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Original Article

The effect of tourniquets on patellofemoral joint congruity during total knee arthroplasty

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ABSTRACT

Background: Incongruity of the patellofemoral joint after total knee arthroplasty (TKA) causes anterior knee pain. Intraoperative congruity tests are necessary to avoid unnecessary lateral retinacular release, and the usage of tourniquets may influence these results. The purpose of this study was to examine the effect of tourniquets on patellofemoral joint congruity during TKA.

Materials and methods: Two hundreds and seventeen knees were examined after TKA. Skyline radiographs at 60° and 90° flexion were taken immediately after wound closure before and after tourniquet deflation to compare changes in patellar tilt angle.

Results: In the patellar tilt angle at 60° flexion, lateral tilt was observed in 18 knees. Tourniquet deflation changed the patellar tilt angle by a mean −0.7° ± 1.2° ($p = 0.030$). Medial tilt was observed in 10 knees. Tourniquet deflation changed the patellar tilt angle by 0.9° ± 0.7° ($p = 0.004$). Tourniquet deflation improved the degree of lateral and medial patellar tilt. In the patellar tilt angle at 90° flexion, lateral tilt was observed in 118 knees. Tourniquet deflation changed the patellar tilt angle by a mean −1.1° ± 1.2° ($p < 0.001$). Medial tilt was observed in 71 knees. Tourniquet deflation changed the patellar tilt angle by 0.5° ± 1.0° ($p < 0.001$). Tourniquet deflation improved the degree of lateral and medial patellar tilt.

Conclusions: Tourniquet deflation improved patellofemoral congruity in a statistically significant way, but only to a small extent, indicating low clinical significance. Therefore, intraoperative congruity tests performed with tourniquets in place are reliable.

1. Introduction

Primary total knee arthroplasty (TKA) has proven to be highly successful in pain relief and improving function in patients with severe arthritis of the knee. However, some studies [1–3] have reported that up to one-fourth of patients experience anterior knee pain, which decreases patient satisfaction with the surgery. Anterior knee pain after TKA is a serious complication that can necessitate revision surgery [4,5]. One cause of anterior knee pain is poor congruity of the patellofemoral joint, and a severe degree of poor congruity leads to actual instability [6,7]. Such incongruity not only causes anterior knee pain but may also lead to complications such as patellar luxation, patellar fracture, component wear, poor range of motion, and so on [8–10]. Finally, patellofemoral congruity is assessed by intraoperative tests (such as the no thumb test, one thumb test, and two stitches test) [13,14], and incongruity has been addressed intraoperatively using lateral retinacular release in some reports [11,12]. These tests may be helpful for avoiding unnecessary intraoperative lateral retinacular release, but cannot be said to be accurate reflections of postoperative patellofemoral congruity, because these are performed with the tourniquet in place. There are only a few reports of the intraoperative effects of tourniquet application on patellofemoral congruity [15,16], but they examined patellofemoral joint congruity without the joint capsule and skin sutured. The purpose of this study was to examine the effect of tourniquets used during TKA on patellofemoral joint congruity, using postoperative radiographs taken immediately.

Abbreviations: FTA, femoro-tibial angle; TKA, total knee arthroplasty.

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2. Material and methods

2.1. Participants

The study consisted of 217 knees from 179 patients who had undergone TKA between June 2011 and April 2016, and for whom an accurate skyline radiograph could be obtained during surgery. The study consisted of 137 women and 42 men with an average age of 74 years (range, 44–91 years). The average body mass index was 25.6 (range, 16.0–37.5). The femoro-tibial angle (FTA) was measured using long film radiographs of the lower extremity. Of the 217 knees, 144 exhibited preoperative varus deformities (mean FTA, 6.6° varus with Kellgren–Lawrence classification of 6, 33, and 105 knees of Grades 2, 3, and 4, respectively). Further, 73 of the 215 knees were classified preoperatively as valgus (mean FTA, 6.7° valgus with Kellgren–Lawrence classification of 1, 11, 25, and 36 knees of Grades 1, 2, 3, and 4, respectively).

With respect to intraoperative findings of patellofemoral joint degeneration among the varus knees, using the Outerbridge classification,6, 17, 46, and 75 knees had Grade I, II, III, and IV degeneration, respectively. Among the valgus knees, using the Outerbridge classification, 2, 14, 33, and 24 knees had Grade I, II, III, and IV degeneration, respectively.

Among the varus knees, TKA was performed for osteoarthritis in 123 knees, rheumatoid arthritis in 9 knee, and osteonecrosis in 12 knees. Among the valgus knees, TKA was performed for osteoarthritis in 56 knees, rheumatoid arthritis in 9 knees, and osteonecrosis in 8 knees.

