Case Report

Anesthesia for laparoscopic adrenalectomy (pheochromocytoma) in an anemic adult Jehovah's Witness

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Purpose: To report the anesthetic management of an anemic Jehovah's Witness patient presenting for laparoscopic adrenalectomy for pheochromocytoma.

Clinical Features: A 49-yr-old woman presented with hemodynamic instability progressing to cardiogenic shock and subsequent acute renal failure. Her course was complicated by anemia. An adrenal pheochromocytoma was diagnosed. Preoperatively, alpha- and beta-adrenergic blockade was instituted with phenoxybenzamine and metoprolol therapy and her anemia was treated with erythropoietin. She underwent laparoscopic resection of the adrenal tumour. A cell saver device was employed and attached to the laparoscopic suction-irrigation apparatus to provide salvage capability in the event of a major hemorrhage. The surgical intervention was uneventful and well tolerated. The patient was discharged home and well on follow-up.

Conclusions: Cell salvage is the only mechanism currently acceptable to Jehovah's Witnesses which will allow for perioperative salvage and replacement of blood loss. Its use is encouraged in all situations in which surgical hemorrhage is anticipated.

Objectif : Rapporter la prise en charge anesthésique d'une patiente anémique, témoin de Jéhovah, qui présentait un phéochromocytome et a subi une surrénalectomie laparoscopique.

Éléments cliniques : Une femme de 49 ans présentait une instabilité hémodynamique en évolution vers un choc cardiogénique et une insuffisance rénale aiguë secondaire. Sa situation était compliquée par de l'anémie. Un diagnostic de phéochromocytome surrénalien a été posé. Avant l'opération, un blocage alpha et bêta adrén-ergique a été instauré avec de la phénoxybenzamine et du métoprolol et l'anémie a été traitée avec de l'érythropoïétine. On a procédé à la résection laparoscopique de la tumeur surrénalienne. Un dispositif de concentré d'hémoglobine a été utilisé et raccordé à l'appareil d'aspiration-irrigation laparoscopique pour permettre un rattrapage en cas d'hémorragie importante. L'intervention chirurgicale s'est déroulée sans incident. La patiente a reçu son congé et a connu une bonne convalescence.

Conclusion : Le concentrateur d'hémoglobine est le seul mécanisme, accepté actuellement par les témoins de Jéhovah, qui permet le rattrapage et le remplacement des pertes sanguines périopératoires. Son usage est recommandé pour toutes les situations où on s'attend à une hémorragie chirurgicale.

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THE considerations for providing care to Jehovah's Witness (JW) patients presenting for surgery have been well described.¹⁻³ The major concern is the lack of acceptance, by JW patients, of red cell transfusion in the setting of life-threatening blood loss. The need for a multidisciplinary approach to both limit the potential for blood loss as well as in maximizing strategies for intervention and management in the event of hemorrhage cannot be over-emphasized. We present a case to describe the perioperative management of a JW patient undergoing laparoscopic adrenalectomy with cell salvage back-up, after an unusual, dramatic presentation with pheochromocytoma.

Case Report

A 49-yr-old previously healthy female Jehovah's Witness patient presented to our emergency room with complaints of sudden onset of chest pain, palpitations, and severe headache associated with hand numbness and photophobia. Her initial vital signs were heart rate 48 bpm, blood pressure 180/102 mm Hg, respiratory rate 24 breaths·min⁻¹, SpO₂ 98% breathing room air and she was afebrile. Subarachnoid hemorrhage was initially suspected, but a computerized tomograph (CT) of her head was normal. Three hours after the onset of headache, she developed an intermittent, wide complex tachycardia diagnosed as ventricular tachycardia, which initially responded to lidocaine. However, within 30 min, she developed both florid pulmonary edema and sustained ventricular tachycardia unresponsive to both medical therapy and electrical cardioversion. Her trachea was intubated and positive pressure ventilation initiated. Transesophageal echocardiography demonstrated global left ventricular hypokinesis and moderate mitral regurgitation.

She was transferred to the intensive care unit with a diagnosis of cardiogenic shock and initially required infusions of dobutamine, milrinone and norepinephrine for hemodynamic support. Subsequently she developed anuria and acute tubular necrosis requiring hemodialysis. Over the next four days, her condition stabilized and the inotropic support was weaned and discontinued. Her trachea was extubated on the eighth day and she was transferred to the ward in stable condition on the tenth day after admission.

