Work in progress report - Cardiopulmonary bypass

Video-assisted right atrial surgery with a single two-stage femoral venous cannula

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Abstract

In the present paper, we report our experience with a single two-stage femoral venous cannula, ideated to drain simultaneously both the superior and the inferior vena cava during minimally invasive cardiac surgery. This cannula has been used in 79 patients (mean age 66.2 ± 11.3 years; mean body surface area 1.9 ± 0.2 m²) who underwent limited access mitral and tricuspid valve surgery at our institution. In our experience, this cannula permits to obtain a safe venous drainage (mean arterial flow 4.7 ± 0.6 l/min, 104 ± 13.3% of the theoretical flow) and it allows for a correct functioning of the pump even when the right atrium is opened. In redo cases (17 patients) the procedure was conducted without snaring the caval veins. In all cases, insertion and positioning of the venous cannula was easily obtained and no patients required a conversion to an alternative perfusion strategy. In conclusion, during minimally invasive procedures requiring opening the right atrium, venous return can be safely accomplished with this two-stage femoral venous cannula. The use of this cannula permits the avoidance of the risk associated with the insertion of a second venous cannula and, in so doing, significantly simplifies the procedure. © 2009 Published by European Association for Cardio-Thoracic Surgery. All rights reserved.

Keywords: Minimally invasive surgery; Extracorporeal circulation; Valve disease

1. Introduction

In the present paper, we report our experience with a new two-stage femoral venous cannula during minimally invasive cardiac surgery requiring opening of the right atrium.

2. Materials and method

2.1. Cannula description

The Remote Access Perfusion Femoral Venous™ cannula (RAP FV™; Estech Inc, USA) is a wire-reinforced polymer venous cannula which has two perforated distal sections, separated by a non-perforated segment of 15 cm in length (Fig. 1). The two distal sections have multiple holes at multiple stage to allow increased fluid flow and to drain simultaneously both the superior and inferior vena cava. The cannula is furnished with a mated obturator that has a 0.039" central lumen to accommodate a 0.035" guidewire. The RAP FV™ is actually available in two sizes, 22/22 French and 23/25 French, indicating the diameter of the proximal and distal perforated segments.

3. Surgical technique

The procedure is performed via a right mini-thoracotomy in the third intercostal space. Two thoracic ports are inserted in the third and fifth intercostal spaces to allow placement of a videoscope and a carbon dioxide insufflation tube. After opening the pericardium and standard heparinization, the right femoral vein is cannulated using the Seldinger’s technique. Appropriate positioning of the perforated sections into both the caval veins is confirmed under trans-esophageal echo guidance. After that, arterial cannulation is performed, the CPB is started and venous return is optimized by a vacuum-assisted venous drainage (~30 mmHg and ~50 mmHg) directly applied to the cardiomyotomy reservoir. The negative pressure is applied to the bypass circuit by connecting a wall suction unit to the venous cardiomyotomy reservoir and regulated by a suction regulator. When the heart is arrested, the left atrium is opened and mitral procedure is performed. Consecutively, the caval veins are snared, the right atrium is opened and tricuspid valve procedure is performed. In patients undergoing redo procedures no caval veins’ occlusion is adopted.

4. Results

Between April 2007 and December 2008, 79 patients (mean age 66.2 ± 11.3 years; female 19) underwent concomitant minimally invasive mitral and tricuspid valve surgery via a right mini-thoracotomy, using the Remote Access Perfusion Femoral Venous™ cannula (RAP FV™; Estech Inc, USA). The mean body weight was 77 ± 12.3 kg, mean body surface area (BSA) was 1.9 ± 0.2 m² and mean body mass index was 26.1 ± 5.1 kg/m². In 17 patients the
operation was a second intervention. The mean theoretical target flows on-pump was 4.5 ± 0.3 l/min. The cannula size was 22/22 in 19 and 23/25 in 60. The mean observed arterial pump flow was 4.7 ± 0.6 l/min (104 ± 13.3% of the theoretical flow). The mean negative pressure applied on the venous line was −46 ± 9 mmHg. In all patients, perfusion was adequate as evidenced by normal venous saturation during CPB. In all cases, insertion and positioning of the venous cannula was easily obtained and no complications related to the insertion of the cannula were observed. No patients required a conversion to an alternative perfusion strategy. All the redo procedures were performed without de-airing of caval veins.

5. Comment

An increasing number of patients undergoing mitral valve surgery require a concomitant tricuspid valve procedure. For these patients, if a minimally invasive approach is adopted, venous return is usually obtained by cannulating the femoral vein for the inferior vena cava and the right internal jugular vein for the superior vena cava [1, 2]. The use of a single two-stage femoral venous cannula was described firstly by Loulmet et al. in 1998 [3], and then Tavaearai et al. in 2001 confirmed its usefulness for procedures requiring opening of the right atrium [4]. Despite the fact that it represents an interesting strategy during minimally-invasive cardiac surgery, peripheral jugular and femoral cannulation still remain the most diffused approach [1, 2]. In the present series the RAP FV™ cannula provides a constant and safe venous drainage from the inferior and the superior part of the body and assures an adequate systemic perfusion during CPB. The blood drainage through the RAP FV™ cannula is unlimited indeed, as it is with any other peripheral cannula, therefore, a negative pressure assistance should be applied on the cardiotomy reservoir. However, we recommend not to exceed −70 mmHg of negative pressure to reduce the risk of cavitation, hemolysis and trapping of the vein walls around the cannula holes [3]. We would like to stress the importance of a correct positioning of the two distal perforated sections into both the caval veins to obtain a maximal performance of the cannula. For this reason a close collaboration between the surgeon and the anesthetist is mandatory. The use of the RAP FV™ cannula offers many advantages over the bicaval cannulation. Firstly, it permits the avoidance of complications related to the insertion of a right internal jugular vein cannula, such as bleeding, hematoma, inadvertent carotid lesions and pneumothorax. In addition, the avoidance of the jugular vein cannula significantly reduces the time of the preoperative preparation of the patient. Second, this cannula achieves a satisfactory bloodless working field also without occluding the venae cavae [5]. This is of particular importance in redo patients, where placement of caval snares may be particularly challenging through a very small incision. If a backflow from the unsnares caval veins is present, a small increase in negative pressure usually results in a clean operative field. Despite the fact that one may argue that air could be entrained in the venous line when the right atrium is open, if the two perforated sections are correctly positioned, reduction of the venous return and air locks in the venous line can be safely avoided. Another issue may be the fact that because the non-perforated segment of the cannula crosses the right atrium, it could restrict the exposure of the tricuspid valve. However, as shown in Fig. 2, the non-perforated segments of the cannula lie on the interatrial septum and do not obstruct the valve view. In conclusion, the RAP FV™ cannula may be safely used during the procedure on the right atrium and it allows for a correct functioning of the pump, both when the left atrium is retracted during mitral procedure as well as when the right atrium is opened during tricuspid surgery. Actually, it represents our preferred approach for venous return in minimally invasive procedure requiring opening of the right atrium.

References