Comparison of femoral neck fracture healing and affected limb pain after anterolateral-approach minimally invasive total hip replacement and hemiarthroplasty

Xiao-Dong Cao, Jun Ye, Feng-Wu Wang

Department of Orthopedics, Chang’an Hospital of Dongguan City Guangdong Province, Dongguan City, Guangdong Province, 523843

Objective: To study the differences in femoral neck fracture healing and affected limb pain after anterolateral-approach minimally invasive total hip replacement and hemiarthroplasty.

Methods: A total of 92 patients with femoral neck fracture who received hip replacement in our hospital between May 2013 and December 2015 were selected and randomly divided into total hip and half hip group. Total hip group received anterolateral-approach minimally invasive total hip replacement, half hip group received anterolateral-approach minimally invasive hemiarthroplasty. In the following study, the differences in femoral neck fracture healing and affected limb pain after anterolateral-approach minimally invasive total hip replacement and hemiarthroplasty were compared from the aspects of serum bone metabolism indexes and pain media.

Results: 1 month after operation, serum PINP, PICP, BMP, TGF-β, FGF, IGF-I and IGF-II levels of total hip group were significantly higher than those of half hip group while TRAP5b and CatK levels were significantly lower than those of half hip group; the day after operation, serum pain media SP and CGRP levels were not significantly different between the two groups of patients; 36 h after operation, serum SP and CGRP levels of total hip group were significantly lower than those of half hip group.

Conclusion: The bone metabolism after anterolateral-approach minimally invasive total hip replacement is better than that after hemiarthroplasty, and the degree of pain is less than that after hemiarthroplasty.

1. Introduction

Femoral neck fracture is a rather difficult type of limb fracture that tends to occur in elderly people, and the femoral neck fracture easily causes blood supply injury and increases the risk of ischemic necrosis of femoral head. Both internal fixation and hip replacement are the clinically common surgical procedures for the treatment of femoral neck fracture. Femoral neck fracture end is affected by the damaged blood supply, so the effect of internal fixation is poor; the place with internal fixation is affected by the of hip muscle contractility and will form a larger shear force, so the internal fixation materials easily loosen. Total hip replacement is the preferred surgical treatment for elderly patients with femoral neck fracture, it can reconstruct the hip joint structure and function, and the patients are able to carry out functional exercise early after operation, which is conducive to fracture healing and functional recovery[1]. Total hip replacement and hemiarthroplasty are the two common ways of hip arthroplasty for treatment of femoral neck fracture, and it has been reported that the femoral neck fracture healing after total hip replacement is superior to that after hemiarthroplasty[2,3]. In the following study, the differences in femoral neck fracture healing and affected limb pain after anterolateral-approach minimally invasive total hip replacement and hemiarthroplasty were compared from the angles of the serum bone metabolism indexes and pain media.

2. Subjects and methods

2.1 Research subjects

A total of 92 patients with femoral neck fracture who received hip replacement in our hospital between May 2013 and December 2015 were selected as the research subjects, they were with clear history of trauma and diagnosed with femoral neck fracture Garden III-IV type through imageological examination after admission, and they accepted emergency hip replacement. Random number table

Corresponding author: Xiao-Dong Cao, Department of Orthopedics, Chang’an Hospital of Dongguan City Guangdong Province, Dongguan City, Guangdong Province, 523843.
Tel: 13751325175.
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was used to divide the included patients into total hip and half hip group, 46 cases in each group. Total hip group received anterolateral-approach minimally invasive total hip replacement, 29 cases were male and 17 cases were female, they were 22-47 years old, 26 cases were with Garden III type and 20 cases were with IV type; half hip group received anterolateral-approach minimally invasive hemiarthroplasty, 31 cases were male and 15 cases were female, they were 24-45 years old, 25 cases were with Garden III type and 21 cases were with IV type. The two groups of patients were not statistically different in general information (P>0.05).

2.2 Operation methods

Both groups of patients took the supine position and accepted surgery under continuous epidural anesthesia, the improved Harding incision was made to separate the tissue step by step and reveal the hip joint, the joint capsule was incised to reveal femoral neck, sever the acetabular ligament fracture and take out the fractured femoral head, and then osteotomy processing was done to the femoral neck. After the above operations were completed, half hip group received hemiarthroplasty, which was as follows: the femur was reamed, then the right femoral stem and femoral prosthesis were imbedded into the femur, the joint capsule was sutured after pairing, and the incision was closed; total hip group accepted total hip replacement, and the method was as follows: the acetabulum was treated at first, the acetabular cartilage was eliminated after appropriate polishing, then the acetabular cup prosthesis was fixed, the femur was reamed, the right femoral stem and femoral prosthesis were imbedded, the joint capsule was sutured after pairing, and the incision was closed.