During evaluation for the etiology of her presentation, an intracerebral lesion was re-considered, but a repeat CT scan of her head was again negative for pathological findings. However, a CT scan of her abdomen revealed a hemorrhagic right adrenal mass. Serum catecholamine concentrations were elevated to > 20 times normal values, suggestive of a pheochro-

mocytoma. Due to anuria, collection of urine catecholamines was not possible at this time; however her elevated serum catecholamines and a positive clonidine suppression test both supported the diagnosis of a pheochromocytoma.

Alpha-adrenergic blockade with phenoxybenzamine was instituted. Over the next 31 days in hospital, phenoxybenzamine treatment was titrated to achieve a resting blood pressure of 115/75 with an orthostatic drop to 95/65 mmHg. Metoprolol therapy was also initiated and titrated to regulate heart rate between 70 and 80 bpm.

Over her course in hospital, she developed anemia with hemoglobin concentrations as low as 66 g·L⁻¹. This was likely multifactorial in etiology resulting from the acute renal failure causing both suppression of erythropoiesis and necessitating hemodialysis and multiple blood sampling. The insertion of vascular lines for monitoring, fluid management and dialysis, and repeated invasive radiological assessments, all superimposed on her critical illness. Erythropoietin 20,000 u *sc* three times a week and ferrous sulphate 300 mg *po* t.i.d. were administered to stimulate erythropoiesis. Serial echocardiograms demonstrated a return of normal left ventricular function and ejection fraction by dy 17. Renal function also had recovered by dy 23 and she no longer required dialysis. A 24 hr urine collection at this time was positive for elevated catecholamines, confirming the diagnosis of pheochromocytoma. She was booked for elective resection of the pheochromocytoma by a laparoscopic technique. Surgery was delayed until her preoperative hemoglobin concentration exceeded 100 g·L⁻¹ (105 g·L⁻¹, HCT 0.326).

TABLE Blood products prohibited and sanctioned for use by the Jehovah's Witness Church.

Church-prohibited Blood Components

Whole Blood
Plasma
White Cells
Red blood cells
Autologous transfusions
Platelets

Allowed Blood Components

Albumin
Immunoglobulins
Hepatitis B Immune Globulin (HBIG)
Tetanus Immune Globulin
Rabies Immune Globulin (RIG)
Rho Immune Globulin (RhoGam)
Antithrombin III
Human Immune Globulin
Hemophiliac preparations (Factor VIII and IX)

She was reviewed in anesthetic consultation. After discussion regarding alternatives to blood transfusion, she confirmed her refusal of transfusion of all blood products but she agreed to the use of intraoperative cell salvage. The perioperative course was planned and the patient consented to the plan.

The patient was taken to the operating room and, following application of a five-lead ECG with continuous ST segment analysis, noninvasive blood pressure monitoring, and pulse oximeter, she received 1 mg midazolam *iv*. With the patient sitting, an epidural catheter was placed aseptically and uneventfully at the mid-thoracic level, to be used in the event of conversion to an open procedure. Then, after local infiltration, a 20 ga right radial arterial line was placed. General anesthesia was induced with 200 µg fentanyl, 250 mg thiopental and muscle relaxation was provided with 50 mg rocuronium. The trachea was intubated and anesthesia subsequently maintained with oxygen in nitrous oxide and desflurane (end tidal concentrations of 4.6 to 5.0%). Ventilation was adjusted to maintain a normal $P_{ET}CO_2$. Intermittent boluses of 50 µg fentanyl *iv* were administered for a perioperative total of 500 µg. Muscle relaxation was maintained with intermittent boluses of 15 mg rocuronium.

The patient was positioned in the left lateral decubitus position. A five port technique for laparoscopy was used. Prior to beginning surgery, the suction tubing of a Brat 1© cell saver (COBE Cardiovascular, Denver, Colorado) was attached to the suction-evacuation port of the (Nehzat-Dorsey) laparoscopic suction device as depicted in Figure 1. This allowed for the addition of heparin to the evacuated blood without the need for introducing heparin into the surgical field with the irrigation.

Surgery proceeded uneventfully with the hemodynamic variables remaining stable throughout surgery. Figure 2 depicts the intraoperative HR and BP recordings. Catecholamine levels were drawn before the induction of anesthesia, at times of increased heart rate and blood pressure, occurring concurrent with tumour manipulation and after completion of surgery; the results are displayed in Figure 3. Metoprolol, 1 mg, was given twice to treat increases in heart rate and blood pressure associated with prolonged manipulation of the adrenal gland.

