Tokai J Exp Clin Med., Vol. 31, No. 3, pp. 99-102, 2006

Recent Surgical Outcomes of Acute type-A Aortic Dissection

Shunichi INAMURA, Hidekazu FURUYA, Kentarou YAGI, Eriko IKEYA,
Masaomi YAMAGUCHI, Takabumi FUJIMURA and Kazuo KANABUCHI

Department of Cardiovascular Surgery, Tokai University School of Medicine

(Received May 15, 2006; Accepted May 22, 2006)

The aim of this study is to assess the early outcome of the surgical treatment of acute type-A aortic dissection using recent improvements in antegrade selective cerebral perfusion. This study included 38 patients who had undergone surgery for acute type-A aortic dissection from October 2003 through March 2006. The surgery results were evaluated in 2 groups: group A was composed of those who had undergone the surgery before the procedures of antegrade selective cerebral perfusion was changed in December 2004, and group B consisted of those who had the surgery after the change. Operations were performed with hypothermic cardiopulmonary bypass, antegrade selective cerebral perfusion during the arch repair, and open distal anastomosis.

Times to awakening after the surgery were 27.6 ± 26.2 hours in group A and 19.8 ± 22.3 hours in group B (p = 0.5). Intubation times were 8.55 ± 7.09 days in group A and 5.11 ± 2.56 days in group B (p = 0.06). Permanent neurologic dysfunction was observed in 3 patients in group A and 1 in group B (p = 0.6). Transient neurologic dysfunction was observed in 4 patients each in groups A and B (p = 1). Mortality rates were 21.1% in group A and 10.5% in group B (p = 0.65). There were no significant differences in mortality or morbidity between the two groups, but the intubation time tended to be shorter in group B.

Key words: acute type-A aortic dissection, antegrade selective cerebral perfusion

INTRODUCTION

Antegrade selective cerebral perfusion and deep hypothermic circulatory arrest with or without retrograde cerebral perfusion are widely accepted methods of brain protection during surgery of the thoracic aorta. Current methods of brain protection include deep hypothermic circulatory arrest (DHCA), retrograde cerebral perfusion, and antegrade selective cerebral perfusion (ASCP). All three methods have advantages and disadvantages.

In our department, antegrade selective cerebral perfusion using a parallel circuit with one pump had been performed since April 1996. However, since the parallel circuit caused unstable blood flow to the branches of the arch and did not allow adjustment of the blood flow to them, a series circuit with three pumps has been adopted since December 2004 to infuse blood into the three branches of the arch. We evaluated short-term results of this newly-adopted antegrade selective cerebral perfusion.

SUBJECTS AND METHODS

This study included patients who had consecutively undergone surgery for acute type-A aortic dissection from October 2003 through March 2006. In December 2004, independent pumps for blood infusion to the respective branches started to be used in antegrade selective cerebral perfusion via both axillary arteries and the left common carotid artery. Those who had undergone the surgery before December 2004 were classified into group A and those after December 2004 were classified into group B.

Groups A and B were composed of 19 patients each. The age of those in group A was 32-84 years and the mean age was 60.7 ± 10.8 years. The age of those in group B was 34-84 years and the mean age was 57.8 ± 10.3 years. There were 9 males and 10 females in group A, and 8 males 11 females in group B. In group A, 14 patients were classified into type I of DeBakey classification, and 5 into type II. Group A included 1 patient each with annulo aortic ectasia (AAE) and Marfan syndrome. In the group B, 15 patients were classified into type I DeBakey classification, and 4 into type II. Group B included 5 patients with AAE and 3 with Marfan syndrome. Patient profiles were essentially similar between the two groups (Table 1).

Surgical procedures performed in group A were replacement of the ascending aorta in 2 patients, partial replacement of the aortic arch in 4 (reconstruction of the innominate artery, 2; reconstruction of the innominate artery and left common carotid artery, 2), and total replacement of aortic arch in 13. Concomitantly performed aortic root reconstruction included uni-remodeling procedure (total resection of the noncoronary cusp and Valsalva sinus) in 8 patients, remodeling procedure in 1, and Bentall procedure in 1. In group B, 16 patients underwent partial replacement of the aortic arch (reconstruction of the innominate artery, 3; reconstruction of the innominate artery and left common carotid artery, 13) and 3 total replacement of the aortic arch. Concomitantly performed aortic root reconstruction included Bentall procedure in 3, reimplantation procedure in 2, and uni-remodeling procedure (total resection of the noncoronary cusp and Valsalva sinus) in 7 (Table 2).

