Hypotensive Anesthesia for a Patient with Friedreich's Ataxia and Cardiomyopathy


Friedreich's ataxia is an autosomal recessive, inherited condition resulting in progressive limb and truncal ataxia. Cardiomyopathy is present in 90% of cases and kyphoscoliosis, causing severe deterioration of pulmonary function, in up to 80% of the cases.1 Insertion of Harrington rods and spinal fusion may slow the progress of the pulmonary dysfunction,2 but perioperative cardiopulmonary failure is a risk.3 Surgery is associated with marked blood loss4,5 which may be reduced by hypotensive anesthesia.6,7 We report a case of Friedreich's ataxia with cardiomyopathy who underwent hypotensive anesthesia for insertion of Harrington rods and spinal fusion. Sodium nitroprusside infusion resulted in a marked decrease in cardiac output associated with supraventricular tachycardia. Administration of isoflurane produced satisfactory hypotension with considerable reduction of intraoperative bleeding.

REPORT OF A CASE

A 20-year-old woman was diagnosed as having Friedreich's ataxia at the age of 6 years. At the same age, a systolic ejection murmur and abnormal electrocardiogram (ECG) were interpreted as evidence of a probable fibrotic cardiomyopathy. She had noted increasing dyspnea while climbing stairs before being permanently confined to a wheelchair at 14 years of age because of muscular weakness and incoordination. She was taking 0.125 mg digoxin bid to prevent arrhythmias and congestive cardiac failure. During the five years preceding this ad-

mission, a progressive thoracolumbar kyphoscoliosis had developed, and she was to undergo a Harrington rod insertion and spinal fusion to prevent further spinal curvature and compromise of her cardiopulmonary status.

Preoperative examination showed a normally developed girl of high intelligence, with the typical findings of Friedreich's ataxia and marked kyphoscoliosis, convex to the right. Cardiovascular examination showed an arterial blood pressure 100/60 mm Hg with a regular heart rate of 100 bpm. There were no signs of left or right heart failure, although she did have marked gravitational edema of her ankles. A grade 2/6 systolic ejection murmur was heard over the precordium, but other heart sounds were normal. ECG showed sinus rhythm, a QRS axis of +100°, right ventricular dominance, and QRS and T patterns consistent with left ventricular strain or digoxin therapy. Echocardiography showed normal cardiac dimensions with good left ventricular function. Chest roentgenogram demonstrated clear lung fields with minimal cardiac enlargement and confirmed the gross thoracolumbar kyphoscoliosis centered around T7. Pulmonary function tests suggested a mixture of restrictive and reversible obstructive lung disease. With an FIO2 of 0.2, pH was 7.43, PaO2 29 mm Hg, PaCO2 91 mm Hg, bicarbonate 19 mEq·L−1, and base excess −5 mEq·L−1, implying chronic hyperventilation. No nerve conduction studies were available.

Morphine, 10 mg, and hyoscine, 0.3 mg, were given im before anesthetia. Under local anesthesia, a 7-FG flow directed (R) catheter was inserted via the right internal jugular vein and the left radial artery was cannulated. A 14-gauge cannula was placed in a peripheral vein and all iv solutions were warmed. Hemodynamic variables were monitored using the computerized Haemodynamic Tracking System (Global Office Automation Systems, Calgary) and included cardiac index (CI), stroke volume (SVI), left ventricular stroke work (LVSWI), and systemic and pulmonary vascular resistance (SVRI, PVRI) (table 1).

Anesthesia was induced with iv droperidol, 5.0 mg, fentanyl 1,500 μg, and thiopental, 50 mg. After administration of pancuronium, 8.0 mg iv, the trachea was intubated and ventilation controlled breathing 65% nitrous oxide and oxygen. Other than a slightly elevated pulmonary capillary wedge pressure (PCWP), all hemodynamic variables were normal (table 1). The patient was then turned to the prone position, placed on a warming blanket, and all monitoring equipment repositioned and recalibrated. An infusion of sodium nitroprusside (50 mg in 500 ml 5% dextrose in water) was started at 1.0
TABLE 1. Perioperative Hemodynamic Variables

<table>
<thead>
<tr>
<th></th>
<th>Pre-Induction</th>
<th>Post-Induction</th>
<th>Nitroprusside Infusion</th>
<th>Isoflurane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse rate (beats/min)</td>
<td>92</td>
<td>77</td>
<td>140</td>
<td>70</td>
</tr>
<tr>
<td>Mean systemic arterial pressure (mmHg)</td>
<td>92</td>
<td>95</td>
<td>60</td>
<td>56</td>
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<tr>
<td>Mean pulmonary arterial pressure (mmHg)</td>
<td>25</td>
<td>18</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure (mmHg)</td>
<td>18</td>
<td>14</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Right atrial pressure (mmHg)</td>
<td>13</td>
<td>20</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Cardiac output (l/min)</td>
<td>7.6</td>
<td>5.4</td>
<td>2.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Cardiac index (l/min/m²)</td>
<td>5.1</td>
<td>3.7</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Stroke volume index (ml/beat/m²)</td>
<td>55.3</td>
<td>48.2</td>
<td>36.2</td>
<td></td>
</tr>
<tr>
<td>LV stroke work index (g-m/beat/m²)</td>
<td>53.1</td>
<td>49.3</td>
<td>17.8</td>
<td></td>
</tr>
<tr>
<td>Systemic vascular resistance index (RU)*</td>
<td>15.4</td>
<td>21.2</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>Pulmonary vascular resistance index (RU)*</td>
<td>1.4</td>
<td>1.3</td>
<td>3.2</td>
<td></td>
</tr>
</tbody>
</table>

*To convert to dynes/s/cm², multiply by 79.9.