A perioperative total of 2000 ml warmed saline 0.9% was given *iv*. The estimated blood loss collected by the cell saver suction was 75 ml; the salvaged blood was discarded. At the completion of surgery, the residual muscle relaxation was reversed with 2.5 mg neostigmine and 0.4 mg glycopyrrolate. The duration of surgery was 105 min. The epidural was not used

FIGURE 1 Laparoscopic suction-irrigation device. The right-side (irrigation) port receives a saline line which delivers saline to the operative field. The left-side port receives the cell-saver line, which adds heparin to the aspirated blood and delivers the heparinized blood to the cell saver.

FIGURE 2 Print-out of arterial blood pressures (A) and heart rates (B) recorded intraoperatively. The asterisks correspond to times of blood sampling for serum catecholamine levels.

postoperatively although the port incisions were infiltrated with bupivacaine 0.25% to provide postoperative analgesia. The trachea was extubated in the operating room and she was transferred to the intensive care unit for postoperative monitoring.

She experienced transient hypoglycemia postoperatively which was treated with an *iv* infusion of dextrose. Her phenoxybenzamine and metoprolol therapy was weaned and discontinued. She was trans-

FIGURE 3 Serum catecholamine levels measured intraoperatively, before induction of anesthesia ("pre-ind"), following completion of surgery ("end"), and at times of increased heart rate and blood pressure, occurring concurrent with tumour manipulation.

ferred to the ward on the second postoperative day and was discharged home on the fifth postoperative day after an uneventful recovery, 38 dy after her initial admission to hospital. Her urine catecholamine levels were within the normal range when she was seen at a follow-up visit one week after discharge.

Discussion

The major issue facing anesthesiologists providing perioperative care to patients who do not accept transfusion is how to minimize the likelihood that the patient will suffer uncontrolled hemorrhage leading to morbidity or death. At this time, Jehovah's Witness patients will not accept the use of a number of blood products including red cells. (Table) Although there is some variability as to what products individual JW patients will accept, some guidance is provided to them both by a church published document, *Family Care and Medical Management for Jehovah's Witnesses*, (© 1995, Watch Tower Bible and Tract Society of Pennsylvania) and through discussion with elders. There is also a list of church approved techniques that may be employed during surgery to reduce blood loss. These include hemodilution, hypotensive anesthesia and red cell salvage. It has been our experience over the last five years, that the use of the above-cited church document during the consultation process invariably leads to acceptance by the patient of the full range of options sanctioned by their church. This reduces the likelihood that the patient will refuse church-sanctioned therapy and increases the number of interventional strategies available to the attending physicians.

Carson attempted to quantify the threat posed by perioperative hemorrhage in JW patients in a retrospective cohort study of 1958 adults who both underwent surgery and refused blood transfusion.⁴ In the series, a strategy of total transfusion avoidance resulted in morbidity and mortality. There was increased mortality associated with a lower preoperative hemoglobin level ([Hb]). This risk was enhanced by the presence of cardiovascular disease (CVD). Thirty day mortality was 1.3% in patients with an initial preoperative [Hb] of 120 g·L⁻¹ and this increased to 33.3% in patients with an initial [Hb] < 60 g·L⁻¹. In healthy patients (no CVD) with smaller volume blood losses (a decrease in [Hb] < 20 g·L⁻¹), the starting [Hb] had little impact on outcome. However, in patients with CVD who experienced similar volume blood losses, the starting [Hb] had a considerable impact on mortality. The odds ratio (OR) for mortality was 12.3 in CVD patients with initial [Hb] < 60 g·L⁻¹ compared with those with initial [Hb] > 120 g·L⁻¹. In all patients who experienced larger volume losses, there were even more marked increases in OR for mortality in patients with lower initial [Hb]. Although OR were highest in patients with underlying CVD, even healthy patients had limited tolerance for blood loss if the initial [Hb] was low.

During preparations for surgery, it is necessary to scrutinize the history of these patients to ensure that there are no congenital or acquired bleeding disorders or end-organ disease which may enhance blood loss. It is also prudent to review the effects of current medications or treatments to ensure that none may increase the risk of iatrogenic anemia, hypoprothrombinemia or bleeding. Finally, although it is important to establish baseline coagulation parameters, caution must be exerted to restrict phlebotomy and perform only essential tests, so as to minimize iatrogenic losses.

