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Case Report

Initial Experience of Anesthetic Management in Combined Liver-Kidney Transplantation: A Case Report

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Abstract: In this case report, we present a successful combined liver-kidney transplantation (CLKT) performed on a 41-year-old female with end-stage liver and renal disease. The patient, previously undergoing liver transplantation and regular hemodialysis, underwent CLKT with a focus on specific anesthesia management strategies. Key aspects included the use of desflurane for anesthesia, balanced crystalloid solutions for fluid management, and careful monitoring of hemodynamics without intraoperative renal replacement therapy. Despite substantial intraoperative fluid and blood product administration, careful management ensured stable vital signs and acid-base balance. The patient's postoperative recovery was notable for significant improvements in liver and renal functions, demonstrated by decreased creatinine and bilirubin levels, and improved estimated glomerular filtration rate, without the need for postoperative dialysis. This case underscores the effectiveness of CLKT in patients with concurrent liver and renal dysfunction, highlighting the importance of tailored anesthesia and fluid management strategies. The report contributes to the limited literature on anesthesia in CLKT, providing insights for better outcomes in such complex surgical procedures.

Keywords: Anesthesia, General; Case Reports; Liver Transplantation.

INTRODUCTION

Approximately 16% of liver transplantation recipients are concurrently diagnosed with chronic kidney disease (CKD) at the time of transplant [1]. In cases involving these patients, there is evidence suggesting that combined liver-kidney transplantation (CLKT) results in a higher survival rate than liver transplantation alone. Since the first reported CLKT by Margreiter *et al*., in 1984 [2], the number of CLKT cases has increased significantly, with the count in 2019 being triple that of 2001 [3]. In South Korea, only 38 CLKTs were performed from 2000 to 2019 [4]. However, considering the rising incidence of CKD in the South Korean population, an increase in CLKT procedures is expected [5].

Since 2020, our hospital has conducted 71 liver transplants, among which our first CLKT was performed. Although there are some publications on anesthesia management in CLKT, they are few in number [6-8]. Thus, our report aims to share our initial experiences with CLKT, with a particular focus on anesthesia-related aspects.

CASE REPORT

A 41-year-old female patient (height 160.9 cm, weight 47.8 kg) with a preoperative model for end-stage liver disease (MELD) score of 37 was scheduled for a deceased donor combined liver-kidney transplantation (CLKT). She previously underwent deceased donor liver transplantation in 2016 due to alcoholic liver cirrhosis. In 2020, she was diagnosed with end-stage renal disease and has since undergone hemodialysis three times per week. Her last hemodialysis was conducted three days before her scheduled CLKT.

On the day of the surgery, the patient was monitored using a pulse oximeter, 3-lead electrocardiography, and two invasive arterial pressure measurements (one from the right radial artery and the other from the left femoral artery). Central venous

pressure was assessed via the left internal jugular vein. To minimize transfusion volume, a cell saver was employed, and an air warming blanket was used to prevent hypothermia. Anesthesia was induced using midazolam, remifentanil, and rocuronium, and maintained with desflurane. Renal replacement therapy was not employed during the procedure. The total anesthetic duration was 12 hours, with uneventful liver reperfusion occurring 3 hours and 35 minutes, and kidney reperfusion 7 hours, after the start of the operation. The total volume of fluid administered was 10000 ml (plasmalyte 7000 ml, hartmann solution 1000 ml, 0.9% normal saline 500 ml, 5% albumin 1500 ml) and the transfusion volume was as follows: 11 packs of red blood cells, 9 packs of fresh frozen plasma, 7 packs of cryoprecipitate, 6 packs of platelets. The total bleeding amount was 6000 ml. Despite employing an air warming blanket, the core temperature, as measured in the esophagus, consistently remained below 36°C throughout the surgical procedure. Following liver reperfusion, central venous pressure was maintained within a range of 12-15 mmHg and subsequently rose to a maximum of 20 mmHg post-kidney reperfusion. The stroke volume variance was predominantly maintained below 15 for the majority of the operation. Information about blood pressure, pulse, central venous pressure, body temperature, and input-output from the start to the end of anesthesia is summarized in Fig 1. Results of the arterial blood gas analysis during the operation are presented in Fig 2. Throughout the procedure, the pH and potassium levels were maintained within the ranges of 7.15-7.45 and 3.0-5.0, respectively, even without renal replacement therapy. Total 40 mEq of sodium bicarbonate was administrated during the procedure.

