

## Fanconi Syndrome and Anesthesia

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Fanconi syndrome was first described by Lignac in 1924 and better defined by Fanconi in 1936.<sup>1</sup> The syndrome results from a disturbance of proximal renal tubular function causing generalized hyperaminoaciduria, glucosuria, and hyperphosphaturia, as well as renal loss of potassium, bicarbonate, water, and other substances normally conserved by the proximal tubule. Fanconi syndrome can be acquired or inherited. In its acquired form, it is associated with cystinosis, Wilson's disease, galactosemia, myeloma, exogenous toxins such as outdated tetracyclines, amyloidosis, and several other conditions. When inherited, it is transmitted as an autosomal recessive trait in about one in 40,000 births.

Symptoms and signs reflect the tubular abnormality and include polyuria, polydipsia, acidosis due to bicarbonate loss, and muscular weakness related to hypokalemia. Dwarfing with osteomalacia reflecting phosphate wasting and presenting as vitamin D-resistant rickets is a prominent clinical finding. Severe photophobia occurs with cystinosis.<sup>2-5</sup>

## REPORT OF A CASE

A 26-year-old male dwarf (35 kg, 112 cm) with idiopathic Fanconi syndrome was admitted for open reduction and internal fixation of a hip fracture. Since three years of age, the patient had received medical treatment for hypophosphatemic rickets, aminoaciduria, and glycosuria. At nine years of age, his glomerular filtration rate was noted to be decreased, as documented by a creatinine clearance of 41 ml·m<sup>-2</sup>·24 h<sup>-1</sup>; renal biopsy revealed a "swan-neck" deformity of the proximal convoluted tubule as characteristically found in Fanconi syndrome. Large urinary losses of sodium, potassium, bicarbonate, phosphate, and glucose resulted in polyuria of 5-7 l/day and a tendency to metabolic acidosis, hypokalemia, and hypophosphatemia.

At 19 years of age, the patient was diagnosed as having diabetes mellitus requiring insulin; in spite of good blood glucose control, he had severe glucosuria, which further increased the polyuria. He also had episodes of lactic acidosis of obscure etiology. At 25 years of age the patient had a lung abscess, which was drained and treated with

antibiotics. At the time of the present admission, he had residual pulmonary scarring and increased venous admixture, as evidenced by an alveolar-to-arterial oxygen tension difference of 33 torr (F<sub>I</sub>O<sub>2</sub> = 0.21). Blood urea was 17 mg/dl, and creatinine clearance 23 ml·m<sup>-2</sup>·24 h<sup>-1</sup>, with no evidence of nephrocalcinosis or urinary tract infection.

Prior to admission, the patient was maintained on a daily regimen of 160 mEq of K<sup>+</sup> (as KCl), 16 g of NaHCO<sub>3</sub>, 1,400 mg of neutral phosphate, 1 g of calcium, 5 μg of 1.25 (OH)<sub>2</sub> cholecalciferol, and an obligatory fluid intake of over 200 ml/h. Insulin requirements averaged 14 U of NPH insulin and 20 U of regular insulin per day.

For four days preoperatively, the patient was stabilized in traction, during which time he was seen in consultation for assessment of the anesthetic implications of his various metabolic abnormalities. Large urine losses were expected to continue intraoperatively, as well as blood and third-space losses. Based on expected requirements (established during previous hospitalizations by measurement of his daily obligatory urinary losses and dietary requirements to replace these), a solution was prepared that consisted of D5W with 30 mEq/l K<sup>+</sup> (as KCl), 20 mEq/l HCO<sub>3</sub><sup>-</sup> (as NaHCO<sub>3</sub>), and an additional 14 mEq/l Na<sup>+</sup> (as NaCl).

Preoperatively (8 A.M.) the patient received one-third his usual insulin dose; an intravenous line was inserted at 7 A.M. and the prepared solution infused at the rate of 200 ml/h throughout the fasting period (7 A.M. to 1 P.M.). Premedication consisted of 0.1 mg/kg morphine sulfate and 0.01 mg/kg scopolamine.

He was preoxygenated and anesthesia was induced with 200 mg thiopentone iv, followed by administration of 70 mg succinylcholine, iv. The trachea was intubated using a 7.0-mm Portex® blue-lined cuffed endotracheal tube, and the patient was mechanically ventilated with 70 per cent N<sub>2</sub>O and 30 per cent O<sub>2</sub> through a Bain circuit. Anesthesia was supplemented with fentanyl and droperidol, and relaxation was produced with *d*-tubocurarine. The patient was monitored with a central venous pressure line (internal jugular vein), continuous arterial pressure line (radial artery), ECG, precordial stethoscope, bladder catheter, and peripheral nerve stimulator.

