A lateral parapatellar approach with iliotibial band dissection from the Gerdy tubercle for total knee arthroplasty of the valgus knee

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Abstract. Valgus knee, which causes severe dysfunction and seriously affects the quality of life of patients, is a condition affecting 10% of patients who undergo total knee arthroplasty (TKA). The best choice of surgical approach and the method of release of soft tissue, however, is still unclear. Therefore, the aim of the present study was to investigate the clinical efficacy of a lateral parapatellar approach with iliotibial band (ITB) dissection from the Gerdy tubercle for TKA in valgus knees. In total, 56 patients (25 males and 31 females) who underwent surgery via a lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA due to valgus knee, with at least one-year follow-up, were retrospectively analyzed. Operation duration, length of time leg was raised post-surgery, prosthetic position, lower limb force line, visual analogue score for pain (VAS), range of movement (ROM), and Knee Society Scores (KSS; including knee score and functional score) were reviewed and analyzed. The data indicated that VAS, ROM and KSS were significantly improved after surgery compared with those before surgery. Additionally, no patient had a deviation in prosthetic position or limb alignment greater than 5˚. These results suggest that a lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA is an effective technique to treat valgus knee, which can significantly improve pain and function without deviation of the lower limb mechanical axis or prosthesis position.

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Introduction

Total knee arthroplasty (TKA), a strategy used to treat multiple advanced knee diseases, has been widely reported to significantly improve knee function and patient quality of life (1). Valgus knee is the condition which leads to the requirement for TKA (2) and is often associated with lateral condylar hypoplasia, lateral tibial plateau defect, contracture of the lateral ligament complex of the knee joint and patellar locus defects, all of which cause severe dysfunction and seriously affect patients' quality of life (3). The main goal of TKA in the treatment of valgus knee is to correct valgus deformity, restore the balance of the flexion and extension gap and ultimately restore joint function (1-3).

Surgical field exposure and soft tissue release play crucial roles in the treatment of valgus knee. The choice of operative approach determines the exposure of the surgical field, and the main approaches to valgus knee surgery include the medial parapatellar approach and the lateral parapatellar approach (4). Soft tissue release mainly refers to the release of lateral tense structures, including the iliotibial band (ITB), lateral collateral ligament (LCL), popliteus tendon (POP), posterolateral capsule (PLC) and lateral patellar retinaculum (5). However, the best choice of surgical approach and the best mode and order of soft tissue release remains unknown (6). Therefore, the aim of the present study was to investigate the clinical efficacy of a lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA in the valgus knee.

Materials and methods

Clinical data. The present study is a retrospective analysis of all patients that underwent TKA via a lateral parapatellar approach with ITB dissection from the Gerdy tubercle for valgus knee between January 2014 and May 2018 at the Second Affiliated Hospital of Anhui Medical University and the Lu'an Affiliated Hospital of Anhui Medical University. The inclusion criteria were: i) Patients primarily underwent TKA; and ii) patients were followed up for more than one year. The exclusion criteria were: i) Patients with additional diseases

(e.g. spinal or hip diseases) that may affect the clinical efficacy of TKA; and ii) patients lost to follow-up.

In total 56 patients (25 males and 31 females) were included in the present study, and all patients signed written informed consent for the surgery and use of their data at the time of the study. The patients ranged in age from 55 to 72 years, with a mean age of 62 years. There were 23 cases of rheumatoid arthritis, 22 cases of osteoarthritis and 11 cases of traumatic arthritis. The clinical valgus deformity ranged from 10˚ to 35˚ (mean 21.4˚) and the deformity was mild (<15˚) in 23 knees, moderate (16˚-30˚) in 28 knees and severe (>30˚) in five knees based on Keblish grade (6). The following indicators were reviewed and analyzed: i) Operation duration; ii) straight leg raising time (The time the leg was raised after the operation); iii) correction angle of valgus deformity; iv) the hip-knee-ankle angle (HKA angle); v) the frontal femoral component angle (FFC angle); vi) the frontal tibial component angle (FTC angle); vii) visual analogue score for pain (VAS) (7); viii) range of movement (ROM) (8) and ix) Knee Society Score (KSS) (9). The HKA angle was used to assess the lower limb force line and the FFC and FTC angles were used to assess the prosthetic position. The ideal values of the HKA, FFC, and FTC were 180˚, 96˚ and 90˚, respectively (8). In addition, prosthetic position deviation and limb alignment deviation within 5˚ were considered to be within an acceptable range (8).

