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Clinical curative effect and logistic regression analysis of bone anchor assisted knee extensor mechanism reconstruction for patellofemoral instability.

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Abstract

The aim of this study is to explore the clinical curative effects of bone anchor assisted knee extensor mechanism reconstruction, and analyze the relative variables affecting outcome with a logistic regression method. Reconstruction was performed in 83 patients (Jan 2012-Dec 2015), including 54 males and 29 females (13 to 53 y of age, mean age 24 y) with an average disease course of 9 y (range from 1 to 13 y). Patients were clinically evaluated *via* the Lysholm and Kujula knee scores and the Insall criterion, and postoperative follow-up time varied from 12 to 48 months (average 28 months). At the first year follow-up time point, all patients were significantly improved from the Lysholm (69.33 ± 8.38 preoperatively and 88.65 ± 12.93 postoperatively) and Kujula (69.33 ± 8.38 preoperatively and 88.65 ± 12.93 postoperatively) knee scores (P<0.05). According to the Insall Criterion Evaluation, the results were indicative of 56 "Excellent" cases, 10 "Good" cases, and 9 "Normal" cases, with a ratio 79.5% of "Excellent" and "Good" cases. Logistic regression analysis suggested that this reconstruction had a better effect in adolescent patients, while Patella Alta and flat lateral femoral condyle exerted poor influence on procedure outcome.

Keywords: Extensor mechanism reconstruction, Patellofemoral instability, Anchor technique, Logistic regression.

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Introduction

Patellofemoral instability is a common knee disease, notorious for complicated etiology, diversified treatment methods, and difficulty in curative effect assessment, which can be effectively treated by MPFL (Medial patellofemoral ligament) reconstruction [1-4]. However, for adolescents with immature epiphysis, this operation can lead to a risk of epiphysis damage, ultimately resulting in abnormal bone growth. Furthermore, a distal realignment operation was required for patients with TT-TG (Tibial Tubercle Trochlear Groove) values greater than 20 mm [5]. The realignment operations, especially for the transposition of the tibial tubercle, could present a risk of damaging the epiphysis, resulting in knee recurvatum. Conversely, soft tissue procedures can be preceded without such risks. For instance, some classical soft tissue procedures have obtained a satisfactory result for reconstruction using a bone anchor technique, which was with excellent outcomes in bone and ligament healing [6]. Thus, the classical soft tissue procedures have been performed on adults, but few indications have been deeply studied. In this paper, 83 patients with patellofemoral instability were treated by bone anchor assisted extensor mechanism reconstruction in our institution from January 2010 to December 2015. Analyses of the curative effect, as well as logistic regression with related indexes, were carried out in this study.

Materials and Methods

General patient data

For 83 patients, 52 and 31 cases were involved in the left and right knees, respectively. Moreover, all patients presented knee pain, unstable gait and suffered subluxation of the patella with flexion deficiency. Also, the patients suffered from tenderness at the gap of the patellofemoral joint, the bone margin, and the lateral patellar-femoral ligament from physical examination, while positive results were obtained in patellar push and patellar declination examinations. Average preoperative Lysholm knee and Kujula anterior knee scores were 69.33 ± 8.38 and 67.05 ± 8.43, respectively [7-9]. Meniscal and other ligamentous injuries were excluded using MRI (Magnetic Resonance Imaging) [10]. In addition, CT examination suggested that the distance from tibial tubercle to femoral trochlea (TT-TG) was 18.5-25.6 mm, with an average distance of 21.6 mm, and X-ray examination excluded obvious varus and valgus deformities with normal osseous structure of the knee. For MRI imaging, it demonstrated that lateral trochlear inclination was 4-29 degrees with an average angle of 16.7

degrees. Standard knee X-ray showed that the Insall-Salvati ratio was 0.68-1.56 with an average of 1.12 at 30 degrees of flexion, as An Insall-Salvati index greater than 1.2 has been defined as patella alta [11].

