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Sevoflurane anesthesia for renal transplanted patient—comparison with normal renal function subjects

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Introduction

There are many studies on serum inorganic fluoride (F^-) levels and renal function in sevoflurane anesthesia [1–3] because sevoflurane produces F^- and may cause renal dysfunction. It is not clear, however, what the effect of sevoflurane anesthesia is on a transplanted kidney. In this report, we investigate the serum and urinary F^- levels and renal function of a patient with a transplanted kidney who underwent sevoflurane anesthesia and compared the results with those of two patients with normal renal function.

Case report

The patient with a transplanted kidney was a 40-year-old man weighing 42.5 kg. He began receiving hemodialysis 8 years ago, and had a renal transplant 2 years ago. Thereafter he has taken cyclosporin 160 mg, mizoribine 100 mg, and methylprednisolone 8 mg/day. The patient was scheduled for posterior spinal fusion for L4-5 spondylolysolisthesis. A presurgical examination showed blood urea nitrogen (BUN) of 16 mg·dl^{-1}, creatinine (Cr) of 1.2 mg·dl^{-1}, and urine output of 1500–2000 ml/day.

Midazolam 3 mg and atropine 0.3 mg were injected intramuscularly as premedicants 15 min before entering the operating room. Anesthesia was induced with midazolam 3 mg, fentanyl 0.2 mg, and vecuronium 6 mg and was maintained with 0.8% to 2.0% of sevoflurane, nitrous oxide 3 l·min^{-1} in oxygen 2 l·min^{-1}. Sevoflurane consumption, which was measured with a measuring cylinder, was 132.5 ml for about 3.4 minimum alveolar concentration (MAC)-hours. Duration of sevoflurane inhalation was 4 h and 25 min. No corticosteroids were administered during surgery and he began to take immunosuppresive drugs, which were the same as those before surgery, on the day after surgery.

Materials and methods

In this patient, we measured the serum and urinary F^- levels during and after anesthesia. A sample collected over 1 h was used for urinary measurement. For the measurements, we used a Microprocessor Ionalyzer (Orion Research, Boston, MA, USA). The limit of detection was 1.0 μmol l^{-1}).

We also measured BUN, Cr, serum and urinary levels of β_2-microglobulin (BMG), and urinary level of *N*-acetyl-β-D-glucosaminidase (NAG) before and after surgery. We measured BMG by immunoturbidimetry (LPIA-100, Diatron, Tokyo, Japan, limit of detection was 0.4 mg·l^{-1}) and NAG by MCP-colorimetry (Shionogi, Osaka, Japan, limit of detection was 0.2 U·l^{-1}).

For control patients we selected two men with normal BUN and Cr before surgery, and about the same age and the inhalation time of sevoflurane as that of the transplanted patient. Control patient 1 was a 43-year-old man weighing 48 kg who underwent brain tumor resection. The amount of sevoflurane consumption was 115 ml for about 3.2 MAC·h; sevoflurane inhalation lasted 3 h and 45 min. Control patient 2 was a 46-year-old man weighing 56 kg who underwent cerebral aneurysm clipping. Sevoflurane consumption was 110 ml for about 3.1 MAC·h; sevoflurane inhalation lasted 4 h and

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40 min. The same examinations were performed on the two control patients as on the transplanted patient. This protocol was approved by the ethics committee of our hospital and informed consent was obtained from all three patients.

Results

The serum F^- level of the transplanted patient reached the maximum level of 38.4 $\mu mol \cdot l^{-1}$ immediately after the end of sevoflurane inhalation, and then decreased. Those of the two control patients showed almost the same changes (Fig. 1). The urinary F^- level decreased after the end of sevoflurane inhalation in the transplanted patient, but it increased 3 and 5 h after the inhalation in the two control patients (Fig. 1). The BUN of the transplanted patient was higher than that of the two control patients (Fig. 2). Cr (Fig. 2) and the serum BMG level (Fig. 3) were higher in the transplanted patient from even before surgery, but did not show an increase after surgery. There was no difference in urinary BMG and NAG between the transplanted patient and the two control patients (Fig. 3). Clinically, none of the three patients showed renal damage.

