Effect of locking plate internal fixation system treatment on the levels of bone turnover biomarkers and inflammatory factors in patients with proximal humeral fractures

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ARTICLE INFO

Article history:
Received 7 Jul 2016
Received in revised form 17 Jul 2016
Accepted 12 Jul 2016
Available online 24 Jul 2016

Keywords:
Proximal humeral fractures
Locking plate
Bone turnover
Inflammatory factors

ABSTRACT

Objective: To study the effect of locking plate internal fixation system treatment on the levels of bone turnover biomarkers and inflammatory factors in patients with proximal humeral fractures. Methods: 62 patients with proximal humeral fractures who received surgical treatment in the hospital between May 2013 and February 2016 were selected and divided into the control group (n=34) who received traditional common anatomical bone plate internal fixation treatment and the observation group (n=28) who received locking plate internal fixation system treatment. 4 weeks after operation, enzyme-linked immunosorbent assay (ELISA) was used to detect the serum levels of bone formation indexes, bone resorption indexes, pro-inflammatory factors and anti-inflammatory factors of two groups of patients. Results: 4 weeks after operation, serum bone formation indexes osteocalcin (OC), N-terminal propeptide of procollagen type I (P1NP), bone alkaline phosphatase (BALP) and bone gla protein (BGP) levels of observation group were higher than those of control group while bone resorption indexes pyridinoline (PYD), tartrate-resistant acid phosphatase (TRAP), cross-linked C-terminal telopeptides of type I collagen (CTX) and deoxypyridinoline crosslink (D-pyr) levels were lower than those of control group (P<0.05); serum pro-inflammatory factors interleukin 1β (IL-1β), interleukin-6 (IL-6) and interleukin-22 (IL-22) levels of observation group were lower than those of control group while anti-inflammatory factors soluble tumor necrosis factor receptor I (sTNF-RI), interleukin-4 (IL-4) and interleukin-13 (IL-13) levels were higher than those of control group (P<0.05). Conclusion: Locking plate internal fixation system treatment of proximal humeral fractures can promote the fracture end healing and improve the bone metabolism without causing strong systemic inflammatory reaction.

I. Introduction

Humeral fracture mostly occurs in surgical neck, supracondylar, etc., is mostly caused by the direct or indirect violence, and the open reduction and internal fixation can furthest restore the anatomical position of fracture end, and ensure the shoulder joint function and activity[1,2]. Internal fixation with common anatomical bone plate is a common way for proximal humeral fractures, but there are the defects such as unstable fracture fixation, screw loosening, much tissue stripping, and large trauma. Internal fixation with locking plate has the advantages such as high holding force within the bones and good angulation stability, and it has been widely used in the treatment of fractures in near joints at abroad[3]. In the following study, the effect of locking plate internal fixation system treatment on the levels of bone turnover biomarkers and inflammatory factors in patients with proximal humeral fractures was analyzed from the aspects of bone metabolism and inflammation.
2. Materials and methods

2.1. Clinical information

62 patients with proximal humeral fractures who received surgical treatment in the hospital between May 2013 and February 2016 were included, and the patients themselves signed consent form. After the operation methods were reviewed, the included patients were divided into the control group (n=34) who received traditional common anatomical bone plate internal fixation treatment and the observation group (n=28) who received locking plate internal fixation system treatment. Control group included 18 male cases and 16 female cases, they were 24–67 years old, and the causes of injury were: 10 cases with traffic injuries, 13 cases with falling injury, 8 cases with ground falling and 3 cases with others; observation group included 15 male cases and 13 female cases, they were 25–69 years old, and the causes of injury were: 9 cases with traffic injuries, 12 cases with falling injury, 5 cases with ground falling and 2 cases with others. Two groups of patients were not statistically different in the distribution of age, gender and causes of injury (P>0.05), and the study was approved by the hospital ethics committee.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) diagnosed with proximal humeral fractures after X-ray examination; (2) without history of surgery within half a year before admission; (3) with normal bleeding and clotting function; (4) could cooperate with treatment and related examination, and with complete clinical data. Exclusion criteria: (1) with pathological fracture; (2) with basic shoulder joint disease, and unable to tolerate surgical trauma; (3) with the local fracture or systemic infectious diseases; (4) with long-term use of corticosteroids and bone metabolism disorders.