Operation procedure

After a subarachnoid block anesthesia tourniquet was applied to patients in the supine position, we carried out microtubule excision forward knee excision, excised the skin and superficial fascia, loosened the lateral retinaculum loosened, and exposed the internal oblique muscle of the quadriceps femoris. Next, the internal oblique muscle of the quadriceps femoris was rearranged in accordance with the Madigan method, and fixed to 1/3 of the lateral side of the patella and pavilion of the quadriceps femoris. The patellar ligament was separated and cut into two parts, and then the lateral half of the patellar ligament was separated from the tibial tubercle and fixed to the pes anserinus with a bone anchor (Depuy Mitek GII), to ensure that the exterior margin of the patella was in the line of the exterior margin of the fermoral lateral condyle. Finally, the surgical area was flushed and the excision was closed by conventional suturing.

Postoperative treatment

It was routinely used antibiotics to prevent infection before and after surgery, and postoperatively applied long plaster splints or external immobilizations to stabilize the affected limb into a full extension position for 3 weeks. Patients were guided to take patella loosening and femoris forceps muscle contraction exercises, but without knee joint flexion and extension exercises. After 4 weeks of the surgery, CPM (continuous passive motion) was performed from 0-90° in the injured knee. With 2 months after the surgery, knee flexion range was extended to 120° with quadriceps femoris strengthening exercises applied.

Statistics

Data were analyzed using SPSS22.0, and expressed as mean ± S.D. P-value of the difference between pre-operation and post-operation was evaluated using paired t-test, and $P<0.05$ was considered statistically significant. For logistic regressions, age (>18 y old, mature; <18 y old, immature), Insall-Salvati index (>1.2, patella alta; <1.2, non-patella alta), and lateral trochlear inclination (>15°, normal; <15°, abnormal) were defined as independent variables, while 1 y postoperative Insall score was defined as a dependent variable [12].

Ethics

This study was approved by Ethics Committee of Kunming Medical University, and we obtained signed written informed consents from all participants before the research.

Results

All excisions were healed well without operative complications, such as nerve injuries occurred. The postoperative follow-up time was ranged from 12 to 48 months with an average time of 28 months. After symptomatic treatment, significant pain relief was reported among 13 patients suffered knee pain. For another 13 patients, knee pain was not subside postoperatively but relieved by symptomatic treatment. After 12 months of the surgery, knee X-ray confirmed the correct location of the patella at 60° flexion. Also, we found that the anatomic aspects of the patellofemoral joint recovered satisfactorily, without signs of nerve injury, visible development of pseudoarthrosis, fixation failure, postoperative patellar subluxation, and any other complications observed. For adolescent patients, there did not exist injuries of epiphysis.

Table 1. *Lysholm score of pre-operation and 1 y post-operation ($\bar{x}$ ± s, n=83).*

Pre-operation	1 y post-operation	t value	P value
69.33 ± 8.38	88.65 ± 12.93	-13.64	0

Table 2. *Kujula score of pre-operation and 1 y post-operation ($\bar{x}$ ± s, n=83).*

Pre-operation	1 y post-operation	t value	P value
67.05 ± 8.43	88.55 ± 12.28	-14.91	0

Table 3. *Logistic regression results.*

Parameters	Regression coefficient	SEM	Standard partial egression coefficient	P-value
TT-TG	-19.659	10978.01	0	0.999
-Age	-20.173	7707.076	0	0.998

Table 4. *χ^2 test analysis of age and Insall score.*

Insall score (1 y post-operation)	Age (y)		Total
	<18 (%)	>18 (%)	
Acceptable and bad	0 (5.1)	17 (11.9)	17
Excellent and good	25 (19.9)	41 (46.13)	66
Total	25	58	83

n ≥ 40, T>5, Pearson Chi-Square test was applied, χ^2=9.215, P=0.002<0.05. Statistical difference in Insall score was shown between Age<18 and Age>18 groups 1 y after surgery.