Shunichi INAMURA, Department of Cardiovascular Surgery, Tokai University School of Medicine, 143 Shimokasuya, Isehara, Kanagawa 259-1193, Japan Tel: +81-463-93-1121 (Ext: 2281) Fax: +81-463-95-7567 E-mail: ina-shun@is.icc.u-tokai.ac.jp

Table 1 Patient profile.

	Group A	Group B	P value
Number	19	19	
Age (years; mean ± SD)	60.7±10.8	57.8±10.3	0.38
Age >70 y(n)	6	5	0.41
Gender (male)	9	8	1
DeBakey classification (n)			
I	14	15	1
II	5	4	1
Marfan (n)	1	3	0.29
AAE (n)	1	5	0.07

AAE: annulo aortic ectasia; Marfan: Marfan syndrome.

Table 2 Extent of replacement and associated procedures.

	Group A	Group B	P value
Extent of replacement			
Ascending aorta	2	0	0.48
partial arch	4	16	0.71
total arch	13	3	<0.01
Associated procedures			
Bentall	1	3	0.6
Partial remodeling	8	7	0.73
Remodeling	1	0	1
Reimplantation	0	2	0.48

Surgical procedures

Acid base balance control was carried out by using alpha-stat method. Cerebral monitoring was achieved by means of a bilateral radial artery, left superficial temporal artery, and cannula of the left common carotid artery pressure line and regional oxygen saturation in the bilateral frontal lobes with near-infrared spectroscopy.

The proximal thoracic aorta was approached by means of a median sternotomy in all cases. The bilateral axillary artery and the right femoral artery were anastomosed with a 6 mm PTFE graft for arterial return and the superior and inferior vena cavae each received a single right-angled cannula for venous access. Cardiopulmonary bypass was established, and core cooling was conducted. A cannula for retrograde cardioplegia (RCP) was placed in the coronary sinus, and a vent tube was placed through the right superior pulmonary vein. Myocardial protection was achieved by using intermittent retrograde cold blood cardioplegia with direct antegrade coronary ostia infusion once the aorta was opened. After aortic root reconstruction, the rectal temperature was 25℃, distal perfusion from the femoral artery was stopped (open distal anastomosis), the innominate artery and the left subclavian artery were clamped, a 12 Fr balloon perfusion cannula (Fuji systems, Tokyo, Japan) was placed at the left common carotid artery, and antegrade selective cerebral perfusion was started. For patients who had cerebral ischemia symptoms related to the left common carotid artery or in whom preoperative examination had revealed thrombus or mobile atheromas in the aorta, an arterial cannula was inserted in the left common carotid artery (isolation method) at the initiation of cardiopulmonary bypass. Flow of antegrade selective cerebral perfusion was determined based on pressures of the unilateral radial artery and left superficial temporal artery before the change in the procedure and based on those of both radial arteries, the left superficial temporal artery, and tip of the cannula for blood infusion in the left common carotid artery after the changes (the pressures were at the least 40 mmHg during both periods) and findings near-infrared spectroscopy (INVOS 4100; Somanetics, Troy, Michigan).

Our concept of surgery for acute type-A aortic dissection was that no entry should be left in the ascending aorta and aortic arch and that false lumen on the proximal side should be totally resected. For distal anastomosis, a 4-branched graft was used, Teflon felt strip was used to wrap the stump of the distal aorta, continuous 3-0 polypropylene sutures were placed on a 2-0 braided polyester inverted mattress × 8 sutures. The cannula in the femoral artery was connected to a side branch of the 4-branched graft, and then systemic warming was started. Subsequently, the 4-branched graft was anastomosed with the graft used for aortic root reconstruction to resolve myocardial ischemia. The branches of the arch were reconstructed from the distal side.

Statistical analysis

Continuous variables were expressed as the mean ±1SD and were analyzed by using Student's t test. Categoric variable were analyzed with the χ^2 tests. A p value less than 0.05 were considered significant. All statistical analysis were performed with StatMate III (ATMS, Japan).

