Combined Epidural and General Anesthesia for Paediatric Renal Transplantation—A Single Center Experience

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ABSTRACT

Background. Appropriate anesthesia for pediatric renal transplantation requires stable intraoperative hemodynamics, optimal perfusion of the newly transplanted kidney and good analgesia during recovery. The aim of this study was to assess the preliminary application, success and safety of combined epidural and general anesthesia in pediatric renal transplantation in a small cohort.

Methods. We retrospectively reviewed the anesthesia records of 46 consecutive pediatric patients who received renal transplantation under combined epidural and general anesthesia from January 2003–2007.

Results. The mean patient age and weight were 13.2 ± 2.4 years and 25.7 ± 5.46 kg, respectively. The infused crystalloids, 20% albumin and red blood cell concentrates were 120 ± 2 mL/kg to achieve a CVP of 13 to 15 mm Hg. Brisk diuresis was observed in all patients. Epidural tramadol (2 mg/kg) provided good postoperative analgesia in 89% patients. 15% patients developed radiological evidence of pulmonary edema, only one required mechanical ventilation for hypoxemia. Minor adverse effects were nausea and vomiting (17.5%) and convulsions (8.5%). No perioperative mortality or major morbidity was recorded.

Conclusion. Epidural anesthesia is a useful adjunct to general anesthesia due to stable intraoperative haemodynamics and good postoperative analgesia.

RENAL TRANSPLANTATION is the most effective renal replacement therapy for children with end stage renal disease (ESRD). Historically, the clinical outcomes of pediatric patients has been inferior to adults, Graft hypoperfusion injury leading to acute tubular necrosis in the early post-transplant period is one factor responsible for poorer outcomes.[1] Important goals of perioperative management are to ensure stable intraoperative hemodynamics, provide optimal perfusion for the newly transplanted kidney and to provide good analgesia during recovery. Unfortunately, there are few published data regarding perioperative anesthetic care and postoperative pain management in pediatric renal transplant patients. In particular, the place of epidural analgesia in this setting remains contentious, as data regarding the risks of epidural hematomas and graft hypoperfusion are unavailable.[2]

In the last decade, the efficacy and safety of epidural anesthesia in pediatric practice have been confirmed in several large surveys.[3,4] It has been suggested that the technique may improve perioperative outcomes.[5] However these surveys do not address the risks and benefits of the technique for particular patient subgroups or clinical settings, such as renal failure and kidney transplantation. Since 1997, 130 pediatric renal transplants have been performed at our institution. For the last 3 years we have routinely administered combined epidural and general anesthesia to all patients. This retrospective review provides details of the perioperative anesthesia care of these children with special reference to hemodynamic stability and postoperative complications.

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PATIENTS AND METHODS

After Institutional Review Board approval, we performed anesthetic and perioperative management of 46 children who underwent renal transplantation under combined epidural and general anesthesia between January 2003–2007.

We reviewed the preoperative cardiac, hematological, respiratory, metabolic status and medications. Transplantation occurred within 36 hours of dialysis and antihypertensive medications were continued. Serum electrolyte and coagulation profiles were obtained prior to surgery.

After premedication with midazolam (0.05 mg/kg) intravenously, patients induced with thiopentone were intubated after succinylcholine. Balanced anesthesia was provided with 0_2: N_20/air(50%: 50) isoflurane and fentanyl. Atracurium was used for muscle relaxation. An epidural catheter (19–21 G) was placed in the lateral position at the L3–L4 interspace after anesthetic induction under strict asepsis. We injected 0.25% bupivacaine (0.5 mL/kg; total dose not exceeding 2.5 mg/kg) followed by a half dose at regular 90 minutes intervals.

Standard monitoring consisted of ECG, non-invasive/invasive blood pressure, pulse oximetry, end tidal CO_2, central venous pressure (CVP), peripheral nerve stimulator, temperature and urine output after release of the vascular cross-clamps. Intraoperative hemodynamic stability was judged on the basis of systolic blood pressure (SBP), as it is the principle clinical indicator of graft perfusion pressure.[6] Normal SBP was taken as the last SBP documented in the patient's notes prior to admission for transplantation. We recorded SBP values that deviated >30% above or below the patient's normal SBP lasting more than 10 min. requiring treatment. Crystalloid, 20% albumin and red blood concentrates were given to achieve a *CVP* of 13 to 15 mm Hg and Hct of 25% to 30%. Mannitol (0.5–1 mg/kg) and furosemide (2 mg/kg) were administered prior to release of the cross clamps to ensure a brisk diuresis. At the end of surgery, patients were reversed with atropine (0.02 mg/kg) and neostigmine (0.05 mg/kg).