2.3. Operation methods

The control group of patients received traditional common anatomical bone plate internal fixation treatment. Observation group of patients received locking plate internal fixation system treatment, which was as follows: the affected-side shoulder was elevated, deltoid and pectoralis major clearance access was taken, the cephalic vein inside the interscalene was pulled outwards, and the axillary nerve and musculocutaneous nerve of the deep deltoid surface should not be damaged. The fascia was incised to expose fracture end, the bicipital muscle of arm and interscalene were used as the reduction sign, and kirschner wire was used for fixation. During the operation, the fracture blocks attached to the rotator cuff should be protected in order to help maintain the stability of the shoulder joint. The locking plate was put in the anterolateral humerus and fixed with kirschner wire temporarily. C-arm fluoroscopy was used to ensure the good fracture end alignment and apposition, the hole was drilled under the guide of guider, and the lock screw was imbedded (avoiding drilling into the joint). The affected-side shoulder joint was moved passively, the internal fixation should be firm, and the muscle and skin were sutured layer by layer. The affected limb was hanged for 4 weeks after operation, and rehabilitation exercises should be done early according to the fracture stability.

2.4. Observation indexes

4 weeks after surgery, 1.5 mL of fasting cubital venous blood was extracted from two groups of patients at the same point in time, anti-coagulated, then let stand at room temperature for overnight and centrifuged at low speed to get supernatant and place it at -80°C for test. Specific detection indexes were as follows: (1) bone turnover biomarkers: enzyme-linked immunosorbent assay (ELISA) was used to detect bone formation indexes osteocalcin (OC), N-terminal propeptide of procollagen type I (P1NP), bone alkaline phosphatase (BALP) and bone gla protein (BGP) as well as bone resorption indexes pyridinoline (PYD), tartrate-resistant acid phosphatase (TRAP), cross-linked C-terminal telopeptides of type I collagen (CTX) and deoxypyridinoline crosslink (D-pyr) contents. (2) Inflammatory factors: ELISA was used to detect pro-inflammatory factors interleukin 1β (IL-1β), interleukin-6 (IL-6) and interleukin-22 (IL-22) as well as anti-inflammatory factors soluble tumor necrosis factor receptor I (sTNF-RI), interleukin-4 (IL-4) and interleukin-13 (IL-13) contents.

2.5. Statistical analysis

The data was input in software SPSS15.0 by specially-assigned personnel, the measurement data was in terms of \( \bar{x} \pm s \), comparison between two groups was by paired t test and \( P<0.05 \) indicated statistical difference.

3. Results

3.1. Bone formation indexes

4 weeks after operation, comparison of serum bone formation indexes OC, P1NP, BALP and BGP levels between two groups of patients was as follows: serum bone formation indexes OC, P1NP, BALP and BGP levels of observation group were higher than those of control group. Differences in serum bone formation indexes OC, P1NP, BALP and BGP levels were statistically significant between two groups of patients 4 weeks after operation (\( P<0.05 \), shown in Table 1.)
3.2. Bone resorption indexes

4 weeks after operation, comparison of serum bone resorption indexes PYD, TRAP, CTX and D-pyr levels between two groups of patients was as follows: serum bone resorption indexes PYD, TRAP, CTX and D-pyr levels of observation group were lower than those of control group. Differences in serum bone resorption indexes PYD, TRAP, CTX and D-pyr levels were statistically significant between two groups of patients 4 weeks after operation (P<0.05), shown in Table 2.

3.3. Inflammatory factors

4 weeks after operation, comparison of serum pro-inflammatory factors IL-1β, IL-6 and IL-22 as well as anti-inflammatory factors sTNF-RI, IL-4 and IL-13 levels between two groups of patients was as follows: serum pro-inflammatory factors IL-1β, IL-6 and IL-22 levels of observation group were lower than those of control group while anti-inflammatory factors sTNF-RI, IL-4 and IL-13 levels were higher than those of control group (P<0.05). Differences in serum pro-inflammatory factors IL-1β, IL-6 and IL-22 as well as anti-inflammatory factors sTNF-RI, IL-4 and IL-13 levels were statistically significant between two groups of patients 4 weeks after operation (P<0.05), shown in Table 3.

