addition, there was only one main surgical operation, in which the effect of surgical differences on comparison outcomes was excluded. In the anterograde infusion group, unilateral cerebral perfusion by transaxillary intubation of the transaxillary artery was used, and bilateral monitoring of cerebral oxygen saturation during surgery can predict the integrity of the Will Ring and unilaterally exclude the wills ring due to incomplete anterograde perfusion of left-sided cerebral hypoperfusion samples. And left normal carotid artery cannula and intubation reduce the likelihood of increased surgical time due to obstruction, resulting in fewer and more comparable intervention factors between the two groups. However Mercola et al.[17] on 98 cases of cadaveric brain.

Anterograde Cerebral Perfusion:

Physiological analysis of arteries above 0.5 mm showed that 14% of samples with circulatory defects of the left anterior or posterior circulatory arteries were not suitable for unilateral anterograde cerebral perfusion[7], but bilateral cerebral perfusion can be compared using brain oxygen saturation monitoring and can be determined in advance whether perfusion flow is asymmetric. Currently, most of the literature believes that both infusion methods have a case fatality rate and the incidence of neurological complications is similar, and they found that most post-aortic neurological complications were due to microthrombosis rather than brain protection techniques [18].

Anterograde cerebral perfusion as a continuous perfusion brain protection method close to physiological blood flow has been used in supraortic arc branch blood vessel reconstruction or aortic arc surgery, increasing the safe time frame for brain preservation during the shutdown period [19-23]. Axillary arteries form less atherosclerotic plaque than other surrounding arteries and the main aortic trunk, and transaxillary cannulas cause less embolism than ascending aorta and femoral cannula, and can also be used in cardiac reoperation [20]. In addition, this infusion method also reduces the cooling time of the extracorporeal circulation and can also supplement aortic arch surgery at moderate and low temperatures, reduce the parallel time of extracorporeal circulation due to warming after deep and low temperature surgery, reduce the degree of inflammatory response, and can reduce the incidence of postoperative hypoxia. Despite the benefits of selective anterograde cerebral perfusion, there are no large prospective studies indicating that this type of perfusion can reduce the incidence of postoperative cerebral infarction.

Retrograde Infusion:

Retrograde infusion as another method of perfusion is currently used by many heart centers, which can cool the whole brain evenly and effectively maintain the low temperature state of brain tissue, preventing tissue fragments or blood clots and gas embolisms from falling into the end of cerebral blood vessels. And brain tissue damage can also discharge some thanklift product to delay acidosis due to lack of oxygen. [24] Reported a total of 479 patients who used retrograde infusion compared to retrograde infusion during the cryogenic shutdown note: patients with cryogenic stop circulation had lower mortality rates (7–9% vs.). 14.8% and incidence of cerebral infarction (2.4% vs 6.5%). Safi et al.[24] reported particular protective effects in patients older than 70 years.

Although retrograde infusion can also provide metabolic support to brain tissue, remove thrombi, tissue fragments, lactic acid metabolites and maintain similar hypothermia, its infusion formula is not compatible with normal physiology, the infusion area may be limited, the infusion pressure is insufficient and even excessive perfusion pressure can cause cerebral edema. [25 Found that most human cervical static nerves have anatomical or functional valves, and flow volume and total volume are reduced during retrograde infusion, so there are also clinical studies that find that the incidence of transient neurological perfusion dysfunction is high,[26] reported retrograde infusion times of more than 25 minutes, Transient neurological dysfunction occurs only when the incidence of transient neurological dysfunction increases and anterograde perfusion time can be maintained. In this group of studies, we used central venous catheterization to monitor infusion pressure, improved vena cava cannulaction using direct tubes, and deep improved vena cava infusion during infusion to reduce awkward venous shunts, and cerebral oxygen saturation monitoring to observe changes in brain oxygen before and after infusion.

DISCUSSION

Currently, there are no high-specificity biomarkers that can be routinely applied in the clinic, mainly because these new markers are still in the early stages of evaluation and investigation and human testing is needed for further validation before being used clinically as ideal brain injury biomarkers. We selected NSE, IL-6, S100b, TGF-β, TNF-α, in all five literatures, more markers of brain injury were used, and when their respective concentrations peaked after brain injury, and we found that the preoperative TNF-α concentrations of the two groups were significantly different (p <005), But there are no significant differences in the other 4 markers of brain damage, which may be related to the inflammatory response after the appearance of blood vessels, such as preoperative examination of a CT scan of the head, to further investigate whether a brain lesion is present. Patients with neurological complications do not have significant marker elevation after cerebral perfusion, which may be related to the small area of cerebral infarction.

Both infusion methods have both advantages and disadvantages, retrograde infusion can provide a simple and safe method for brain protection, the strength combined with the use of deep and low temperature low temperature stop cycle does not need to be too high to increase the effect of net use of low temperature deep stop cycle on low infusion pipeline, small surgical field effect, brain protection and reverse spraying pressure, The flow rate is significantly lower than in the anterograde infusion group, but the retrograde infusion infusion is not the most direct and fastest way to achieve the goal of infusion infusion, and blood perfusion through the upper cannula of the vena cava does not necessarily reach the brain through the inner jugular vein. And can reach the brain through the collateral vein. The perfusion effect is largely evaluated from return blood from the intraoperative inominated artery and left common carotid artery, and cerebral oxygen saturation data may also be suggested. Two patients with retrograde infusion developed grade 3 right lower limb muscle strength and grade 0 left lower limb muscle strength after surgery, respectively, and underwent a CT scan of the head to examine the muscle strength of the right lower limb 3 muscle disease. Computed tomography in patients with muscle strength of the lower left limb grade 0 shows that lacunar cerebral infarction in the left radial coronary area are associated with left common iliac artery occlusion and hypotrophinia lower limb artery artery occlusion. Anterograde perfusion can provide more direct physiological ways of protecting the brain, and we also see the withdrawal of blood from the descending aorta during the process of stopping circulation, at the same time brain perfusion can be injected throughout the body by a reduced flow of collateral vessels, the infusion effect is accurate, but because the blood vessels of the supraark branch must be completely detached during surgery, it takes longer to block and anastomosis. The results of the blocking time of both groups in this study were consistent with the above, as well as uneven distribution of cerebral blood flow after dissection thrombosis, plaque, branch intubation and anastomosis, and unilateral anterograde infusion. In this study, the difference in blocking time between the two groups was statistically significant (p <0.). 05), compared to the retrograde infusion group, the anterograde infusion patient has a longer blocking time, here in addition to the consumption time of vascular treatment of the supraark branch before the deep cessation of circulation at low temperatures, it is also possible to have severe tissue edema in the acute phase of sample dissection, the free operation takes a long time to match. We use the near infrared during unilateral anterograde infusion.

Brain oxygen saturation monitoring can compare oxygen saturation data from the left and right frontal lobes and initially determine whether the left and right cerebral hemispheres are equally infected.

CONSLUSION

Anterograde infusion and retrograde infusion can be used, brain oxygen saturation is more altered during retrograde infusion and there may be some risk of under-infusion, but there is no significant difference between postoperative temporal neurological abnormalities and mortality compared to antierograde infusion, whereas anterograde perfusion mainly occurs longer during the operation and without the intubation of the intubation. Increases, however, there was no cerebral infarction in this group of patients, and when the cerebral protective perfusion effect of both groups was close, the appropriate infusion method could be chosen based on the patient's age, estimated circulation time, vascular conditions, etc.

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