Comparison of joint function and trauma severity after arthroscopic headless compression screw fixation and conventional open reduction and internal fixation treatment of patellar transverse fracture

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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:
Patellar transverse fracture
Arthroscopic headless compression screw fixation
Joint function
Trauma severity

ABSTRACT

Objective: To study the differences in joint function and trauma severity after arthroscopic headless compression screw fixation and conventional open reduction and internal fixation treatment of patellar transverse fracture. Methods: 58 patients with patellar transverse fracture who accepted operative treatment in our hospital between August 2012 and December 2015 were collected and divided into open surgery group (n=30) and arthroscopic surgery group (n=28) according to the surgical approach. Before operation and 3 months after operation, the knee joint function index levels were not statistically significant between two groups of patients before operation (P>0.05); 3 d after operation, serum prostaglandin (PGI2), dopamine (DA), neuropeptide Y (NPY), substance P (SP), glucocorticoid (Cor), renin (R), angiotensin 1 (Ang1), angiotensin 2 (Ang2), epinephrine (E), norepinephrine (NE) and aldosterone (ALD) levels of arthroscopic surgery group were significantly lower than those of open surgery group (P<0.05). Conclusions: Arthroscopic headless compression screw fixation can optimize the knee joint function and reduce the surgical trauma in patients with patellar transverse fracture.

1. Introduction

Patellar fractures are common in clinical practice, the main characteristics are the knee joint swelling, pain and motion obstacle, the patellar transverse fracture is a quite common type among them, it is with relatively simple trauma and easy to close, and early operative reduction and fixation is the best way for it.[1,2]. Open reduction and internal fixation is the most common way for clinical treatment of patellar transverse fracture, its operation under direct vision is relatively convenient, but it has the disadvantages such as huge surgical trauma and longer postoperative rehabilitation. With the development of the endoscopic technique and the occurrence of headless compression screw (HCS), arthroscopic headless compression screw fixation treatment has been successfully applied in ankle fracture and fracture of head of radius, but there are not many studies at present about the application value of the technology in the patellar transverse fracture[3,4]. In the study, the patients with patellar transverse fractures who accepted conventional open reduction and internal fixation treatment as well as arthroscopic headless compression screw fixation treatment were reviewed, and the two methods were compared from the knee joint function and surgical trauma.
2. Materials and methods

2.1. General information

The clinical data and laboratory test results of 58 patients with patellar transverse fracture who accepted operative treatment in our hospital between August 2012 and December 2015 were retrospectively analyzed, and the patients themselves signed the informed consent. According to the surgical approach, the patients were divided into open surgery group (n=30) and arthroscopic surgery group (n=28). Open surgery group included 18 male cases and 12 female cases, they were 23–70 years old, and the fracture sites: 16 cases were with left knee fracture and 14 cases were with right knee fracture; arthroscopic surgery group included 15 male cases and 13 female cases, they were 24–68 years old, and the fracture sites: 14 cases were with left knee fracture and 14 cases were with right knee fracture. Two groups of patients were not statistically different in gender, age and fracture site distribution (P>0.05), and the research process was approved by the hospital ethics committee.

Inclusion criteria are as follows: (1) diagnosed with patellar transverse fracture after X-ray examination; (2) with typical knee gall, difficulty in walking and other clinical criteria; (3) with time interval between fracture occurrence and admission < 24 h; (4) without previous history of patellar fractures. Exclusion criteria are as follows: (1) with surgery history 3 months prior to admission; (2) with serious heart, liver and kidney dysfunction; (3) with long-term use of anticoagulant drugs such as aspirin and warfarin, or with basic blood coagulation dysfunction; (4) associated with systemic infectious diseases; (5) pregnant or breastfeeding women; (6) dropping out of the research, and with incomplete clinical information.

