Method and effect of total knee arthroplasty osteotomy and soft tissue release for serious knee joint space narrowing

Abstract: To discuss the method and effect of total knee arthroplasty osteotomy and soft tissue release for serious knee joint space narrowing. Clinical data of 80 patients from October 2013 to December 2014 was selected with a retrospective method. All patients have undergone total knee arthroplasty. Then the X-rays plain film in weight loading was measured before and after operation and osteotomy was performed accurately according to the knee joint scores and the conditions of lower limb alignments. The average angle of tibial plateau osteotomy of postoperative patients was 4.3°, and the corrective angle of soft tissue balancing was 10.7°; the postoperative patients’ indices including range of joint motion, knee joint HSS score, angle between articular surfaces, tibial angle, femoral-tibial angle and flexion contracture were distinctly better than the preoperative indices (p<0.05) and the differences were statistically significant; the postoperative patients’ flexion contracture and range of joint motion were distinctly better than the preoperative indices (p<0.05) and the differences were statistically significant. The effective release of the soft tissue of the posterior joint capsule under direct vision can avoid excess osteotomy and get satisfactory knee replacement space without influencing the patients’ joint recovery.

Keywords: serious knee joint, space narrowing, total knee arthroplasty, osteotomy, soft tissue release

1 Introduction

Total knee arthroplasty has been widely applied in clinical treatment and it can effectively reduce postoperative complications and increase curative effects [1-3]. This surgical method has a better therapeutic effect on the treatment with various arthritis and joint diseases [4,5]. However, it may have some complications for the patients with end-stage joint disease. The major reason is that such patients generally have longer disease course and thinner joint due to wear, easily leading to joint space narrowing and periarticular cartilage tissue contracture. The similar thickness of osteotomy and prosthesis is required in the total knee arthroplasty. The successful operation is guaranteed by the soft tissue balancing after the accurate osteotomy. In order to further study the method and effect of total knee arthroplasty osteotomy and soft tissue release for serious knee joint space narrowing, our hospital selected 80 patients for the analysis and study to make the following report.

2 Data and method

2.1 General data

80 patients with serious knee joint space narrowing admitted to our hospital from October 2013 to December 2014 were randomly selected for retrospective analysis. All patients met the 1987 diagnostic criteria issued by American College of Rheumatology and suffered from serious knee joint space narrowing arthritis. 80 patients, including 45 males and 35 females at the age ranging from 45 to 85, with the average age of (60.35 ± 1.45); disease course ranging from 2 to 15 years, average course of (5.25 ±2.56); primary knee joint diseases: 10 cases of 11 knee arthritis, 12 cases of 13 knee rheumatoid arthritis, 15 cases of 16 knee traumatic arthritis and the remaining
was arthritis of other kinds. 50 cases with unilateral-knee disease and 30 cases with bilateral-knees disease; all patients were with tibial joint space narrowing with the preoperative American knee society score (KSS) of 28.9 and functional score of 23.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the authors’ institutional review board or equivalent committee.

Informed consent: Informed consent has been obtained from all individuals included in this study.

2.2 Method

2.2.1 Measurement index

The patients should receive 40 routine examinations before and after operation. The examination contents include X-ray examination, lateral film measurement, test indices related to knee joints, etc. During index measurement, the femoral-tibial angle of patients should be measured first according to the method reported by Moreland, etc [8]. The range of femoral anatomical axis was generally measured from the patient’s femoral head center to the knee central alignment, while the angle of tibial anatomical axis was generally measured from the anatomical line; the tibial angle was measured from outside of the angle between tibial mechanical axis and tibial articular surface.

2.2.2 Operation method

On the basis of comprehensive attention and understanding of the patient’s condition and pathogenesis before operation, the degree of patient’s knee joint space narrowing was accurately measured, and then suitable prosthesis for the osteotomy treatment was selected according to the degree. All prostheses applied in this study were produced by American Stryker Company. The operations were conducted by the same group of physicians and the osteotomy treatments were generally under the state of lower limb traction. First, the patient’s posterior joint capsule and collateral ligaments were released, and the suitable prosthesis model was determined after the preliminary release of patient’s cartilage tissue such as posterior joint capsule. Then the patient’s distal femur four-in-one osteotomy treatment was completed according to the last step. After that, the patient’s posterior stifle loculus structure was dissected to fully expose it and then the patient’s femoral posterior malleolus osteophyte and free bodies in posterior joint capsule were resected so as to effectively expand the patient’s knee joint. Finally, the prosthesis was installed and the patient’s flexion-extension space and tension balance conditions were tested at the tibial plateau.

The medial joint beside the patella at the knee joint midline incision was taken as the surgical approach. The patient’s cartilage tissue release and balancing could be broadly divided into 3 steps. First, joint release treatment was conducted upon the exposure of the patient’s joint with the main result of resection of the patient’s excess fat pad. The excess fat pads and osteophytes were resected thoroughly in the release range from medial tibial plateau to the deep-layer insertion of medial collateral ligament; the second release method was to perform release after the patient’s osteotomy, with the best period for release after the completion of patient’s femoral and tibial amputations. The excess osteophytes were removed when the patient’s posterior joint capsule was exposed. Meanwhile, the release treatment was performed under the assistance of a periosteal detacher, then the tibial plateau recovery treatment was performed and the patient’s medial plateau osteophytes were removed (Figs. 1 and 2); the third release method was to conduct the release before and after the installation of patient’s prosthesis. First, this method required appropriate adjustment based on the patient’s lower limb alignment and tracking for the measurement of cartilage tissue balancing and flexion-extension space, then the standard patellar tracking was determined and the lateral retinacular release was performed.

