Unexpected surgical difficulties leading to hemorrhage and gas embolus during laparoscopic donor nephrectomy: a case report

[Difficultés chirurgicales inattendues conduisant à une hémorragie et à une embolie gazeuse pendant une néphrectomie laparoscopique chez un donneur : une étude de cas]

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Purpose: To report the case of a laparoscopic donor nephrectomy in which the preoperative evaluation of the patient gave no indication of the surgical difficulties that were encountered intraoperatively, resulting in substantial bleeding, a suspected gas embolism, and emergency conversion of the procedure from laparoscopic to open donor nephrectomy.

Clinical features: A 59-yr-old man – height: 175 cm, weight: 85.5 kg, American Society of Anesthesiologists physical status I – presented as kidney donor for laparoscopic donor nephrectomy. He was healthy, on no medication, and had no previous abdominal surgery or diseases of the urinary tract. The preoperative computed tomography (CT) scan evaluation of his kidneys confirmed this by reporting a normal bilateral renal and renal vascular anatomy. In contradiction to the preoperative CT scan findings, the surgeon discovered abnormalities in the operative field. This included extensive scarring surrounding the left kidney, adenopathy near the right hilum, and a large branch lumbar vein entering the renal vein. The large branch lumbar vein was clipped but the clips dislodged, causing significant blood loss, and a suspected gas embolus. The procedure was converted to an emergency open donor nephrectomy. Postoperatively the patient made a full recovery.

Conclusion: Laparoscopic donor nephrectomies, though usually performed on healthy individuals, have their pitfalls, and complications during this procedure can be sudden and serious. As shown in this case, although CT scan results are regarded as reliable, they can be misleading. As an anesthetic precaution for possible gas emboli during laparoscopic procedures, nitrous oxide should be avoided and the patient be ventilated with 100% oxygen.

Objectif : Présenter le cas d'une néphrectomie laparoscopique chez un donneur. L'évaluation préopératoire du patient n'avait donné aucune indication des difficultés chirurgicales peropératoires rencontrées qui ont causé un important saignement, une embolie gazeuse probable et la conversion d'urgence de la technique laparoscopique en néphrectomie ouverte.

Éléments cliniques : Un homme de 59 ans, 175 cm, 85,5 kg et d'état physique ASA I, s'est présenté comme donneur de rein pour une néphrectomie laparoscopique. Il était en bonne santé, ne prenait aucun médicament et n'avait pas d'antécédent chirurgical abdominal ou de maladies des voies urinaires. L'évaluation préopératoire par tomodensitométrie des reins a confirmé la situation en montrant une anatomie rénale et vasculaire rénale normale bilatérale. Pourtant, le chirurgien a découvert des anomalies au niveau du site opératoire. Elles comprenaient une cicatrisation importante autour du rein gauche, des adénopathies près du hile droit et un grand rameau de la veine lombaire pénétrant dans la veine rénale. Ce rameau a été clip-pé, mais les clips se sont détachés, ce qui a provoqué une perte de sang significative et une embolie gazeuse probable. La laparoscopie a été convertie en néphrectomie ouverte d'urgence. Le patient s'est complètement rétabli par la suite.

Conclusion : Les néphrectomies laparoscopiques chez les donneurs d'organes, quoique réalisées habituellement chez des personnes en bonne santé, ont aussi leurs pièges. Les complications qui peuvent survenir sont parfois soudaines et critiques. Comme ce cas le montre, même les résultats de la tomodensitométrie, considérés comme fiables, peuvent être trompeurs. Le protoxyde d'azote devrait être évité et le patient ventilé avec de l'oxygène à 100 % afin de prévenir une possible embolie gazeuse pendant les interventions chirurgicales laparoscopiques.

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LAPAROSCOPIC donor nephrectomies provide a higher graft survival rate for the recipient than cadaveric kidney donor transplantations and are increasing in numbers because they have been found to result in less postoperative pain, shorter hospitalization, and better cosmetic results for the donor compared to open live donor nephrectomies.¹ The living kidney donor is usually a healthy individual with an unremarkable medical history and preoperative examination. Although such a patient does not usually present as a high risk case for the anesthesiologist, the great technical and procedural demands for the surgeon can make this a complex procedure.

We report the case of a laparoscopic donor nephrectomy during which the surgeon encountered unexpected difficulties. This resulted in substantial intraoperative blood loss (2000 mL), and a suspected gas embolism. Subsequently this case had to be converted to an open procedure.

Clinical features

A 59-yr-old man – height: 175 cm, weight: 85.5 kg, body-mass-index ($\text{kg}\cdot\text{m}^2$): 27.9, American Society of Anesthesiologists physical status I – presented as kidney donor for laparoscopic donor nephrectomy. He was healthy, on no medication, and had no previous abdominal surgery or diseases of the urinary tract. The preoperative computed tomography (CT) scan evaluation of his kidneys confirmed this by reporting a normal bilateral renal and renal vascular anatomy.

