Muscle Force and Bone Mineral Density after Parathyroidectomy and Subcutaneous Autotransplantation for Secondary Hyperparathyroidism

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Abstract. The object of this study was to determine the muscle force and bone mineral density (BMD) of patients with secondary hyperparathyroidism before and 3 months after operation. Thirty-nine patients with secondary hyperparathyroidism and regular dialysis were operated. Their ages were 47 ± 12 (mean ± SD) years and duration of dialysis was 70.5 ± 35.8 months. The clinical symptoms included bone pain in 23 patients (59%), skin itching in 21 (53.8%), general weakness in 13 (33.3%), conscious disturbance in 2, chest tightness in 1, and failure to thrive in 1. Total parathyroidectomy and autotransplantation of 60 mg of parathyroid gland into subcutaneous tissue was done routinely. BMD was measured in the lumbar spine (L2–4), left proximal femur, trochanter, Ward’s triangle, and femoral neck. Six weeks after operation, baseline serum aluminum was checked to rule out aluminum intoxication. One patient on peritoneal dialysis was changed to hemodialysis 2.7 mmol/L) with general weakness in 5, conscious disturbance in 2, chest tightness in 1, and failure to thrive in 1.

The population of patients maintained on dialysis is growing and with it the number who develop various musculoskeletal complications. Although most patients on dialysis can be managed medically, some 5% to 15% develop complications of secondary hyperparathyroidism and require operative intervention [1, 2]. Traditionally, bone pain, skin itching, and soft tissue calcification are the indications for surgery. The goal of this study was to determine the effects of parathyroidectomy and autotransplantation on bone mineral density (BMD), fracture risk, and muscle force. We also wished to know whether general weakness is an indication for surgery in secondary hyperparathyroidism.

Materials and Methods

From June 1996 to October 1997 there were 39 patients (male: female 13:26) with secondary hyperparathyroidism [immunoreactive parathyroid hormone (iPTH) > 10 times normal] who underwent total parathyroidectomy and autotransplantation of 60 mg of parathyroid tissue who were enrolled in this study. Their ages ranged from 15 to 66 years with a mean ± SD of 47 ± 12 years and a duration of dialysis of 10 to 120 months (mean 70.5 ± 35.8 months).

The patient’s symptoms were recorded from medical charts. Severe bone pain was found in 23 patients, intractable skin itching in 21 (53.8%), and general weakness in 13 (33.3%). The indications for surgery included severe bone pain in 8 patients, intractable skin itching in 6, both bone pain and skin itching in 15, persistent high levels of iPTH (> 1000 pg/ml) and hypercalcemia (> 2.7 mmol/L) with general weakness in 5, conscious disturbance in 2, chest tightness in 1, and failure to thrive in 1. All patients had serum levels of calcium, phosphorus, iPTH, and alkaline phosphatase before operation and at 1 day, 1 week, and 3 months after operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation. Thirty-five patients had hemodialysis, and four had peritoneal dialysis. Patients with hemodialysis had regular dialysis three times a week and 1 day before operation.

Neck exploration was performed under general anesthesia with removal of all glands, autotransplantation of 60 mg of parathyroid tissue, and cryopreservation of all the other tissues. A transcervical thymectomy was performed routinely and cautiously to
remove any supernumerary parathyroid glands or embryologic rests of parathyroid tissue. Subcutaneous autotransplantation to the forearm without anteriovenous fistula was done in 34 patients and to the right thigh in five patients. Three separate small incisions 0.4 cm in length were performed 7 cm below the elbow joint, and 20 mg of parathyroid tissue was implanted into each incision. The wound was then closed with one stitch of 3-0 nylon. For those with poor skin conditions of the forearm due to arteriovenous fistula operation, the right thigh was selected for autotransplantation. Three incisions were made 20 cm above the right patella and the other procedures were performed as mentioned before. Parathyroid histology was confirmed (excluding adenoma), and the weight of the excised glands was recorded.

After operation all blood samples were drawn from the antecubital veins of the forearm with implantation or without arteriovenous fistula. Routinely, calcium carbonate (1–12 g) and calcitriol (0.25–1.5 pg/ml) were given daily to keep serum levels of calcium between 2.0 and 2.5 mmol/L. At 3 months after operation, almost all patients took only calcium carbonate 1 g/day and calcitriol 0.25 µg/day prescribed by their nephrologists to inhibit parathyroid function. The BMD was measured in the lumbar spine (L2–4) and left hip (femoral neck, Ward’s triangle, trochanter) with the Lunar DP4 system, Gd-153 (Madison, WI, USA), expressed as g/cm² and mean strength.