Main procedures of the lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA. To ensure the successful completion of the operation, all patients underwent full-length X-ray of their lower limbs, anteroposterior and lateral X-ray of the knee and other routine preoperative examinations of the circulatory system, heart function, lung function and nervous system. All patients received general anesthesia and femoral nerve block anesthesia, and a tourniquet was used for every patient. All the operations were performed by a skilled joint surgeon. An anterior midline longitudinal incision approximately 12-14 cm across the knee was performed from the proximal side of the patella to the lateral side of the tibial tubercle. Skin, subcutaneous tissue and aponeurotic fascia were cut in turn and then were sharply separated in an outward direction. The lateral joint capsule and lateral retinaculum were cut along the lateral margin of the rectus femoris and the lateral margin of the patella to the Gerdy tubercle. The ITB was completely dissected from the Gerdy tubercle and the knee joint was fully exposed through patellar varus and partial removal of the fat pad. After complete dissection of the ITB from the Gerdy tubercle and removal of lateral osteophytes, it was indicated that the majority of patients with straight valgus deformity are corrected and the lower limb force line returns to normal. For most patients, the valgus deformity could be corrected without further release of additional lateral structures (Fig. 1).

After further release of the lateral collateral ligament and posterior lateral articular capsule, soft tissue balancing was performed and it was determined that the medial structure was still relaxed, indicating that severe medial structural relaxation was present. Therefore, simply releasing the lateral structure is insufficient to obtain a good soft tissue balance. Additional tightening reinforcement of the medial collateral ligament and the use of a semi-restricted gasket (Smith & Nephew plc) are required (5,6). Therefore, reinforced sutures and semi-restricted gasket were used for patients with severe medial collateral ligament relaxation, while for other patients, PS (Posterior-stabilized) prostheses (Smith & Nephew plc) were used. For patients with poor patellar locus, the lateral joint capsule and lateral retinaculum were cut along the lateral margin of the patella in a 'Z' shape, which enabled final suture and closure of the articular capsule using a staggered suture (Fig. 2). Then, the stability, flexion and extension, and the force line of the lower limb were checked. In addition, the patella locus and internal and external stress were checked. Finally, the knee was sutured layer by layer. Postoperative X-ray examination showed a satisfactory lower limb force line and prosthesis position (Fig. 3).

No patient received blood transfusion. All patients received cefotiam to prevent infection and rivaroxaban to prevent thrombosis. All patients underwent the same rehabilitation exercise program including passive and active flexion and extension of the knee, leg raising training, and walking with walking aids.

Statistical analysis. All data are shown as the mean ± standard deviation followed by the median (in parentheses). Statistical analysis was performed using SPSS 23.0 (IBM Corp.). One-way ANOVA followed by Student-Newman-Keuls post hoc test was used for the comparison of multiple groups.

Results

All patients were followed up for a minimum of one year. The mean operation duration was 110.6±19.7 min and the mean straight leg raising time was 3.1±1.0 days. The valgus deformity was corrected from a mean of 21.4˚ before surgery to a mean of 2.6˚ after surgery. The mean VAS at 6 and 12 months after operation were 1.2 and 0.6, respectively, which was a significant improvement compared with 4.8 preoperatively (both $^{*}P<0.05$ vs. pre-operatively; Table I). The mean ROMs at 6 and 12 months after operation were 114 and 129, respectively, which was significantly improved compared with 102 preoperatively (both $^{*}P<0.05$ vs. pre-operatively; Table I). The mean KSS knee scores at 6 and 12 months after the operation were 82.5 and 92.3, respectively, which was significantly improved compared with 52.0 preoperatively (both $^{*}P<0.05$ vs. pre-operatively; Table I). The mean KSS functional scores at 6 and 12 months after operation were 78.4 and 84.3, respectively, which was significantly improved compared with 41.1 preoperatively (both $^{*}P<0.05$ vs. pre-operatively; Table I). The mean HKA, FFC and FTC angles after operation were 177.4˚, 95.4˚ and 89.7˚, respectively, with no HKA, FFC or FTC angle deviation over 5˚ (Table II).