After the operation, the patient moved to intensive care unit with norepinephrine 0.14 mcg/kg/min. The patient was extubated on postoperative day 2. On postoperative day 8, the patient was moved to the general ward and was discharged on postoperative day 27. The creatinine level at postoperative day 1 decreased from 10.29 to 3.82, total bilirubin from 8.57 to 3.90, and PT (INR) from 2.94 to 2.78. The estimated glomerular filtration rate improved from 4.2 to 13.9. The patient maintained normal kidney and liver functions for up to 18 months postoperatively, as shown in Fig 3.

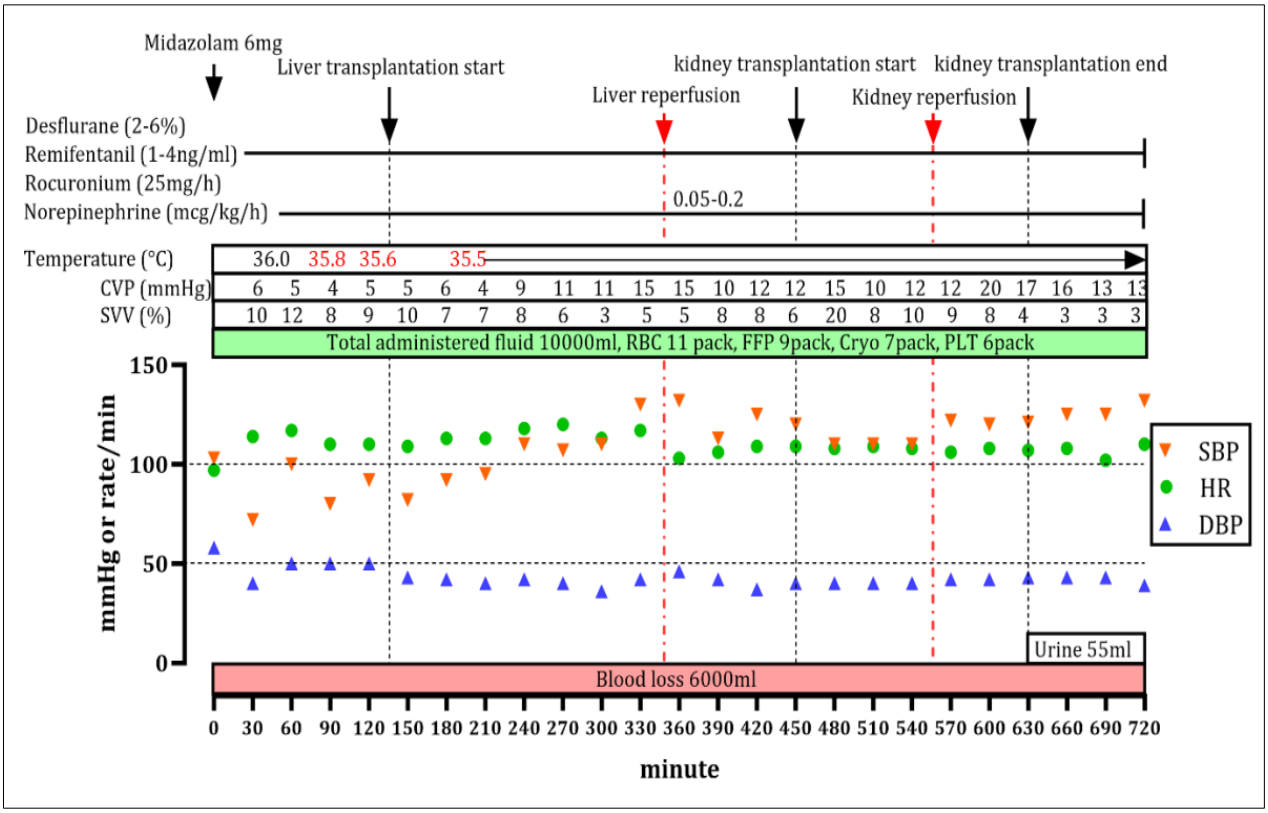

Fig. 1: Anesthetic record during combined liver kidney transplantation. CVP, central venous pressure; SVV, stroke volume variance; FFP, fresh frozen plasma; Cryo, cryoprecipitate; SBP, systolic blood pressure; HR, heart rate; DBP, diastolic blood pressure

