Bilateral Lower Extremity Compartment Syndromes following Prolonged Surgery in the Low Lithotomy Position with Serial Compression Stockings

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A POTENTIALLY devastating complication of prolonged surgery in the lithotomy position is lower extremity compartment syndrome.\(^1\)\(^2\) Compartment syndrome arises from impaired perfusion that causes tissue ischemia, edema, and increased fascial compartment pressures. Presentation may be delayed up to 24 h or longer postoperatively.\(^3\)\(^4\) Contributing factors include vascular insufficiency, intraoperative hypotension, and surgical positioning.

The lithotomy position decreases perfusion to the legs even in persons without vascular disease.\(^5\)\(^6\) Use of compression stockings for deep venous thrombosis prophylaxis may further decrease blood flow to the legs.\(^5\)\(^7\)

We report a case of a man who underwent a lengthy urologic procedure while in the low lithotomy position and who developed bilateral lower extremity compartment syndromes necessitating emergent fasciotomies.

Case Report

A 34-yr-old man (90 kg, physical status I) underwent a cystoscopy, urethrectomy, and urethroplasty while in the low lithotomy position for hypospadias repair. Preoperative blood pressure was 130/72 mmHg. A subarachnoid block was performed using bupivacaine and preservative-free morphine sulfate to augment a general anesthetic. Induction and intubation were performed using sodium pentothal and rocuronium. The patient was placed in the low lithotomy position, with his calves raised approximately 25 cm above his heart. Sequential compression stockings set to intermittently compress to 40 mmHg were used along with antithromboembolism hose, and egg crating and gel padding were placed beneath his calves. The patient remained in this position for 10 h 10 min. Systolic blood pressure remained above 110 mmHg, and mean arterial blood pressure never varied more than 20% from baseline. General anesthesia was maintained with oxygen, nitrous oxide, and isoflurane. Urine output averaged 2 ml·kg\(^{-1}\)·h\(^{-1}\) until output could no longer be reliably measured as a result of bladder opening. Blood loss was 200 ml. The patient was extubated and transferred to the postanesthesia care unit in an alert and comfortable state and without residual subarachnoid block. Blood pressure was unchanged from preoperative levels. The patient was able to move his extremities and continued to produce more than 0.5 ml·kg\(^{-1}\)·h\(^{-1}\) urine.

Approximately 10 h postoperatively, the patient reported bilateral hip and knee pain. Physical examination by surgical and anesthesia teams showed no lower extremity skin changes, edema, or paresthesia; the patient did not report incisional pain. The patient reported increased bilateral calf tenderness and numbness over the dorsum of each foot 17 h postoperatively. An orthopedic consult was immediately obtained. The lateral and anterior compartments of the patient’s calves were found to be tense and tender, with bilateral paresthesia in the superficial peroneal nerve distribution. Compartment pressures measured using a Stryker transducer (Stryker Corporation, Kalamazoo, MI) exceeded 40 and 70 mmHg in the right and left lateral compartments, respectively.

The patient immediately underwent emergent bilateral lower-extremity fasciotomies. The muscle of the left lateral compartment was grossly ischemic. The anterior and posterior compartments were normal, and there was no evidence of deep venous thrombosis, myoglobinuria, or hyperkalemia. Neurologic recovery occurred slowly, and the patient was returned to the operating room 5 days later for closure of the fasciotomies. At discharge, the patient had normal muscle strength but experienced persistent numbness over small areas on the dorsum of each foot.

Discussion

Compartment syndrome was first associated with surgical positioning in 1872, and with prolonged lithotomy position in 1979.\(^8\)\(^9\) The mean time to presentation in this setting is 15 h.\(^6\) Complications include permanent nerve and muscle injury, limb loss, renal failure, and death.\(^3\)\(^5\)

Compartment syndrome is characterized by increased pressure within a closed fascial space. The hydrostatic and oncotic pressures of the intravascular and tissue spaces determine these pressures.\(^10\) When any of these components is out of proportion to the others, perfusion of the tissues may be compromised, thereby causing local ischemia, acidosis, and cell death. Persistently elevated pressure leads to a repeating cycle of ever-increasing pressure and ischemia within the compartment. Ini-
tially, venous drainage is impeded, but ultimately arterial supply is compromised. The syndrome is initiated when compartment pressures approach or exceed systemic diastolic blood pressure.

Matsen et al. demonstrated that compartment pressures greater than 45 mmHg for more than 4 h are associated with permanent ischemic deficits necessitating amputation. Scott et al. reported that reversible neuromuscular deficits may be seen in as few as 15 min of similar pressures. It has been shown that perfusion pressure is decreased by 0.78 mmHg for each centimeter that an extremity is raised above the right atrium. Thus, perfusion in each compartment is reduced approximately 24 mmHg by lower extremity elevation of less than 12 in. Halliwill et al. studied the effect of various lithotomy positions on lower extremity blood pressures, and found that predicted systolic pressures were lower than expected when the lithotomy position was used. They concluded that the lithotomy position should be used intermittently during lengthy procedures to reduce lower extremity hypoperfusion.