### Table 1. Serum chemical measurements at various times before and after operation.

<table>
<thead>
<tr>
<th>Chemical test</th>
<th>Preop (n = 39)</th>
<th>1 Day (n = 39)</th>
<th>1 Week (n = 39)</th>
<th>3 Months (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (normal: 2.0–2.5 mmol/L)</td>
<td>2.7 ± 0.3 (1.8–3.2)</td>
<td>2.2 ± 0.4 (1.5–3.0)</td>
<td>2.0 ± 0.4 (1.3–3.1)</td>
<td>2.2 ± 0.2 (1.8–2.6)</td>
</tr>
<tr>
<td>Phosphorus (normal: 0.8–1.5 mmol/L)</td>
<td>2 ± 0.5 (0.6–3.0)</td>
<td>1.8 ± 0.5 (0.5–3.0)</td>
<td>1.3 ± 0.5 (0.4–3.0)</td>
<td>1.3 ± 0.5 (0.4–2.4)</td>
</tr>
<tr>
<td>iPTH (normal: 10–65 pg/ml)</td>
<td>1215 ± 377 (617–1700)</td>
<td>55 ± 105 (1–426)</td>
<td>58 ± 117 (1–450)</td>
<td>82 ± 131 (1–591)</td>
</tr>
<tr>
<td>Alk-ptase (normal: 24–95 U/L)</td>
<td>260 ± 227 (69–1038)</td>
<td>242 ± 208 (53–897)</td>
<td>389 ± 369 (84–1094)</td>
<td>134 ± 74 (33–351)</td>
</tr>
</tbody>
</table>

Alk-ptase: alkaline phosphatase; iPTH: immunoreactive parathyroid hormone; Preop: preoperation. Numbers in parentheses represent the range of values.

Results

Four glands were found in 34 patients, three glands in 4, and five glands in 1. The weight of the removed parathyroid glands ranged from 14 g to 500 mg with a mean of 3721 ± 2832 mg. Serum calcium levels decreased markedly 1 week after surgery and gradually returned to normal 3 months later (Table 1). None had to take more than 1 g of calcium carbonate per day and 0.25 µg of calcitriol per day 3 months after the operation to keep the serum calcium level in the normal range. Serum phosphorus levels were steady 1 day, 1 week, and 3 months after operation (Table 1). Serum iPTH levels decreased markedly 1 day to 1 week after operation but gradually returned to normal 3 months later (Table 1). At that time 7 of 30 patients had iPTH levels below normal (10 pg/ml), but none required reimplantation of cryopreserved tissue.

Five patients had high levels (> 130 pg/ml) of iPTH immediately after operation, one with three glands at exploration and four with four glands. A missing gland or supernumerary glands might be the cause. Because they experienced alleviation of symptoms such as skin itching and bone pain and the iPTH levels decreased to one-fourth the preoperative levels, no further study was carried out. Six patients had high levels of iPTH (> 130 pg/ml) 3 months after operation or during the follow-up period. Only one who had recurrence of symptoms of hypercalcemia 8 months after operation was operated to remove subcutaneous parathyroid tissue. Serum levels of alkaline phosphatase increased 1 week after operation and gradually returned to normal 3 months later (Table 1). At that time 17 of 30 patients had serum alkaline phosphatase levels above the normal limit (95 U/L). Preoperative 60-degree peak force was significantly higher in males (n = 12; 298 ± 136.7 newtons) than in females (n = 21; 198.6 ± 92.6 newtons) (p = 0.00) and was higher in patients without general weakness (n = 23; 298 ± 136.7 newtons) than in those with general weakness (n = 10; 197 ± 85.2 newtons) (p = 0.039). The preoperative 60-degree peak force was inversely correlated with the patient’s age (n = 33; r = −0.374, p = 0.032). It was not correlated with the BMD of L2–4, BMD of the femoral neck, the duration of dialysis, or serum levels of iPTH, alkaline phosphatase, or calcium. The same findings were also found for the 60-degree average force. Extension force of quadriceps muscle showed marked improvement in both peak force and average force (Table 2). The improvement after operation was significant in patients with general weakness but not in those without general weakness (Table 2). The preoperative BMD of L2–4 was not significantly different with regard to sex or the symptoms of general weakness. It was not correlated with the patient’s age, duration of dialysis, or levels of iPTH, alkaline phosphatase, or calcium. The same findings were also found in the preoperative BMD of the femoral neck. The BMD after operation had marked improvement at L2–4, the femoral neck, Ward’s triangle, and the trochanter (Table 3). There were significant correlations between levels of iPTH and alkaline phosphatase (r = 0.479, p = 0.002), and between the iPTH level and the weight of removed parathyroid tissue (r = 0.445, p = 0.005). Fracture risk was also reduced at L2–4, the femoral neck, Ward’s triangle, and the trochanter. The differences of fracture risk preoperation and postoperation were significant at all sites (Table 4).