# Sevoflurane Anaesthesia in a Patient with Renal Transplantation: Case Report and Literature Review

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**Citation**

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**Abstract**

In this case report, we have presented our anaesthetic management in a patient undergoing urgent abdominal surgery who has undergone renal transplantation before, and has been in a chronic haemodialysis program two times a week. Anaesthesia was induced with sevoflurane in nitrous oxide-oxygen mixture via a mask and maintained with sevoflurane 1.5% in N2O:O2 (50%:50%). A bolus dose of atracurium 25 mg was administered intravenously and intubation was done. Standard monitoring consisted of an electrocardiogram, non-invasive arterial pressure and pulse oximetry. Serum creatinine, potassium, sodium and blood urea nitrogen levels and also creatinine clearance were measured preoperatively and in the first, second, third and seventh postoperative days. Surgical cholecystectomy was performed and the duration of anaesthesia was 60 minutes.

We conclude that sevoflurane does not aggravate renal impairment in measured parameters (serum creatinine, blood urea nitrogen and creatinine clearense) of renal function and does not change the time for haemodialysis in the patient with renal insufficiency.

## INTRODUCTION

In addition to care being shown in the selection of drugs and agents in anaesthesia in renal insufficiency cases that will not increase renal damage and whose degradation will be independent of the kidney, care must also be taken regarding such situations as hypoxia and ischaemia ([1]).

Sevoflurane, an inhalation anaesthetic, is used in anaesthesia induction by mask due to such features as its pleasant smell, the way it does not cause irritation in the respiratory channels, and rapid induction ([2]).

In this report we describe the anaesthesia method used in a case with a transplanted kidney, undergoing dialysis twice a week, taken for emergency acute abdominal surgery.

## CASE REPORT

A 48-year-old male weighing 70 kg and 172 cm tall had received a right kidney transplant 11 years previously due to chronic renal insufficiency. Cyclosporin (Sandimmun, Novartis) 3 x 350 mg, mycophenolate mophetil (CellCept, Roche) 3 x 250 mg and prednisolone (Deltacortil, Pfizer) 1 x 5 mg were used for immunosuppressant treatment. The patient's kidney functions had followed a normal course until three months previously, when he presented to hospital with high fever and complaints of swelling in the hands and feet. In measured parameters serum creatinine was 7.1 $dL^{-1}$, BUN 64 mg $dL^{-1}$, and potassium 4.5 mmol mg $dL^{-1}$ and the patient was admitted to hospital. Due to urinary excretion of 500 ml on the first day and a total of 700 ml on the second, high BUN and creatinine, a creatinine clearance level of 6 mL $min^{-1}$ and hypervolemia, he was admitted to the dialysis program twice a week. On day 20 of hospitalization ultrasonography of the patient, who had pain in the upper right abdominal region, nausea and fever, was compatible with cholelithiasis. He was diagnosed with acute abdomen and taken for emergency surgery.

Following routine monitoring (ECG, non-invasive blood pressures, peripheral oxygen saturation) sevoflurane induction by mask was performed while talking to the patient. Sevoflurane was commenced at 5% and the patient's respiration and sedation level were gradually reduced. Following muscle relaxation with atracurium 25 mg, intubation was performed. Anaesthetic maintenance was established with sevoflurane 1.5% and an oxygen/N2 (40%/60%) mixture. There was no evident intraoperative change in initial blood pressure values of 140/90 mmHg, pulse values of 84 beats $min^{-1}$, or oxygen saturation values of 96%, and these continued within normal levels. A total of

500 ml of 0.9% NaCl was administered intraoperatively. Cholecystectomy was performed, with surgery duration recorded as 50 min and length of anaesthesia as 60 min. Following the operation, the patient was wakened by turning off the sevoflurane and extubated. Recovery was good and rapid. No complications were observed. The patient's preoperative and postoperative days 1st, 2nd, 3rd, and 7th serum creatinine, BUN, potassium, sodium, chloride and creatinine clearance levels were examined (Table 1). According to these values, there was no additional worsening in renal functions. The first postoperative dialysis took place on the day planned.

**Figure 1**

Table 1: Case Findings Monitored

| | First arrival | Before preop. dialysis | After preop. dialysis | Postop. Day 1 | Postop Day 2 | After day 3 dialysis | Before day 7 dialysis | After day 7 dialysis |
|---|---|---|---|---|---|---|---|---|
| Creatinine (mg $dL^{-1}$ ) | 7.1 | 6.5 | 3.4 | 4.5 | 5.5 | 4.0 | 6.6 | 3.8 |
| BUN (mg $dL^{-1}$ ) | 64 | 25 | 12 | 16 | 18 | 13 | 19 | 10 |
| K (mmol $L^{-1}$) | 4.5 | 3.4 | 3.4 | 3.7 | 3.8 | 3.4 | 4.0 | 3.5 |
| Na (mmol $L^{-1}$) | 139 | 141 | 143 | 138 | 140 | 134 | 141 | 146 |
| Cl (mmol $L^{-1}$) | 106 | 102 | 102 | 103 | 100 | 98 | 100 | 110 |
| CC (mL $min^{-1}$) | - | 6 | - | - | 8 | - | 8 | - |

## DISCUSSION

The method of anaesthesia and anaesthetic drugs to be selected in cases of renal insufficiency vary according to the patient's general condition and the site of the surgery to be performed. Regional anaesthesia methods such as spinal anaesthesia and epidural anaesthesia are preferred in appropriate surgical interventions since these damage renal functions less in comparison to general anaesthesia. In both general and regional anaesthesia it is a general rule that renal blood flow be protected and sufficient oxygenation provided ([1]). In our case we selected the general anaesthetic technique since emergency abdominal surgery was to be performed.