After two 16-G *iv* accesses were obtained and routine monitoring was established – consisting of electrocardiogram (ECG), non invasive blood pressure, and SpO_2 – anesthesia was induced with fentanyl and propofol, and succinylcholine was administered to facilitate endotracheal intubation. Anesthesia was maintained with oxygen and sevoflurane, and no nitrous oxide was used. The patient was placed in the right lateral decubitus position, all bony prominences were padded, and the operating table was flexed to increase the space between the left 12th rib and the left iliac crest. After surgery commenced and CO_2 was insufflated into the abdominal cavity, the patient remained in a stable condition and anesthesia continued smoothly. In contradiction to the unremarkable preoperative CT scan findings, however, the surgeon discovered abnormalities in the operative field. This included extensive scarring surrounding the left kidney, adenopathy near the right hilum, and a large branch lumbar vein entering the renal vein. The large branch lumbar vein was initially controlled with clips but the clips dislodged, causing a significant blood loss

(2000 mL). The surgeons attempted to control the bleeding with manual pressure while the procedure was converted to an open donor nephrectomy, after which surgical hemostasis was achieved. At the time that the procedure was being converted to an open procedure, the patient acutely desaturated (SpO_2 : 80%) with a falling ETCO_2 (14 mmHg), and had moderate hypotension, though his heart rate remained unchanged (Figure, which shows the clinical variables during the incident in a minute-to-minute computerized recording). The position of the endotracheal tube was checked, malfunction of the anesthetic machine was excluded, and manual ventilation with high pressure ventilation was commenced for possible atelectasis as a cause for the scenario. As the patient did not respond to those measures, an embolus was suspected. Auscultation of the heart revealed a ‘mill-wheel’ murmur supporting the diagnosis of a gas embolus. The patient was supported symptomatically with blood transfusions of 2 U of packed red blood cells, hetastarch 6% (1000 mL), Ringer’s lactate and normal saline (4000 mL), and vasopressors (ephedrine and phenylephrine) until his condition stabilized about ten minutes later. An intraoperative biplane probe transesophageal echocardiography (TEE) performed shortly after the event found a normal left and right atrium, an intact interatrial septum, a normal left and right ventricular function, and no air or particulate matter in the atria, ventricles, or pulmonary arteries. The patient’s condition remained stable for the rest of the procedure. At the end of the operation the trachea was extubated without problems; the patient was neurologically intact, followed all commands, and moved all limbs. The postoperative ECG showed no changes compared with the preoperative one, but postoperative chest *x-ray* revealed relatively low lung volumes, and postoperative arterial blood gas analysis on 40% oxygen confirmed hypoxia (PaO_2 : 59 mmHg; PaCO_2 : 40 mmHg). The patient was transferred to the intensive care unit where repeated chest *x-rays* reported a slowly regressing pulmonary edema. The patient made a full recovery and was discharged home after five days.

Discussion

The advantages of the laparoscopic donor nephrectomy compared to the open donor nephrectomy are less postoperative pain, shorter hospitalization and better cosmetic results for the donor.¹ The disadvantages, however, are that the laparoscopic approach takes longer,¹ and the pressure exerted by the pneumoperitoneum on the donor kidney can diminish renal blood flow up to renal failure.² Some centres report a com-

FIGURE Computerized (Datex-Ohmeda) data printout of anesthetic record (incident highlighted by gray bar).

parable morbidity and mortality of both approaches.³ At the University of Washington Medical Center in Seattle, this case was the first in a series of 38 laparoscopic donor nephrectomies since 2000 which had to be converted to an open procedure. At this time, however, laparoscopic donor nephrectomy is a new and evolving technique, and it cannot be decided yet whether it is a viable alternative to the open live donor nephrectomy.^{4,5}

For the anesthesiologist, laparoscopic donor nephrectomy usually requires less use of resources than open donor nephrectomy – such as *iv* fluids, thoracic epidural catheter. The greatest – though uncommon – danger during laparoscopic donor nephrectomy is bleeding which, combined with high *ip* and retroperitoneal CO₂ pressures, can lead to potentially lethal gas emboli. Besides accidental surgical vascular injuries,⁶ the spontaneous rupture of abdominal veins caused by the intra-abdominal pressure of the pneumoperitoneum has been suggested as an etiological factor for gas emboli.⁷ While gas emboli during laparoscopic cholecystectomies were detected in 69% of the observed cases,⁸ a study utilizing TEE to detect gas emboli during laparoscopic donor nephrectomies reported an incidence of 6% only, without causing harm to the patient.⁹ In our

case, TEE performed after the incident could not detect any sign of embolism from gas or particulate matter. However, the perioperative clinical picture was suggestive of a gas embolus. A ‘mill-wheel’ murmur, sudden intraoperative decreases of ET-CO₂, desaturation, and hypotension in connection with gas emboli have been described,^{6,10} and the short duration (ten minutes) of the incident can be explained by the high blood solubility of carbon dioxide, which causes CO₂ emboli to be absorbed quickly.^{6,10} If nitrous oxide had been used by the anesthesiologist for inhalation anesthesia during this procedure, the outcome may have been much more serious due to the increased size of the gas embolism.¹¹ Emboli made of particulate matter, on the other hand, are often detectable by TEE for much longer periods of time after an incident.^{12,13} The post-operative pulmonary edema of the patient is also suggestive of a gas embolism.¹⁴

In summary, laparoscopic donor nephrectomies though usually performed on healthy individuals, have their pitfalls, and complications during this procedure can be sudden and serious. As shown in this case, although CT scan results are regarded as reliable,¹⁵ they can be misleading. A magnetic resonance imaging scan, on the other hand, may have detected the abnormalities surrounding the left donor kidney in this case.^{16,17} Whether it was a wise decision by the surgeon to continue with the laparoscopic approach despite increasing surgical difficulties, instead of reverting to the open approach in time, cannot be decided here. A gas embolus is a potential hazard in any laparoscopic surgery, this is why the anesthesia team has to be vigilant at all times and should avoid ventilation with nitrous oxide.

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