Original Article

Relationship between effect of internal fixation and bone mineral density in elderly patients with intertrochanteric fractures

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Abstract: Objective: To study the influence of bone mineral density on the clinical effect of internal fixation of elderly patients with femoral intertrochanteric fracture, to improve the treatment effect of intertrochanteric fracture in the elderly. Methods: 130 cases of elderly patients with intertrochanteric fracture treated at our hospital from June 2010 to August 2015 were selected for this study. The bone mineral density of the upper femur of all elderly patients with intertrochanteric fracture was determined by X-ray before operation. All patients were treated with internal fixation. The hip joint function was evaluated by Harris score after operation, and the follow-up results of sixth months after operation were regarded as the clinical efficacy. According to the results, the patients were divided into significant outcome group and bad outcome group, and hip bone mineral density and age of two groups were compared, to explore and analyze the factors that may lead to the poor efficacy of internal fixation, and to investigate the correlation between these factors. Results: Among the 130 cases, 77 patients achieved good efficacy and the rest achieved poor efficacy. There was no significant differences in age, gender, height, weight, BMI and other aspects between the two groups (all $P > 0.05$). However, significant outcome group had significant better results in BMD values and T-values of femoral neck, Ward’s triangle area, and intertrochanteric femoral area as well as the femoral shaft total BMD value, hip total BMD value and T-value than that of the bad outcome group (all $P < 0.05$). Conclusion: The clinical efficacy of internal fixation of elderly patients with femoral fracture was not correlated with age, gender, height, weight, BMI but with the bone mineral density of the patients.

Keywords: Intertrochanteric fracture, internal fixation, bone mineral density, relevance

Introduction

The incidence of osteoporosis is increasing gradually and it has become a major risk factor that threatens the health of elderly [1]. For severe osteoporosis patient, even a minor trauma can lead to fractures in different parts of the body [2]. At present, hip fractures and vertebral compression fractures are more common in the clinic, often accompany with a high mortality rate [3, 4]. Intertrochanteric fracture is a common fracture that accompanies with osteoporosis, and most patients need surgery; the degree of osteoporosis may be related to intertrochanteric fracture types and the clinical efficacy of internal fixation. This study retrospectively analyzed 130 elderly patients with intertrochanteric fractures that treated in our hospital from June 2010 to August 2015. Bone mineral density of the upper femur of all elderly patients was evaluated by X-ray, and all the patients were treated with internal fixation. The hip joint function was evaluated by Harris score during the post-operative follow-up, and the follow-up results of sixth month were regarded as the post-operative efficacy. The aim of this study was to explore the factors that may lead to the poor efficacy of internal fixation, and to investigate the correlation between these factors. Now the report is as follows.
Table 1. Score criteria for Hip joint (Harris)

(1) Pain (44 possibilities)
1. No pain or can be ignored 44 points
2. Mild or neglectable pain, does not affect activities 40 points
3. Mild pain that does not affect the general activities; rarely in moderate pain during daily activities; Aspirin could be used to ease the pain 30 points
4. Moderate pain that could be tolerated, but it could affect general activities and work 20 points
5. Obvious pain that severely restrict the activities 10 points
6. Completely disabled, claudication, rest pain, bed ridden 0 point

(2) Function (47 possibilities)
1. Gait (33 possibilities)
   (i) Claudication: ① No-11 points; ② Mild-8 points; ③ Moderate-5 points; ④ Severe-0 point.
   (ii) Auxiliary support: ① No-11 points; ② Stick shall be used for long time walk-7 points; ③ Stick shall be used for most of the time-5 points; ④ Single crutch-3 points; ⑤ Double sticks-2 points; ⑥ Double crutches-0 point; ⑦ Unable to walk (special reasons)-0 point
2. Activity (14 possibilities)
   (i) Up and down the stairs: ① Normal, without using armrest-4 points; ② Normal, with armrest-2 points; ③ In other ways-1 point; ④ Cannot go up and down the stairs-0 point.
   (ii) Wearing shoes and socks: ① Easy-4 points; ② Hard-2 points; ③ Unable-0 point.
   (iii) Sit: ① Sit on an ordinary chair for 1 hour without discomfort-5 points; ② Sit on a high chair for 30 min without discomfort-3 points; ③ Sit on any chair with discomfort-0 point.
   (iv) Taking public transportation vehicles-1 point.
(3) No abnormalities, if patients meet the following conditions-4 points
1. Fixed flexion < 30°
2. Adduction < 10°
3. Stretching inward turning < 10°
4. Limb length discrepancy < 3.2 cm
(4) Range of motion, parameter values depend on the motion angle multiplied by the appropriate coefficient
1. Buckling 0°~45°*1.0; 45°~90°*0.6; 90°~110°*0.3
2. Abduction, 0°~15°*0.8; 15°~20°*0.3; > 20°*0
3. Buckling and rotation, 0°~15°*0.4; > 15°*0
4. Extend rotation, any numerical *0
5. Adduction, 0°~15°*0.2

