CASE REPORT

Recent Less-invasive Circulatory Monitoring during Renal Transplantation

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Abstract : For anesthetic management during renal transplantation, it is necessary to maintain the blood flow and function of the transplanted kidney by performing massive fluid management and stabilizing blood pressure. We report anesthetic management for renal transplantation with a less-invasive circulatory monitoring system (Edwards Life Sciences Co., Ltd., Irvine, California, U.S.A.). In November 2010, renal transplantation was started in our hospital, and performed in 6 patients. In the first patient, fluid/circulatory management was conducted by connecting a standard arterial line and a standard central venous (CV) line. In the second patient, a FloTrac™ system and a standard CV line were used. In the third patient, a standard arterial line and a PreSep™ CV Oximetry Catheter were used. In the fourth and fifth patients, a FloTrac™ and a PreSep™ were used. In the latest patient, FloTrac™ and PreSep™ were connected to an EV1000™ Clinical Platform for fluid/circulatory management. The establishment of high-visibility monitors was useful for evaluating the condition and confirming the effects. As there are marked changes in hemodynamics, the CV pressure, which has been used as a parameter of fluid management, is not reliable in renal failure patients with a high incidence of cardiovascular complications. Advances in noninvasive circulatory monitoring with dynamic indices may improve the safety of anesthetic management during renal transplantation. J. Med. Invest. 60 : 159-163, February, 2013

Keywords **:** *renal transplantation, circulatory monitoring, fluid management, EV1000 clinical platform*

INTRODUCTION

For anesthetic management during renal transplantation, it is necessary to maintain the blood flow and function of the transplanted kidney by performing massive fluid management and stabilizing the blood pressure from extirpation of the kidney to be transplanted until the completion of renal artery anastomosis (1). Recently, simple, less-invasive serial monitors have been developed/improved with marked advances in circulatory monitoring. FloTrac™ is a less-invasive, arterial pressure-based cardiac output-monitoring system. The stroke volume (SV) is estimated based on arterial pressure waveforms obtained from the radial artery, and multiplied by the pulse to express the cardiac output (CO) (2). Furthermore, respiration-related changes in the SV (stroke volume variation : SVV) are serially

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expressed. SVV may become a parameter of optimized hemodynamics and fluid responsiveness (3). In addition, the use of a PreSep™ central venous (CV) oximetry catheter facilitates the serial monitoring of central venous oxygen saturation (ScvO2) (4).

We report anesthetic management for renal transplantation with a less-invasive circulatory monitoring system (Edwards Life Sciences Co., Ltd., Irvine, California, U.S.A.) which is used in our hospital.

CASE REPORTS

In November 2010, renal transplantation was started in our hospital, and performed in 6 patients (donated kidney : 1 patient, brain death : 1, and living : 4, age : 18 to 60 years). The patient background is shown in Table 1. In the first patient, fluid/circulatory management was conducted by connecting a standard arterial line and a standard CV line. In the second patient, a FloTrac™ system and a standard CV line were used. In the third patient, a standard arterial line and a PreSep™ CV oximetry catheter were used. In the fourth and fifth patients, a FloTrac™ system and a PreSep™ CV oximetry catheter were used. In the latest patient, a FloTrac™ system and PreSep™ CV oximetry catheter were connected to an EV1000™ Clinical Platform for fluid/circulatory management.

The most recent patient was a 49-year-old male with chronic renal failure. Living renal transplantation was performed (the donor was his wife). Complications included ischemic heart disease, hypertension, diabetes, cerebral infarction, and abdominal aortic stenosis. Anesthesia was induced with remifentanyl and propofol. After achieving muscle relaxation with rocuronium bromide, general anesthesia was induced through tracheal intubation. Subsequently, arterial (FloTrac™) and CV (PreSep™ CV oximetry catheter) lines were inserted, and connected to an EV1000™ Clinical Platform to start serial monitoring. As a monitoring screen, cockpit or physio-view monitors were primarily used. The cardiac output (CO), cardiac index (CI), stroke volume variation (SVV), stroke volume index (SVI), central venous oxygen saturation (ScvO2), and systemic vascular resistance index (SVRI) were comprehensively evaluated, and used as parameters of fluid/circulatory management. Concerning vital signs after the start of surgery, blood pressure (BP) was 107/52 mmHg, heart rate (HR) was 71 bpm, CO was 4.8 L/min, CI was 2.6 L/min/m^2, SVV was 6%, SVI was 4.1 ml/beat/m^2, ScvO2 was 71%, and CVP was 10 mmHg (Fig. 1). To manage the decrease in blood pressure, phenylephrine and ephedrine were administered in the absence of fluid loading, and dopamine therapy at 2 μg/kg/min was started to maintain the blood pressure until bench surgery. The kidney was extirpated from the donor 4 hours after the start of surgery. Fluid loading was initiated at the start of perfusion. With respect to vital signs before fluid loading, the BP was 106/52 mmHg, HR was 108 bpm, CO was 6.9 L/min, CI was 4.0 L/min/m^2, SVV was 22%, and CVP was 10 mmHg under dopamine therapy at 2 μg/kg/min. Establishing a target SVV of 10% or less, fluid loading at a total of