2.3 Serum index detection methods

1 month after operation, 5 mL of peripheral venous blood was collected from two groups of patients and centrifuged to get serum, and enzyme-linked immunosorbent assay kits were used to detect the levels of N-terminal propeptide of procollagen type I (P1NP), C-terminal propeptide of procollagen type I (P1CP), tartrate-resistant acid phosphatase 5b (TRAP5b), cathepsin K (CatK), bone morphogenetic protein (BMP), transforming growth factor-β (TGF-β), fibroblast growth factor (FGF), insulin-like growth factor-I (IGF-I), IGF-II, substance P (SP) and calcitonin gene-related peptide (CGRP).

2.4 Statistical methods

SPSS 21.0 software was used for statistical analysis, measurement data was input in the software and then analyzed by t test and P<0.05 meant statistical significance in differences.

3. Results

3.1 Serum bone metabolism molecule levels of two groups of patients after operation

1 month after operation, analysis of serum bone metabolism molecules P1NP, P1CP, TRAP5b and CatK between two groups of patients was as follows: serum P1NP and P1CP levels of total hip group were significantly higher than those of half hip group while TRAP5b and CatK levels were significantly lower than those of half hip group. Differences in serum PINP, PICP, TRAP5b and CatK levels were statistically significant between two groups of patients (P<0.05).

Table 1.
Comparison of serum bone metabolism molecule levels between two groups of patients after operation (ng/mL).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>PINP</th>
<th>PICP</th>
<th>TRAP5b</th>
<th>CatK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hip</td>
<td>46</td>
<td>26.51±3.52</td>
<td>19.38±2.26</td>
<td>17.59±2.03</td>
<td>9.48±1.05</td>
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<tr>
<td>Half hip</td>
<td>46</td>
<td>12.77±1.53</td>
<td>10.32±1.65</td>
<td>29.15±3.58</td>
<td>22.16±2.79</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
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</tbody>
</table>

3.2 Serum osteocyte cytokine levels of two groups of patients after operation

1 month after operation, analysis of serum osteocyte cytokines BMP, TGF-β, FGF, IGF-I and IGF-II between two groups of patients was as follows: serum BMP, TGF-β, FGF, IGF-I and IGF-II levels of total hip group were significantly higher than those of half hip group. Differences in serum BMP, TGF-β, FGF, IGF-I and IGF-II levels were statistically significant between two groups of patients (P<0.05).

Table 2.
Comparison of serum osteocyte cytokine levels between two groups of patients after operation (ng/mL).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>BMP</th>
<th>TGF-β</th>
<th>FGF</th>
<th>IGF-I</th>
<th>IGF-II</th>
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</thead>
<tbody>
<tr>
<td>Total hip</td>
<td>46</td>
<td>9.29±1.05</td>
<td>35.75±4.62</td>
<td>11.8±2.42</td>
<td>8.6±1.04</td>
<td>14.26±1.77</td>
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<td>Half hip</td>
<td>46</td>
<td>4.42±0.68</td>
<td>16.76±2.06</td>
<td>5.06±0.67</td>
<td>4.16±0.56</td>
<td>7.92±0.89</td>
</tr>
<tr>
<td>T</td>
<td></td>
<td>12.491</td>
<td>14.028</td>
<td>11.772</td>
<td>10.393</td>
<td>9.275</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

3.3 Serum pain medium levels of two groups of patients after operation

Analysis of serum pain media SP and CGRP between two groups of patients the day after operation and 36 h after operation was as follows: (1) the day after operation, serum pain media SP and CGRP levels were not significantly different between the two groups of patients (P>0.05); (2) 36 h after operation, serum SP and CGRP levels of total hip group were significantly lower than those of half hip group. Differences in serum SP and CGRP levels were statistically significant between two groups of patients (P<0.05).

