in ventricular volume can be implicated.[12] Several of these reflex arcs might be expected to be more active in patients with left ventricular dilation and hypertrophy.

Sudden cardiac arrest in healthy patients under spinal anesthesia has been reported previously, with the most recent report by Caplan *et al.*[13–15] In their review, sedation and unrecognized respiratory insufficiency may have played a role in causing most of the arrests, and the long-term outcome was dismal. Our case differs in that our patient was awake and alert with a normal Sp_{O_2} at the time of arrest, was relatively easily resuscitated, and was neurologically undamaged. It is interesting to speculate whether the early administration of epinephrine, as suggested by Keats,[16] might have prevented the recurrence of asystole in our patient.

In conclusion, we report the sudden onset of asystole in a well-trained athlete during spinal anesthesia. It is important for anesthesiologists to become familiar with the more common manifestations of the athletic heart syndrome so that they can recognize the physiologic adaptations that occur in such athletes. Contrary to intuition, individuals with a history of competition-level fitness may be at no less risk for an anesthesia-related life-threatening event than the less fit general population, and such a history should not dull our usual vigilance.

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Anesthesia for a Patient Undergoing Laparoscopic Cholecystectomy

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The use of laparoscopic techniques in general surgery has gained increasing popularity. The small, limited incisions are well accepted by patients and there is the benefit of a faster recovery (compared to open laparotomy). Health care costs may be decreased by the diminishing length of postoperative hospital stay and by reducing the need for postoperative analgesia. Additionally, indirect savings to society may be generated by shortening the recovery period between the operative procedure and the return to gainful employment. One new technique gaining enthusiasm is laparoscopic cholecystectomy. Twenty million people in the United States have gallbladder disease, and roughly 500,000 cholecystectomies are performed annually.[1] This is the first report on the anesthesia for such a procedure.

Case Report

A 26-yr-old woman presented for cholecystectomy for cholelithiasis. Her medical history was unremarkable, and the results of a physical

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examination were normal. She had had an epidural anesthetic for labor and delivery. There was no history of abdominal surgery.

In the operating room, routine monitors (ECG, pulse oximetry, noninvasive blood pressure, and precordial stethoscope) were placed and a 20-G catheter was inserted in a left-hand vein. The patient was sedated with 2 mg intravenous (iv) midazolam while proper functioning of the laparoscopic equipment was confirmed. Anesthesia was induced with iv administration of 0.5 μg/kg sufentanil, 4 mg/kg thiamylal, and 0.1 mg/kg vecuronium. The trachea was intubated with a 7.0 cuffed endotracheal tube. Anesthesia was maintained with 0.6–1.2% isoflurane in oxygen and incremental 5-μg doses of sufentanil. A urinary bladder catheter and a nasogastric tube were placed. A Veres needle was introduced into the abdominal cavity *via* a 1-cm supraumbilical incision, and a pneumoperitoneum was created using 3.5 l carbon dioxide resulting in an intraabdominal pressure of 13 mmHg. The patient was then placed in a steep reverse Trendelenburg position. Blood pressure ranged from 100/70–125/85 mmHg, and the pulse varied between 60 and 80 beats per min. Ventilation was adjusted to keep the end-tidal CO_2 concentration at 37 mmHg. The operation proceeded uneventfully using standard operative techniques.[2] Over the 3-h course of the operation, the patient received a total of 40 μg (0.8 μg/kg) of sufentanil. After successful cholecystectomy, neuromuscular blockade was reversed with 2 mg neostigmine and 0.4 mg glycopyrrolate, and the trachea was extubated. The patient ambulated in her room the evening of surgery and was discharged from the hospital on postoperative day 1 after ingestion of a regular diet. She had no postoperative requirement for analgesia either as an inpatient or following hospital discharge. She recovered completely by postoperative day 5 and returned to work that week. Liver function tests were normal on postoperative day 1.

Discussion

Laparoscopic cholecystectomy is indicated in patients with symptomatic cholelithiasis, generally manifested by biliary colic, and chronic cholecystitis. The potential benefits of cholecystectomy *via* the laparoscope, as opposed to the traditional open technique, include 1) reduction in length of incision, 2) reduction in postprocedural pain, and 3) a prompt return to preoperative activity and employment. There is clear-cut potential for cost savings related to reduction of hospital costs, hospital length-of-stay, and lost time from employment. The currently used technique, with future modifications, is likely to gain more widespread use in the management of the 20 million Americans with gallbladder disease.

Anesthetic considerations for laparoscopic cholecystectomy are similar to those for other laparoscopic procedures. Insufflation of the abdominal cavity with carbon dioxide (CO_2) has several consequences. Pulmonary atelectasis, decreased functional residual capacity, and high peak airway pressures all may result from CO_2 insufflation.[3] These problems can be ameliorated by careful adjustment of the ventilatory patterns. Absorption of CO_2 *via* the peritoneum causes hypercarbia that can typically be controlled by increasing minute ventilation.[4,5] The risk of cardiac arrhythmia from increased P_{CO_2} may be less with isoflurane.[6]

Laparoscopy and CO_2 insufflation also may cause circulatory impairment.[7] Increased intraabdominal pressure from the induced pneumoperitoneum can cause decreased venous return and may result in hypotension.[8] In gynecologic procedures, the patient is normally placed in Trendelenburg's position to keep the small bowel and colon out of the pelvis. During laparoscopic cholecystectomy, reverse Trendelenburg's position is used, shifting the abdominal contents away from the upper abdomen. While such positioning may reduce the ventilatory abnormalities, it may accentuate circulatory impairment. Adequate hydration (to replace expected preoperative fluid deficit) before this stage should prevent hypotension from these causes.

