

Effect of modified dual plating and less invasive stabilization system on the treatment of complex fractures of tibial plateau.

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Abstract

Objective: To compare the clinical efficacy of modified dual plating and less invasive stabilization system for the treatment of complex tibial plateau fractures, and to analyse their effects on serum inflammatory cytokines, including interleukin-1 beta (IL-1 β), interleukin -6 (IL-6) and Tumor Necrosis Factor alpha (TNF- α).

Methods: 240 patients of complex tibial plateau fractures in our hospital from February 2015 to February 2016 were selected as the research objects and divided into Groups A-C according to the different treatment, with 80 cases in each group. Patients in Group A received modified dual plating treatment, patients in Group B were treated with Less Invasive Stabilization system, and patients in Group C underwent unilateral locking plate internal fixation. Treatment effects, operation time, intraoperative blood loss, the length of hospital stay, healing time, and changes of serum IL-1 β , IL-6, TNF- α levels before and after treatment were compared in three groups.

Results: After treatment, the excellent-effective rates of Groups A and B were 87.5% and 85% respectively, which were both significantly higher than that of Group C, but there were no significant differences between Groups A and B. There was no significant difference in the incidence of postoperative complications between Groups A-C. Both Groups A and B were better than Group C in operation time, the length of hospital stay, intraoperative blood loss and healing time, but there was no significant difference between Groups A and B. Before treatment, no significant difference of serum IL-1 β , IL-6, TNF- α levels was found in Groups A-C. However, 7 d after treatment, serum IL-1, IL-6, TNF- α levels in Groups A and B were lower than that in Group C, but there was no significant difference between Groups A and B.

Conclusion: For the treatment of complex tibial plateau fractures, modified dual plating and less invasive stabilization system were both better than unilateral locking plate internal fixation in treatment effects. However, no significant differences were found in curative effects and lowering serum inflammatory factors levels of between Groups A and B.

Keywords: Modified dual plating, Less invasive stabilization system, Complex tibial plateau fracture, Curative effect, Inflammatory factors.

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Introduction

Tibial plateau fracture is a type of intraarticular fractures of the knee commonly seen in the middle-aged and elderly people. It often begins with changes in anatomical structures of the tibial and femoral joints due to internal and external violence or vertical compression violence, and then intra-articular fracture happens [1]. However, the condition of complex tibial plateau fractures is more serious, and the fractures are often caused by high-energy injuries and combined with different degrees of articular cartilage, anterior and posterior cruciate ligament of knee joint, meniscus injuries [2]. The treatment of complex

tibial plateau fractures has always been a difficult problem in the department of orthopedics, and improper treatment will affect the function of the knee joint. The fracture is often complicated with severe injuries of soft tissues around knee joint. Due to severe vascular damage, less soft tissue coverage, local pain and swelling, if not promptly treated, infection, skin necrosis, bone exposure and disability may happen after fracture [3]. Therefore, prompt surgical treatment and internal fixation for complex tibial plateau fractures are especially important. The goal of treatment is to restore the patient's knee joint function and maintain stable and pain free. Non-surgical treatment is often used in clinic as it can avoid the risk of

surgery. However, its indication is quite strict, and the clinical effect of non-surgical treatment is difficult to satisfy the patients and clinicians especially in difficult reduction cases [4,5]. As a result, surgical treatment of complex tibial plateau fractures has been paid more and more attention. Unilateral locking plate internal fixation is easy to lead to complications of soft tissues. Combined incision and modified double plating method is the most frequently used method in recent years, which can effectively reduce the incidence of complications of soft tissues. Less invasive stabilization system is a new method of treatment. At present, there were few reports about the effect of modified double plating method, less invasive stabilization system and unilateral locking plate internal fixation in the treatment of complex tibial plateau fractures. The purpose of this study was to compare the clinical efficacy of modified dual plating and less invasive stabilization system for the treatment of complex tibial plateau fractures, and to analyse their effects on serum inflammatory cytokines, including interleukin-1 beta (IL-1 β), interleukin -6 (IL-6) and Tumor Necrosis Factor alpha (TNF- α).