All patients were monitored for 48 hours in the intensive care unit. An Immediate postoperative chest X-ray was obtained to confirm the position of the central venous catheter and to exclude pulmonary edema. Serum electrolytes and hematocrit were estimated at 4 hourly intervals and arterial blood gas analysis, at 12 hourly interval. Intravenous fluid replacement included 0.9% NS: 5% dextrose (50:50), and 10 mEq/L sodium bicarbonate with potassium supplementation as required. Pain relief was achieved with epidural tramadol (2 mg/kg) in isotonic saline (0.2 mL/kg) 8 hourly; the catheter was removed before discharge to the ward. All data are expressed as mean values ± SD.

RESULTS

There were 41 male and 5 female recipients of mean age of 13.2 ± 2.4 years (range = 6–18 years and weight of 25.7 ± 5.46 kg (range = 8–32 kg). Four patients weighed less than 15 kg. Live donor grafts were used in 41 and cadaveric kidneys in 5 patients. The etiology of renal failure is shown in Table 1.

Thirty-eight patients were on maintainence hemodialysis; 7, continuous ambulatory peritoneal dialysis and one underwent pre-emptive transplantation. 36 patients were on antihypertensive medications including 3 patients who underwent bilateral nephrectomy for uncontrolled hypertension before transplantation. Mild anemia was common (mean Hb 9.04 ± 2 g/dL) with 70% of children receiving either iron supplements, erythropoietin or both. 7 patients suffered renal osteodystrophy and all received calcium and vitamin D_3 supplementation. Serum electrolytes and coagulation profile were within normal limits at the time of surgery.

Table 1. Aetiology of Renal Failure in Transplant Recipients

Cause of Renal Failure	Number	%
Glomerular disease	27	59
Congenital nephrotic syndrome	8	17.5
Vesico-ureteric reflux disease	7	15
Obstructive uropathy	3	6.5
Renal dysplasia	1	2
Total	46	100

The radial artery was cannulated in two patients weighing less than 10 kg for invasive BP monitoring. Crystalloid (115.4 ± 10.6 mL/kg), colloid (4.5 ± 0.45 mL/kg) and red blood cell concentrates (10.3 ± 1.9 ml/kg) were infused to maintain intravascular volume prior to release of the renal vessel clamps. Only 2 patients required inotropic support with dopamine up to 10 μg/kg per minute after release of the clamps. Vascular anastomosis sites were the external iliac vessels (n = 33), common iliac vessels (n = 10), common iliac artery and IVC (n = 2), aorta and IVC (n = 1). Three grafts were placed intraperitoneally and the remainder extraperitoneally in the iliac fossa.

Immediate allograft function was established in all patients; the average urine output in the OR was 32.5 ± 4.6 mL/kg. The mean duration of surgery was 270 ± 23 minutes and duration of anesthesia was 294 ± 12 minutes. Postoperative complications included electrolyte abnormalities in 6 patients, convulsions in 4 patients and nausea and vomiting in 8 patients. X-ray evidence of pulmonary edema was present in 7 patients, including one who required postoperative ventilatory support for 6 hours due to hypoxaemia. One patient aged 12 years was re-explored for bleeding and was managed under epidural anesthesia with light sedation. All patients experienced good pain relief with epidural tramadol as assessed by visual analogue scale[7], only 5 patients required parenteral supplementation with opioids. No perioperative mortality or major morbidity was observed.

DISCUSSION

General anesthesia is the most popular technique for adult as well as pediatric renal transplantations; perioperative use of an epidural catheter has not gained wide acceptance. Recently there are increasing reports of successful use of regional anesthesia in adult recipients,[8,9,10] although one center has reported safety and efficacy of epidural anesthesia in the pediatric population.[6] The major concerns with the use of epidural anesthesia are (i) the perceived risks of hemodynamic instability on reperfusion of graft, (ii) a theoretically increased risk of epidural hematoma and

abscess formation, and (iii) limited data on the profile of minor adverse effects.