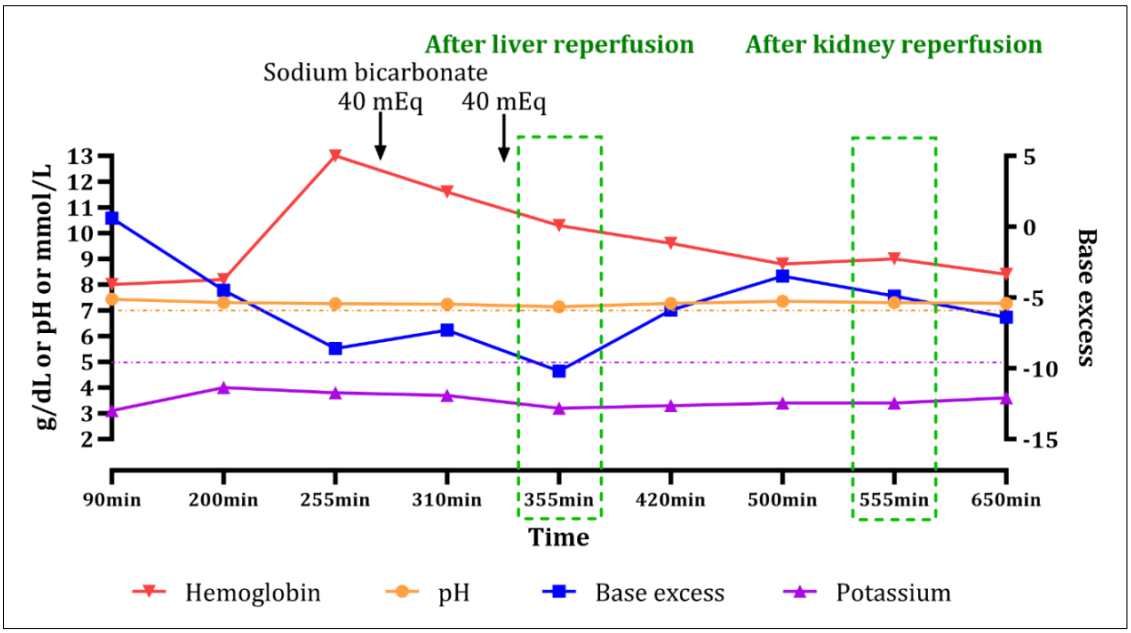

Fig. 2: Arterial blood gas analysis result during combined liver kidney transplantation anesthesia.

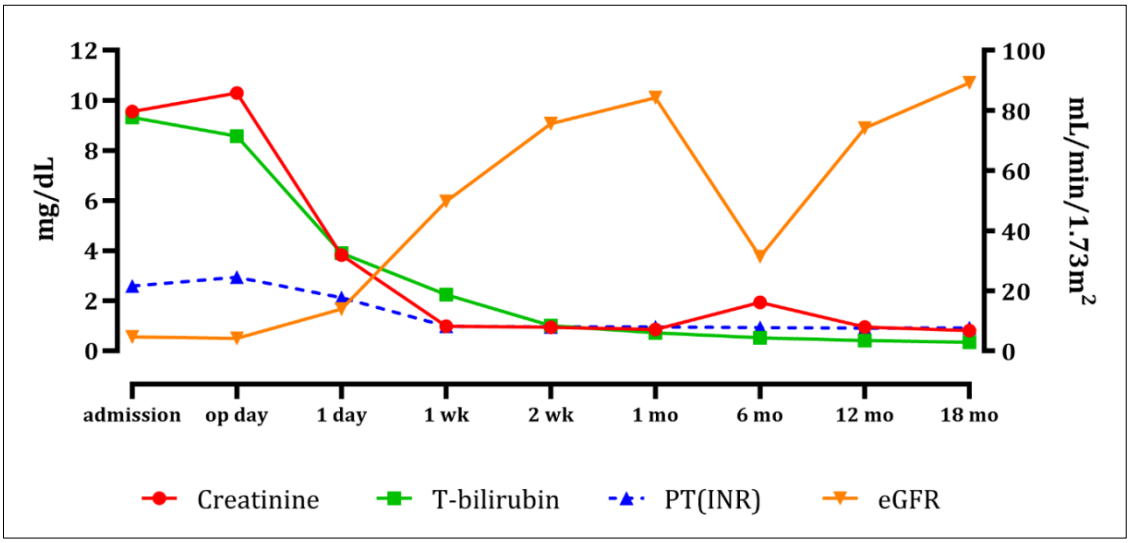

Fig. 3: Laboratory result from admission to 18 month post-transplantation. T-bilirubin, total bilirubin; PT, prothrombin time; eGFR, estimated glomerular filtration rate.

DISCUSSION

Currently, there are no universally accepted criteria for CLKT worldwide. However, according to criteria published by the United Network for Organ Sharing (UNOS) in 2017, candidates for CLKT are considered if they have an estimated glomerular filtration rate of 60 ml/min/1.73m² for more than 3 months, sustained acute kidney injury, or metabolic disease [3]. In this case, the patient was eligible for CLKT as she was receiving dialysis for end-stage renal disease for two years prior to surgery. During CLKT surgery, liver transplantation is performed first, as the ischemic time for the liver is shorter than that for the kidney [6].