In total, 5 patients with severe valgus deformity underwent further release of the lateral collateral ligament and posterior lateral articular capsule. An additional 2 patients with severe medial collateral ligament relaxation were treated with reinforced sutures and semi-restricted gasket. A single patient with avulsion of the patellar ligament during the operation recovered well after drilling and suture fixation, and no obvious complications ensued. No patient underwent tibial nodule osteotomy, which is used to fully expose the knee joint. There were no instances of common peroneal nerve injury, patellar

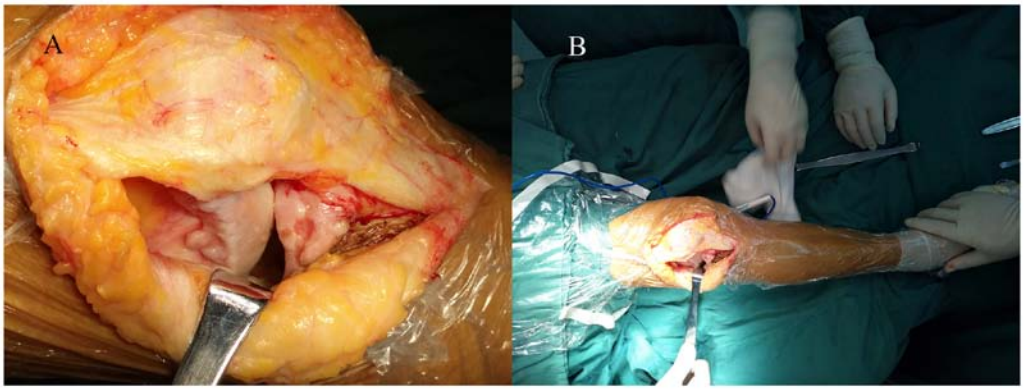

Figure 1. (A) Iliotibial band dissection from the Gerdy tubercle in the right knee. (B) After iliotibial band dissection from the Gerdy tubercle, the medial space was significantly increased, and the valgus deformity could be corrected.

Figure 2. The lateral joint capsule and lateral retinaculum were cut in a 'Z' shape. For patients with poor patellar locus, the lateral joint capsule and lateral retinaculum were cut along the lateral margin of the patella in a 'Z' shape, which ensured final suture and closure of the articular capsule via staggered suture.

Figure 3. Full-length standing radiographs of the lower extremity. The lower limb force line and the prosthesis position were both within the acceptable range and were better than those before operation (right knee).

necrosis, or poor patellar locus. All patients had good knee stability. Until the last follow-up, no other complications were found in any of the patients. In addition, 20 of the patients were followed up for more than two years, but there was no significant difference in the indicators in these patients at two years after operation compared with at one year after operation (data not shown).

Discussion

The main finding of this study is that the lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA can be used as an effective technique to treat valgus knee, significantly improving pain and function without deviation of the lower limb mechanical axis or prosthesis position. The factors causing knee joint valgus deformity can be divided into bone tissue factors and soft tissue factors (10). Bone tissue factors include lateral cartilage erosion, lateral condylar hypoplasia, and metaphyseal femoral and tibial plateau remodeling, while soft tissue factors mainly refer to the lateral tense structures including the ITB, LCL, PLC, POP, and hamstring tendons. Therefore, soft tissue release and osteotomy are the top priority in total valgus knee arthroplasty, especially soft tissue release. In addition, the choice of operative approach and the method of soft tissue release are still controversial and challenging (5,6). The purpose of the present study was to explore the operative approach and the release of soft tissue for TKA of the valgus knee.