Table 1. Summary of 6 patients who underwent renal transplantation in Tokushima University hospital

Case	1	2	3	4	5	6
Indication	Brain death	Living	Living	Donated kidney	Living	Living
Age, yr	52	18	46	60	24	49
Weight, kg	55.5	44.5	48.3	65.9	54.8	70.9
Duration of surgery, min	323	465	360	408	361	476
Duration of anesthesia, min	413	540	426	517	444	563
Flo Trac™	-	+	-	+	+	+
PreSep™	-	-	+	+	+	+
EV1000™	-	-	-	-	-	+
Fluid until bench surgery/weight, ml/kg	37.8	60.7	31.0	17.5	20.1	16.9
Fluid from bench surgery until initial urine confirmation/weight, ml/kg	-	40.5	33.1	-	40.3	26.8
Total fluid/weight, ml/kg	81.1	139.3	110.7	45.5	100.9	56.4

Fig. 1 : Cockpit monitor after the start of surgery
CI ; cardiac index, SVV ; stroke volume variation, SVI ; stroke volume index, ScvO2 ; central venous oxygen saturation

approximately 3,000 ml was performed before anastomosis of the renal artery. When the BP, HR, CI, SVV, SVI, ScvO2, and CVP reached 118/51 mmHg, 107 bpm, 5.6 L/min/m^2, 7%, 51 ml/beat/m^2, 79%, and 12 mmHg, respectively, under dopamine therapy at 2.5 μg/kg/min, the vascular clamp was opened (Fig. 2). The decrease in the blood pressure after opening was slight, and there were slight changes in the SVV. Initial urine was confirmed after 40 minutes. A urine volume of 3 ml/kg/hr was maintained until the completion of surgery. The hemodynamics at the completion of surgery were stable : BP, 147/63 mmHg ; HR, 101 bpm ;

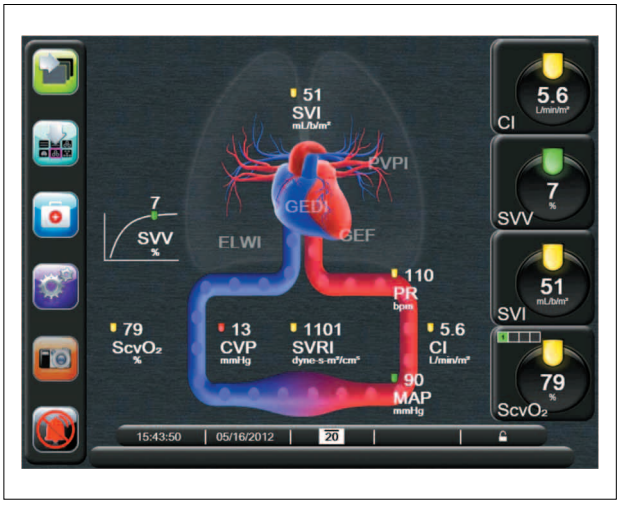

Fig. 2 : Physio-view monitor at the time the vascular clamp was opened
CI ; cardiac index, SVV ; stroke volume variation, SVI ; stroke volume index, ScvO2 ; central venous oxygen saturation, CVP ; central venous pressure, SVRI ; systemic vascular resistance index, PR ; pulse rate, MAP ; maximum arterial pressure

CI, 5.3 L/min/m^2 ; SVV, 12% ; SVI, 53 ml/beat/m^2 ; ScvO2, 75% ; and CVP, 11 mmHg. The postoperative course was favorable.