In elective situations, it is important to optimize the red cell count and [Hb] by ensuring appropriate therapy for hematinic deficiencies. We treated our patient with erythropoietin to enhance marrow production and also provided prophylactic iron therapy to maximize stores and optimize her response to the administered erythropoietin. This resulted in an increase in [Hb] from 66 to 105 g·L⁻¹ preoperatively. The surgery was delayed until the [Hb] had recovered to a level at which we agreed it was prudent to proceed with non-urgent surgery.

Efforts must be made to control or avoid hemorrhagic and iatrogenic blood loss. A laparoscopic technique was chosen for a number of reasons. The blood loss during a laparoscopic technique is less than that of open resection of adrenal tumours.⁵⁻⁸ The surgical team was experienced in the technique and it had been

the consistent experience that blood loss was small and less than that seen with open resection. In the event of unexpected hemorrhage, the plan was to convert quickly to an open technique so as to rapidly obtain control of vascular bleeding. In fact, measured blood loss was < 100 ml. As well as reducing blood loss, laparoscopic adrenalectomy is associated with shorter hospital stays and shorter recovery time compared with open techniques.⁵⁻⁸

The hemodynamic and catecholamine responses to laparoscopic adrenalectomy have been well described.⁹ The times of peak hemodynamic response and catecholamine secretion are during the creation of the pneumoperitoneum and during tumour manipulation. Our patient also experienced brief hemodynamic response at the time of pneumoperitoneum and also on several occasions during tumour manipulation. The epinephrine and norepinephrine levels determined in samples obtained from our patient at times of hemodynamic responses are similar to those reported by other authors.^{9,10}

Her cardiovascular responses might have been attenuated using epidurally administered local anesthetics. We did not use this technique due to concern about persistent hypotension following adrenal vein ligation and a consequent decrease in circulating catecholamines. This hypotension is presumed to be due to down-regulation of sympathetic alpha- and beta-receptors resulting from prolonged sympathetic nervous system stimulation.¹⁰ We chose not to compound this down-regulated state by effecting persistent sympatholysis with regional blockade.

At present, cell salvage is the single technique permissible to Jehovah's Witnesses that will allow for perioperative salvage administration of blood products. A cell saver device was made available during surgery as to ensure that there was immediate capability to salvage shed blood in the event of large volume losses. The cell saver suction was linked to the laparoscopic suction-irrigation apparatus to allow for the heparinization of the aspirated blood in the outflow channel of the device. This negated the need for heparin to enter the surgical field and facilitated maintenance of a hemostatic surgical field. In the event of smaller volume losses, the blood would be collected mainly from the tumour bed and we would expect the shed blood to be contaminated by high levels of both adrenaline and noradrenaline.^{11,12} We intended neither to wash nor re-transfuse such small volumes as there would have been no medical indication for the transfusion. It was our expectation that larger volumes (> 1000 ml) would be collected primarily in the event of vascular trauma. This blood, not coming from

tumour bed, should contain considerably lower concentrations of catecholamines; there would also be greater patient benefit derived from re-transfusion of these larger volumes. As it would be difficult to reduce the concentration of the catecholamines during cell washing, caution would still have to be exerted during re-transfusion of these larger shed volumes and the patient observed for hemodynamic responses suggesting receipt of large doses of endogenously derived catecholamines. Fortunately operative losses were minor and the shed blood was discarded. Unfortunately, a sample of the shed blood, intended for the laboratory, to have levels of catecholamines measured and the quality of the salvaged product assessed, was lost.

We did not employ either hypotensive anesthesia or hypervolemic hemodilution to reduce red cell losses, in our anesthetic management. We avoided controlled hypotension both because of the absence of evidence supporting the intervention in this setting and because of the potential for marked hemodynamic lability associated with tumour manipulation and resection. Our rationale for not undertaking hypervolemic hemodilution was based on a number of factors. Anticipating low losses and an ability to salvage higher shed losses, there seemed little advantage in doing so. Additionally, the actual blood sparing effect of hypervolemic hemodilution is limited.

This case report describes the perioperative management of a JW patient undergoing laparoscopic adrenalectomy for pheochromocytoma. Preoperative alpha- and beta-blockade were established to optimize her medical condition and erythropoietin was administered to treat moderate anemia. The surgery was performed under a balanced general anesthetic and hemodynamic control maintained with beta blockers titrated intravenously. The surgical intervention was uneventful and she made a rapid recovery. This report describes the feasibility of merging a cell saver apparatus to laparoscopic equipment and encourages the use of cell salvage whenever surgical hemorrhage is anticipated. As laparoscopic approaches to many different types of surgery are becoming more common, it is important to recognize the compatibility of potentially life saving devices not originally designed for laparoscopic use.

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