Table 3.
Comparison of serum pain medium levels between two groups of patients before and after operation (μg/mL).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Operation</th>
<th>SP</th>
<th>CGRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>46</td>
<td>Before operation</td>
<td>5.61±0.76</td>
<td>17.85±2.03</td>
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<td></td>
<td></td>
<td>36 h after operation</td>
<td>3.62±0.43</td>
<td>7.26±0.98</td>
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<tr>
<td>Control</td>
<td>46</td>
<td>Before operation</td>
<td>5.55±0.62</td>
<td>18.13±2.39</td>
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<tr>
<td></td>
<td></td>
<td>36 h after operation</td>
<td>4.91±0.52</td>
<td>12.77±1.85</td>
</tr>
</tbody>
</table>

4. Discussion

Total hip replacement and hemiarthroplasty are two common ways of hip arthroplasty for femoral neck fracture. Existing study of domestic scholars has found that compared with hemiarthroplasty, the overall fracture healing after total hip replacement treatment of
femoral neck fracture is more ideal, the total effective rate is higher, and the complication rate is lower[4]. In the study, in order to clear the differences between total hip replacement and hemiarthroplasty treatment of femoral neck fractures from molecular levels, the bone metabolism after two surgeries was analyzed at first. Bone metabolism balance is an important factor to promote fracture healing, the bone collagen deposition mediated by osteoblasts is conducive to porosis and fracture healing[5]. PINP and PICP are the products when osteoblasts synthesize type I collagen, and serum PINP and PICP levels can reflect the viability of osteoblasts[6,7]; TRAP5b and CatK are the acidic phosphatase and protease secreted by osteoclasts respectively, and they are involved in bone resorption process[8,9]. In the study, analysis of the levels of the bone metabolism marker molecules showed that serum PINP and PICP levels of total hip group were significantly higher than those of half hip group while TRAP5b and CatK levels were significantly lower than those of half hip group. This means that bone metabolism after total hip replacement is better than that after hemiarthroplasty, the osteoblast viability is stronger, and the osteoclast viability is weaker.

In the process of fracture healing, bone metabolism activity-related osteoblast activity and osteoclast activity are affected by BMP, TGF-β, FGF, IGF-I, IGF-II and other factors bone cytokines. BMP is the hydrophobic acid peptide synthesized and secreted by bone progenitor cells, osteoblasts and chondrocytes, and it can promote the mesenchymal stem cell differentiation to osteoblasts and increase the formation of bone matrix, which induces bone structure formation[10]; TGF-β has inducing effect on osteoblast differentiation, maturation and chemotaxis, can also promote the synthesis and secretion of fibronectin and collagen, and is conducive to fracture healing[11]; FGF is the mitogen of bon progenitor cells, IGF-I and IGF-II are the mitogen of cells in a variety of tissues, and the three have promoting effect on progenitor cell proliferation, migration and differentiation, and are conducive to the formation and repair of bone and cartilage tissues[12,13]. In the study, analysis of the levels of the bone metabolism marker molecules showed that serum BMP, TGF-β, FGF, IGF-I and IGF-II levels of total hip group were significantly higher than those of half hip group. This means that the bone cytokine levels after total hip replacement are significantly higher than those after hemiarthroplasty, and higher bone cytokine levels can enhance the osteoblast viability and inhibit the osteoclast viability to create favorable local microenvironment for fracture healing.

Total hip replacement can more completely repair the acetabulum, the acetabular edge and prosthesis edge remain parallel, and it avoids postoperative stress concentration and thus reduces the postoperative local pain. SP and CGRP are the important neurotransmitters mediating pain perception, the former can increase the excitability of dorsal horn neurons and the primary afferent fiber endings, and reduce pain threshold, and the operation damage to local tissue as well as the friction between the prosthesis and acetabulum can cause postoperative pain[14]; the latter can not only increase the formation of nerve impulses and cause pain and infection, but can also inhibit the SP degradation and extend the pain effect caused by SP[15,16]. In the study, analysis of the levels of the serum pain media between two groups of patients after operation showed that the day after operation, serum pain media SP and CGRP levels were not significantly different between the two groups of patients; 1 month after operation, serum SP and CGRP levels of total hip group were significantly lower than those of half hip group. This means that the trauma caused by total hip replacement and hemiarthroplasty is basically equivalent, and there was no significant difference in the pain extent the day after operation; in the process of postoperative fracture healing, the pain caused by total hip replacement is significantly weaker than that caused by hemiarthroplasty.

In conclusion, it is believed that compared with the hemiarthroplasty, the anterolateral-approach minimally invasive total hip replacement helps to improve the bone metabolism, enhance the osteoblast viability and inhibit the osteoclast viability, and it can also inhibit the postoperative pain.

References