Materials and Methods

General information

From February 2015 to February 2016, 240 patients of complex tibial plateau fractures in our hospital were selected as the research objects. Baseline characteristics were: 132 male cases, 108 female cases; age was 21-70 y, the mean age was 45.2 ± 3.1 y. The time of injury was 6 to 11 d, the average time of injury 8.4 ± 0.7 d. The time of fracture is less than 2 w; according to Sehzatker classification: 90 cases of Sehzatker type V, 150 cases of Sehzatker type VI; causes of injury: 130 cases of traffic accident injuries, 94 cases of tumble, 10 cases of falling, 6 cases of the other.

Inclusion criteria: (1) all patients were diagnosed as tibial plateau fractures by imaging examination; (2) no fracture experience of lower limb before 3 months.

Exclusion criteria: (1) patients with severe internal medical diseases, such as severe cardiovascular diseases, serious infection, etc. (2) patients with incomplete clinical data. All patients were divided into Groups A-C according to the different treatment, with 80 cases in each group. There were no significant differences between the three groups in gender, Sehzatker classification, injury time, injury cause and other general information.

Treatment methods

After admission, all the patients received calcaneal traction and patients with haemarthrosis underwent puncture. All the patients underwent CT examination before operation to ensure a detailed understanding of fractures in patients and to make a proper operation plan.

Group A received modified dual plating treatment: anterolateral combined with posteromedial arc incision of knee joint was adopted, the width of incision bridge was not less

than 7 cm, then cut layer and exposed the articular surface of tibia by opening the meniscus, plate fixed and made a posteromedial incision along the medial margin of the tibia without cutting medial collateral ligament, pull it forward and exposed the bone fold line of the inner end of the dry end of the pulp, traction reduction, restored the inner column force line. Fractures of the posterior tibia were fixed with 4.5 system 1/2 tube plate or limited contact compression plate (Swiss Synthes Medical Instrument Co., Ltd.).

Patients in Group B were treated with less invasive stabilization system: tibial tubercle bone traction was used before operation to correct fracture shortening, lateral displacement and overlap. Continuous epidural anesthesia was conducted, and anterolateral thigh incision was performed to expose the distal lateral femur. The choosing of methods of reduction and implantation of LISS plate was according to the different conditions of patients. For patients with femoral shaft fractures accompanied by comminuted fractures of the medial column, the fracture reduction was firstly performed, and the lag screws were used for fixation. The 3.5 system limited contact compression plate can be used on the back side, and the bone defect or collapse can be filled with cortical bone under the direct vision or through the dry bone end.

Group C underwent unilateral locking plate internal fixation. All patients underwent knee joint functional rehabilitation exercises 3 d after operation with the help of CPM machine.

Observation index

The patients were followed up for 6 to 12 months after the operation and the knee joint function of the affected limb were measured. According to the conditions of disappearance of symptoms, lower extremity strength recovery and wound healing, four grades were determined: excellent, good, medium and poor. Excellent: after operation, the knee joint of the lower limb recovered well, and it could be straightened completely, flexion > 120, and the wound healed well with no pain. Good: The strength of the lower limb was restored or improved, and the knee flexion activity was 90 to 120. The wound healed well and had a slight pain. Medium: Knee joint recovery was acceptable; the knee flexion activity was 60 to 90 and had pain when moving. Poor: The patient did not recover significantly, the recovery of lower limb knee was poor, the wound healing was slow, or the fracture displacement occurred again.

During the operation, the operation time and t-intraoperative blood loss during operation were recorded. The fracture healing time and the full weight-bearing time were recorded according to the X-ray and clinical examination. The wound healing and complications were observed during the follow-up period.

Before and 7 d after treatment, 5 ml fasting elbow vein blood at 6:00 am to 8:00 am in three groups were extracted. After anticoagulation and centrifugation, the upper serum was retained and frozen in the deep hypothermic refrigerator. The levels of inflammatory factors in serum were determined by Enzyme Linked Immunosorbent Assay (ELISA), including

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interleukin-1 β (IL-1 β), interleukin-6 (IL-6) and Tumor Necrosis Factor α (TNF- α).

