The Heart Surgery Forum #2006-1032
9 (4), 2006 [Epub July 2006]
doi:10.1532/HSF98.20061032 Online address: http://cardenjennings.metapress.com/link.asp?id=112496

Short Moderate Hypothermic Circulatory Arrest without Any Adjunctive Cerebral Protection for Surgical Repair of the Ascending Aorta Extending into the Proximal Aortic Arch: Is It Safe?

Hiroyuki Kamiya, MD, Uwe Klima, MD, Christian Hagl, MD, Klaus Kallenbach, MD, Malakh L. Shrestha, MD, Nawid Khaladj, MD, Antje Bog, MD, Axel Haverich, MD, Matthias Karck, MD

Division of Thoracic and Cardiovascular Surgery, Hannover Medical School, Hannover, Germany

ABSTRACT

Introduction. We have been using only moderate hypothermic circulatory arrest (HCA) for patients with ascending aortic aneurysms extending into the proximal aortic arch if the distal anastomoses seem to be simple and easy. The aim of this study is to evaluate the early and midterm results of the use of moderate HCA without any adjunctive cerebral protection in such patients.

Methods. Between October 2000 and March 2005, 23 patients with an age range of 39 to 77 years (mean, 59.7 ± 12.2 years) received surgical repair of the ascending aorta extending into the proximal aortic arch using HCA without any adjunctive cerebral protection. Mean circulatory arrest time was 7.5 ± 2.0 minutes (range, 2-13 minutes), and mean core temperature at induction of the circulatory arrest was 26.7 ± 1.4°C (range, 24-30°C).

Results. Operative mortality was 4.3% (1/23) due to unknown cause after successful extubation. Temporary neurological dysfunction was observed in only 1 patient (4.3%), and no persistent neurologic event was observed in any of the patients. One patient died 3 months after the operation due to a mediastinitis. No other cardiac or neurologic event was observed in the 21 surviving patients.

Conclusion. Our results suggest that moderate HCA at 26°C to 28°C without any adjunctive cerebral protection within 10 minutes is safe in selected patients.

INTRODUCTION

It is well known that appropriate selection of cerebral protection methodology during surgical repair of the thoracic aorta has a substantial influence on the surgical outcome [Coselli 1997; Hagl 2001; Okita 2001; Kazui 2002; Di Eusanio 2003; Hagl 2003]. Based on our experiences, antegrade selective cerebral perfusion (SCP) with moderate hypothermic circulatory arrest (HCA) at a temperature of 26°C to 28°C has been the cerebral protection method of choice in our institute, particularly in cases of aortic arch disease requiring complicated and time-consuming repair. However, we have been using only moderate HCA for patients with ascending aortic aneurysms extending into the proximal aortic arch if the distal anastomoses seem to be simple and easy. The aim of this study is to evaluate the early and midterm results of the use of moderate HCA without SCP in such patients.

Received March 31, 2006; received in revised form April 24, 2006; accepted May 3, 2006.

Address correspondence and reprint requests to: Hiroyuki Kamiya, MD, Division of Thoracic and Cardiovascular Surgery, Hannover Medical School, Carl-Neuberg-Strasse 1, 30625 Hannover, Germany; 49-511-532-6581; fax: 49-511-532-5404 (e-mail: hkamiya88@yahoo.co.jp).

MATERIAL AND METHODS

Patients

Between October 2000 and March 2005, 783 adult patients underwent surgery for ascending aortic disease with or without a repair of the aortic arch. Of these, moderate HCA with SCP was used in 437 patients and moderate HCA without SCP was used in 23 patients. These 23 patients were retrospectively examined and included in this study.