DISCUSSION

For anesthetic management during renal transplantation, it is important to promote the transplanted kidney function and maintain an adeguate volume of blood flow in the transplanted kidney to prevent acute tubular necrosis (1). During renal transplantation, monitoring is commonly conducted using electrocardiogram, blood pressure, arterial line, central venous pressure, end-tidal CO2 (ETCO2), pulse oximeter, and body temperature. However, cardiac hypofunction is frequent in patients with renal failure (5, 6). Furthermore, a pulmonary artery catheter should be inserted, if necessary, to measure the pulmonary arterial pressure/cardiac output and perform fluid management, as the number of diabetic patients has increased (7). However, a pulmonary artery catheter may cause complications (8). For circulatory monitoring during renal transplantation, invasive arterial and central venous pressures have been primarily used. However, hemodialysis is performed in most patients undergoing renal transplantation, and cardiovascular complications are present ; the central venous pressure may not be an accurate parameter in some cases (9).

As a method of circulatory management, there is the entity of goal-directed therapy (GDT), a so-calld, "goal-targeting treatment" (10, 11). In particular, individualized GDT in circulatory management during anesthesia has recently been used. This refers to patient-matched, SV-/CO-based circulatory/fluid management in which oxygen supply meeting tissue oxygen demand is maintained, but not the administration of a specific volume of fluid based on parameters such as blood pressure, pulse, and urine volume (12). This therapy reduces the doses of vasoconstrictors/catecholamines, and reduces the incidence of postoperative complications, shortening the admission period (12, 13). The FloTrac™ system is appropriate for individualized GDT. Flow-based dynamic indices such as the CO, SV, and SVV are more useful than pressure information-based management.

Flo Trac™ is a less-invasive, arterial pressure-based cardiac output-monitoring system developed by Edwards Life Sciences Co., Ltd. In Japan, it

became clinically available in April 2006. The arterial pressure-based CO is based on the principle that the aortic pressure is proportional to the SV, but inversely proportional to aortic compliance. Many studies have reported the accuracy of arterial pressure-based CO monitors (2). Furthermore, SVV is the most reliable predictor of optimized hemodynamics and fluid responsiveness. Many studies have reported its accuracy (3, 14, 15). In addition, the use of a PreSep™ CV Oximetry Catheter (for adults) or PediaSat™ Oximetry Catheter (for children) facilitates the serial monitoring of central venous oxygen saturation (ScvO2) (4). ScvO2 changes in parallel to SvO2 (16). As ScvO2 depends on the CO/hemoglobin level/arterial blood oxygen saturation involved in oxygen transport, as well as metabolism involved in oxygen consumption, continuous monitoring of the oxygen demand/supply balance is possible (17). Continuous monitoring of ScvO2 enabled evaluation of the oxygen supply to tissues to help determine the need for blood transfusion.

We performed circulatory management during renal transplantation using a less-invasive circulatory monitoring system. In the sixth case, the latest EV1000™ Clinical Platform was available, facilitating individualized GDT based on the CO, SVV, SVR, and ScvO2, in addition to CVP. The establishment of high-visibility monitors was useful for evaluating the condition and confirming the effects. The color-coded image of the target on cockpit monitors facilitated visual/intuitive assessment of the patient's condition. Physio-view monitors made it possible to understand the interrelationships among the heart, blood, and vascular system through animation. As a result, intraoperative management at a fluid volume smaller than previously used was achieved (Table 1). For renal transplantation, it is necessary to restrict fluid management using a vasopressor until bench kidney surgery and start rapid fluid loading during anastomosis of the renal artery/vein. However, most patients with chronic renal failure do not have any heart reserve to promptly receive a massive volume of fluid in a relatively short interval during surgery. A close circulatory monitoring system is essential. The use of the EV1000™ Clinical Platform facilitated appropriate GDT. The EV1000™ clinical platform (with FloTrac™ and PreSep™) provided reliable information for the intraoperative management of high risk patients during renal transplantation without the need for an invasive pulmonary artery catheter. Goal-directed hemodynamic and fluid optimization using a less-invasive circulatory monitoring system may result in improved outcomes.

CONCLUSION

As there are marked changes in hemodynamics, the CVP, which has been used as a parameter of fluid management, is not reliable in renal failure patients with a high incidence of cardiovascular complications. Advances in less-invasive circulatory monitoring with dynamic indices (the EV1000™ Clinical Platform) may improve the safety of anesthetic management during renal transplantation. In the future, additional monitoring items, such as the extra-vascular lung water (EVLW) system may contribute to more comprehensive circulatory management. In addition, much less-invasive monitoring methods will be developed leading to marked changes in the renal transplantation area. Anesthesiologists must acquire broad, deep knowledge of the avove methods, including those of the perioperative period.

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