Total score point * 0.05, = total score of movement range. Record Trendlenburg test results (positive, neutral degree). Optimal 90~100; Good 80~89; General 70~79; Bad < 70.
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Materials and methods

Study subjects

130 elderly patients with intertrochanteric fractures treated in the orthopedics department of our hospital from June 2010 to August 2015 were enrolled in this study. Among them, 64 cases were male and 66 were female, aged 57 to 81 years old with an average age of (61.5 ± 1.7) years old. There were 61 cases on the right side and 69 cases on the left. All cases were single part fracture, and there were no tumor pathological fracture, old fracture history, metabolic bone disease, or history of lumbar vertebral and contra-lateral femoral intertrochanteric fracture, no artificial joint replacement, or other special disease on lower limbs. The operations were all performed by the same surgeon, and anti-rotation nails were used on the proximal femur for internal fixation during the operation. After the operation, all patients carried non-weight-bearing exercise for 6 weeks, and performed hip joint function evaluation according to Harris score at 6th month. Evaluation criteria for the clinical efficacy of internal fixation: 90-100 points for excellent, 80-89 points for good, 70-79 points for fair, < 70 points for bad; 80 points or above were regarded as good efficacy, and less than 80 points, or lag screw came out from femoral head, plate broken or nail broken after operation were regarded as poor efficacy of internal fixation.

Main reagents and instruments

Bone mineral density measurement was performed by dual-energy X-ray absorptiometry (GE Company, USA). All measurements were carried out by the same technician with the same instrument. DR imager (Philips, Holland) was used for X-ray photography.

Methods

The measurement of bone mineral density: Dual-energy X-ray absorptiometry was used to measure bone mineral density and the image resolution was higher than 1 mm * 1 mm; regions of interest were established and compared on the uninjured side.

Imaging examination analysis: X-ray filming was performed by one senior technician with the same machine; the evaluation method was double blind method; all the films were reviewed individually by three imaging doctors, and then comparatively analyzed.

Harris score: a senior orthopaedic surgeon evaluated the Harris score at the follow-up on 6th month. See Table 1.

Table 2. Comparison of Harris scores of subjects

<table>
<thead>
<tr>
<th>Group</th>
<th>Harris scores 90-100</th>
<th>Harris scores 80-90</th>
<th>Harris scores 70-79</th>
<th>Harris scores &lt; 70</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant outcome group</td>
<td>67</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>77</td>
</tr>
<tr>
<td>Bad outcome group</td>
<td>0</td>
<td>0</td>
<td>47</td>
<td>6</td>
<td>53</td>
</tr>
</tbody>
</table>

Table 3. Comparison of clinical data between two groups

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Age (year)</th>
<th>Male (n/%)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant outcome group</td>
<td>77</td>
<td>57.7 ± 11.7</td>
<td>34 (44.16%)</td>
<td>161.5 ± 6.1</td>
<td>65.5 ± 10.5</td>
<td>25.1 ± 1.5</td>
</tr>
<tr>
<td>Bad outcome group</td>
<td>53</td>
<td>61.7 ± 10.5</td>
<td>23 (43.40%)</td>
<td>165.6 ± 7.5</td>
<td>67.7 ± 11.7</td>
<td>24.6 ± 1.7</td>
</tr>
</tbody>
</table>

Figure 1. Comparison of clinical data between two groups.
Table 4. Comparison of excellent and good rates between unstable and stable fractures

<table>
<thead>
<tr>
<th>Classification of fracture</th>
<th>Significant outcome group</th>
<th>Bad outcome group</th>
<th>Total</th>
<th>Excellent and good rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable type</td>
<td>21</td>
<td>43</td>
<td>64</td>
<td>32.8%</td>
</tr>
<tr>
<td>Stable type</td>
<td>56</td>
<td>10</td>
<td>66</td>
<td>84.8%</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>53</td>
<td>130</td>
<td>59.2%</td>
</tr>
</tbody>
</table>

Comparison of the general clinical features of the two groups of subjects

There was no significant difference in age, gender, height, weight, BMI and other aspects between the two groups (all P value > 0.05). See Table 3; Figure 1.