µg·kg⁻¹·min⁻¹ (30 ml·hr⁻¹). Within five minutes, a mean systemic arterial pressure of 60 mmHg was reached, but a supraventricular tachycardia at 140 bpm caused a drop in cardiac index to 1.8 l·min⁻¹·m⁻² (table 1). Carotid sinus massage was ineffective as was propranolol, 3 mg iv, in divided doses. PCWP and RAP indicated that there was an adequate circulatory volume and the lung fields were clear (table 1). The nitroprusside infusion was terminated, and within four minutes the blood pressure had returned to normal and the tachyarrhythmia had resolved spontaneously. A further attempt was made to induce hypotension with nitroprusside with the same result. In view of the potentially marked decrease in cardiac output, the infusion was abandoned after a total dose of 2 mg (0.04 mg·kg⁻¹).

Following marked blood loss (800 ml in 20 min), arterial blood pressure was once more reduced deliberately. One per cent isoflurane was added to the inspired gases and within 10 min mean systemic arterial blood pressures of 50–55 mmHg were achieved at a heart rate of 75 bpm. Cardiac index was still relatively low, but acceptable (table 1). The surgeons noted a marked reduction in bleeding and surgery continued uneventfully. Neuroumuscular function was monitored and reversal of blockade with neostigmine, 1.0 mg, and atropine, 0.6 mg iv, was successful. The trachea was extubated after observing that ventilatory and hemodynamic parameters were normal.

After four hours surgery, a total blood loss of 2.5 l was replaced by six units of packed erythrocytes, 1.5 l of 0.9% saline, and 2.8 l of lactated Ringer's solution. Urine output for the operative period was 500 ml (2.5 ml·kg⁻¹·h⁻¹). In the post-anesthetic recovery room (PARR), core temperature had dropped to 36°C from an initial 38°C, and analysis of arterial blood gases showed a marked metabolic acidosis (base excess −15 mEq·l⁻¹), thought to be due to the reduced cardiac output during surgery. This was rapidly corrected following the iv administration of 30 mEq sodium bicarbonate. However, persistent mental confusion and a reduced urine output in PARR raised the possibility of cerebral edema. Dexamethasone, 5 mg, dexamethasone, 20 mg, and furosemide, 10 mg, were given iv, and the patient was transferred to the Intensive Care Unit. She made a good recovery over the next six hours and was discharged to the ward 48 hours after completion of surgery.

**DISCUSSION**

Several investigators have tried to define the primary defect of Friedreich's ataxia. Barbeau has proposed that there is a defect in renal tubular reabsorption of the amino-acid taurine. Abnormally high density lipoprotein synthesis, and disordered pyruvate and bilirubin metabolism are among the secondary effects. Taurine is implicated in the regulation of intracellular calcium and hence may be a causative agent in the cardiomyopathy seen in this disease. Abnormal intracellular calcium regulation also could be expected to interfere with neuromuscular transmission, although this has not been documented.

The major new aspect is the likelihood of cardiopulmonary compromise from the disease and the possibility of cardiac and respiratory failure during the perioperative period. Cardiomyopathy will be present in up to 90% of cases and may even be the presenting feature while cardiac failure is generally a common mode of death in scolioses and Friedreich's ataxia in particular. The severity of the cardiomyopathy may not correlate with that of the neurologic condition. ECG abnormalities include sinus tachycardia, right ventricular dominance, and ST/T wave changes. Echocardiography generally shows a concentric, hypertrophic cardiomyopathy with decreased left ventricular cavity size, 15,16 Postmortem findings show myocardial fibrosis with cardiac muscle degeneration and intracellular calcification. Hemodynamic studies show raised right atrial and pulmonary capillary wedge pressures with decreased ejection fractions but cardiac indices which may be above normal. As seen in our patient, these relatively normal pre-anesthetic hemodynamic variables do not necessarily predict a normal response to drugs. Administration of nitroprusside, even in very small doses (0.4 mg/kg) provoked a serious deterioration in cardiac function due to tachyarrhythmia. Cyanide toxicity would not be expected at this dose. Sinus tachycardia is a common response to nitroprusside infusion, but not usually to the extent seen in our patient. However, in Friedreich's ataxia, vagal lesions result in relative sympathetic overactivity, accounting for the resting sinus tachycardia seen in this patient. This could have been enhanced by the reaction to arterial hypotension induced by the nitroprusside, thus representing an exaggerated physiologic response rather than drug toxicity. A similar response to isoflurane might
be expected but would be masked in this case by the use of propranolol. Isoflurane normally does not cause marked decreases in cardiac output, and this probably was related to the prior use of propranolol. With the disorder of intracellular calcium described, verapamil may have been a better choice for the treatment of supraventricular arrhythmias associated with Friedreich's ataxia and cardiomyopathy.