Statistical analysis

The data were analysed with SPSS21.0 software. The measurement data in accordance with the normal distribution were expressed as mean \pm SD. Single factor analysis of variance was used among all three groups. The t test was used between the two groups and Chi-square test was used to compare the categorical data. P<0.05 suggests that the difference is statistically significant.

Results

Comparison of treatment effects in three groups

After treatment, the excellent-effective rates of Groups A and B were 87.5% and 85% respectively, which were both significantly higher than that of Group C, but there was no significant differences between Groups A and B (Table 1).

After 6 to 12 months of follow-up, 2 cases (2.5%) of superficial infection occurred after operation in Group A, but recovered quickly after conservative treatment. In Group B, there were 3 cases (3.8%) of postoperative complications, including 1 case of posterior bone graft reaction and 2 cases of superficial infection, which were cured after conservative treatment. In Group C, 3 cases (3.8%) of superficial infection occurred after operation, and recovered after conservative treatment. There was no deep infection, severe nerve damage, venous thrombosis or other complications in all three groups. There was no significant difference in the incidence of postoperative complications between Groups A-C.

Table 1. Comparison of treatment effects in three groups.

Groups	n	Excellent	Good	Medium	Poor	Excellent-effective rates
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Table 3. Comparison of serum inflammatory factors levels in three groups.

Groups	IL-1 β		IL-6		TNF- α	
	Before treatment	7 d after treatment	Before treatment	7 d after treatment	Before treatment	7 d after treatment
Group A	5.39 \pm 0.72	2.15 \pm 0.54	12.91 \pm 21.56	4.05 \pm 1.27	8.17 \pm 1.57	3.06 \pm 0.76
Group B	5.38 \pm 0.74	2.19 \pm 0.63	12.85 \pm 19.72	4.11 \pm 1.35	8.16 \pm 1.28	3.09 \pm 0.64
Group C	5.37 \pm 0.68	3.78 \pm 0.55	12.89 \pm 18.76	6.92 \pm 1.66	8.21 \pm 1.04	5.18 \pm 1.03
F	1.67	10.45	1.94	11.60	1.43	12.07
p	0.165	0.039	0.211	0.027	0.177	0.020

Discussion

Complex tibial plateau fracture is one of the most common clinical fractures, mostly due to high energy damage that results in comminuted fracture of articular surface and knee joint of femur condyle and will seriously affect the quality of patients' lives. The traditional unilateral locking plate internal

Group A	80	60	10	3	7	87.5%
Group B	80	55	13	4	8	85%
Group C	80	47	9	10	14	70%
χ^2						9.16
p						0.029

Comparison of operation and recovery in three groups

Both Groups A and B were better than Group C in operation time, the length of hospital stay, intraoperative blood loss and healing time, but there was no significant difference between Groups A and B (Table 2).

Table 2. Comparison of operation and recovery in three groups.

Groups	n	Operation time (min)	Intraoperative blood loss (ml)	Hospital stay (d)	Healing time (months)
Group A	80	76.2 \pm 6.7	191.4 \pm 37.8	16.1 \pm 1.5	12.6 \pm 1.7
Group B	80	74.7 \pm 8.1	203.1 \pm 34.2	16.5 \pm 1.8	11.9 \pm 1.4
Group C	80	80.5 \pm 4.6	256.9 \pm 43.3	19.4 \pm 2.5	18.5 \pm 2.2
F		9.73	11.08	10.43	10.00
p		0.031	0.022	0.035	0.027

Comparison of serum inflammatory factors levels in three groups

Before treatment, no significant difference of serum IL-1 β , IL-6, TNF- α levels was found in Groups A-C. However, 7 d after treatment, serum IL-1, IL-6, TNF- α levels in Groups A and B were lower than that in Group C, but there was no significant difference between Groups A and B (Table 3).

fixation method can easily lead to wound infection, unsmooth blood circulation and affect the healing speed due to the large range of skin flap stripping [6,7]. In this study, the excellent-effective rate of unilateral locking plate internal fixation was 70%, with a larger intraoperative blood loss and longer operation time, hospitalization time and healing time.