Comparison of the fracture types between two groups

56 cases in significant outcome group and 10 cases in bad outcome group were stable fractures (Tronzo-Evans type I and type II); 21 cases in significant outcome group and 43 cases in bad outcome group were unstable fractures (Tronzo-Evans type III and type IV). The results of chi-square test showed that the curative effect of two different fracture types was statistically different ($\chi^2 = 5.568, P < 0.05$), see Table 4.

Statistical treatment

SPSS 19.0 software was used for statistical analysis; measurement data were expressed as $\bar{x} \pm S$ and enumeration data were expressed as percentage. The comparison of measurement data between groups was examined by $t$ test, and the comparison of enumeration data between two groups was examined by $\chi^2$ test. $P < 0.05$ was considered with statistical significance.

Results

Comparison of Harris scores between two groups

In this study, we enrolled 130 elderly patients with intertrochanteric fractures treated in orthopedics of our hospital from June 2010 to August 2015. Among them, 64 cases were male and 66 were female, aged 57-81 years old with an average age of (61.5 ± 1.7) years old. There were 61 cases on the right side and 69 cases on the left. All cases were single fracture. According to the follow-up results of postoperative 6 months, the patients were divided into significant outcome group ($n = 77$) with Harris score ≥ 80, and bad outcome group ($n = 53$) with Harris score < 80. See Table 2.

Comparison of hip bone mineral density on uninjured side between two groups of patients

We compared the hip bone mineral density of uninjured side between two groups of patients, and the results showed that the patients in significant outcome group had a much better results in BMD value and T-value of femoral neck, ward's triangle region, and intertrochanteric region, as well as the total BMD value and T value of hip and total femoral BMD value, than those of patients in bad outcome group ($P < 0.05$). See Table 5; Figure 2.

Comparison of mean bone mineral density between two groups of patients

The mean value of bone mineral density in the group of patients with good curative effect was $(638 \pm 25.15)$ mg/cm$^2$, compared to $(509 \pm 35.25)$ mg/cm$^2$ of the patients with poor curative effect, the difference was statistically significant ($t = 5.827, P < 0.05$); For the patients with stable fracture, the mean value of bone mineral density in the significant outcome group was $(640 \pm 27.45)$ mg/cm$^2$, compared with $(512 \pm 31.85)$ mg/cm$^2$ of bad outcome group, the difference was statistically significant ($t = 6.572, P < 0.05$); For patients with unstable fracture, the mean value of bone mineral density in the significant outcome group was $(636 \pm 40.15)$ mg/cm$^2$, compared to $(506 \pm 37.05)$ mg/cm$^2$ of bad outcome group, the difference was statistically significant. See Figure 3.

The correlation of bone mineral density and types of fracture

The mean value of bone mineral density of patients with stable fractures was $(604 \pm 10.15)$ mg/cm$^2$, while the mean density of patients with unstable fractures was $(614 \pm 20.95)$ mg/cm$^2$. There was no statistical difference between the two groups.
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Table 5. Comparison of hip bone mineral density (\( \bar{x} \pm S \)) on the uninjured side between two groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Significant outcome group</th>
<th>Bad outcome group</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD value of femoral neck</td>
<td>0.83 ± 0.15</td>
<td>0.72 ± 0.10</td>
<td>0.006</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>T value of femoral neck</td>
<td>-1.45 ± 0.05</td>
<td>-2.55 ± 0.07</td>
<td>0.002</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>BMD value of Ward triangle region</td>
<td>0.72 ± 0.12</td>
<td>0.51 ± 0.21</td>
<td>0.002</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>T value of Ward triangle region</td>
<td>-1.82 ± 1.50</td>
<td>-2.55 ± 0.75</td>
<td>0.005</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>BMD value of femoral intertrochanteric region</td>
<td>0.73 ± 0.15</td>
<td>0.70 ± 0.01</td>
<td>0.003</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>T value of femoral intertrochanteric region</td>
<td>-1.23 ± 0.98</td>
<td>-1.88 ± 0.01</td>
<td>0.010</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Total BMD value of femoral shaft</td>
<td>0.97 ± 0.15</td>
<td>0.87 ± 0.01</td>
<td>0.007</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Total hip BMD value</td>
<td>0.68 ± 0.05</td>
<td>0.52 ± 0.01</td>
<td>0.005</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Total hip T value</td>
<td>-1.16 ± 0.96</td>
<td>-1.89 ± 0.75</td>
<td>0.020</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Figure 2. Comparison of bone mineral density on uninjured side between two groups of patients. *\( P < 0.05 \), vs. bad outcome group.