Most general anaesthetics reduce renal blood flow in line with the level of anaesthetic and cause a general depression in renal functions. Narcotic analgesics and intravenous general anaesthetics such as pentothal, propofol, etomidate, diazepam, midazolam, morphine, meperidine and fentanyl may prolong their effects in renal insufficiency. Accumulative effects linked to level of anaesthetic and the dosage applied may be seen. Inhalation anaesthetics such as halothane, sevoflurane, desflurane and isoflurane generally depress renal functions ([1]). Among muscle relaxants, succinylcholine may be contraindicated if hyperkalemia is present. Among non-depolarizing muscle relaxants, atracurium and vecuronium may be used. Atracurium is an appropriate choice in patients of this type since it undergoes Hoffman degradation and degradation is not dependent on renal function ([3]). In our case we performed induction by mask with sevoflurane and used the muscle relaxant atracurium (Tracrium) for intubation.

In the analysis of renal functions, serum creatinine and BUN values, creatinine clearance, urinary protein and glucose extraction are reliable parameters ([4]). Proteinurea shows glomerular damage, and glucosuria shows proximal tubular damage. Creatinine clearance (CC) exhibits an ability to filter glomerular creatinine and thus shows the glomerular filtration rate (GFR). CC, an early indicator of renal dysfunction, of < 25 $min^{-1}$ is shown among those findings requiring sensitivity ([5]). In addition, the most sensitive indicators of proximal tubular cell damage and necrosis in the proximal tubular cells are enzymuria (N-acetylglucosaminidase, NAG; alpha-glutathione-S transferase, -GST) and urinary $_2$ -microglobulin ($_2$ –M) excretion ([5]). In order to monitor kidney functions in our case, having a transplanted kidney and who had embarked on dialysis, we observed serum creatinine, BUN, potassium and sodium levels, measured creatinine clearance and monitored time of entry into dialysis.

Due to its pleasant, non-acrid smell and failure to cause irritation, sevoflurane can be used in anaesthetic induction by mask in children and adults. It has been reported to perform good induction with no negative effects on haemodynamics or irritation, as well as providing rapid waking and recovery ([2]). We applied induction by mask with sevoflurane in our case and encountered no complications. We continued to monitor oxygen saturation and blood pressures in order to protect the kidney against hypoxia and ischaemia.

The effects on renal functions of sevoflurane are a matter for debate. Of sevoflurane metabolites, the free fluoride ion may lead to a loss of renal concentration ability and to tubular damage leading to polyuric acute renal insufficiency. Renal damage is correlated with $F^{-1}$ levels ([6]). Another sevoflurane metabolite that can give rise to kidney damage is Compound A. Compound A has been reported to cause microscopic renal damage in rats ([7]). It has been shown in various studies that sevoflurane anaesthesia leads to higher $F^{-1}$ ion formation

compared to isoflurane anaesthesia. The occurrence of Compound A, the product of this increase in the inorganic fluoride ion and metabolism, has been reported as responsible for nephrotoxicity ([8]).

Experimental studies in rats have shown that sevoflurane causes renal damage, but has also been shown in standard clinical tests to have no harmful effects on renal functions in clinical studies on patients and volunteers ([2]). Kharasch et al. ([4]) showed that BUN, creatinine, and creatinine clearance did not alter in long-term low-flow sevoflurane and isoflurane anaesthesia, and that protein and glucose expulsion with urine was frequent and similar between the two groups. Sarıcaoğlu et al. ([9]) reported that inorganic fluoride levels rose in patients undergoing coronary by-pass surgery with sevoflurane anaesthesia, and that it did not lead to renal tubular damage. Bito et al. ([10]) reported that the expulsion through urine of NAG, a tubular damage indicator, increased on postoperative day 3 in both sevoflurane anaesthesia and isoflurane anaesthesia. Güler et al. ([11]) demonstrated that sevoflurane had no effect on standard kidney function tests, and that it caused significant but temporary changes in $\beta_2$ –M levels, a specific renal function test. They also stated that in the absence of histopathological findings it was inappropriate to refer to these temporary changes as damage or toxicity. Bilgin et al. ([12]) investigated sevoflurane in measurements repeated at two different concentrations in rabbits, and Atalay et al. ([13]) investigated the effects on the kidneys of 10-hour sevoflurane anaesthesia in rats, and stated that at histopathological examination no finding of tubular necrosis had been encountered. Cesur et al. ([14]) recorded that sevoflurane was more of a theoretical nephrotoxicity problem than a clinical one.

In this case we chose sevoflurane anaesthesia by mask in induction due to its pleasant smell and failure to cause irritation. We avoided intravenous agents that might prolong effects and damage renal functions. As a muscle relaxant we used atracurium, whose degradation is independent of the kidney. We monitored renal functions by observing BUN, creatinine and potassium levels, creatinine clearance and time of entry into dialysis. There was no impairment in the patient parameters we observed following sevoflurane anaesthesia, and the patient commenced dialysis at the planned time. Mazze et al. ([15]) concluded in a 22-centre retrospective study that BUN and creatinine levels, the most appropriate and easy measurements for monitoring renal functions in surgical patients, were valuable and reliable parameters. Our observations in this case were parallel to those of Mazze et al.

In conclusion, we wish to emphasize that in this case with a transplanted kidney, included in the dialysis program, sevoflurane anaesthesia led to no increased damage in renal function tests such as BUN and creatinine, and did not alter the planned timing of dialysis.

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