Table 3 Cardiopulmonary bypass data.

	Group A	Group B	P value
CPB time (min)	259±30	262±36	0.82
Myocardial ischemic time (min)	147±20	158±25	0.28
Circulatory arrest time (min)	64±15	54±9	0.09
Cerebral perfusion time (min)	121±33	117±35	0.78
Cerebral perfusion flow (ml/min/kg)	13±1.6	20.2±4.6	<0.001

Table 4 Hospital mortality and hospital morbidity.

	Group A	Group B	P value
Hospital mortality	4	2	0.65
Hospital morbidity			
PND	3	1	0.6
TND	4	4	1
Re-entry	4	4	1
mediastinitis	3	1	0.6
Time to awaking (hours)	27.6±26.2	19.8±22.3	0.5
intubation time (days)	8.55±7.09	5.11±2.56	0.06

PND: permanent neurologic dysfunction (stroke or coma)

TND: transient neurologic dysfunction (postoperative confusion, agitation, delirium, prolonged obtundation with negative results of brain computed tomographic scanning and complete resolution before discharge)

RESULTS

Operation times in group A were 340-765 minutes and the mean time was 507.4 ± 107.2 minutes. Those in the group B were 315-750 minutes and the mean time was 485.2 ± 114.9 minutes. Cardiopulmonary bypass times in the group A were 177-352 minutes and the mean time was 259.6 ± 42.3 minutes. Those in group B were 195-358 minutes and the mean time was 262.8 ± 44.5 minutes (p = 0.82). Myocardial ischemic times in group A were 87-195 minutes and the mean time was 147.3 ± 26.9 minutes. Those in group B were 100-234 minutes and the mean time was 158.3 ± 35.4 minutes (p = 0.28). Circulatory arrest times in group A were 26-92 minutes and the mean time was 64.2 ± 19.8 minutes. Those in group B were 31-90 minutes and the mean time was 54.9 ± 14.5 minutes (p = 0.09). Cerebral perfusion times in group A were 34-210 minutes and the mean time was 121.2 ± 45.6 minutes. Those in group B were 56-224 minutes and the mean time was 117.3 ± 45.5 minutes (p = 0.78). Mean cerebral perfusion flows were 871 ± 75.9 ml (13.0 ± 2.1 ml/min/kg) in group A and 1,194 ± 280 ml (20.2 ± 5.6 ml/min/kg) in group B (p <0.001). Perfusion data are summarized in Table 3.

Awakening was considered as established when the patient followed operator's instructions. Times to awakening from the completion of the operation (excluding patients with cerebral infarction) in group A were 3-90 hours and the mean time was 27.6 ± 30.6 hours. Those in group B were 2-137 hours and the mean time was 19.8 ± 36.0 hours (p = 0.5).

Durations of endotracheal tube placement in group A were 2-30 days after the operation and the mean length was 8.5 ± 7.0 days. Those in group B were 1-10 days and the mean length was 5.1 ± 2.5 days (p = 0.06). Numbers of patients who had required mechanical ventilatory support for at least 1 week were 7 in group A and 5 in group B.

Repeat thoracotomy for bleeding was performed in 4 patients in group A and 4 in group B. Omental patch for mediastinitis was performed in 3 patients in group A and 1 in group B (p = 0.6).

Permanent neurologic dysfunction was observed in 3 patients in group A and 1 in group B (p = 0.6). Transient neurologic dysfunction was observed in 4 patients each in groups A and B.

Mortalities, including hospital mortality, were 21.1% (4 patients) in group A and 10.5% (2 patients) in group B (p = 0.06). The caused of the death in group A were cerebral infarction in 2 patients, mediastinitis in one, and sudden death in one. Those in group B were cerebral infarction in one, and rupture of descending false lumen in one. Hospital mortality and morbidity the 2 groups are compared Table 4.