At present, the operative approaches to valgus knee are largely divided into the medial parapatellar approach and the lateral parapatellar approach (4). The medial parapatellar approach, as a widely used approach for TKA, can provide sufficient surgical field exposure and is convenient when performing surgical procedures because of the outside location of the lower tubercles of the tibia, rendering patella eversion easier (11). Additionally, Ranawat *et al* (12) reported that the medial parapatellar approach can reduce the incidence of post-operative skin infection, necrosis and other complications and avoid lateral structural spasms caused by sutures during lateral approach suturing. However, the medial parapatellar approach also has its drawbacks. It is difficult to release lateral tension structures directly, especially in the posterolateral region, and the medial approach may result in injury to the common peroneal nerve without direct protection (12-14). In addition, the medial parapatellar approach can also result in damage

Table I. Pre-operative and postoperative clinical results.

Measurement	Pre-operation	6 months	12 months
VAS	4.8±0.72 (5.0)	1.2±0.33[a] (1.0)	0.6±0.28[a] (0.5)
ROM	102±10.25 (105)	114±4.85[a] (115)	129±4.37[a] (130)
KSS			
Knee score	52.0±3.12 (52.0)	82.5±2.89[a] (83.0)	92.3±4.13[a] (95.0)
Functional score	41.1±4.85 (40.0)	78.4±8.12[a] (80.0)	84.3±5.13[a] (85.0)

VAS, visual analogue score for pain; ROM, range of movement; KSS, Knee Society Score. [a]P<0.05 vs. pre-operation. Data are presented as the mean ± SD (median).

Table II. Prosthetic position deviation and limb alignment results.

	Post-operation	Deviation over 5˚ (n)
HKA angle (˚)	177.4±2.01 (178.2)	0
FFC angle (˚)	95.4±1.40 (96.1)	0
FTC angle (˚)	89.7±1.15 (88.9)	0

HKA angle, hip-knee-ankle angle; FFC angle, frontal femoral component angle; FTC angle, frontal tibial component angle.

to the blood supply inside the patella and thus increase the risk of patellar necrosis because of the better blood supply of the medial patellar flap compared with the lateral side (13,14). Especially for patients with external patellar dislocation, in order to obtain a good patellar locus, it is necessary to further release the lateral patellar retinaculum, which can cause additional damage to the blood supply of the patella and lead to ischemic necrosis of the patella (13,14). The greatest advantage of the lateral parapatellar approach in the treatment of valgus knee is the ability to reach and release the tense lateral soft tissues directly, with little damage to the medial femoral muscle. Other advantages include a quick recovery after operation (15) and the avoidance of damage to the blood vessels around the patella (16). Because the lateral patellar retinaculum is cut directly during the surgery, the patellar locus remains good after operation (13,14). It has been reported that the main disadvantages of the lateral patellar approach are the difficulty of patellar varus and the difficulty of incision closure (17). However, the difficulty of incision closure can be solved by using a 'Z' shape incision and dislocation suture and the difficulty of patellar varus can be solved by tibial tubercle osteotomy (17). In the present study, only two patients had difficulty with patellar varus due to complete exfoliation of the ITB, but the operation was not affected. In addition, in the present study, there were no incision-related complications and no tibial tubercle osteotomy was required during operation. Avulsion of the patellar ligament occurred in one patient during the operation, which may have been caused by osteoporosis, but intraoperative traction cannot be excluded. After drilling and suture fixation, the patient recovered well and no obvious complications ensued. In summary, the present data suggest that the lateral parapatellar approach can be used to treat valgus knee and that the difficulties of incision closure and patellar varus can be overcome by employing a 'Z' shaped incision and dislocation suture.