Several factors contribute to decreased perfusion pressures. Sequential compression stockings transfer pressure to the osteofascial compartment immediately below, further decreasing perfusion to an extremity already compromised by the lithotomy position. Theoretically, blood flow may intermittently approach zero. Cases of compartment syndrome have been directly attributed to malfunctioning devices that remained in the inflated position for the duration of the surgery. Some cases report directly associate normally functioning sequential compression stockings, compartment syndromes, and procedures using the lithotomy position.

Martin observed that intermittent reperfusion with properly cycling sequential compression stockings causes worsening extravasation of intravascular contents through new microdefects in the vascular wall, thereby increasing compartment pressures. In addition to these devices, peripheral vascular disease, intraoperative hypotension, and direct pressure from surgical team members leaning on elevated limbs also may contribute to the development of compartment syndrome by promoting hypoperfusion injury.

Conclusion

In summary, we describe a young, healthy patient in whom bilateral lower extremity compartment syndromes developed necessitating fasciotomies, despite adequate precautions and treatment. With venous and lymphatic drainage facilitated by positioning, sequential compression stockings should not be used in these circumstances. In regard to compression stockings and the lithotomy position, Martin concluded, "wrapping elevated legs to prevent blood from pooling therein is thoughtless and counterproductive." Lachmann suggested that the use of sequential compression stockings for deep venous thrombosis prophylaxis in patients in the lithotomy position is inappropriate. Based on this experience and a subsequent, careful literature review, we are reevaluating our routine use of sequential compression stockings during prolonged procedures in patients in the lithotomy position.

References

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Pregnant Patient with Primary Pulmonary Hypertension: Inhaled Pulmonary Vasodilators and Epidural Anesthesia for Cesarean Delivery

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PRIMARY pulmonary hypertension (PPH) is rarely encountered in pregnant women, but carries a high risk of maternal morbidity and mortality.1 We report a case of PPH in a pregnant patient treated with antithrombotic drugs, inhaled pulmonary vasodilators, and epidural anesthesia for cesarean delivery; follow-up examination occurred at 6 months.

Case Report

Two years previously, the 26-yr-old woman was diagnosed with PPH after cardiac decompensation, which occurred 5 months after uncomplicated delivery of a neonate. She refused treatment at that time. During her second pregnancy, at 15 weeks' gestation, Doppler echocardiography showed a right atrial diameter of 6.2 cm (normal diameter, 2.2-4.1 cm), a short-axis end-diastolic diameter of the right ventricle of 5.1 cm (normal, 1.9-4.0 cm), a right ventricle with eccentric hypertrophy and fractional area shortening of 33%, and a small, normally contracting left ventricle.

The patient was lost to further follow-up examinations and reappeared at 31 weeks' gestation, severely dyspneic at rest and with dilated neck veins and lower limb edema. Ultrasonography showed a growth-retarded fetus. The patient's systemic arterial pressure (AP) was 108/69 mmHg, with a regular heart rate of 94 beats/min. Electrocardiography showed a sinus rhythm, prominent P waves in V1-V6, and a partial right bundle branch block. Oxygen saturation by pulse oximetry (SpO₂) of 88% increased to more than 94% with supplemental nasal oxygen. Hemoglobin was 11.4 g/dl, and platelet count was 177 10³/µl. Radial artery and thermodilution pulmonary artery catheters were inserted to test the response to nitric oxide (NO) and to oxygen breathing at inspiratory fraction (FI(O₂)) of 1.0. Nitric oxide (40 ppm) failed to improve pulmonary hemodynamics, but oxygen breathing slightly decreased pulmonary artery pressure (PAP) and pulmonary vascular resistance (PVR) and the catheters were removed. Dalteparin (Fragmin; Pharmacia-Upjohn, Stockholm, Sweden), a low-molecular-weight heparin, was administered subcutaneously at 5,000 and 7,500 IU/day. The patient received digoxin, magnesium for its tocolitic properties, and betamethasone at 31 weeks and 32 weeks of gestation to promote fetal lung maturation. Continued right-sided heart dilatation (atrial diameter = 6.3 cm, end-diastolic ventricular diameter = 5.4 cm) and a decrease of right ventricular fractional area shortening to 25% were found at 32 weeks' gestation. Ultrasound biometry showed insufficient fetal growth, and the decision was made to proceed with cesarean delivery at 34 weeks' gestation.

In the operating room, the patient was placed in a supine position with left uterine displacement. Radial artery, thermodilution pulmonary artery, and lumbar epidural (L2-3) catheters were placed during local anesthesia. After baseline measurements, 6 l/min O₂ by mask increased SpO₂ from 90 to 90%. The hemodynamic parameters, hemoglobin concentration, and platelet count obtained peripartum are summarized in table 1. Thromboelastography (reaction time, 6.0 mm; clot

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Key words: Coagulation; iloprost; nitric oxide; pregnancy; pulmonary artery pressure.

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