Resistance exercise training restores bone mineral density in renal transplant recipients

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Summary

Background. The kidneys are complex organs of the human body sustaining a number of vital and important functions. These organs need to be replaced in some subjects due to various diseases. Bone mineral density (BMD) of the subjects with kidney transplantation reduced as a result of poor mobility and use of especial drugs. Due to lack of information regarding the influences of weight training exercise on BMD of long bone, this research was done.

Method. 24 subjects with history of kidney transplantation were recruited in this study. They were divided into two groups who received weight training exercise and control group. The BMD of femur and lumbar spine was measured by use of dual energy X-Ray absorptiometry in both groups. The difference between BMD was evaluated by use of two sample T test.

Result. The mean values of BMD of femur were 0.679±0.09 g/cm² and 0.689±0.09 before and after exercise in this first group. In contrast it was 0.643±0.11 before follow-up and 0.641±0.11 g/cm² after follow-up in the control group. There was no difference in BMD of lumbar spine after exercise.

Conclusion. The result of this research study showed that BMD of long bone improved follow exercise. Therefore, it was concluded that weight training exercise can be used for the subjects with kidney transplantation.

KEY WORDS: bone mineral density; kidney transplantation.

Introduction

The kidneys are complex organs of the human body sustaining a number of vital and important functions: the most is maintaining the level blood urine below the limit (1, 2). Unfortunately the performance of this organ is influenced by various diseases, which at the end led to renal replacement or dialysis (3, 4). The number of subjects with end-stage renal disease (ESRD) has been increased. The incidence rate of ESRD varies from 69.4 to 103.7 per million populations (4-6). Most of the patients with ESRD or who have received kidney transplantation has to use especial medications which have adverse effects on bone and mineral metabolism (7-9). Rapid bone mass loss has been reported in 28-88% of whom with kidney transplantation (9). Based on the results of various research studies, the frequency of fracture in kidney transplant recipients varies between 6 and 45% which is 5-44 times more than usual (10-13). During the first 6 months after transplantation a rapid bone loss and fracture occur due to one of especial medicine to protect the transplanted kidney which influence bone formation and resorption cycle (7, 14, 15). Then due to a change in the dose of the prescribed medicine and activity of the patients, the speed of bone osteoporosis decreases and there may be some improvement in bone mineral density after a while (16).

The main treatment approaches to establish the bone loss after kidney transplantation include prescription of calcium and vitamin D, correction of hormone deficiency and hypophosphatemia and use of nonpharmacological approach such as exercise (8).

Weight resistance training has been used to improve BMD in patients with heart and lung transplantation (8, 17-19). It has been shown that resistance training reserves prednisone induced muscle wasting; improve glucose metabolism, decrease blood pressure and body fat (17, 19-21). There is not any evidence in literature to support the effects of weight resistance training on improving bone mineral density in the subjects with kidney transplantation. Therefore, the aim of this study was to evaluate the BMD of the subjects with kidney transplantation. The main hypothesis associated with this research was that the BMD of these subjects can be improved after a period of weight resistance training.

Method

This was a clinical trial study compromising 24 subjects with kidney transplantation. The mean subjects were selected from those referred to Yazd hospital for kidney transplantation. The main criteria to select the subject included those with kidney transplantation with no more than 1 year before selection, those without history of bone fracture, cardiovascular disease, diabet and other bone diseases which preventing them to stand and walk. Table 1 shows the characteristics of the subjects participated in this study.
In control group, the bone mineral density of femur decreased after 12 weeks exercise: it was 0.643±0.11 g/cm² before follow-up compared to 0.641±0.11 g/cm² after follow-up. Table 2 summarized the mean values of BMD of femur and lumbar spine before and after follow-up.

Discussion

Osteoporosis which is represented as decrease in bone mineral density is one of most important challenge of the subjects with end stage kidney failure or kidney transplantation (8, 24-26). Therefore, the aim of this research was to evaluate the effect of a period of weight resistance training on BMD of the subjects with renal transplantation.

As can be seen from Table 2, the BMD of the femur improved significantly follow exercise. Although the BMD of lumbar spine did not improved significantly, the bone loss established.

In contrast in the control group, the BMD of both lumbar and femur decreased significantly. Therefore, it can be concluded that weight training exercise is a good nonpharmacological approach to establish bone loss and to improve the BMD of long bone follow kidney transplantation. Poor mobility and muscular strength are major factors influencing the BMD in kidney transplantation subjects (27, 28).

Based on Mechanostat theory which was developed by Harold frost, the local deformation from the mechanical loading stimulates bone cells and results in bone adaptation (it means that bone tissues accommodate to the stress applied on it) (29, 30). Without any doubt bones are subjected to two sources of load including ground reaction force and muscular force (29).

Based on the results of various studies, the effects of muscular force is more important and effective than the force of gravity (31). Therefore, weight resistance training influences bone mineral density of long bones as it involves the activity of various muscular groups.