After 12 months of follow-up, Lysholm score 88.65 ± 12.93 of patients were significantly improved compared with preoperative values (t=-13.64, P=0.00, Table 1), and the same trend for Kujula scores 88.55 ± 12.28 were also noticed (t=-14.91, P=0.00, Table 2), while all patients presented significant increase in Lysholm knee score ($P<0.05$). After 12 months of the surgery, the Insall criterion was applied to evaluate curative effects (standard descriptions: Excellent: no knee pain, no unstable symptoms, normal knee joint movement; Good: mild discomfort, accidental discomfort, no

influence on daily activities; Acceptable: pain of the patellofermoral joint, slight instability of the patellofermoral joint, restricted range of motion, incapable of taking part in some activities; Bad: recurrent dislocation or even further deformity, incapable of taking part in any activities, required further operations). The results classified 56 "Excellent" patients, 10 "Good" patients, 9 "Acceptable" patients and 8 "Bad" patients, with "Excellent" and "Good" accounted for 79.5% of the total patient pool. Logistic regression results were analyzed by independent variables (age, TT-TG value, Insall index and lateral trochlear inclination) and a dependent variable (the Insall score). However, the lateral trochlear inclination and Insall-Salvati index were excluded from logistic regression analysis (Table 3), while age and Insall scores were analyzed using χ^2 tests (Table 4). A typical case is presented in Figure 1, with logistic regression factors of this patient's injured (right) knee as shown in Figure 2.

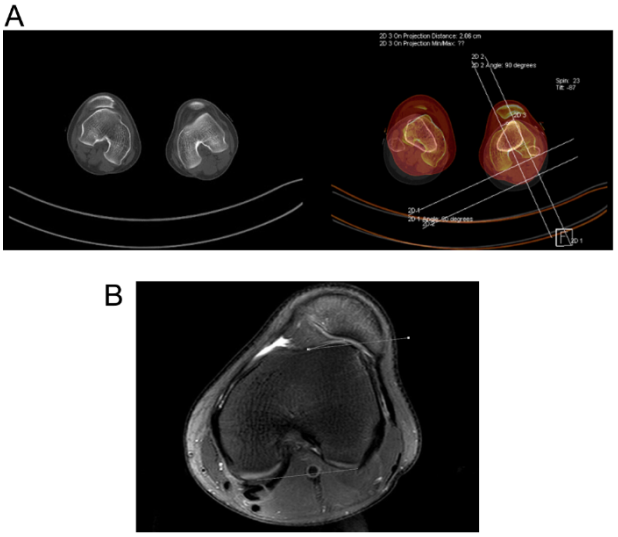

Figure 1. *Patient, female, 26 y old. Recurrent patellar subluxation of right knee. (A) Preoperative anteroposterior and lateral X-ray films showed that the right patella was located slightly outward; (B) Preoperative X-ray showed no lower limb varus and valgus deformity.*

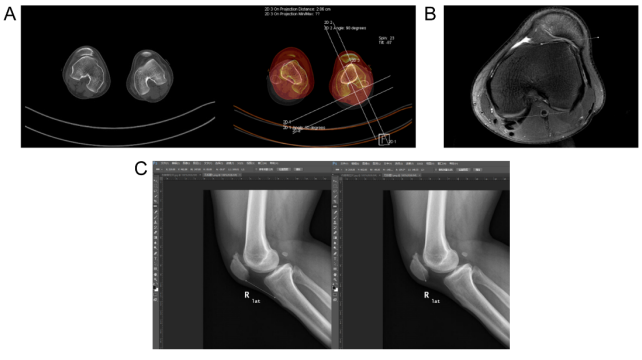

Figure 2. *Logistic regression indexes of patient's injured (right) knee. (A) Preoperative CT test showed the patella subluxation. The TT-TG value of the patella femoral joint was 2.14 cm; (B) Lateral femoral condyle inclination angle was 14.8°; (C) The Insall-Salvati value was 1.26. These parameter values were detected by Photoshop CC 2015 Preoperatively.*

Discussion

Pathogenesis of the patellofemoral instability

It has been reported that dynamic stability was of great importance for patellofemoral instability, which includes patellofemoral subluxation and patellar dislocation. Nowadays, the quadriceps femoris can be divided into the vastus medialis oblique and vastus lateralis obliquus, which were believed to better, contribute to patellofemoral stability, especially for the prevention of patella lateral dislocation [13,14]. In this study, the vastus medialis oblique and the lateral half of patellar tendon were transposed to the patella lateral the pes anserinus, respectively. The transposition of the vastus medialis oblique was to induce medial traction on the coronal plane and generate pressure on the sagittal position, while the transposition of the vastus medialis oblique could reconstruct the stability of the patellofemoral joint and avoid the rotation of the patella with assist of patella tendon rearrangement.