Maintenance of hemodynamic stability is a major concern in pediatric patients receiving an adult kidney. The adult kidney can hold 300 mL of circulating blood volume, which may be a significant portion of pediatric patients' cardiac output.[11] Also the transplanted kidney may initially produce adult quantities of urine further aggravating hypotension. Episodes of hypoperfusion and ischemia in the perioperative period may contribute to renal artery thrombosis, delayed graft function or acute tubular necrosis rendering the kidney more immunogenic.[12] For this reason, optimization of physiological variables to ensure prompt graft perfusion at the time of unclamping and immediate reperfusion is essential. In our small, single-center study, supplementing general anesthesia with epidural anesthesia was associated with stable hemodynamics in the majority of pediatric patients. Although we did not compare it with general anesthesia, several other small controlled studies have shown comparable or greater hemodynamic stability of epidural anesthesia among pediatric and adult renal transplantations.[6,13,14,15] The possible mechanisms are (1) reduced circulating catecholamines, (2) better cardiac function due to decreased systemic vascular resistance, (3) reduced volatile agent requirements and therefore less myocardial depression, and (4) controlled preloading under CVP monitoring prior to reperfusion.

The risk of epidural hematoma and abscess formation may be magnified in renal transplant patients due to potential coagulopathy and immunosuppression. The incidence of epidural hematoma associated with continuous epidural anesthesia in the general surgical population is estimated to be between 1:150000 to 1:190000.[16] A literature analysis shows that regional techniques may be safely used in patients with various forms of coagulopathy if strict guidelines are followed.[17] Recently there are increased reports of epidural analgesia use among children undergoing open heart surgery without adverse events.[18,19] None of our patients showed preoperative laboratory abnormalities that might indicate a bleeding diathesis. All patients had undergone nonheparinized hemodialysis in the preoperative period. In each patient, well-trained anesthetists performed atraumatic placement of epidural catheters.

Similarly the incidence of epidural abscess formation was extremely rare when asepsis was observed and catheters maintained only for short periods. Auletta and John reported 8 epidural abscesses in children over 15 yrs. of age; none were related to epidural catheterization.[20] Straford demonstrated a low infection rate in a retrospective study of more than 1620 children who were treated with epidural analgesia for a few days.[21] In the postoperative period, no neurological sequelae were observed, although the total number of patients was too small to provide reassurance about these complications.

Epidural analgesia with narcotics has been shown to be superior to parenteral opioids in pediatric patients due to minimal side-effects.[22] We used tramadol because it rarely causes cardiovascular or respiratory depression even in large doses; many reports have shown its analgesic efficacy to be comparable to morphine in the pediatric age group.[23,24] We also observed adequate analgesia in majority of patients, only 11% required systemic opioids. There is a theoretical risk of pulmonary edema at the time of cessation of the sympathetic block but with careful fluid management and close monitoring, this risk may be minimized. The 7 patients (15%) who developed radiographic evidence of pulmonary edema in our series resolution experienced early with only one patient requiring mechanical ventilation with PEEP for a short period.

The incidence of nausea and vomiting was lower than previously reported in the literature.[25] We administered methylprednisolone intraoperatively as an immunusuppressant which might have decreased emesis in this group.[26] One area of concern was the occurrence of convulsions in 4 patients, whether they were due to electrolyte disturbances as a result of the adult quantity of urine produced by the newly transplanted kidney or the use of tramadol in association with epileptogenic drugs[27] like immunosuppressants remains speculative. Common technical problems related to catheter leakage, occlusion or disconnection were not observed in our series.

In conclusion, This retrospective study suggested that epidural anesthesia is a useful adjunct to general anesthesia in pediatric patients receiving adult kidneys. It provided effective perioperative analgesia without compromising cardiovascular stability. However, prospective, randomized, controlled studies are needed to compare the benefits of epidural plus general versus general anesthesia alone in children undergoing renal transplantation.

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