Figure 3. Comparison of mean value of bone mineral density between the two groups. *\( P < 0.05 \), vs. significant outcome group.

Discussion

At present, the number of patients with osteoporosis has significantly increased in clinic, hip fracture of many patients were caused by low-energy trauma [5, 6]. The treatments of intertrochanteric fracture of femur are generally internal fixations with angled blade plate, condylar plate and dynamic hip screws, interlocking nails as well as Richard’s screw-plate system, etc. [7-9]. Now, more popular methods are Dynamic Hip Screw (DHS) and Proximal Femoral Nail Anti-Rotation (PFNA) for the treatment of intertrochanteric fracture of femur [10, 11].

The loss of balance between bone resorption and bone formation is the main reason to cause osteoporosis [12-14]. With the increase of age, osteoporosis occurs, bone mass decreases, and eventually weakens bone strength, easily resulting in bone fracture. According to the literature reports, bone mineral density begin to decrease gradually after reaching a peak at the age of 30-40, and the maximum reduction of the bone mineral density of the femoral head can reach about 5% per year [15, 16]. So, osteoporosis is one of the most serious risk factors for fracture. At present, widely used diagnostic criteria for osteoporosis include X-ray absorption measurement of bone mineral density [17].

Bone mineral density reflects the bone mineral content per unit of the bone, and is one of the key indices of bone density to examine and predict osteoporosis and the occurrence of fracture [18]. On the basis of a strong laboratory
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test for the fracture of osteoporosis, bone mineral density has been the gold standard for the diagnosis of osteoporosis. According to the results of clinical research, patients have BMD decrease in hip, especially femoral trochanteric region, which is significantly correlated to the occurrence of intertrochanteric fractures; it suggests that the level of local bone mineral density may be related to the fracture caused by osteoporosis. And clinical research results also show that the bone density of the elderly women increase by 1%, the probability of hip fracture will reduce by 4%, and spinal bone mineral density increase by 1%, the probability of hip fracture will reduce by 35%-40% [19].

Our results showed that within certain extent, the lower the mineral density of femoral trochanteric region was, the higher the incidence of osteoporotic femoral fractures would be. We also found that the severity of osteoporosis and bone mineral density was positively related to the number of fracture fragments. At the same time, it also showed that the mean T value of the Ward triangle region, especially when it was less than -2.0 SD, had a certain meaning to the fracture caused by osteoporosis. Based on the analysis of anatomical structure, the Ward triangle region is weak in mechanics, and it is easy to have intertrochanteric fractures. This research showed that the patients in significant outcome group had a much better results in BMD value and T-value of femoral neck, ward's triangle region, and intertrochanteric region, as well as the total BMD value and T value of hip and total femoral shaft BMD value, than those of patients in bad outcome group (all P < 0.05). It suggests that there is a correlation between bone mineral density and the prognosis of intertrochanteric fractures in elderly patients. The higher the bone mineral density is, the better the prognosis will be.

The results also showed that there were no significant differences in age, gender, height, weight, and BMI value between the two groups (all P > 0.05). It suggests that age, gender, height, weight and BMI value may not be the risk factors for the prognosis of intertrochanteric fractures.

There are some deficiencies in this study. Firstly, the sample size in this study is relatively small with only 130 cases. The conclusion under large sample size is still to be decided with further research. Secondly, all the patients selected in this study had no complications; for patients with diabetes mellitus, liver and kidney dysfunction or parasympathetic dysfunction etc, whether there is a correlation between bone mineral density and the prognosis of intertrochanteric fractures in elderly patients should be further investigated. Thirdly, during the follow-up period of 6 months, rehabilitation training, drug taking, and nutrition of the patients were not under strict control; as we all known that those factors will certainly influence the prognosis of internal fixation. Whether the above factors would affect the final outcome and the results of this study should be further investigated.

To sum up, the clinical effect of internal fixation of intertrochanteric fracture in elderly patients is correlated with bone mineral density, instead of the age, sex, height, weight, and BMI of the patients.

Disclosure of conflict of interest

None.

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