2.3 Curative effect evaluation standard

Postoperative follow-up observations were conducted on the patients. The curative effect should be evaluated in detail based on the patient’s knee joint motion score, observation of the loosening condition and range of joint motion of the patient’s artificial limb.

2.4 Statistical analysis

SPSS15.0 software was adopted for statistical analysis of the data in this study. The enumeration data were represented by %, represented by X2, measurement data represented by (X ±s), and t-test was used. If P<0.05, it shows that the data are of statistical significance.


3 Result

3.1 Comparison of angles and HSS score between patients before and after surgery

The average angle of tibial plateau osteotomy of postoperative patients was 4.3°, and the corrective angle of soft tissue balancing was 10.7°; the postoperative patients’ indices including range of joint motion, knee joint HSS score, angle between articular surfaces, tibial angle, femoral-tibial angle and flexion contracture were distinctly better than the preoperative indices (p<0.05) and the differences were statistically significant. Specific data analysis is shown in Table 1.

3.2 Improvement situation of flexion contracture and range of joint motion between patients before and after surgery

After 1-2 years of follow-up visits to patients, it was found that the postoperative patients' flexion contracture and range of joint motion were distinctly better than the preoperative indices (p<0.05) and the differences were statistically significant. Specific data analysis is shown in Table 2.

4 Discussion

Under normal circumstances, the normal physiological activities of the knee joint rely mainly on the integrity of the surrounding ligaments and articular surfaces. In a variety of common knee joint diseases, progressive degeneration of articular cartilage may occur due to the influence of various factors [12]. Under the influence of various factors, joint space narrowing may appear in degenerative joint diseases, thereby leading to collapse of the articular surface and causing periarticular cartilage tissue contracture. Knee joint motion will reduce under the stimulation of pain, which causes the patients to lose elasticity and fiber gradually, resulting in irreversible joint space narrowing and deformity [13-14].

Total knee arthroplasty is generally implemented in accordance with relevant principles of osteotomy. For instance, in this study, patients received osteotomy with respect to the principle of “equal osteotomy”. In the process of osteotomy, the prosthesis’s thickness requires the patient’s knee joint after the osteotomy to be provided with certain space for knee replacement so as to meet the condition of implanting prosthesis into the patient’s knee. If serious space narrowing appears in the patient’s knee joint in this process, then collapse and abrasion might appear on the articular surfaces of the patient’s tibial plateau and distal femur. Thus, it’s required to implement osteotomy according to standard amount, but there might inadequate space because the patient’s knee joint is too narrow. Furthermore, it might be hard to implant prosthesis for the patient. Doctors can operate by increasing knee replacement space of the osteotomy, so that the osteotomy can have enough processing space, but this operation is
likely to lead to the joint line displacement or instability, etc., which will affect the patient’s patellar tracking and cause imbalanced flexion-extension space. That might prejudice the fixation of prostheses.

Therefore, clinically, total knee arthroplasty is generally based on the expansion of the knee joint space. Under standard osteotomy, it achieves the best surgery by releasing and balancing the periarticular cartilage [15-16]. If the patient’s joint dislocation still fails to be well corrected after cartilage tissue release, secondary osteotomy has to be performed. However, the bone coaptation quantity of the patient’s distal femur cannot be adjusted again after the secondary osteotomy. In this study, through comprehensive judgment based on the position and size of the prosthesis, the thickness of the bone block cut off in the first osteotomy and other fineness, the right distal femoral was chosen to implement osteotomy. Medial knee structure dissection was conducted, and the internal anatomic release method was utilized to enhance the patient’s joint tissue. The key point of femoral release is the release treatment of the medial proximal tibia, which was released from the patient’s periosteum to the medial tibial tubercle, then to the rear joint capsule of the medial tibia, the medial collateral ligament and other structures in the shape of a sleeve. It should be noted that the inner structure should be released to the same length of the outer structure in this process.

The postoperative patients’ indices including range of motion, knee joint HSS score, angle between articular surfaces, tibial angle, femoro-tibia angle and flexion contracture were distinctly better than the preoperative indices and the postoperative patients’ flexion contracture and range of joint motion were distinctly better than the preoperative indices. It shows that total knee arthroplasty osteotomy and soft tissue release have a better curative effect when they are applied to serious knee joint space narrowing, and can effectively promote the patients’ functional recovery of knee.

Conflict of interest statement: Authors state no conflict of interest.

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Table 1: Comparison of angles and HSS score between patients before and after surgery.

| Time | Flexion contracture (°) | Femoral-tibial angle (°) | Tibial angle (°) | HSS score(°) | Angle between articular surfaces (°) |
|------|------------------------|-------------------------|----------------|-------------|-------------------------------------|
| Before | 18.50±0.40 | 9.20±3.10 | 95.50±1.20 | 38.00±3.20 | 4.90±0.75 |
| After | 0.20±0.30 | 5.80±1.50 | 91.20±1.40 | 87.00±4.50 | 0.12±0.01 |
| value | 327.3604 | 8.8304 | 20.8581 | 79.3711 | 56.9998 |
| P | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Table 2: Improvement situation of flexion contracture and range of joint motion between patients before and after surgery.

| Case number | Flexion contracture before surgery | Flexion contracture after surgery | Range of joint motion before surgery | Range of joint motion after surgery |
|-------------|-----------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|
| 34          | 20°~                              | 3~2 (0.57°)                      | 65.35°                               | 103.21°                             |
| 29          | 30°~                              | 0~4 (1.83°)                      | 46.25°                               | 95.83°                              |
| 12          | 40°~                              | 2~4 (2.80°)                      | 24.00°                               | 91.00°                              |
| 5           | 50°~60°                           | 5~10 (7.50°)                     | 37.50°                               | 92.50°                              |
|            |                                    |                                   |                                     |                                     |
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