Intraoperative Hyperkaliemia Complicating Hand-assisted Live-donor Nephrectomy

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Abstract

Objectives: **Live donation has become increasingly valuable as a potential source of kidneys for transplant with hand-assisted laparoscopic donation is an important method of organ procurement. An important consideration is adequate preoperative and intraoperative planning, and precautions to minimize potential risks in the donor while providing a graft with good primary function.**

Materials and Methods: **We present a case of live donation in which a hand-assisted laparoscopic approach was used to facilitate kidney donation. The process was complicated by a period of profound intraoperative hyperkalaemia, subsequently ascribed to rhabdomyolysis owing to muscle necrosis.**

Results: **A 46-year-old man underwent assessment for live kidney donation for his brother. Preoperative investigations revealed normal renal function with no contraindications to donation. However, at the time of donation, a period of unexplained hyperkalaemia occurred that resolved spontaneously with fluid resuscitation and aggressive diuresis. After surgery, he was demonstrated to have an elevated creatine kinase level associated with unilateral gluteal pain and bruising. There were no long-term complications, and the donor made a full recovery with normal renal function. Hyperkalaemia was ascribed to extensive rhabdomyolysis owing to positioning on the operating table at the time of surgery.**

Conclusions: **Rhabdomyolysis associated with laparoscopic renal surgery requires prompt recognition and treatment while unexplained hyperkalaemia may herald its onset. It is important that an increased sense of vigilance is given to patients with increased muscularity or body mass, especially in donor nephrectomy patients, because of its effect on the remaining solitary kidney.**

Key words: *Live donation, Rhabdomyolysis, Creatine kinase, Acute tubular injury*

Introduction

Live-renal donation has become increasingly used for organ procurement as the demand for transplants has outstripped the supply of deceased donor organs. After the procedure's initial description in 1997, hand-assisted laparoscopic nephrectomy has been increasingly used by the transplant community for donor kidney procurement.[1] This method has well-documented benefits compared to open operations including decreased morbidity, shorter hospital stays, and improved cosmesis.[2,3] Live donation also has distinct advantages for the potential recipient in that it not only circumvents the requirement to wait for a deceased organ, but it also is associated with significantly better graft and patient survival.[4, 5] Despite the fact that life-expectancy of kidney donors appears to be similar or even longer than that of nondonors, it is important that adverse outcomes are minimized in live donation.[6-8]

Rhabdomyolysis, the rapid breakdown of skeletal muscle owing to injury to muscle tissue, is accompanied by the excretion of myoglobin in the urine. It was first reported in Germany in 1881, but was described in detail after the London Blitz, during

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World War II.[9] It most frequently presents as a complication of trauma-related crush injuries, but may be associated with any condition that causes extensive muscle ischemia and may present with profound hyperkalaemia.[10] During surgery, rhabdomyolysis also may occur secondary to prolonged muscle compression owing to surgical positioning and patient body mass, resulting in muscle injury and subsequent ischemia owing to elevated compartment pressure.[11, 12]

Various reports have previously demonstrated the danger of rhabdomyolysis secondary to patient positioning for laparoscopic donor nephrectomy and complex urologic procedures with episodes also noted during bariatric surgery.[13-16] However, we present the first case of rhabdomyolysis presenting with profound unexplained hyperkalaemia intraoperatively.

Case Report

A 46-year-old previously healthy, muscular man, with a body mass index of 33.58 kg/m^2 (weight 120.3 kg; height 188 cm), was fully evaluated for possible donation to his brother using published British Transplantation Society guidelines.[17] These guidelines aim to ensure the patient's fitness to undergo surgery; establish anatomic suitability for donation of the kidneys and urinary tract, and assess preoperative renal function. His brother had end-stage renal failure secondary to familial adult polycystic kidney disease. His mother had had a deceased-donor renal transplant 1 year previously, but there was no other history of polycystic or cerebral vascular disease, and the donor had been fully screened and found to have normal kidneys on ultrasound. The donor had no significant medical or surgical history, and preoperative investigations were all within normal limits, with a creatinine of 102 μmol/L and a calculated creatinine clearance of 160 mL/min (Cockcroft and Gault) (Table 1).

