Right atrial surgery with unsnared inferior vena cava

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Abstract

Right atrial procedures require snaring the venous cannulas to prevent air entrapment in the venous line. In particular situations with complex congenital morphology and/or presence of severe pericardial adhesions the right atrial opening without the inferior vena cava cannula in the surgical field and without dissecting and snaring the inferior vena cava itself, might substantially facilitate the surgical technique, provided an adequate venous drainage is assured to avoid flow reduction or circulatory arrest. In several patients with congenital or acquired heart disease with potentially complicated venous drainage, like extracardiac Fontan procedure and tricuspid valve replacement, cardiopulmonary bypass was conducted either on normothermia (congenital lesions) or with mild hypothermia (acquired disease), with 3 l/min per m² flow index and venous drainage through femoral vein cannulation. The right atrium was opened without snaring the inferior vena cava, never provoking reduction of the venous drainage nor air locks in the venous line. This approach substantially enhanced the surgical exposure and therefore facilitated the operative technique without any negative consequence to the patients. Right atrial surgery on cardiopulmonary bypass without direct cannulation and snaring of both superior and inferior vena cava is feasible without flow reduction for surgeons taking care of both congenital and acquired cardiac lesions.

Keywords: Cardiopulmonary bypass; Cavopulmonary connection; Fontan procedure; Inferior vena cava; Tricuspid valve repair; Tricuspid valve replacement

General agreement exists concerning the need for snaring the venous cannulas draining the blood from the superior and inferior vena cava during a right atrial procedure on cardiopulmonary bypass, to prevent air entrapment in the venous line.

Nevertheless, there are particular situations either because of a complex congenital morphology and/or because of the presence of severe pericardial adhesions as a result of several (sometimes three or four) previous operations on cardiopulmonary bypass. In these circumstances the possibility of opening the right atrium without having the inferior vena cava cannula in the surgical field, as well as without the need of dissecting and snaring the inferior vena cava itself, might substantially facilitate the surgical technique, provided that the venous drainage remains adequate. Of course these precautions are valid only if flow reduction or circulatory arrest, with the associated hypothermia, are not considered as the ideal method of perfusion on cardiopulmonary bypass [1,2].

In our recent experience we were faced with several patients admitted for surgery either for congenital or acquired heart disease, with potentially complicated venous drainage, like the two following examples:

(1) extracardiac Fontan procedure [3] because of a complex congenital heart defect (right isomerism, absent right superior vena cava, persistent left superior vena cava draining to the left atrium, single ventricle with common atrio-ventricular valve, valvular and subvalvular pulmonary stenosis), after three previous surgical procedures through median sternotomy: pulmonary valvotomy with subpulmonary resection, pulmonary annulus enlargement with trans-annular patch associated with central shunt, and bi-directional cavo-pulmonary connection of the left superior vena cava to the left pulmonary artery;

(2) tricuspid valve replacement because of severe tricuspid valve regurgitation, after three previous surgical procedures: mitral valve replacement, tricuspid valve repair, permanent pace-maker implantation.
In these patients the cardiopulmonary bypass was conducted either on normothermia (congenital lesions) or with mild hypothermia (acquired disease), with high flow index (3 l/min per m²) and venous drainage obtained through peripheral venous cannulation of the femoral vein, with the tip of the venous cannula inserted at a level lower than the hepatic veins under transesophageal echocardiographic control. To drain the upper part of the body, a superior vena cava cannula was also used in the presence of normal venous connections, or a common atrium cannula in the presence of anomalous venous connection. In all cases the surgical dissection was limited to the antero-lateral aspect of the right atrial wall, with or without the anterior aspect of the inferior vena cava (where needed for completion of the extracardiac Fontan connection). The inferior vena cava was not entirely dissected, nor controlled with surgical tapes. When it was necessary the right atrium was opened without snaring the inferior vena cava (Fig. 1), never provoking reduction of the venous drainage nor air locks in the venous line.

This approach substantially enhanced the surgical exposure and therefore facilitated the operative technique, with a bloodless operative field, without any need for extra aspirations nor negative consequence for the patients. Hemolytic parameters (lactate dehydrogenase and plasma hemoglobin) remained unchanged compared to conventional cardiopulmonary bypass.

The venous drainage was also enhanced by the recent availability of a specially designed venous cannula (Smart-Canula®, Cardiosmart Ltd, Fribourg, Switzerland), self-expandable and therefore able to maintain the vein open at the largest possible lumen, successfully tested in in-vitro [4,5] and in an experimental study on calves [6]. Due to the fact that peripheral veins were cannulated whose lumen was smaller compared to direct cannulation of the inferior vena cava, normally the venous drainage would have been reduced and vacuum assisted venous drainage [7,8] was required. However, this was not necessary due to the Smart-Canula’s® unique design. In the two patients reported above the effective pump flow was, respectively, to 88 and 105% of the calculated blood flow index (3 l/min per m²), but in the first case the operation (extracardiac Fontan procedure) was performed on beating heart, therefore the output provided by the heart should be added to the effective pump flow, which makes up for the 12% deficit.

A pump flow of 3 l/min per m² is the aimed perfusion, since it has been demonstrated able to provide an adequate tissue perfusion even in long and complex cardiac surgery procedures for complex congenital heart defects [2].

Of course this technique can be performed also with a conventional venous cannula, but because of the above underlined limits of the conventional cannulas; in this case, an optimal synergy of both the surgeon and the perfusionists to overcome the mismatch of the size of the inferior vena cava of the patient versus the size of the used venous cannula, to allow for an adequate venous drainage, is required.

In conclusion, the ingenuity of the currently available cardiopulmonary bypass devices and techniques allows for adaptation of the surgical technique to the unique morphological and pathophysiological condition for each individual patient. Right atrial surgery on cardiopulmonary bypass without the need for direct cannulation and snaring of both superior and inferior vena cava is now feasible for surgeons taking care of both congenital and acquired cardiac lesions.

References