Soft tissue release is not only an important step in treatment of the valgus knee, but also a technical problem. Controversies remain concerning the best method and sequence of release of the lateral tense structures. The lateral tense structures mainly include the ITB, LCL, PLC, and POP. The valgus knee is generally divided into two types: Extension deformity without concurrent flexion deformity, and extension deformity complicated by flexion deformity. Most valgus deformities occur during knee extension and there is no valgus deformity during flexion. In addition, the ITB mainly affects valgus deformity in knee extension, while the LCL, PLC and POP can affect valgus deformity in both knee extension and knee flexion (5,6). Krackow and Mihalko (18) suggested that the ITB and LCL were the tensest lateral structures in the valgus knee, such that the LCL should be considered first for release and that the POP and ITB should be used to grade the release when there is severe valgus deformity. Additionally, the PLC is occasionally released and the lateral head of the gastrocnemius is released only during flexion contracture. Aglietti *et al* (19) carefully performed the release of lateral tense structures using the 'pie-crusting' technique with small, multiple inside-out incisions using a small knife blade (with a size of 15#). The POP was first released, and then the LCL and ITB were released. In the present study, all valgus deformities occurred during knee extension, which was mainly caused by contracture of the ITB, and no valgus deformity was observed in knee flexion. Therefore, the data suggest that release of the ITB was the key to correcting the valgus deformity. After dissection of the ITB from the Gerdy tubercle and removal of lateral hyperplastic osteophytes from the knee, the valgus deformity was corrected and soft tissue was well balanced. The exposure of the surgical field and the release of lateral contracture tissues were combined into one. When the knee joint field was exposed, a satisfactory balance of force line could be obtained, and the complex soft tissue balance technique of the valgus deformity was simplified. In the present study, only 5 patients with severe valgus deformity needed further release, which involved releasing the LCL and PLC using syringe needles through repeated poking, which enabled avoidance of the excessive release caused by the 'pie-crusting' technique (19). Additionally, the dissection of the ITB facilitated exposure of the knee joint and reduced

the pressure of the ITB on the common peroneal nerve after valgus correction. What needs to be emphasized is that after dissection of the ITB, adaptive contracture of the ITB was produced according to the corrected joint space, which meant that effects on the stability of the knee could be avoided. In addition, because the lateral structures of the valgus knee, except the ITB, were also contracted, complete dissection of the ITB did not affect the stability of the knee. All patients in the present study were followed up and showed good knee joint stability. Therefore, it can be suggested that simple ITB dissection can correct most valgus deformities, especially mild and moderate knee valgus deformity. The lateral parapatellar approach may minimize the operation time and avoid further damage caused by long-term patella varus.

The present results demonstrated that the lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA in valgus knees significantly improved pain and function at different time points postoperatively compared with preoperative values. No instances of common peroneal nerve injury, patellar necrosis, or poor patellar locus occurred. All patients had good knee stability. In addition, lower limb force line and prosthesis position were within acceptable ranges.

This study is a preliminary observation of the clinical efficacy of a new surgical approach and traditional methods of surgery, such as simple lateral and medial approach, were not compared to the new surgical method, which is a limitation of the present study. Additionally, the small sample size is a further limitation. A large sample study to compare the clinical efficacy between this new surgical method and the traditional surgical method is necessary to further confirm the findings.

In conclusion, the lateral parapatellar approach with ITB dissection from the Gerdy tubercle for TKA can be used as an effective technique to treat valgus knees, significantly improving pain and function without deviation of the lower limb mechanical axis or prosthesis position. The exposure of the surgical field and the release of the lateral contracture tissue were combined into one. When the knee joint field was exposed, a satisfactory balance of force line could be obtained, and the complex soft tissue balance technique of the valgus deformity was simplified.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Authors' contributions

WC, ZL, JZ, and JJ contributed to the conception of the study. QC, HY, LQ and FY provided substantial contributions to the acquisition, analysis and interpretation of data. WC and JJ critically revised the work for important intellectual content. All authors read and gave their final approval of the version to be published.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendment. This study was approved by the Ethics Committee of The Second Affiliated Hospital of Anhui Medical University. The patients agreed to the use of their follow-up data in scientific research and signed an informed consent form.

Patient consent for publication

The patients signed consent forms agreeing to the use of their data in scientific research.

Competing interests

The authors declare that they have no competing interests.

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