Surgery was uncomplicated although prolonged (3.5 h). Total drug requirements consisted of 250 μg fentanyl, 2.5 mg droperidol, and 33 mg *d*-tubocurarine. Fluid and electrolyte management is summarized in table 1. Low measured urine output during the first two hours was thought to be due to an obstruction of the urinary catheter. Systolic blood pressure (90-120 torr) and pulse (60-80 beats/min) were stable throughout.

After adequate reversal of neuromuscular blockade with 1.8 mg neostigmine and 0.6 mg atropine, the trachea was extubated and the patient was taken to the Intensive Care Unit breathing spontaneously with supplemental oxygen via face mask. One hour postoperatively, naloxone (0.1 mg, iv) was given to counteract residual narcotic effect, reflected by a PaCO<sub>2</sub> of 50 torr, in the face of a mild metabolic acidosis. Naloxone promptly improved ventilation and the PaCO<sub>2</sub> (42 torr). Large urinary losses continued postoperatively. Central venous pressure gradually returned to preoperative levels, and 12 hs postoperative, oral intake was resumed. The remaining hospital course was uneventful, and the patient was discharged on the seventh day after surgery.

## DISCUSSION

Patients with Lignac-Fanconi syndrome usually die from chronic renal failure before 30 years of age. Surgical

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TABLE 1. Summary of Perioperative Metabolic Changes and Fluid/Electrolyte Management of a Patient with Fanconi Syndrome

	Preoperative	Intraoperative Hour				Postoperative Hour	
		1	2	3	4	1	2
Central venous pressure (torr)	5	4	4	1	0	0	1
Blood glucose (mg/dl)	260	257	308	—	300	—	—
Na <sup>+</sup> (mEq/l)	142	140	—	—	148	—	—
K <sup>+</sup> (mEq/l)	4.5	4.1	—	—	6.1	—	—
Cl <sup>-</sup> (mEq/l)	104	—	—	—	113	—	—
Pa <sub>O<sub>2</sub></sub> (torr)	—	141	—	155	140	75	68
pH <sub>a</sub>	—	7.5	—	7.47	7.47	7.23	7.28
Pa <sub>CO<sub>2</sub></sub> (torr)	—	31	—	31	30	50	42
HCO <sub>3</sub> <sup>-</sup> (mEq/l)	—	24.5	—	23	22.2	20.5	19.7
Accumulated							
Urine output (ml)	—	100	350	1,000	1,740	—	—
Blood loss (ml)	—	125	250	275	300	—	—
Replacement, Ringer's lactate (ml)	—	200	600	600	600	—	—
Replacement, normal saline (ml)	—	—	150	500	1,200	—	—
Prepared solution* (ml)	—	200	400	600	800	—	—

\* D5W with 30 mEq/l K<sup>+</sup> (as KCl), 20 mEq/l HCO<sub>3</sub><sup>-</sup> (as NaCHO<sub>3</sub>), and an additional 14 mEq/l Na<sup>+</sup> (as NaCl).

treatment of complications, as well as the occasional kidney transplantation in these cases,<sup>6</sup> will increasingly involve the anesthesiologist in their management. Our report describes some of the problems that may be encountered.

From table 1, it is clear that in spite of seemingly adequate volume replacement, central venous pressure decreased towards the end of the procedure, indicating relative hypovolemia. Bicarbonate requirements were somewhat underestimated, possibly because acidosis was aggravated by a decreased cardiac output secondary to decreased filling pressures. Since a pulmonary arterial line was not available, no objective calculations of left-ventricular filling pressure, cardiac output, or mixed-venous oxygen content were made. The metabolic acidosis was inadvertently compensated for by intraoperative hyperventilation, but was aggravated by initial postoperative hypoventilation due to residual narcotic effect. Administration of 0.1 mg naloxone, iv, improved the respiratory acidosis. Asymptomatic hyperkalemia towards the end of surgery could be related to acidosis and decreased utilization of glucose but more likely was due to hemolysis of red blood cells. A normokalemic value was obtained after insulin was reinstated.

Oxygenation and management of the patient's diabetes presented no additional problems intra- or postoperatively. A few recommendations for the anesthetic management of these patients can be made. The anesthesiologist should be well-acquainted with the biochemical and other abnormalities of the specific case, as these may

vary greatly. Careful planning and rigorous attention to fluid/electrolyte management is indicated. Extensive monitoring will facilitate a prompt and appropriate response to the rapid and large volume shifts that may be encountered. A pulmonary arterial catheter can be helpful in assessing the left-ventricular failure secondary to uremia often present in the final stages of Fanconi syndrome. Finally, these patients are reportedly very anxious, and a tendency to treat them like children because of the dwarfism should be resisted.

Fanconi syndrome, although rare, may present the anesthesiologist with formidable problems, especially regarding fluid/electrolyte and acid/base homeostasis. This case illustrates some of the problems, and recommendations are made for anesthetic management.

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