Preoperative patient characteristics are presented in the Table. Seventeen (73.9%) men and 6 (26.1%) women were included in the study, with an age range of 39 to 77 years (mean, 59.7 ± 12.2 years). All patients but 2 (91.3%) were operated electively. Indications for surgical intervention were degenerative aneurysm in 20 patients (86.9%) and chronic postdissection aneurysm in 3 patients (13.1%). The surgical intervention was a first-time operation for 18 patients (86.9%) and a re-operation for 3 patients (13.1%). The mean size of aneurysms was 5.6 ± 0.5 cm. All patients who had elective surgery underwent preoperative carotid duplex sonography.

Operative Technique

Anesthesia was induced and maintained in a standard manner. The proximal thoracic aorta was approached by means of a median sternotomy in all cases. After systemic heparinization, cardiopulmonary bypass (CPB) was instituted with a cannula for arterial return to the aortic arch and a venous single 2-stage cannula in the right atrium. The left side of the heart was vented through the right superior pulmonary vein. Myocardial protection was achieved with cold crystalloid or blood cardioplegia. The ascending aorta was clamped and manipulation of the proximal site was performed. After the patients were cooled, the systemic circulation was arrested, and the aneurysm was opened with the patient in the Trendelenburg position. During

Characteristics of Patients and Perioperative Data*

Patients	Age, y	Sex	Concomitant Procedure	CA Time, min	Temperature at HCA, °C	CPB Time, min	In-Hospital Death	Neurological Event
1	57	M	AVR	8	26	91	No	No
2	66	M	Composite graft	10	26	149	No	No
3	75	F	Aortic valve reimplantation	9	26	131	No	No
4	66	M	Composite graft	7	26	143	No	No
5	59	M	AVR	6	28	94	No	No
6	69	M	CABG	7	24	105	No	No
7	46	F	AVR	8	25	115	No	No
8	67	M	Composite graft	5	27	201	No	No
9	67	M	AVR	6	26	123	No	No
10	79	M	Composite graft	5	25	100	Yes	No
11	44	M	Composite graft	13	26	257	No	No
12	41	M	AVR	9	28	92	No	No
13	65	F	Composite graft†	5	30	180	No	Yes
14	39	M	ASD I closure, MVP	8	28	115	No	No
15	43	F	AVR	7	28	76	No	No
16	77	M	AAA repair	7	27	193	No	No
17	60	M	AVR, CABG	5	26	187	No	No
18	65	F	AVR, CABG	7	26	126	Yes	No
19	47	F	Nothing†	7	26	68	No	No
20	55	M	AVR	9	28	110	No	No
21	68	M	AVR, CABG†	9	28	204	No	No
22	63	M	Aortic valve reimplantation	8	28	130	No	No
23	61	M	Nothing†	6	28	112	No	No

*CA indicates circulatory arrest; HCA, hypothermic circulatory arrest; CPB, cardiopulmonary bypass; AVR, aortic valve replacement; CABG, coronary artery bypass grafting; ASD, atrial septal defect; MVP, mitral valve plasty; AAA, abdominal aortic aneurysm.

†Performed as a re-operation.

the circulatory arrest, distal anastomoses were performed. Then, CPB was resumed and the patient was rewarmed. Other necessary procedures including an anastomosis between prostheses were performed during the warming phase.

All the patients received replacement of the ascending aorta and the proximal aortic arch. As concomitant procedures, aortic valve replacement was performed in 10 patients (43.5%) (ie, supracoronary aortic replacement was performed in those patients), aortic root replacement with a composite graft in 6 (26.0%), and aortic valve reimplantation in 2 (8.6%). In the other 5 patients, supracoronary aortic replacement was performed without intervention for the aortic valve. Additionally, 4 patients received coronary artery bypass grafting, 1 closure of atrial septal defect type I with mitral valve repair, and 1 replacement of infrarenal abdominal aorta.

Mean circulatory arrest time was 7.5 ± 2.0 minutes (range, 2-13 minutes), and mean core temperature at induction of the circulatory arrest was 26.7 ± 1.4°C (range, 24-30°C). Mean cross-clamp, CPB, and operation times were 71.4 ± 26.8 minutes (range, 22-130 minutes), 136.2 ± 49.8 minutes (range, 68-257 minutes), and 251.7 ± 89.1 minutes (range, 138-463 minutes), respectively.