Modified dual plating treatment adopts combined incision which solves the defects of soft tissue complications in traditional single median incision bilateral plate fixation. The joint incision keeps away from a relatively ischemic area in the anterior tibia and exposes the lateral tibial plateau with a larger anterolateral incision. Besides, through the lateral fracture window, the articular surface of the medial tibial plateau was reduced, and the abundant muscle tissue under the lateral incision could cover the larger implant [8,9]. In the study, the excellent-effective rate of the modified double plate method was 87.5%. The amount of bleeding was small, and the symptoms almost disappeared 6 months after operation, and the recovery of the lower limb and the healing of the wound were good.

Less invasive stabilization system is a treatment based on BO principle. The incision is small without complete exposure of the tibia and the soft tissue injury is very small. Moreover, the shape of the plate conforms to the anatomical contour of the anterolateral tibia. The position and direction of the fixed screws are accurately measured and designed, which can protect the periosteum and bone blood transportation. Its stability depends on the stability of the locking angle of the screws and plates, which is beneficial to the healing of the fracture and the soft tissue [10,11]. Biomechanical tests showed that unilateral less invasive stabilization system for complex tibial plateau fractures was similar to the mechanical stability provided by double plate fixation. [12]. Less invasive stabilization system has accurate installation of system that can avoid repeated irradiation and improve the success rate of operation and save the operation time. Matters needing attention during operation with less invasive stabilization system [13,14]: (1) The fixing is firm, and once it's fixed, it's hard to change. This requires stricter surgical procedures. The doctors are required to perform the operation strictly according to the fracture reduction requirement. During the operation, the C arm fluoroscopy should be used to confirm a satisfied reduction. Then the screws can be fixed. Tension screws can be fixed if necessary. (2) Less invasive stabilization system requires a higher demand for the position and method of the steel plate fixation. In addition to the help of X-ray fluoroscopy, it is also necessary to rely on the doctor's experience to feel the alignment of the position. Steel plates are usually placed on the lateral side of soft tissue. In order to maintain the position of the plate, the Kirschner wire can be temporarily fixed at the proximal and distal ends of the plate. (3) More attention should be paid to specific patients, such as combined with tibial shaft fractures or have cancellous bone on the tibial plateau, the steel plate should be lengthened when it is selected. The steel plate should be placed in the center of the tibia as much as possible to prevent the fixation instability due to the deviation of the locking screws in patients combined with tibial fractures. The tibial trunk can be fixed by self-drilling screw, and when the screw is screwed in, the relevant nerve line should be avoided to prevent accidental injury in patients that have cancellous bone on the tibial plateau.

Fracture and soft tissue injury can directly lead to local or systemic inflammatory reaction, and inflammatory factors can

be excessive secreted and released into the blood [15]. Inflammatory response can increase the pain sensitivity of patients, and further stimulate nerve endings and induce pain perception. Therefore, the detection of inflammatory factors in serum can objectively reflect the degree of pain and recovery of patients. In our study, before treatment, no significant difference of serum IL-1 β , IL-6, TNF- α levels was found in Groups A-C. However, 7 d after treatment, serum IL-1 β , IL-6, TNF- α levels in Groups A and B were lower than that in Group C, but there was no significant difference between Groups A and B. This reminds us that modified dual plating treatment and Less Invasive Stabilization System can both effectively inhibit the systemic inflammatory response in patients, reduce the serum IL-1 β , IL-6, TNF- α levels. And this may be one of the important mechanisms to relieve pain and promote the recovery of the patients of these two treatments.

In conclusion, for the treatment of complex tibial plateau fractures, modified dual plating and less invasive stabilization system were both better than unilateral locking plate internal fixation in treatment effects. However, no significant differences were found in curative effects and lowering serum inflammatory factors levels of between Groups A and B.

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