4. Discussion

The treatment of proximal humeral fractures has been the clinical difficulties, and especially for the middle-aged and old people with osteoporosis, how to increase the screw holding force and maintain strong internal fixation has always been the clinical research difficulties[4,5]. Locking plate internal fixation is the new internal fixation system that integrates the concept of biological osteosynthesis and takes into account the local anatomic characteristics, and it has the following advantages: (1) with small volume and causing small stimulation to soft tissue around the fracture end; (2) with no need of pre-bending, and easy for intraoperative operation and fracture reduction; (3) with less contact pressure with bone surface, and protecting the periosteum and the surrounding blood supply; (4) with vesicular involvement around internal fixation devices, providing polydirectional locking fixation for the patients with comminuted fracture or osteoporosis to ensure the stability of the fracture end[6,7]. Given its multiple application advantages, many scholars have currently recommend it as the mainstream way for humeral fracture, and the differences in fracture healing and inflammatory response were also compared between locking plate internal fixation and normal anatomical plate internal fixation in this study in order to clarify the advantages and disadvantages of the two methods in terms of the specific application effect.

The ultimate aim of internal fracture fixation is to promote good fracture end healing and restore limb function, so the evaluation of fracture healing after internal fixation is the most reliable way to determine the overall efficacy[8,9]. Fracture healing is the integrated process of osteogenesis/osteoclasia, and when the osteogenetic activity is greater than the osteoclastic activity, bone cell growth thrives, and the bone mineral density and bone strength rise[10]. There is widespread enhanced osteoclast activity and inhibited osteogenic activity in patients with osteoporosis, which is the root

<table>
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<th>Groups</th>
<th>n</th>
<th>OC (μg/L)</th>
<th>P1NP (ng/mL)</th>
<th>BALP (IU/L)</th>
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<td>28</td>
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<td>93.26±9.77</td>
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<th>TRAP (U/L)</th>
<th>CTX (ng/mL)</th>
<th>D-pyr (pg/mL)</th>
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<td></td>
<td></td>
<td>IL-1β (pg/mL)</td>
<td>IL-6 (μg/mL)</td>
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<td>Observation group</td>
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<tr>
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cause of ultimate fracture[11,12]. In the study, the contents of serum bone metabolism indexes of two groups of patients were detected 4 weeks after treatment, and it was found that compared with control group, the observation group of patients were with higher serum OC, P1NP, BALP and BGP levels. OC, P1NP, BALP and BGP are all defined as bone formation indexes, they can reflect the activity of osteoblasts and maintain normal bone mineralization rate, and high levels of above indexes mostly indicate exuberant fracture end osteogenesis and good fracture healing[13]. Further detection of the contents of serum osteoclasia indexes in the study showed that compared with control group, the observation group of patients were with lower serum PYD, TRAP, CTX and D-pyr levels, indicating that the activity of osteoclasts is lower after locking plate internal fixation and showing that fractures overall progress in the direction of bone formation. Optimization of above osteogenetic/osteoclastic activity is because that the locking plate internal fixation system does not require the complete fitting between bone plate and bone surface, reduces the friction between the fracture surface and internal fixation system, and is conducive to the maintenance of good blood supply to fracture end and postoperative fracture healing.

There may be micro-inflammatory state in patients during blood crust absorption in fracture end, the internal fixation system, as a foreign body, stimulates the body to produce a large number of inflammatory mediators, and severe cases can cause systemic inflammatory response and impact fracture healing[14,15]. The pro-inflammatory/anti-inflammatory system keeps dynamic balance in physiological state, and postoperative levels of pro-inflammatory/anti-inflammatory factors in patients with fractures can quantifiably reflect the degree of fracture end inflammation, and indirectly show the fracture healing condition[16,17]. It was found in the study that compared with control group, the observation group of patients were with lower serum pro-inflammatory factors IL-1β, IL-6 and IL-22 levels, and higher anti-inflammatory factors sTNF-RI, IL-4 and IL-13 levels 4 weeks after operation, confirming that locking plate internal fixation treatment will not cause excessive pro-inflammatory/anti-inflammatory imbalance, has high biocompatibility, and helps good fracture end healing.

To sum up, it is concluded that the fracture end healing is good and the systemic inflammatory reaction is lighter in patients with proximal humeral fractures after locking plate internal fixation treatment, and it is an ideal way for fracture treatment.

References