The main aim of weight resistance training exercise in this research study was to strength the muscles surrounding the hip joints and also extensor and flexors of the back. Based on the results of the study done by Spindler et al., there is a

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (year)</th>
<th>Height (m)</th>
<th>Mass (kg)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>27.4±17.36</td>
<td>1.7±0.12</td>
<td>75±5.27</td>
<td>12</td>
</tr>
<tr>
<td>Group 2 (control)</td>
<td>36.0±4.35</td>
<td>1.72±0.13</td>
<td>74.5±5.1</td>
<td>12</td>
</tr>
</tbody>
</table>

**Table 1 - The characteristics of the subjects participated in this study.**

**Parameter:** The bone mineral density (BMD) of lumbar spine (L2- L4) and proximal femur was measured by of dual energy X-ray absorptiometry (DEXA) (22). BMD is the most important and common used outcome to reflect the effect of physical activity on bone composition. This parameter actually measure the amount of mineral measured per unit area or volume of bone tissue. Based on results of various studies lumbar spine and proximal femur are the most common sites influencing by osteoporosis (8, 23).

**Procedure:** The subjects were divided into two groups by random. The first group was those who received weight resistance training program for 12 weeks. The second group was control group without any intervention. The exercise protocol consisted of a 12 weeks program consisted of upper and lower body resistance training. 2 days per week. The exercise protocol included 10 minutes stretching exercises, 10 minutes walking on treadmill, 10 minutes cycling, 20 minutes resistance training for the upper limb, 20 minutes resistance training for lower limb and 10 minutes cool-down walk at low intensity on the treadmill. All training sessions were supervised by two exercise specialists. A single set consisted of 10 to 15 repetitions was completed for each exercise. For the initial training resistance, 50% of one repetition maximum was selected. For the next sessions the resistance was increased by 5 to 10% (17).

The BMD of both groups was measured by DEXA method before and after the interventions. The difference between the BMD of the lumbar spine and proximal femur of the first group was evaluated by use of paired t test, to investigate the influence of exercise on BMD. The difference between BMD of the first and second group was evaluated by two sample t test with a significant point set at 0.05.

**Bone mineral density evaluation:** For evaluation of BMD the subjects were asked to be in supine position while the X-ray scanner moved from top to the button of the region to take some transverse scanning. The scanner moves from the top of L2 to the button of L3 while subjects lying on lateral side with hip joint in 10 degrees of flexion. For scanning the neck of the femur the subjects were asked to be in supine position and scanner move across the hip joint (17, 22).

**Result**

The mean values of BMD of the femur increased in the first group (received exercise) by 1.4% compared to the control group. The mean values BMD of the femur was 0.679± 0.09 g/cm² and 0.689 ± 0.09 g/cm², before and after exercise, respectively in the first group (P≤0.05). In contrast, BMD of lumbar spine did not changed follow the exercise (it was 0.852±0.05 before and 0.853±0.05 after exercise). Figure 1 shows the BMD test of one subject.

In control group, the bone mineral density of femur decreased after 12 weeks exercise: it was 0.643±0.11 g/cm²
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Table 2 - The mean values of BMD of the participants, before and after follow-up.

<table>
<thead>
<tr>
<th>BMD</th>
<th>First group</th>
<th>Second group (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Femur</td>
<td>0.679 ± 0.09 (g/cm²)</td>
<td>0.643 ± 0.11 (g/cm²)</td>
</tr>
<tr>
<td>After</td>
<td>0.689 ± 0.09 (g/cm²)</td>
<td>0.641 ± 0.11 (g/cm²)</td>
</tr>
<tr>
<td>P-value</td>
<td>0.00</td>
<td>0.05</td>
</tr>
<tr>
<td>Lumbar spine</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td></td>
<td>0.853 ± 0.06 (g/cm²)</td>
<td>0.841 ± 0.06 (g/cm²)</td>
</tr>
<tr>
<td>After</td>
<td>0.852 ± 0.58 (g/cm²)</td>
<td>0.834 ± 0.59 (g/cm²)</td>
</tr>
<tr>
<td>P-value</td>
<td>0.463</td>
<td>0.02</td>
</tr>
</tbody>
</table>

positive and significant correlation between the BMD of femoral neck and the force of muscles surrounding the hip joint (32). However, no correlation achieved between lumbar musculature strength and BMD of lumbar spine. The results of current study also supported the finding of Spindler et al. study. There is a limitation which needs to be acknowledged in this study which was the limited number of participants. Therefore, it is recommended that the same study will be done on big number of subjects.

Conclusion

The results of this study showed that weight resistance training exercise influences bone mineral density of long bones in subjects with kidney transplantation. Due to little side effects of this treatment intervention it is recommended that this method is used to improve BMD in subjects with various organs transplantation to reduce the effects of drug treatment.

Conflict of interest

None conflict of interest confirmed.

References


Clinical Cases in Mineral and Bone Metabolism 2017; 14(2):157-160


