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Direct Aortic Cannulation in Minimally Invasive Mitral-Valve Operations

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ABSTRACT

The minimally invasive Port-Access (Heartport, Redwood City, CA) approach in mitral-valve operations originally required femoral arterial cannulation, which is considered a disadvantage, especially in patients with peripheral vessel disease. In this study 20 patients were prospectively randomized into 2 groups, to undergo either standard femoral (group A) or direct aortic cannulation (group B). Pre- and postoperative data as well as markers for myocardial damage were assessed. Postoperatively, patients of group B showed lower levels of damage, indicating that direct aortic cannulation might provide better myocardial protection. Furthermore, the direct aortic cannulation technique may eliminate complications associated with the standard femoral artery cannulation.

INTRODUCTION

The standard approach of installing cardiopulmonary bypass in minimally invasive operations using Port-Access technology (Heartport, Redwood City, CA) is achieved through cannulation of the femoral vessels [Stevens 1996, Mohr 1999, Vanermen 1999]. However, this technique provides retrograde blood flow in the aorta, which is considered a disadvantage, particularly in patients with peripheral vessel disease. Furthermore, in some patients it is difficult to achieve a stable balloon position due to the long catheter, reaching from the groin to the ascending aorta.

To address these problems, a direct aortic cannulation device for minimally invasive Port-Access cardiac surgery was developed by Heartport. This study was set up to test the feasibility of this new device as well as myocardial protection and neurological outcome.

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MATERIAL AND METHODS

Patients

Between May 1999 and February 2000, 20 patients, sent to our center for minimally invasive mitral-valve operations, were prospectively randomized. Group A was cannulated with the standard femoral, group B with a direct aortic cannula. All patients were preoperatively assessed to ensure suitability for either approach. Exclusion criteria were concomitant aortic or tricuspid valve dysfunction, coronary artery disease, a height smaller than 1.50 m or greater than 2.00 m, and a body mass index greater than 35.

Mean age was 66.1 ± 6.1 years (range, 56-78 years). Thirteen patients (65%) were male, 7 (35%) female. Mean body mass index was 28.7 ± 4.3 (range, 22-35).

Underlying diagnoses were mitral incompetence in 16 patients (80%) and mitral stenosis in 4 patients (20%). Preoperatively, 2 patients (10%) were in New York Heart Association (NYHA) class II, 12 patients (60%) in NYHA class III, and 6 patients (30%) in NYHA class IV.

Operative Technique

Under full anesthesia, all patients received a double lumen tube. A mini-thoracotomy of about 5 to 8 cm in length was carried out in the right fourth or fifth intercostal space. In patients of group A, the right femoral artery and vein were dissected, and the Heartport EndoReturn cannula was inserted under direct vision. In patients of group B, the Heartport EndoDirect cannula for the ascending aorta was passed through a working port in the second or third right intercostal space. In these latter patients the femoral vein was punctated directly using the Seldinger technique and a 28 F Heartport QuickDraw venous catheter. In all patients, aortic crossclamping was performed with the help of an intraaortic balloon. After electrical induction of ventricular fibrillation, cold antegrade Buckberg blood cardioplegia was administered through the vent line in the balloon catheter and was readministered every 20 to 30 minutes, depending of electrical or mechanical activity of the heart. At the end of the ischemia no hot shot was given. De-airing was performed either through the ventline in the balloon catheter, or via a separate needle vent in the ascending aorta. During the whole operation, transoesophageal echocardiography (TEE) was used to ensure proper placement of the balloon. Blood samples for CK-MB and cardiac Troponin-I (cTnI) were drawn preoperatively and 5 times postoperativly (PO) (on arrival at ICU, 6 h PO, 12 h PO, 24 h PO, and 48 h PO).

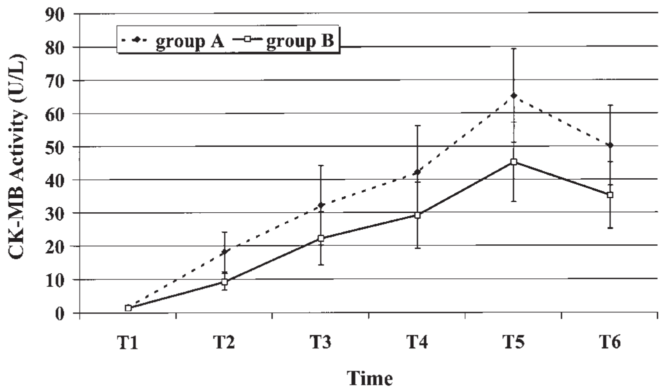

Figure 1. CK-MB activities after minimally invasive mitral valve operations. Group A, standard femoral cannulation; group B, direct aortic cannulation. T1 indicates preoperatively; T2, on arrival at ICU; T3, 6 hours postoperatively; T4, 12 hours postoperatively; T5, 24 hours postoperatively; T6, 48 hours postoperatively.