RESULTS

Early Outcome

Operative mortality was 4.3% (1/23). He (Patient 10) underwent extubation 10 hours after the operation and was transferred to a general ward on the first postoperative day without any problem including neurological events, but the patient died suddenly on the third postoperative day, presumably due to a cardiac event.

Patient 12 received re-thoracotomy due to postoperative bleeding. Patient 11, who was operated emergently because of progressive heart failure due to severe aortic valve insufficiency, needed an extracorporeal membrane oxygenation up to the second postoperative day. Patient 16, who underwent simultaneous surgical repair of the infrarenal abdominal aorta, was ventilated up to the thirty-fourth postoperative day because of severe respiratory failure. Patient 21 suffered from acute abdomen due to perforation of the sigmoid colon 1 week after the operation and underwent resection of the colon. Three patients (Patients 2, 13, and 21) suffered from postoperative intermittent atrial fibrillation.

Patient 13 (4.3%, 1/23) suffered from temporary neurological dysfunction (delirium) up to the fourth postoperative day. No persistent neurologic event was observed in any of the patients.

Seventeen patients (73.9%) were transferred to a general ward on the first postoperative day. Mean intensive care unit and hospital stay were 3.8 ± 9.6 days (range, 1-45 days) and 13.4 ± 8.3 days (range, 7-46 days), respectively.

Late Outcome

Clinical follow-up was complete in all patients with a mean follow-up period of 26.6 ± 20.1 months (range, 1-56 months). A patient died 3 months after the operation. She (Patient 18), who underwent extubation 12 hours after the operation, was transferred to a general ward on the first postoperative day without any problem including neurological events, and was discharged from the hospital on the fourteenth postoperative day. However, she was hospitalized again 1 week after the discharge due to a mediastinitis and died because of septic shock after 2 months. Patient 6 has suffered from a recurrence of angina pectoris, and is receiving medical therapy. No other cardiac or neurologic event was observed in the 21 surviving patients.

DISCUSSION

In this series, it was possible to perform surgical repair of the ascending aorta extending into the proximal aortic arch in selected patients using moderate HCA at mean 26.7 ± 1.4°C (range, 24-30°C) for mean 7.5 ± 2.0 minutes (range, 2-13 minutes) without any adjunctive cerebral protection with excellent results; 4.3% (1/23) had temporary neurological dysfunction and 4.3% (1/23) died early due to an unknown cause after successful extubation.

Recently, many surgeons have begun to consider that cerebral protection with only HCA for thoracic aortic surgery may not be reliable for performing complicated anastomoses. It has been considered that 35 to 40 minutes of HCA at 20°C is relatively safe, but there is increasing evidence that the safe interval is probably a lot shorter [Hagl 2003]. The Mount Sinai group showed in a clinical study that the predicted safe duration of HCA at 13°C was only 29 minutes [McCullough 1999], and confirmed that patients with arrested times longer than 25 minutes had a higher incidence of temporary neurological dysfunction [Reich 2001]. To take a larger safety margin, SCP is at present used as an adjunctive cerebral protection in many institutes [Hagl 2001, 2003; Okita 2001; Kazui 2002; Di Eusanio 2003]. It is widely considered that up to 80 minutes of HCA with SCP is safe, but the core temperature during HCA is different among institutes, from 10°C to 13°C reported by Hagl et al [2001] to 22°C to 26°C reported by Di Eusanio et al [2003]. We began the use of SCP in combination with deep HCA at 20°C in April 2000, and with accumulation of our own experiences, SCP with moderate HCA at a temperature of 26°C to 28°C has become the cerebral protection method of choice in our institute (data not published).