2.2. Surgical treatment

Open surgery group of patients received conventional open reduction and internal fixation treatment, specifically as follows: a prepatellar midline incision (about 10 cm long) was made after anesthesia to fully expose fracture end and inspect the quadriceps tendon and joint capsule tearing condition. The blood clots in fracture end were removed, the fracture blocks connected to the soft tissue were kept, and then the joint cavity was flushed. Large fracture blocks were restored in the direction perpendicular to fracture line and then temporarily fixed after inspection showed that the fracture surface is smooth and flat, two hollow screw guide pins were screwed in (perpendicular to the fracture line), the hollow screws (4 mm in diameter) were screwed in along the direction of the guide pin after the fracture reduction was satisfactory under C-arm (Chongqing Jufu Medical Instrument Co., LTD., the article number 0211), No. 18 steel wire was put through the hollow screw for "8" type fixation, the quadriceps tendons and joint capsule were repaired at last, the knee joint was moved again to make sure it was firmly fixed, and then the incision was sutured step by step. 3 months after operation, the maximal flexibility and maximal extension of two groups of patients were recorded.

Arthroscopic surgery group of patients received the arthroscopic headless compression screw fixation treatment, specifically as follows: patients were put in supine position after anesthesia, the hematocole/blood clots in knee joint cavity were thoroughly removed under arthroscopy, the joint structure and damage condition were inspected, the blood clots in joint cavity were flushed, 2 reduction forceps were used for patellar reduction, and the artilcular surface reduction was inspected under direct vision of arthroscopy. After the reduction was confirmed to be good, two guide pins (with 2 cm interval) were punched in the middle and lower 1/3 of the patella perpendicularly to the fracture line, the guide pin position and patellar reduction were examined under C arm fluoroscopy, small incisions (about 0.5 cm in diameter) were made when the guide pins were, the HCS (3 mm in diameter) were screwed in along the direction, and then the guide pins were pulled out. The knee joint was moved under direct vision of arthroscopy to make sure the fracture end was firmly fixed, then the drainage tubes were placed and the incisions were sutured step by step. 3 months after operation, the maximal flexibility and maximal extension of two groups of patients were recorded.

2.3. Early postoperative trauma indexes

3 d after operation, 2 mL of peripheral venous blood was extracted from two groups of patients at the same time point and centrifuged (2 500 r/min, 15 min) in a low-speed centrifuge (Shanghai Wancheng Medical Instrument Co., LTD., the article number TDZ4-WS) to get supernatant, and the following trauma-related indicators were detected: (1) pain mediators: ELISA method was used to detect prostaglandin (PGI2), dopamine (DA), neuropeptide Y (NPY) and substance P (SP) levels; (2) stress hormones: ELISA method was used to determine glucocorticoid (Cor), renin (R), angiotensin 1 (Ang1), angiotensin 2 (Ang2), epinephrine (E), norepinephrine (NE) and aldosterone (ALD) levels.

2.4. Statistical analysis

SPSS15.0 software was used for statistical processing, measurement data was in terms of \( \bar{x} \pm s \), comparison within same group before and after treatment was by paired \( t \) test, comparison between groups after treatment was by routine \( t \) test and \( P<0.05 \) indicated statistical significance in differences.
3. Results

3.1. Knee joint function

3 months after operation, the maximal knee joint flexibility and maximal extension of arthroscopic surgery group were (130.82±15.79) and (8.76±0.95) respectively, and the maximal knee joint flexibility and maximal extension of open surgery group were (121.64±14.76) and (5.84±0.61) respectively. The maximal knee joint flexibility and maximal extension levels of arthroscopic surgery group were higher than those of open surgery group, and differences between groups were statistically significant ($P<0.05$).

3.2. Pain mediators

3 d after operation, comparison of serum pain mediators PGI2, DA, NPY and SP levels between two groups of patients is as follows: serum PGI2, DA, NPY and SP levels of arthroscopic surgery group were significantly lower than those of open surgery group, and differences in serum PGI2, DA, NPY and SP levels were statistically significant between two groups of patients 3 d after operation ($P<0.05$), shown in Table 1.

