Heart, Lung and Circulation (2017) **26,** 201–204
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2016.06.1219

A New Venous Drainage Technique in Minimally Invasive Redo Tricuspid Surgery: Vacuum-Assist Venous Drainage via a Single Femoral Venous Cannula☆

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Received 13 February 2016; received in revised form 24 May 2016; accepted 25 June 2016; online published-ahead-of-print 17 August 2016

Objective To summarise the experiences of applying vacuum-assist with a single femoral venous cannula drainage technique in minimally invasive isolated redo tricuspid surgery.

Methods Eight consecutive patients underwent minimally invasive redo tricuspid surgery through a right thoracotomy at our institute. All of the patients had isolated significant tricuspid regurgitation after previous cardiac surgeries, and received minimally invasive redo tricuspid surgery. The arterial cannula was inserted into the femoral artery, and at the same time, the venous cannula was placed into the femoral vein. The venous cannula was guided by transoesophageal echocardiography and reached the superior vena cava (SVC). The caval veins did not need to be snared with the heart beating during the operation, but applying the vacuum-assisted venous drainage (VAVD) controller was necessary.

Results This cannulation makes it possible to achieve adequate drainage (3.48±0.44L/min) and accomplishes complete arterial perfusion. Most importantly, it guarantees a good visual field without blood and allows safe surgery. The average time of cardiopulmonary bypass (CPB) was 68.25 ± 13.84 min. The length of ICU and hospital stays were 4.13 ±3.52 days and 8.14±4.98 days, respectively. In eight patients, there was no early death in the hospital. One patient experienced acute renal dysfunction.

Conclusion Vacuum-assist venous drainage via a single femoral venous cannula in isolated redo tricuspid surgery is safe, effective, reliable, and significantly simplifies the procedure.

Keywords Cardiopulmonary bypass • Vacuum-assist • Femoral venous cannula • Minimally invasive surgery • Redo tricuspid surgery

Although the isolated tricuspid valve (TV) operation itself may not be technically complicated, in terms of patients who have had previous cardiac surgery, it has a high operative risk, especially in those who receive a redo TV operation by the traditional median sternotomy, which has a high operative mortality and morbidity [1–3]. In recent years, many reports have shown that the clinical outcome of the right anterolateral thoracotomy minimally invasive surgery is

☆ This work was supported in whole or in part, by the Project of Shanghai Health Development Planning Commission (Grant W2014-009).

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better than that of the traditional median sternotomy surgery for the redo TV operation [4]. During the TV operation it is necessary to open the right atrium, and snare the superior vena cava (SVC) and the inferior vena cava (IVC); there are some difficulties and risks exposing the caval veins due to the dense adhesions around the vena cavae. In our institute, we attempted to use vacuum-assist with a single femoral venous cannula drainage technique in minimally invasive isolated redo tricuspid surgery. In the operation, the vena cavae did not need to be snared with the heart beating and the clinical effect was satisfactory, showing that this technique can completely accomplish minimally invasive redo TV surgery.

Materials and Methods

Clinical Data

From August 2015 to January 2016, eight patients in our institute underwent isolated redo TV operations with the heart beating, by minimally invasive access through a right anterolateral thoracotomy. The overall mean age was 48.89±8.39 years. The New York Heart Association (NYHA) functional classes were III-IV. All patients had isolated significant tricuspid regurgitation (TR). In the eight cases, the previous cardiac operation involved four mitral valve replacements (MVR), two MVR + aortic valve replacements (AVR), one MVR +AVR + tricuspid valvuloplasty (TVP), and one atrial septal defect (ASD) closure. All patients underwent TV replacement. The patients' clinical profile is shown in Table 1.

Table 1 **Demographic patient data**

Variable	Patients(n=8)
Age (years)	48.89±8.39
Male/Female	2/6
Weight (kg)	54.69±7.42
TR grade	
Severe	8
NYHA class	
III	6
IV	2
Previous cardiac operation	
MVR	4
MVR+AVR	2
MVR+AVR+TVP	1
ASD closure	1
LVEF (%)	66.78±3.53
RA (mm)	92.43±18.33
RV (mm)	59.93±10.73
Pulmonary artery systolic pressure (mmHg)	41.25±8.58

NYHA, New York Heart Association; MVR, mitral valve replacement; TVP, tricuspid valvuloplasty; AVR, aortic valve replacement; ASD, atrial septal defect; RA, right atrium; RV, right ventricle.

Surgical Technique

After successful anaesthesia with double lumen endotracheal intubation, the arterial cannula (Fem-Flex™ Femoral Arterial Cannula, Edwards Lifesciences) and venous cannula (Femoral Venous Cannula, Edwards Lifesciences) were inserted into the femoral artery and the femoral vein respectively. The size of the cannula was determined according to the diameter of the blood vessel or the surgeon's choice. It was emphasised that the top of the femoral venous cannula should be inserted into the SVC, which was performed under the guidance of ultrasound. The Xijian reservoir (Xijing Medical Instrument Limited Company, Xi'an, China) was selected during the CPB. After the establishment of the CPB, a right anterolateral thoracotomy was performed through the fourth intercostal space. Before the incision of the right atrium, the CPB was started and carbon dioxide was introduced into the surgical incision until the right atrial incision was sutured. For more effective vena caval drainage, a vacuum-assisted venous drainage (VAVD) controller was necessary. Negative pressure was maintained between -20 mmHg and 30 mmHg, or according to the amount of blood in the right atrium. During the entire process of CPB, the arterial blood gaseous bubble monitoring system was used. There was no need to dissect the adhesions around the aorta and vena cava during the operation. The whole operation process was performed without snaring the vena cavae and with the heart beating.

Results

All patients underwent TV replacement and the procedure was successful. There was one acute renal dysfunction and no early in-hospital death among the eight patients. The mean venous drainage was 3.48±0.44 L/min in CPB and arterial perfusion was performed completely. The average pump time was 68.25±13.84 min (47-85 min). The mean mechanical ventilation time was 30.75±25.23 h (12-82 h). The average length of ICU and hospital stay were 4.13±3.52 days (1-12 days) and 8.14±4.98 days (5-19 days), respectively (Table 2). There were no CPB accidents or complications related to this technique. Micro bubbles were not detected in the arterial line during the operation. The peri-postoperative patient characteristics are shown in Table 2.

Table 2 **Peri-Postoperative patient characteristics**

VariablePatients(n=8)	
CPB time(min)	68.25±13.84
Vein drainage(ml)	3475.00±440.78
SIMV time(h)	30.75±25.23
ICU time(d)	4.13±3.52
Postoperative length of stay(d)	9.25±5.57
Haemodialysis(n,%)	1(11.11%)
Postoperative lactic acid(mmol/L)	1.40±0.55

SIMV,synchronous intermittent mandatory ventilation.