However, it is unclear whether SCP is useful also for very short duration of HCA because manipulations to establish SCP itself require a few minutes, cannulation tubes disturb quick anastomosis, and, moreover, cannulation into the arch vessels can cause embolic events. Considering such facts, we have been performing distal anastomoses using moderate HCA without SCP in patients with ascending aortic aneurysms extending into the proximal aortic arch if those distal anastomoses seem to be simple and easy. Originally, we performed moderate HCA within 10 minutes for proximal anastomoses in patients with porcelain aorta undergoing coronary artery bypass grafting, and introduced it also into aortic surgery based on these favorable clinical results. To our knowledge, this is the first report on the use of moderate HCA at a temperature of 26°C to 28°C without any adjunctive cerebral protection. Because cognitive functions were not evaluated in this study, the conclusion should be limited. However, our results suggest that moderate HCA at 26°C to 28°C without SCP within 10 minutes is safe.

Nevertheless, it should be noted that moderate HCA without SCP was used only in 5.2% of patients (21/404) who required circulatory arrest during surgery. Although 1 patient received 13 minutes of HCA at a temperature of 26°C without any neurological complications, at present we consider moderate HCA longer than 10 minutes dangerous. This method should be cautiously used only in patients with simple morphology of the aortic arch, in whom it is clearly expected prior to introducing HCA that the distal anastomosis will be quick and easy. Degenerative aneurysm of the ascending aorta extending to the arch may be a preferable indication for this procedure. On the other hand, this method should not be used in patients with atherosclerotic aneurysms, usually seen in elderly patients.

In conclusion, it was possible to perform surgical repair of the ascending aorta extending into the proximal aortic arch in selected patients using short moderate HCA without any adjunctive cerebral protection with excellent results. The results suggest that moderate HCA at a temperature of 26°C to 28°C without SCP within 10 minutes is safe, but this method should be cautiously used only in patients with simple morphology of the aortic arch, in whom it is clear before introducing HCA that the distal anastomosis will be quick and easy.

REFERENCES

Coselli JS. 1997. Retrograde cerebral perfusion is an effective means of neural support during deep hypothermic circulatory arrest. Ann Thorac Surg 64:908-12.

Di Eusanio M, Wesselink RM, Morshuis WJ, Dossche KM, Schepens MA. 2003. Deep hypothermic circulatory arrest and antegrade selective cerebral perfusion during ascending aorta-hemiarch replacement: a retrospective comparative study. J Thorac Cardiovasc Surg 125:849-54.

Hagl C, Ergin MA, Galla JD, et al. 2001. Neurologic outcome after ascending aorta-aortic arch operations: effect of brain protection technique in high-risk patients. J Thorac Cardiovasc Surg 121:1107-21.

Hagl C, Khaladj N, Karck M, et al. 2003. Hypothermic circulatory arrest during ascending and aortic arch surgery: the theoretical impact of different cerebral perfusion techniques and other methods of cerebral protection. Eur J Cardiothorac Surg 24:371-8.

Kazui T, Yamashita K, Washiyama N, et al. 2002. Usefulness of antegrade selective cerebral perfusion during aortic arch operations. Ann Thorac Surg 74:S1806-9.

McCullough JN, Zhang N, Reich DL, et al. 1999. Cerebral metabolic suppression during hypothermic circulatory arrest in humans. Ann Thorac Surg 67:1895-9.

Okita Y, Minatoya K, Tagusari O, Ando M, Nagatsuka K, Kitamura S. 2001. Prospective comparative study of brain protection in total aortic arch replacement: deep hypothermic circulatory arrest with retrograde cerebral perfusion or selective antegrade cerebral perfusion. Ann Thorac Surg 72:72-9.

Reich DL, Uysal S, Ergin MA, Bodian CA, Hossain S, Griepp RB. 2001. Retrograde cerebral perfusion during thoracic aortic surgery and late neuropsychological dysfunction. Eur J Cardiothorac Surg 19:594-600.