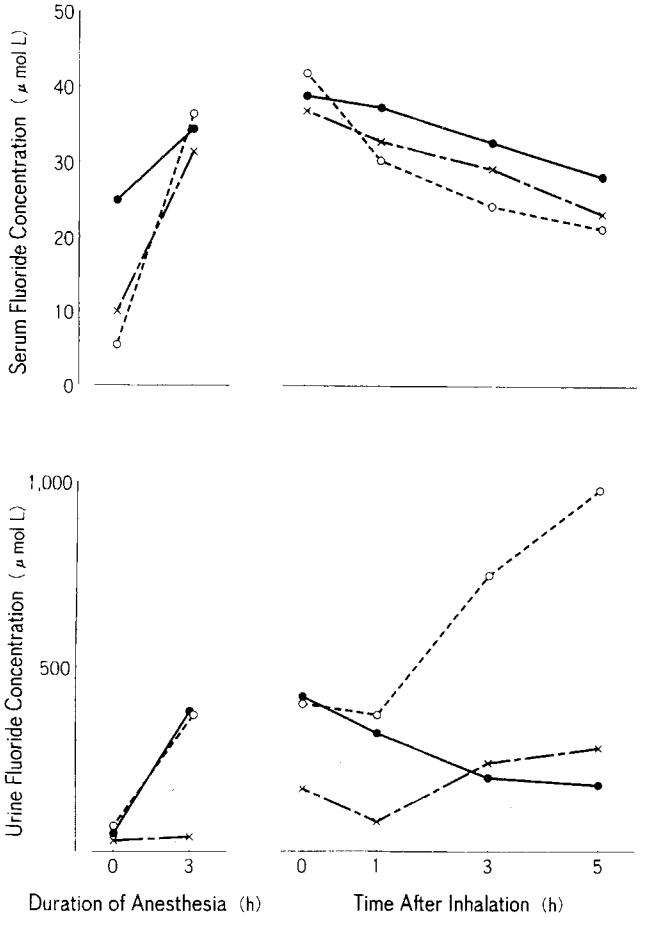

Fig. 1. Serum and urinary inorganic fluoride levels. *Closed circles* show the renal transplanted patient. *Open circles* show control patient 1, and *crosses* show control patient 2

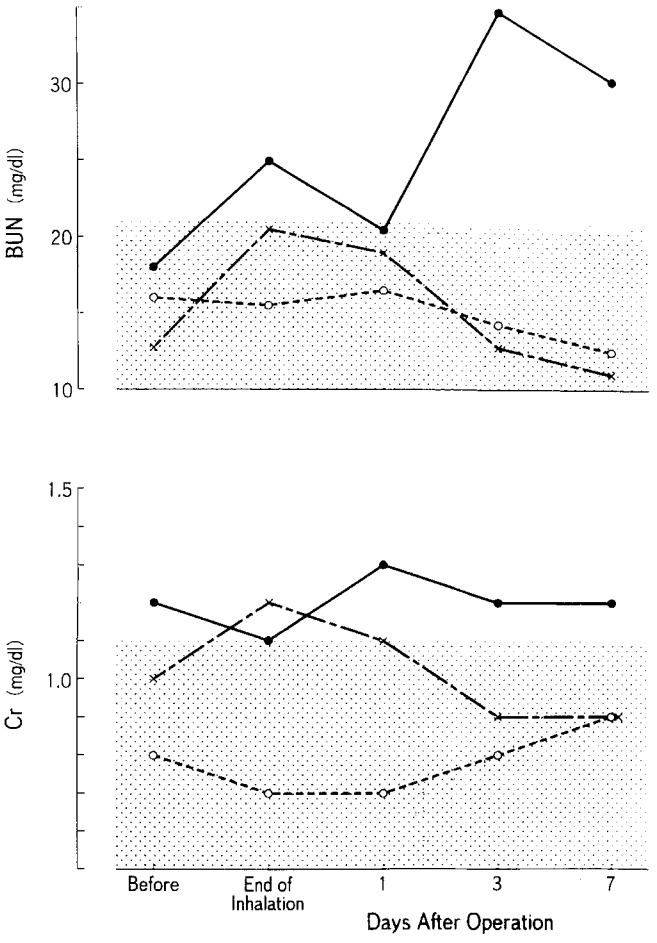

Fig. 2. Renal function. BUN, blood urea nitrogen; Cr, creatinine, *Shaded area* shows the normal range; *elosed circles* renal transplanted patient; *open circles*, control patient 1; *crosses*, control patient 2

Discussion

Many renal transplanted patients undergo general anesthesia. It should be taken into account that the transplanted kidney might not function normally.

It has been reported that transplanted kidneys maintained glomerular function relatively well, but the function of the renal tubule was sometimes severely disturbed [4]. The renal tubular function of the transplanted patient in this report might be relatively well maintained, because his urinary BMG and NAG levels before surgery were the same as those of the two control patients.

