Thyrotoxic hypokalaemic paralysis in a Black man

Sir,

A 32-year-old African-American male construction worker and martial arts student presented to the emergency room complaining of generalized weakness that was more pronounced in the lower extremities and confined him to bed. Weakness began about 12 h after vigorous physical exercise and ingestion of a high carbohydrate diet.

He had no significant personal or family medical history. Initial blood pressure was 220/60 mmHg and resting pulse rate was regular at 98–104/min. His blood pressure normalized after 8 h without treatment (120/70 mmHg). Physical examination revealed a diffusely enlarged palpable thyroid gland and motor power of 3/5 in upper and 1–2/5 in the lower extremities. The rest of the examination was normal. In the emergency room the concentrations of electrolytes were potassium 2.3 mEq/l (range 3.5–5.0 mEq/l), magnesium 2.2 mEq/l, calcium 9.5 mEq/l, phosphate 3.5 mEq/l. Serum creatinine phosphokinase (CPK) level was 474 U/L (24–195 U/L) and the blood pH was 7.45. Urine pH was 7.5 and specific gravity was 1.025. Concentrations of spot urine electrolytes were: potassium 13 mEq/l, sodium 177 mEq/l and chloride 132 mEq/l. Electrocardiogram showed mild sinus tachycardia (rate of 100/min) and U-waves in leads I, II, III, V1–V6.

Treatment was started with intravenous administration of potassium chloride at 10 mEq/h and oral potassium chloride at 40 mEq every 8 h. Muscle weakness and hypokalaemia resolved within 24 h after the patient received a total of 360 mEq of potassium. Potassium supplementation was discontinued when serum potassium reached 4.6 mEq/l, but serum potassium continued to rise, peaking at 6.5 mEq/l on hospital day 3. Iatrogenic hyperkalaemia was treated with oral sodium polystyrene sulphonate 30 g every 4 h for three doses until serum potassium decreased to 4.6 mEq/l. On hospital day 3, repeat urine electrolyte concentrations (in a 24-h urine volume of 1.6 l) were potassium 198 mEq/l (317 mEq/day), sodium 287 mEq/l (459.2 mEq/day) and chloride 380 mEq/l (608 mEq/day). Plasma renin activity and aldosterone levels at admission and on hospital day 3 were within normal limits. Thyroid function tests 24 h after admission revealed hyperthyroidism. Thyroid-stimulating hormone (TSH) was <0.05 mU/l (0.4–5 mU/l), thyroxine (T-4) 18.26 μg/dl (5–12 μg/dl), free thyroxine (FT-4) 2.5 μg/dl (0.71–1.85 μg/dl), tri-iodothyronine resin uptake (T-3RU) 35.38% (25–35%), thyroid-stimulating immunoglobulin was 84% (0–130, Quest Lab). TSH receptor antibody was 17.2% (<10%, Quest Lab), thyroglobulin antibodies 6.7% (<2%, Quest Lab). Tc99 thyroid uptake and scan revealed diffuse uptake. HLA type was A23 A74, B53B58, C4 and BW4+.

Treatment for hyperthyroidism was started with propylthiouracil 150 mg twice daily, and the patient was discharged on hospital day 7. At further follow-up visits, the symptoms had not recurred after 2 years. He was clinically and biochemically euthyroid (Table 1) at the fourth month after initiation of propylthiouracil treatment, and has remained so thereafter.

Our patient presented with Graves’ disease, inducing hypokalaemia and weakness. Given the low urinary potassium and absence of vomiting or diarrhoea at presentation, the cause of hypokalemia was immediately followed by loss of K in the urine with subsequent hyperkalaemia, implying that the patient was not deficient in total body K. TSH, thyroid-stimulating hormone, T3RU, tri-iodothyronine resin uptake, T4, thyroxine.

Table 1 Laboratory data

<table>
<thead>
<tr>
<th></th>
<th>Serum Na (mEq/l)</th>
<th>Serum K (mEq/l)</th>
<th>Urine K (mEq/l)</th>
<th>T-4 (μg/dl)</th>
<th>TSH (mU/l)</th>
<th>T3RU (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 1 to 3</td>
<td>143</td>
<td>2.3</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>146</td>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>146</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>143</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>6.5</td>
<td>198</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>139</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>137</td>
<td>4.6</td>
<td>24</td>
<td>18.3</td>
<td>&lt;0.05</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>141</td>
<td>3.9</td>
<td></td>
<td>15.3</td>
<td>&lt;0.05</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>3.9</td>
<td></td>
<td>5.8</td>
<td>&lt;0.05</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>5.4</td>
<td></td>
<td>6.2</td>
<td>2.1</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
was attributed to shift of potassium into cells. Potassium replacement was stopped when serum potassium was normalized after 24 h, but hypokalaemia with concomitant kaliuresis (Table 1) occurred subsequently. This was treated with 90 g of oral sodium polystyrene sulphonate. We estimated that 126 mEq of potassium was eliminated from the stool after ingestion of 90 g since 1 g sodium polystyrene sulphonate binds about 1.4 mEq of potassium. The sum of the estimated urinary and stool losses of potassium was 443 mEq. This was equivalent to the amount administered intravenously in the preceding 24 h (360 mEq) plus the usual dietary intake (about 73 mEq/day), suggesting that the total body potassium was not decreased when he first presented with hypokalemia.

Although rare, this case is significant because if hyperthyroidism is not diagnosed and treated, periodic paralysis secondary to thyrotoxicosis is likely to recur. This is referred to as thyrotoxic hypokalaemic periodic paralysis (THPP). THPP is common in Asians but rare in Blacks, with only ten cases reported to our knowledge. It is characterized by sudden, transient, recurrent episodes of painless weakness or paralysis without alteration in consciousness or sensation, usually occurring after heavy exertion or a high carbohydrate diet followed by a prolonged rest. We believe that exercise followed by a diet rich in carbohydrate precipitated the attack in our case. Anti-thyroid medications, radioactive iodine or surgery is indicated once the diagnosis is confirmed. Beta-blockers and spironolactone have been used for prophylaxis.

In THPP, the mechanism of potassium shift into cells is not completely understood. Thyroid hormone directly stimulates Na-K-ATPase and increases the sensitivity of beta-receptors, resulting in catecholamine-mediated potassium uptake. The cell membrane becomes depolarized, blocking propagation of action potentials, resulting in weakness and muscle fibre abnormalities.

Human Leucocyte Antigen (HLA) subtypes have been studied in patients among different ethnic groups: Japanese (DRw8); Singapore Chinese (A2BW22, AW19B17); Hong Kong Chinese (B5, BW46); and two Navajo patients (A2, BW62, CW1, CW-, BW6), with a Black patient being reported by Kelley et al. (A23 and B14B15), but no consistent pattern has been found. Our patient is the second report of thyrotoxic hypokalaemic periodic paralysis associated with HLA A23+ type in a Black patient. The frequency of this HLA subtype among Blacks is 14.3% (www.onelambda.com). It is unclear whether Blacks with this particular HLA subtype are at increased risk for developing thyrotoxic hypokalaemic periodic paralysis. Physicians should be aware of this disease, as identification and treatment of hyperthyroidism can lead to cure, as in our case.

M.O. Salifu
K. Otah
H.J. Carroll
O. Ifudu
E.A. Friedman
M.S. Oh
Department of Medicine
SUNY Downstate Medical Center
New York

S. Aytug
Division of Endocrinology & Metabolism
Winthrop University Hospital
Mineola, NY

References