3.3. Stress hormones

3 d after operation, comparison of serum adrenal gland-related stress hormones Cor, E and NE between two groups of patients is shown in Table 2: serum Cor, E and NE levels of arthroscopic surgery group were significantly lower than those of open surgery group; analysis of serum RAS system-related stress hormones Ang1, Ang2 and ALD is also shown in Table 2: serum Ang1, Ang2 and ALD levels of arthroscopic surgery group were significantly lower than those of open surgery group. Differences in serum stress hormones Cor, E, NE, Ang1, Ang2 and ALD levels were statistically significant between two groups of patients 3 d after operation ($P<0.05$).

4. Discussion

Conventional open reduction and internal fixation is commonly applied in the patellar transverse fracture, but a number of studies have shown that the kirschner wire is smooth and easy to shift, there is no compression effect on fracture end, the incidence of postoperative incision infection, limited knee joint motion and other complications is also high, and looking for a more safe and reliable operation treatment is the key of the current clinical research[5,6]. Headless compression screw is a new type of consumable in recent years, and it is hollow, can be screwed in along the guide pin during operation, doesn’t stimulate the patellar surrounding soft tissue and joint surface, but keeps the feature of direct compression on fracture end of ordinary pressure screw[7]. With the advent of arthroscopy, some scholars put forward the combined application of arthroscopy and headless compression screw for the treatment of patellar fractures to realize two clinical surgery principles of minimal invasion and safety at one time[8]. In the study, the patients with patellar transverse fracture treated with different surgical methods were selected as the research subjects, and the differences in knee joint function, surgical trauma and so on in patients with minimally invasive and open surgery were preliminarily elaborated.

The knee joint function in patients with patellar fracture is severely damaged, which is mainly characterized by the reduced joint motion. In addition to the severity of fracture itself, surgical trauma, postoperative functional exercise and many other factors also affect the knee joint function[9,10]. In the study, the arthroscopic surgery group accepted arthroscopic headless compression screw fixation,
and the tension band fixation was abandoned, which avoids the related complications caused by local open reduction and internal fixation device[11]. Based on previous studies, the limb function is generally fully recovered 3 months after patellar fracture, so the knee joint function of two groups of patients was evaluated in the study 3 months after operation, and it was found that compared with open surgery group, the arthroscopic surgery group were with larger maximal knee joint flexibility and maximal extension ($P<0.05$), illustrating that the arthroscopic headless compression screw fixation treatment can more effectively recover patients' knee joint function. Arthroscopic surgery achieves the visual reduction of articular surface and helps to achieve the anatomical reduction of patellar articular surface, and this is also the root cause of the maximal recovery of knee joint function after surgery[12].

Surgical trauma directly affects the patients’ postoperative rehabilitation, and the incidence of early postoperative infection is redoubled in some patients with huge trauma[13]. Patients with fracture surgery are generally in varying degrees of pain and stress state after operation, the excessive pain and stress can make the patients in a continuous decomposition consumption state, and the fracture end is difficult to heal or even does not heal[14,15]. In the study, serum pain mediator and stress hormone levels of two groups of patients were detected to quantitatively and objectively evaluate the early postoperative trauma of two groups of patients, and it was found that compared with open surgery group, the arthroscopic surgery group were with lower levels of serum pain mediators PGI2, DA, NPY and SP as well as lower levels of stress hormones Cor, R, Ang1, Ang2, E, NE and ALD ($P<0.05$), confirming that the arthroscopic headless compression screw fixation treatment causes less surgical trauma. Study has shown that patients with the extension of operative time and the aggravation of trauma in patients, the duration of arthroscopic headless compression screw fixation is short because of the factors such as no "8" type band fixation, small incision suture and shorter duration, so its macroscopic surgical trauma is less[16]. At the same time, arthroscopic operation can remove the bone scraps in the fractured joint cavity and find the meniscus damage and other fracture complications in time, the fracture flat spacing is small after the headless compression screw fracture treatment, all these factors reduce the early postoperative local fracture end damage and prompt the patellar healing, and they are also the direct causes of lighter postoperative trauma in arthroscopic surgery group[17].

To sum up, it is concluded as follows: arthroscopic headless compression screw fixation can optimize the knee joint function and reduce the surgical trauma in patients with patellar transverse fracture, and it’s worth popularization and application in clinical practice in the future.

References