Although there is no specific research dedicated to the preferred inhalation anesthetic for Combined Liver-Kidney Transplantation (CLKT), existing literature suggests that both desflurane and sevoflurane are effective in minimizing ischemia-reperfusion injuries [9]. When evaluating postoperative outcomes, particularly in terms of renal and liver functions as indicated by measurements like eGFR, creatinine, and total bilirubin, desflurane demonstrates superior results. Furthermore, it provides enhanced liver protection compared to sevoflurane [10]. While the distinct advantages of these anesthetics are less apparent seven days after transplantation [11], desflurane, when considering all factors, can be regarded as the more favorable option for volatile anesthesia in CLKT.

In this case, we administered balanced crystalloid solutions (Plasmalyte and Hartmann solution) as the maintenance fluid. As 0.9 % normal saline does not contain potassium, previous CLKT case report used

this as a maintenance fluid [7]. However, a case report published by Wi *et al*., [6], used balanced crystalloids as the primary fluid choice. This aligns with the recommendation to utilize balanced salt solutions for patients with end-stage renal disease [12]. These solutions have a more neutral pH compared to 0.9 % normal saline and contain only a minimal amount of potassium (typically 4-5 mEq/L). However, 0.9% normal saline can cause hyperchloremic acidosis, which in turn can increase extracellular potassium levels [12]. Fluid management during surgery can be divided into two phase. During pre-anhepatic phase, restricted fluid replacement is recommende (central venous pressure below 7 mmHg, stroke volume variation below 10 %) because excessive fluid administration can lead to liver graft dysfunction [13, 14]. During this phase, if the patient received preoperative dialysis, hemodynamic instability during the induction of general anesthesia may be more pronounced [13]. After liver reperfusion, central venous pressure should be increased to around 10 mmHg while avoiding fluid overload to increase renal blood flow [7-15]. Stroke volume variance can also be used as a alternative to central venous pressure. one study described that a stroke volume variance of 6% is equivalent to a central venous pressure of 8 mmHg during kidney transplantation [16]. In the present case, we also maintained central venous pressure at approximately 12 mmHg and stroke volume variance 10 % before kidney reperfusion.

It is recommended to maintain the target mean arterial pressure between 60-75 mmHg during CLKT by using norepinephrine, as it has been shown to increase glomerular filtration rate and renal oxygen consumption [17]. This recommendation is further supported by another study, which associates maintaining a systolic blood pressure of 121-130 mmHg with good kidney graft survival [18].

In liver transplantation patients with renal dysfunction, intraoperative renal replacement therapy (IORRT) can be utilized. However, despite its high cost, invasiveness, and the considerable effort required for initiation, there is no quantified benefit from its use [19]. There is also a study shown that compared to non-IORRT liver transplantation patient, emergent IORRT is associated with more intraoperative complications and longer ICU hospitalizations [20]. In our case, pH and potassium levels were maintained within normal limits without IORRT during the procedure, and metabolic acidosis was managed with sodium bicarbonate.

In this case report, a crucial aspect to consider is the patient's body temperature. In our case, patient warming was initiated after the induction was completed. Due to the delay in starting warming, the patient's body temperature remained below 36 °C throughout the surgery. Low body temperatures during surgery can increase the risk of cardiac arrhythmia and hyperkalemia [21]. Therefore, in subsequent CLKT cases, special attention should be paid to maintaining the patient's body temperature.

Recipients of CLKT demonstrated higher survival rates than those who received only liver transplants and had renal dysfunction [22]. The frequency of post-operation dialysis was higher among CLKT recipients compared to liver transplant recipients [23]. In our case, the CLKT patient exhibited dramatic improvements in creatinine, total bilirubin, prothrombin time, and estimated glomerular filtration rate after the operation, and did not require dialysis post-surgery.

The limitation of our case report is its basis on a single case, meaning the findings and conclusions drawn may not be widely applicable to all CLKT patients. There is a need for larger studies or a series of case reports to validate these findings and ensure broader applicability.

In conclusion, this case report illustrates the effectiveness of combined liver-kidney transplantation (CLKT) for patients with concurrent liver and renal dysfunction. Our findings indicate that CLKT recipients have higher survival rates and improved postoperative outcomes compared to liver-only transplant recipients. Key factors contributing to this success include the careful choice of anesthetic agents, particularly desflurane, and the strategic management of intraoperative fluids and hemodynamics.

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Ethics Approval

This case report was reviewed and approved by the Institutional Review Board of Keimyung University Dongsan Medical Center at 4 Dec 2023 (IRB no. 2023-11-039). Informed consent was waived due to retrospective design.

Conflict of Interest: The authors have no conflict of interest relevant to this article.

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