The left kidney was chosen for donation based on preoperative imaging. General anaesthesia was induced with propofol and fentanyl, and tracheal intubation was facilitated with atracurium. Anaesthesia was maintained using 2% sevoflurane in an oxygen/air mixture, and with judicious epidural top-ups of 0.25% bupivacaine. The total operative time was 225 minutes. The average operative systolic blood pressure was 95 mm Hg with a single episode of hypotension (systolic blood pressure = 60 mm Hg) before the start of surgery, which responded to ephedrine. He initially received 3l of 0.9% saline intraoperatively as part of the routine protocol. Five hundred mL of 10% mannitol was given before cross-clamping, and total operative urine output was 200 mL before mannitol and 1300 mL after administration. Estimated blood loss was minimal.

Table 1. Summary of preoperative investigations as per published British Transplantation Society guidelines.[17]

Investigation	Result
Urinalysis	Negative (2 occasions)
24-hour urine creatinine clearance	160 mL/min
Renal ultrasound	Nonobstructed kidneys Left: 12.4 centimeters; Right: 12.7 centimeters
Preoperative blood tests:	
Serum potassium	4.1 mmol/L
Serum creatinine	102 μmol/L
Dimercaptosuccinic acid (DMSA) scan	Split function: left 48%; right 52%
Glomerular filtration rate (GFR)	Creatinine clearance: 127.8 mL/min 91.0 mL/min
Electrocardiogram	Normal
Chest radiograph	Normal
Computed tomography (CT)	Single renal arteries bilaterally with no evidence of early branching. Duplicated left renal vein.

All investigations were within normal limits and form part of the local preoperative assessment protocol.

The patient was positioned in a modified lateral decubitus position on the padding that comes with the operating table, with back supports at the hip, shoulder, and mid-back at a 45° angle with the right-side down, and a lumbar table break facilitating access to the space between the costal margin and iliac crest. Ports were then placed as follows: a 6-cm upper midline incision for the insertion of the hand port; two 10-mm ports inserted in the left iliac fossa, and a pneumoperitoneum insufflated. Hand-assisted left-donor nephrectomy was then initiated as previously described.[1, 3, 18]

The patient complained of right hip and buttock pain once awake without any clinical evidence of compartment syndrome. A diagnosis of rhabdomyolysis was made based on a raised creatine kinase serum level of (peak level 13 033 U/L on the first postoperative day), hyperkalaemia, and muscle pain. Two hours after beginning surgery, the patient developed peaked T waves, and blood gas analysis revealed a profound unexplained hyperkalaemia (6.8 mmol/L). This was treated with a 50 mL bolus of 50% dextrose and 20 units of human actrapid insulin with a further 2 L of 0.9% saline as fluid resuscitation.

The potassium decreased to 5.83 mmol/L. Blood lactate (a marker for anaerobic metabolism) was raised between 2.3 and 2.4 mmol/L. Blood glucose increased from 5.80 to 12.40 mmol/L as a consequence of the emergency administration of dextrose and insulin. Procurement of the left kidney was uneventfully completed.

He remained hemodynamically stable and pain free with the use of thoracic epidural (fentanyl 2 μg/mL and bupivacaine 0.125%; 5 to 0 mL/h). Aggressive fluid resuscitation was initiated as part of his postoperative management to prevent any detrimental effects to the renal function (Table 2). The patient's creatinine and renal function responded well, and no renal replacement therapy was required. Follow-up was done at 2 months and 1 year as per unit guidelines, and renal function was within normal parameters on both occasions.[17]

Discussion

Hyperkalaemia, a potassium level greater than 5.5 mmol/L, is a potentially fatal disorder, with a multitude of causes including renal failure, uncompensated acidosis, rhabdomyolysis, hemolysis, and medications.[10] The major clinical effects of this electrolyte abnormality include impaired cardiac conduction, resulting in potential arrhythmias. Electrocardiography is important as it may be diagnostic and dictate emergency treatment.[19]

Rhabdomyolysis, the cause of hyperkalaemia in this case, is a potentially life-threatening syndrome and is an important potential complication of laparoscopic renal surgery with a reported incidence of 0.4% to 4.9%.[16, 20-22] The classic presentation includes muscular aches, weakness, and tea-colored urine. This triad may not always be present, and the diagnosis, therefore, may largely rest on clinical acumen. An elevated plasma creatine kinase level, as seen in this case, is the most-sensitive laboratory finding pertaining to muscle injury. The clinically relevant sequelae may include hyperkalaemia, acute renal failure, and compartment syndrome.

