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Moderate versus deep hypothermic circulatory arrest for ascending aorta and aortic arch surgeries using open distal anastomosis technique

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ABSTRACT

Background: There are two common strategies for brain protection during aortic arch surgeries, deep hypothermic circulatory arrest (DHCA) with retrograde cerebral perfusion (RCP) and moderate hypothermic circulatory arrest (MHCA) with antegrade cerebral perfusion(ACP). They are hotly debated, although the superiority of the latter is shown. We, therefore, have adopted MHCA with ACP for reconstruction cases and compared the hospital outcomes for these two circulatory arrest management strategies prospectively.

Methods: From June 2015 to July 2017, a concurrent series of 43 patients (DHCA, 25; MHCA, 18) underwent ascending aortic ± aortic arch procedures for aortic aneurysm and dissection diseases using routine open distal anastomosis technique. The incidences of the three main types of operations performed (Bentall procedure (88.0% of DHCA vs 77.8% of MHCA), replacement (20% of DHCA vs 16.7% of MHCA) and interposition tube graft (12.0% of DHCA vs 16.7%of MHCA) did not reveal any statistical differences between the two groups. Similarly, rates of concomitant cardiac procedures (mitral valve repair and CABG, p-value of 0.664) were comparable.

Results: All demographics were similar. Of note the prevalence of aneurysm pathology (76.0% of DHCA vs 72.2% of MHCA, p-value of 0.779). Total operative time (306.60 ± 25.31 vs 281.56 ± 30.06 min, p-value of 0.005), CPB time (208.04 ± 30.04 vs 179.83 ± 45.47 min, p-value of 0.019) and aortic cross-clamp time (150.20 ± 26.15 vs 125.56 ± 39.20 min, p-value of 0.018) were significantly higher in the DHCA group. Overall perioperative transfusion requirements were significantly lower in the MHCA group (72.0% of DHCA vs 55.6% MHCA, p-value 0.000. Postoperative outcomes were similar. Hospital mortality was 16.0% and 16.7% in DHCA and MHCA respectively. Similarly, stroke and reoperation for bleeding were similar (8.0% of DHCA vs 5.6%of MHCA, p-value of 0.756). Again, renal failure requiring dialysis rate was 12.0% in the DHCA group compared to 5.6% of MHCA (p-value 0.473).

Conclusions: MHCA with ACP achieved very good and comparable results to DHCA with RCP for ascending and aortic reconstruction. Furthermore, MHCA significantly shortened total operative, cardiopulmonary bypass and ischaemic times and, basically, decreased transfusion requirements compared with the former strategy and consequently may lead to better patient's outcome.

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1. Introduction

There are two main principles used to protect the brain during arch reconstruction surgeries; hypothermia and cerebral perfusion that can be achieved either by retrograde or antegrade manner. The traditional retrograde cerebral perfusion (RCP) had been surpassed by the antegrade cerebral perfusion (ACP) and there is some evidence culminating for the superiority of the ACP over the traditional retrograde one. [1–8]. Our practice reflects this new trend with the tendency to avoid the inherited risk of deep hypothermia. Although there are a number of studies that compare the two strategies together, the studies that directly compare hospital outcomes of both strategies in a prospective manner are few.

The open distal anastomosis technique has got several advantages such as facilitating a technically more meticulous anastomosis, a more extensive replacement, inspection of the arch especially in dealing with an aortic dissection and prevention of "clamp injury" by avoiding aortic cross-clamping distal to the distal anastomosis [9].

In this study, we reported our single-institutional experience with ascending aorta and arch replacement in elective and emergent aortic aneurysm and dissection cases using routine open distal anastomosis by comparing the two strategies; ACP with moderate hypothermic circulatory arrest (MHCA) versus RCP with deep hypothermic circulatory arrest (DHCA). The hypothesis is that MHCA with an ACP strategy provides outcomes that are equivalent or even superior to the traditional practice of DHCA with RCP for elective and emergent ascending aorta and aortic arch reconstruction. The added benefit of the former technique would be shorter intraoperative times and less need for blood transfusion and its products, which may improve patient outcomes.

2. Materials and methods

The study included a concurrent series of patients undergoing elective and emergent ascending aorta and aortic arch reconstruction. The patients' population included acute, subacute, chronic aortic dissection and aneurysms. The data of these cases were prospectively collected from June 2015 to July 2017 at Madianh Cardiac Center, Madianh, Kingdom of Saudia Arabia. During this period a total of 43 patients had aortic ± aortic arch procedures using routine open distal anastomosis technique. 25 patients had DHCA with RCP compared to 18 patients who had MHCA with ACP. 7 cases (28%) of the first group and 6 cases (33.3%) of the second group had their operations as emergent/urgent basis because of aortic dissection pathology.

The primary endpoint was in-hospital mortality that was defined as all-cause mortality within the same hospital admission regardless of its duration. Secondary endpoints were perioperative transfusion requirement, operative times, length of stay, ventilator dependence, and reoperation for bleeding, neurological complications as stroke which was defined as any sign of new brain injury or neurological deficit recorded clinically or radiographically within 48 h postoperatively. Acute renal failure was defined as rising of the serum creatinine value during the in-hospital stay by double or the new need to start hemodialysis or clinical anuria.

Cardiac complications (atrial fibrillation, low cardiac output syndrome, postoperative myocardial infarction), respiratory complications (respiratory failure, prolonged ventilation more than 24 h, effusion, atelectasis, need for tracheostomy), and infective complications (mediastinitis, pneumonia, septicemia) were also reported.

2.1. Operative techniques

2.1.1. Cardiopulmonary bypass

All patients in the DHCA group underwent cardiopulmonary bypass (CPB) via peripheral cannulation of the femoral artery by anastomosing 8 mm Dacron tube graft to it, central cannulation of superior vena cava (SVC) and inferior vena cava (IVC) with snares around them. In the MHCA group patients underwent innominate artery cannulation centrally for ACP via same median sternotomy incision by anastomosing 8 mm Dacron tube graft to it and cannulating the right atrium by dual-stage venous cannula or double venous cannulation depending on the need for concomitant cardiac procedures like mitral valve repair.

2.1.2. Transverse aortic arch reconstruction

After starting of circulatory arrest, the routine open distal anastomosis was performed after inspection of the arch intima and arch wall character and resecting out most of the lesser curve of the aortic arch. Reinforcement of the distal anastomosis was performed with a Teflon felt using 4-0 polypropylene suture technique. Cannulation of the distal graft was done to resume CPB in both DHCA and MHCA patients.

2.1.3. RCP with DHCA

The SVC cannula was connected tube configuration so that it was connected to both IVC cannula and the femoral tube graft via another Y connector. Patients were systemically cooled to less than 18 °C and after EEG silence, the snare of the SVC was fastened to use it to retrogradely perfuse the brain with a rate of 500 ml per minute and central venous pressure maintained between 20 and 25 mmHg.