Merits and demerits of the bone anchor

Bone anchoring has been applied clinically as a convenient method of repairing and reconstructing the tendon bone junction, and the theory of bone anchor application originated from the Dead-man theory of suture anchors [15,16]. Some researchers reported that after a rough surface of the bone was produced and then locally sutured around where the anchor implanted, the tendon bone junction was repaired with a firmed anchor to provide sufficient anti-traction [17]. Therefore, compared with traditional extensor reconstruction operation methods, the application of a bone anchor had advantages in maintaining accurate contact bone-tendon contact without the establishment of a bone tunnel or elongated tendon grafts. In addition, the issues of lesion, decohesion and soft tissue were less generated bone anchor application after surgery. Also, complications resulting could be avoided from excessive bone manipulation in this procedure.

Curative effects of the bone anchor assisted extensor mechanism reconstruction

It is a classical operation of bone anchor assisted extensor mechanism reconstruction. In our study, the results of this kind of operations are with "Excellent" and "Good" cases accounting for 79.5% of the total patients which was lower than that of medial patellofemoral ligament reconstruction (95%) [18]. However, we found that with poor curative effects, the patients suffered a long disease course and developed into patellofemoral arthritis resulting from patellofemoral instability, while the patients (children and adolescents with immature epiphysis) with shorter disease courses did not have obvious patellofemoral arthritis with a ratio of 90% of "Excellent" and "Good" to the total cases. It was also reported that the pressure would increase on the patellofemoral joint after the operation, but this operation improved femoral condyle development for children and adolescents with immature epiphysis [19]. This type of soft tissue operation would not damage the epiphysis, and dysplasia of the epiphysis

and genu recurvatum were not found in postoperative follow-up.

Clinical curative effect and the relevant factors logistic analysis

Logistic regression is a multifactor correlation analysis. In this study, age was selected as a factor since the postoperative follow-up indicated a better clinical effect in younger patients. Also, we chose the Insall index and lateral trochlear inclination as factors, because which were widely reported as important parameters for the prediction of patellofemoral instability. In addition, TT-TG is a well-known parameter for the rearrangement of the distal tissue, and the postoperative follow-up suggested worse curative effects when TT-TG value was increased (>20 mm).

Limitations of this Research

As a clinical retrospective study, it was difficult to collect patient data. For our study, all patients had satisfied curative effective, even though few of them were with lower TT-TG values and majority were adolescents. Therefore, the Insall index and lateral trochlear inclination were confirmed to have poor influence on curative effect analysis at 12 month post-operation. Age and TT-TG value were key parameters: for the patients older than 18 y of age, the curative effect worsened with increased TT-TG values (>20 mm). However, the reliability of the data was insufficient and this study needs to be augmented through the collection of additional clinical data, comparing this operational method with other operational approaches.

Conclusion

The use of bone anchor assisted extensor mechanism reconstruction that seems to be relatively easy and reliable, offers a good option for patellofemoral instability with a satisfactory short-term effect and fewer complications. In this study, this method was helpful for limiting and recovering patellofemoral instability, with a satisfied early clinical effect and fewer complications. This operation indicated additional benefit on adolescent patients, and presence of patella alta and flat lateral femoral condyle had little influence on the curative effect of this operation. Moreover, further follow-up analysis is required for long-term clinical results.