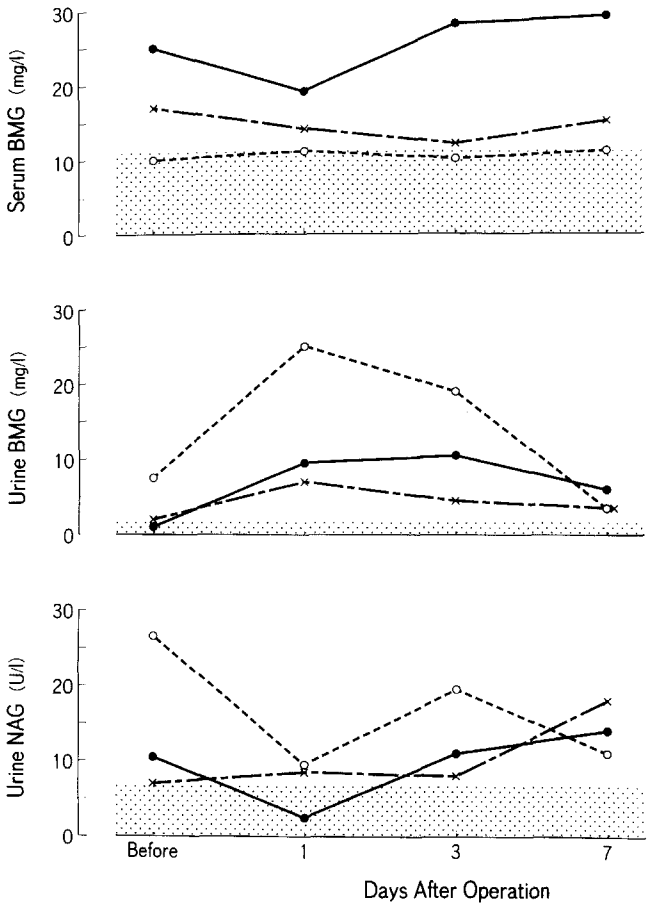

Fig. 3. Parameters in renal tubular functions BMG, β_2-microglobulin; NAG, *N*-acetyl-β-D-glucosaminidase. *Closed circles*, renal transplanted patient; *open* circles, control patient 1; *crosses*, control patient 2

Sevoflurane has some advantages such as a low blood-gas partition coefficient [5], small circulatory depressive effects [6], and a high controllability for the depth of anesthesia [7]. However, sevoflurane has fluorine atoms in its constitution and thus liberates F^- after its biodegradation [7]. It has been reported that F^- might cause renal insufficiency after methoxyflurane anesthesia [8], and that renal dysfunction might result when the level of serum F^- exceeded 50 μmol·l^{-1} [9]. On the other hand, no renal dysfunction occurred with sevoflurane anesthesia even if the level of serum F^- exceeded 50 μmol·l^{-1} [10]. This is considered to be due to the rapid decrease of the serum F^- level in sevoflurane anesthesia [10]. If renal function is impaired, excretion of F^- should be slower and its serum level may continue to be higher. Kondo et al. [11] reported that the serum F^- levels of hemodialysis patients were higher by 20 μmol·l^{-1} compared with patients having normal renal function. Some reports have documented that, although the function of the transplanted kidneys was inferior to that of healthy subjects [12,13], no renal dysfunction was observed in the transplanted patients after enflurane anesthesia [12].

Based on the finding that the serum BMG in our transplanted patient before surgery showed an abnormal value while his urinary BMG was normal, his renal tubular function appears to have been relatively well maintained.

Saitoh et al. [13] reported that the urinary BMG and NAG increased after sevoflurane anesthesia, which was thought to be due to various factors such as surgical stress, immunosuppresive drugs, and sevoflurane. In our transplanted patient, urinary BMG and NAG were high even on the 7th day after the operation, but these levels were the same as the two control patients. BUN and urinary BMG showed higher values after surgery compared to before surgery in the transplanted patient. This change of urinary BMG is considered not to be specific to this patient because urinary BMG increased in the control patients as well, and urinary BMG can be increased by other anesthetics [14]. Although BUN increased after surgery, Cr did not increase. Besides, one month after surgery, BUN returned to the presurgical level. Therefore, this increase in BUN might be due to surgical stress, not to renal damage. Clinically, renal failure did not occur.

Therefore, although sevoflurane did not cause noticeable dysfunction in the transplanted kidney, this was only one case and further study with more patients is necessary to confirm these preliminary findings.

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