Kyphoscoliosis appears in up to 80% of cases, being rapidly progressive once patients become chairbound. This results in a progressive restriction of pulmonary function with a decrease in vital and total lung capacity. An initial rise in residual volume and functional residual capacity due to reduced tone in the muscles of the thoracic cage is followed by an inevitable deterioration. Although respiratory failure is a hazard, our patient had normal ventilatory variables throughout the perioperative period.

Neuromuscular junctional activity has not been studied in relation to anesthesia in Friedreich's ataxia, but there is a report of hypersensitivity to d-tubocurarine; 3.9 mg produced apnea in a 47-kg boy for 90 min when used with nitrous oxide/oxygen and halothane. Although not documented, a disturbance of intracellular calcium metabolism could result in abnormal neuromuscular transmission. Our patient responded normally to pancuronium with clinical recovery from a dose of 1.6 mg/kg within three hours of administration. We did not use succinylcholine to facilitate intubation of the trachea. These patients show reduced motor nerve conduction velocities but normal electromyography. Thus, marked hyperkalemia is unlikely after succinylcholine administration.

Diabetes mellitus, not seen in our patient, may occur in up to 18% of patients, with as many as 40% displaying abnormal glucose tolerance curves. Both insulin- and non-insulin-dependent varieties are seen and can be managed as in normal anesthetic practice.

Harrington rod insertions and spinal fusion involves extensive dissection of the spinal musculature and skeleton. Average intraoperative blood losses of up to 96% of the estimated total blood volume have been reported. Hypotensive anesthesia with trimetaphan, pentolinium, or halothane may reduce blood loss by as much as 40%. Sodium nitroprusside has been used effectively in children reducing blood loss by 92%. In this case, despite effective induced hypotension, 77% of the estimated blood volume needed replacement. Other methods for reducing the amount of homologous blood transfused have included the use of a Cell-Saver and hemodilution with subsequent autologous transfusion. Both methods are limited in their usefulness; the former by cost and efficiency, the latter by the acceptable level of hemodilution. Thus, hypotensive anesthesia appears to be the most effective method of reducing blood loss.

References

Preoperative Cessation of Smoking and Pulmonary Complications in Coronary Artery Bypass Patients

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Smoking-related pulmonary dysfunction is a major determinant of postoperative respiratory morbidity. Cessation of smoking often is encouraged prior to surgery, but the efficacy of short-term abstinence from cigarette smoking in reducing postoperative pulmonary complications has not been proven. Therefore, we retrospectively studied the perioperative course of a group of adult patients undergoing coronary artery bypass grafting (CABG): 1) to determine if preoperative abstinence from cigarette smoking decreases postoperative pulmonary morbidity; and 2) to quantify any relationship between time of preoperative cessation of smoking and improvement in such morbidity.

METHODS

From January 1979 to December 1980, 1,056 patients underwent CABG at our institution. Of these, 500 patients were selected retrospectively for study by choosing alternate Mayo Clinic registration numbers in numerical sequence arranged from low-to-high. In this manner, there was no prior knowledge of vital statistics or clinical history. The medical, anesthetic, respiratory therapy, and preoperative pulmonary function test (PFT) records were examined to ascertain specifics of smoking history, 30-day perioperative course and management, and postoperative pulmonary morbidity.

Smoking histories were elicited carefully by staff internists, cardiologists, or thoracic disease specialists. At our institution, a medical history questionnaire is answered by the patient prior to meeting a staff physician. This questionnaire specifically asks for smoking history in packs per day, number of years smoked, and duration of smoking abstinence, if any. Also, sputum production is elicited regarding quantity per day and frequency. The staff physician then reviews the questionnaire in the presence of the patient to check for completeness and reliability. Patients with symptoms or physical findings suggestive of pulmonary disease are evaluated further by thoracic disease staff physicians. Again, detailed smoking, sputum production, and asthmatic histories are reviewed thoroughly.

Sufficient symptoms of pulmonary disease were present in 94 patients, both smokers and nonsmokers, to warrant complete preoperative PFTs. Impaired respiratory function was not suspected clinically in the other 406 patients, and no preoperative PFT’s were obtained. A forced expiratory volume in one second (FEV₁) of <70% predicted normal value was considered to represent abnormal function. Cardiac function and pathology were detailed by left ventricular end-diastolic pressures (LVEDP), left ventricular ejection fractions (LVEF), and number of major coronary arteries with >50% luminal stenosis.

Respiratory complications were defined as problems requiring more definitive therapy than the usual postoperative care given all our CABG patients. Such prob-

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