Venous CO_2 embolism, both in the operating room and in the immediate postoperative period, has been reported and must be considered in the differential diagnosis of cardiovascular collapse.[9,10] Because of the need to monitor ventilation, the chance of CO_2 embolism, and the risk of arrhythmias in the setting of hypercapnia, end-tidal CO_2 monitoring is essential.

High intraabdominal pressures may increase the risk of passive reflux of gastric contents.[11] Clearly, tracheal intubation with a cuffed tube can minimize the risk of aspiration should reflux occur. This is particularly important in the setting of day-of-surgery admission, since outpatients have been shown to have a higher volume of intragastric contents and hydrogen ion concentrations.[12] Placement of a naso- or orogastric tube intraoperatively allows decompression of stomach contents and may reduce the risk of visceral puncture at the time of creation of the pneumoperitoneum. Also, gastroduodenal decompression can improve laparoscopic visualization and ease retraction of the right upper quadrant structures.

As with all laparoscopic procedures, careful observation for unintentional injury to intraabdominal structures is essential. Intraoperative hemorrhage may be difficult to recognize and quantify due to the optics of the visual magnification system and the limited fields used during dissection. Loss of hemostasis on the cystic artery, or injury to the hepatic artery or liver may lead to significant hemorrhage requiring open laparotomy to secure hemostasis.

In addition to hemorrhage, other findings at laparoscopic cholecystectomy may mandate open laparotomy. Visceral perforation may occur during trocar insertion or during the gallbladder dissection and require open repair. Unexpected pathologic findings including, but not limited to, hepatic masses or gastric neoplasms may be recognized. Finally, bile duct anomalies may be encountered during laparoscopic cholecystectomy, and their repair may require open surgery.

In summary, laparoscopic cholecystectomy is well tolerated by patients and may result in shorter hospital stays for surgical treatment of cholecystitis. Although similar to traditional laparoscopy, there are unique aspects to the anesthetic management of these procedures.

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Airway Obstruction in Lungs Obtained from an Asthmatic Donor Complicating Heart–Lung Transplantation

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Severe bronchospasm following transplantation of heart and lungs obtained from a nonasthmatic donor into an asthmatic recipient has previously been reported.[1] There have been no previous reports, however, of respiratory problems encountered during transplantation of lungs obtained from asthmatic donors. We report a case of extreme difficulty in pulmonary ventilation complicating transplantation of heart and lungs obtained from an asthmatic donor into a nonasthmatic recipient.

Case Report

The donor, a 15-yr-old boy, had sustained a severe head injury 3 days previously. Ventilatory support had been commenced immediately on admission to a neurosurgical intensive care unit, and conservative management aimed at restricting further neurologic damage had been instituted. Brain stem death was confirmed on the third day, and the patient was referred for multiple organ donation.

The only previous medical history was of asthma requiring occasional treatment with a salbutamol inhaler. There was no other history of atopy.

During the period of ventilation in intensive care, regular chest physiotherapy and tracheal suctioning had been performed until confirmation of brain stem death, and there had been no requirement for bronchodilator therapy; peak airway pressures never exceeded 20 cmH_2O. Clinical examination on the day of organ donation revealed course crepitations dorsally, and small quantities of viscid secretions were obtained on tracheal suctioning. There was no evidence of infection: the patient was afebrile, with negative microbiologic cultures and a normal chest x-ray. Arterial blood gases before transfer to the operating room for organ harvesting were as follows: *p*H, 7.5; P_{CO_2}, 34 mmHg; and Pa_{O_2}, 170 mmHg at an FI_{O_2} of 0.4.

The donor operation proceeded uneventfully until just before cannulation of the pulmonary artery when a rise in peak airway pressure from 20–35 cmH_2O was noted. The only drugs administered up to this point were pancuronium, vasopressin, and metaraminol. Intravenous fluids had been limited to colloid in the form of 20% human albumin solution and crystalloid as 4% dextrose/saline. Using the technique of a single cold pulmonary artery flush for lung preservation,[2] a mixture of prostacylin (epoprostenol; Flolan [Burroughs Wellcome]), albumin, mannitol, and autologous blood at 4 °C was flushed through the pulmonary circulation *via* a cannula in the main pulmonary artery. The aorta was cross-clamped, cardioplegia administered through the aortic root, and the heart–lung bloc excised after full inflation of the lungs and application of the tracheal cross-clamp. Following our usual practice, the lungs were deflated to two thirds of their vital capacity before immersion of the organs in ice cold normal saline for transportation.

The recipient, a 43-yr-old man with end-stage pulmonary sarcoidosis, was anesthetized and supported on cardiopulmonary bypass pending arrival of the donor organs. When the donor heart–lung bloc was examined at the transplant center, it was noted that the lungs would not fully deflate. However, as the degree of deflation was sufficient to allow implantation into the recipient's chest and to permit surgical access for anastomosis of donor and recipient circulation and trachea to be performed, the operation proceeded in the normal way.

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