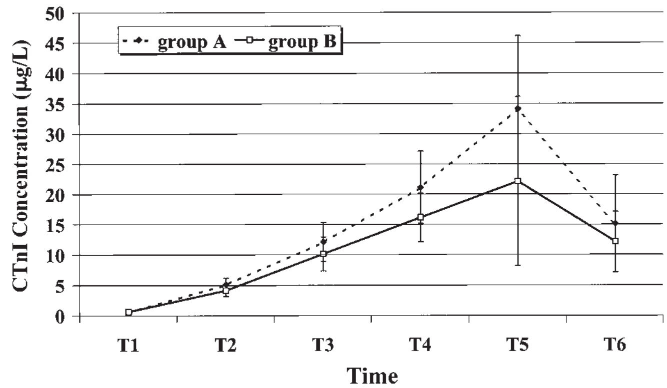

Figure 2. Cardiac Troponin-I concentrations after minimally invasive mitral valve operations. Group A, standard femoral cannulation; group B, direct aortic cannulation. T1 indicates preoperatively; T2, on arrival at ICU; T3, 6 hours postoperatively; T4, 12 hours postoperatively; T5, 24 hours postoperatively; T6, 48 hours postoperatively.

Statistical Analysis

Variables are expressed as mean ± standard deviation. A Student *t* test was applied to analyze continuous variables, and the Fischer exact test was used for discrete variables. All statistical analysis was performed using a computer program (StatView, SAS Institute, Cary, NC, USA). Differences between groups were considered statistically significant if the *P* value was less than .05.

RESULTS

The cannulation approach that was planned before surgery could be achieved in all 20 patients. Mean length of operation time was 270 ± 35 minutes in group A versus 240 ± 48 minutes in group B. Mean cross-clamp time was 69 ± 14 minutes in group A and 63 ± 18 minutes in group B. Mean flow rate on cardiopulmonary bypass was 4400 ± 1020 mL/min in group A versus 4600 ± 1380 mL/min in group B. Lowest temperature on bypass was 28.6 ± 1.2 °C in group A versus 29.2 ± 2.8 °C in group B.

Mean ventilation time was 12.0 ± 2.3 hours in group A versus 11.8 ± 4.1 hours in group B. Mean length of stay in ICU was 1.5 ± 0.8 days in group A, and 1.5 ± 0.9 days in group B. Mean length of hospital stay was 8.8 ± 3.1 days in group A versus 9.1 ± 3.9 days in group B. All these parameters showed no statistically difference.

No stroke occurred in either group.

CK-MB and Troponin-I levels were lower in group B (group A, CK-MB (max.) = 63 ± 27 U/L, Troponin-I (max.) = 33 ± 11 µg/L; group B, CK-MB (max.) = 44 ± 26 U/L, Troponin-I (max.) = 21 ± 13 µg/L) (Figures 1 and 2 ◎). These differences did not reach statistical significance.

DISCUSSION

An increasing number of heart centers around the world offer minimally invasive techniques, mostly via right-sided mini-thoracotomies, as an alternative approach for mitral valve surgery.

Femoral arterial cannulation, as first used in the standard Port-Access technique, is associated with an incidence of wound infection, arterial injury, aortic dissection, and limb ischemia [Serry 1978]. Another well-known potential complication of femoral cannulation is ischemic injury to the lower extremity in some cases that require prolonged bypass times [Hendrickson 1998]. Postoperative increased CK-levels after femoral arterial cannulation have been explained often with this limb ischemia.

Cardiac Troponin I is considered a sensitive and specific biomarker for myocardial damage in patients undergoing aorto-coronary bypass grafting, peaking 6 ± 8 hours after aortic declamping [Eigel 2001]. In our series, in patients in whom the standard Port-Access technique was used, cTnI concentration was remarkably higher than in patients with direct aortic cannulation. Although this finding did not reach statistical significance, these data suggest that myocardial protection is worse in these cases, correlating well with the subjective finding that electrical and mechanical activity is decreased in patients with direct aortic cannulation.

The main reason for the decreased markers of myocardial damage seems to be the more stable balloon position due to the shorter and less curved access path of the balloon catheter in direct aortic cannulation. For this reason, it is very important to guarantee a proper sealing of the ascending aorta.

An alternative approach that helps to ensure proper cross-clamping is the method described by Chitwood [2000]. Cardiopulmonary bypass is also established via femoral cannulation, and blood cardioplegic arrest is induced using a percutaneous, transthoracic cross-clamp, which is introduced through a separate stab incision in the right chest wall. Many surgeons have adopted this technique because it is simple and safe [Aybek 2000].

An attractive aspect in direct aortic cannulation is the possibility to punctate the femoral vein using the Seldinger technique.

Groin complications are well-known when standard open femoro-femoral cannulation techniques are used [Merin 1998]. The 28 F Heartport QuickDraw venous catheters provided sufficient flow for all patient sizes. In our series we did not see any wound complications after direct femoral punctation.

CONCLUSION

Direct aortic cannulation in minimally invasive mitral valve operations and ASD closure procedures can be achieved easily from a right-sided mini-thoracotomy. Furthermore, the possibility of direct punctation of the femoral vein reduces the amount of skin incisions, and the risk of wound infection in the groin.

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