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References

1. Barber FA, Aziz-Jacobo J, Oro FB. Patellofemoral instability: Diagnosis, management, and operative decision making. Minerva Ortoped E Traumatologica 2008; 59: 253-268.
2. Balcarek P, Oberthuer S, Hopfensitz S, Frosch S, Walde TA, Wachowski MM, Schuettrumpf JP, Stuermer KM. Which patellae are likely to redislocate? Knee Surgery Sports Traumatol Arthroscopy 2014; 22: 2308-2314.
3. Arendt. MPFL reconstruction for PF instability. The soft (tissue) approach. Orthop Traumatol Surg Res 2009; 95: 97-100.
4. Kita K, Tanaka Y, Toritsuka Y, Yonetani Y, Kanamoto T, Amano H, Nakamura N, Horibe S. Patellofemoral chondral status after medial patellofemoral ligament reconstruction using second-look arthroscopy in patients with recurrent patellar dislocation. J Orthop Sci 2014; 19: 925-932.
5. Rhee SJ, Pavlou G, Oakley J, Barlow D, Haddad F. Modern management of patellar instability. Int Orthop 2012; 36: 2447-2456.
6. Li Y, Wang G, Cai G, Jia D, Ji L, He C, Zheng J. Effectiveness of knee extensor mechanism reconstruction for recurrent patellar subluxation with bone anchor in adolescents. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2015; 29: 1204-1027.
7. Becher C, Kley K, Lobenhoffer P, Ezechieli M, Smith T, Ostermeier S. Dynamic versus static reconstruction of the medial patellofemoral ligament for recurrent lateral patellar dislocation. Knee Surgery Sports Traumatol Arthroscopy 2014; 22: 2452-2457.
8. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy 1993; 9: 159-163.
9. Cheung RT, Ngai SP, Lam PL, Chiu JK, Fung EY. Chinese translation and validation of the Kujala scale for patients with patellofemoral pain. Disabil Rehabil 2012; 34: 510-513.
10. Saggin PR, Saggin JI, Dejour D. Imaging in patellofemoral instability: An abnormality-based approach. Sports Med Arthrosc 2012; 20: 145-151.
11. Stefanik JJ, Zumwalt AC, Segal NA, Lynch JA, Powers CM. Association between measures of patella height, morphologic features of the trochlea, and patellofemoral joint alignment: The most study. Clin Orthop Relat Res 2013; 471: 2641-2648.
12. Biyani R, Elias JJ, Saranathan A, Feng H, Guseila LM, Morscher MA, Jones KC. Anatomical factors influencing patellar tracking in the unstable patellofemoral joint. Knee Surgery Sports Traumatol Arthroscopy 2014; 22: 2334-2341.
13. Lefebvre R, Leroux A, Poumarat G, Galtier B, Guillot M, Vanneuville G, Boucher JP. Vastus medialis: Anatomical and functional considerations and implications based upon human and cadaveric studies. J Manipulative Physiol Therap 2006; 29: 139-144.
14. Lin YF, Lin JJ, Jan MH, Wei TC, Shih HY, Cheng CK. Role of the vastus medialis obliquus in repositioning the patella-a dynamic computed tomography study. Am J Sports Med 2008; 36: 741-746.

15. Burkhart SS. The Deadman theory of suture anchors: Observations along a south texas fence line. Arthroscopy 1995; 11: 119-123.
16. Kim MK, Na SI, Lee JM, Park JY. Comparison of bio-absorbable suture anchor fixation on the tibial side for anterior cruciate ligament reconstruction using free soft tissue graft-experimental laboratory study on porcine bone. Yonsei Med J 2014; 55: 760-765.
17. Petri M, Dratzidis A, Brand S, Calliess T, Hurschler C, Krettek C, Jagodzinski M, Ettinger M. Suture anchor repair yields better biomechanical properties than transosseous sutures in ruptured quadriceps tendons. Knee Surgery Sports Traumatol Arthroscopy 2015; 23: 1039-1045.
18. Zhou JW, Wang CH, Ji G, Ma LF, Wang J, Zhang F, Dong JT, Wang F. A minimally invasive medial patellofemoral ligament arthroscopic reconstruction. Euro J Orthop Surg Traumatol 2014; 24: 225-230.
19. Wang S, Ji G, Yang X, Wang X, Wang R, Li M, Wang F, Dai C, Li X. Femoral trochlear groove development after patellar subluxation and early reduction in growing rabbits. Knee Surg Sports Traumatol Arthrosc 2016; 24: 247-253.

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