DISCUSSION

Recent brain protection methods during aortic arch repair include hypothermic circulatory arrest, circulatory arrest in combination with retrograde cerebral perfusion, and antegrade selective cerebral perfusion. Postoperative permanent neurologic dysfunction is attributed to emboli, which still remain unsolved with any of the methods [1, 2]. All methods have advantages and disadvantages, and a major disadvantages of hypothermic circulatory arrest is its time restriction. Our manipulation of the arch takes 117 minutes on average. Safe manipulation of the arch requires antegrade selective cerebral perfusion and we have consistently adopted it for brain protection. In 1982, we began using antegrade selective cerebral perfusion in which the innominate artery and left common carotid artery were directly cannulated. In 1991, the method was replaced with construction of extra anatomic bypass for antegrade cerebral perfusion, in which both axillary arteries and left common carotid artery were connected with a PTFE graft, in combination with blood perfusion via its side branch. In 1996, further development yielded parallel-type antegrade selective cerebral perfusion with one pump by anastomosing a PTFE graft with both axillary arteries and the left common carotid artery for arterial return. Subsequently, to decrease the time to establishment of antegrade selective cerebral perfusion and to ensure blood supply to the arch branches, the method under discussion was adopted. Di Eusanio *et al.* have reported favorable results of surgery with a method in which cerebral perfusion flow was started at 10 ml $\times$ min^{-1} $\times$ kg^{-1} and pressures of the right radial artery were maintained at 40-70 mmHg [6, 7]. Our newly-adopted method, in which pressures of the respective branches were maintained at 40 mmHg or higher significantly increased the cerebral perfusion flow from 13.0 ± 2.1 ml/min/kg to 20.2 ± 5.6 ml/min/kg. This may be explained by an increase in indicators and by easier adjustment of blood flow to the respective branches. Determinants of postoperative cerebral infarction are reported to be thrombi or atheromas in the aorta during manipulation of the arch. [2]. Therefore, in patients with severe atheromatous changes in the aorta before or during the operation, isolation method, in which blood infusion via the left common carotid artery and cardiopulmonary bypass are started at the same time, is used to separate systemic circulation from cerebral circulation [3]. Although favorable results of blood perfusion only to the 2 branches of the arch have been reported [4], embolic stroke during cardiopulmonary bypass is distributed more densely in the posterior portion of the brain [5] and we encountered infarction of the left cerebellum while blood perfusion to the 2 branches was being used at our department. We therefore have performed blood perfusion to the 3 branches since then.

CONCLUSION

The new method for brain protection with antegrade selective cerebral perfusion using 3 independent pumps did not significantly improve the mortality or morbidity. However, there was a tendency toward a decrease in intubation time. The significant increase in cerebral perfusion flow may result from the increase in indicators for cerebral monitoring and adjustment of blood flow to the respective branches.

REFERENCES

1) Svenson L, Crawford ES, Heso KR. Deep hypothermia circulatory arrest. Determinants of stroke and early mortality in 656 patients. J Thorac Cardiovasc Surg 1993; 106: 19-31.
2) Ergin MA, Galla JD, Lansman SL, Quintana C, Bodian C, Grippe RB. Hypothermic circulatory arrest in operations on the thoracic aorta. Determinants of operative mortality and neurologic outocome. J Thorac Cardiovasc Surg 1994; 107: 788-99.
3) Shiiya N, Kunihara T, Kamikubo Y, Yasuda K. Isolation technique for stroke prevention in patients with a mobile atheroma. Ann Thorac Surg 2001; 72: 1401-2.
4) Kazui T, Yamashita K, Washiyama N, Terada H, Bashar AHM, Suzuki T, Ohkura K. Usefulness of antegrade selective cerebral perfusion during aortic arch operations. Ann Thorac Surg 2002; 74: S1806-9.
5) Barbut D, Grassineau D, Lis E, Heier L, Hartman GS, Lsom OW. Posterior distribution of infarcts in strokes related to cardiac operations. Ann Thorac Surg 1988; 65: 1656-9.
6) Di Eusanio M, Schepens MAA, Morshuis WJ, Dossche KM, Di Bartolomeo R, Pacini D, Pierangeli A, Kazui T, Ohkura K, Washiyama N. Brain protection using antegrade selective cerebral perfusion: Multicenter study. Ann Thorac Surg 2003: 76: 1181-9.
7) Di Eusanio M, Schepns MAA, Morshis WJ, Di Bartolomea R, Pierangeli A, Dossche KM. Antegrade selective cerebral perfusion during operations on t he thoracic aorta: Factors influencing survival and neurologic outcome in 413 patients. J Thorac Cardiovasc Surg 2002; 124: 1080-6.