Rhabdomyolysis has been reported after use of the lateral decubitus position for open flank operations and may result from direct compression injury and poor tissue perfusion owing to decreased cardiac output.[23] However, in this case, important contributing factors, which were clinically relevant, may have included the increased muscular mass, associated with an increased susceptibility to acute renal failure because of a solitary kidney. In addition, it may be postulated that the lumbar break may have been an important contributory factor toward the development of this sequelae as has previously been reported.[12, 23] It may be prudent to carefully consider the benefit of the use of any lumbar break in laparoscopic donors as adequate exposure may be obtained without this positional modification. The negative effect of this position may therefore outweigh the benefits in terms of ease of procurement. Fortunately, early recognition and treatment of the hyperkalemic episode coupled with vigorous fluid resuscitation have prevented any detrimental effects for the donor's renal function and no replacement therapy was required.

Urinary alkalinization, coupled with mannitol administration, to prevent myoglobin precipitation in the renal tubules and to facilitate osmotic diuresis, renal vasodilatation, and free radical scavenging, have been recommended for treatment based on

Table 2. Objective parameters and markers of renal function and rhabdomyolysis.

	Laboratory reference range	Preoperative	Intraoperative*	Intraoperative#	Day 0 (postoperative)	Day 1	Day 2	Day 3	Day 4	Day 5	2 mo
Potassium (mmol/L)	3.5-5.5	4.4	6.8	4.3	4.6	4.3	4.3	3.9	3.9	3.9	4.6
Creatinine (μmol/L)	62-106	85	-	134	144	151	152	136	129	123	124
GFR (mL/min)		89		53	49	46	46	52	55	58	58
CK (U/L)	0-190	-	-	-	-	13033	-	-	3376	-	-
Intravenous Fluid administration (L) (0.9% normal saline)	1	1	2	4.4	3	3	0.4	N/A	N/A		
Oral intake (L)		N/A	N/A	N/A	0.2	4.4	5.4	3.9	0.9	-	N/A
Urine output (L)		-	0.3	1.2	2.5	4.8	8.1	5.6	2.7	-	N/A

Serum potassium, Creatinine, Glomerular filtration rate (GFR) and creatine kinase (CK) were established at relevant time points preoperatively, intraoperatively, and postoperatively. *And #denote intraoperative blood results pre–dextrose-insulin and post–dextrose-insulin infusion (170 minutes after start of the procedure). N/A denotes not applicable (either not recorded or not appropriate for time point)

favorable results in previous animal studies.[24-26] As part of standard unit protocol to facilitate diuresis, mannitol is administered to all living donors, and this appears to have had beneficial results in this case. Postoperatively, vigorous oral and intravenous fluid resuscitation (Table 2) proved beneficial in preventing any adverse nephrotoxic effects from the myoglobin.

Previous cases of rhabdomyolysis owing to patient position in laparoscopic donor nephrectomy and urologic cases have been described, but they have invariably presented postoperatively with muscle pain potentially progressing to acute renal failure.[13-16] This appears to be the first case in which the preemptive finding of hyperkalaemia with subsequent aggressive correction and prompt diuresis may have facilitated safe donation and prevented any adverse renal sequelae.

Conclusions

Unexplained hyperkalaemia remains a diagnostic conundrum within the anesthetic and surgical setting but may herald the onset of profound rhabdomyolysis in this environment. It is important that increased vigilance is used in patients with an increased body mass, especially in donor nephrectomy patients, because of their position for surgery coupled with the subsequent solitary kidney. However, the rarity of this complication precludes the recommendation of preemptive therapy routinely.

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