2.2. Total knee arthroplasty

Three senior surgeons performed TKA in 164 knees using the Vanguard PS system (Biomet Inc., Warsaw, IN, USA) and in 53 knees using the Persona PS system (Zimmer Inc., Warsaw, IN, USA). Each surgeons had worked together in the same hospital for more than one year and unified the surgical procedure. We performed TKAs using a medial parapatellar approach with the measured resection method. First, an Esmarch bandage was applied with the knee extended, and the affected limb was wrapped in the same direction distally to proximally. Next, a tourniquet was applied at 250–300 mmHg of pressure with the knee at maximal flexion. Osteotomy of the distal femur was performed perpendicular to the mechanical axis using an intramedullary guide, with external rotation of 4° to the posterior condylar axis. The tibia cut was perpendicular to the anatomical axis with a 3° posterior slope using an extramedullary guide, and rotation was along the line connecting the center of the attachment of the posterior cruciate ligament to the medial one-third of the tibial tuberosity. The patella was replaced in all TKAs. The patellar component was placed as medial as possible, and osteophytes around the patella were removed. Intraoperative lateral retinacular release was not performed in any case, because there was no patella that tilted over 10 mm away from the femoral component under one thumb test. The positioning of each component was confirmed with postoperative frontal and lateral radiographs using the Radiographic Evaluation System of the Knee Society [17,18].

2.3. Evaluation of tourniquet effects

To evaluate the effect of the tourniquet on patellofemoral joint congruity, a skyline radiograph was taken immediately after wound closure with the patient under general anesthesia. A repeat skyline radiograph was taken at the same position after tourniquet deflation. The flexion angles of knees determined by skyline radiograph were at 60° and 90° in 28 and 189 knees, respectively. The patellar tilt angle (lateral tilt = positive value) was measured on the skyline radiograph for comparisons before and after tourniquet deflation. The patellar tilt angle (Fig. 1) was defined as the angle between a line drawn from the anterior limit of the femoral condyles and a line drawn through the patellar prosthesis–bone interface [19,20].

2.4. Statistical methods

Patellar tilt angle before and after tourniquet deflation was expressed as mean ± standard deviation and compared using a paired t-test. Changes in patellar tilt angle after tourniquet deflation between varus and valgus knees were compared using an unpaired t-test. The proportion of knees in which the patellar tilt angle changed by 1° or more was compared between varus and valgus knees using a chi-squared test for independence. Significant differences were defined as $p < 0.05$.

3. Results

Regarding femoral component positioning, the α angle was 95.2° ± 6.2° and the β angle was 90.2° ± 1.7°. For the tibial component, the γ angle was 1.7° ± 2.3° and the δ angle was 87.1° ± 2.3°. All components were placed within normal limits [21].

3.1. The patellar tilt angle at 60° flexion

Eighteen of 28 knees had lateral tilt of patella with the tourniquet inflated. The patellar tilt angle with the tourniquet inflated and after deflation was 2.3° ± 1.7° and 1.6° ± 1.8°, respectively (difference: −0.7° ± 1.2°), showing that deflating the tourniquet reduced the degree of lateral tilt ($p = 0.030$) (Table 1). Ten of 28 knees had medial tilt of patella with the tourniquet inflated. The patellar tilt angle with the tourniquet inflated and after deflation was −2.8° ± 2.7° and −1.9° ± 2.4°, respectively (difference: 0.9° ± 0.7°), showing that deflating the tourniquet reduced the degree of medal tilt ($p = 0.004$) (Table 1).

3.2. The patellar tilt angle at 90° flexion

The patellar tilt angle at 90° flexion was measured in 189 knees (123 varus knees and 66 valgus knees). One hundred and eighteen of 189 knees had lateral tilts, and the patellar tilt angle with the tourniquet inflated and after deflation was 4.0° ± 2.9° and 2.9° ± 2.6°, respectively (change of −1.1° ± 1.2°), showing that tourniquet deflation reduced the degree of lateral tilt ($p < 0.001$).

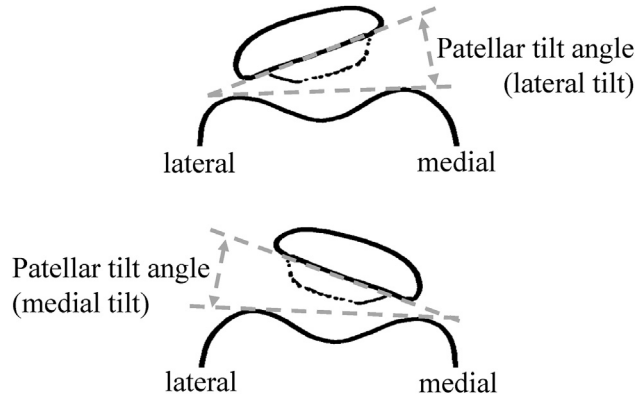

Fig. 1. Angle between patellar cut surface line and a line tangent to femoral medial and lateral trochlear ridge was defined as patellar tilt angle. Lateral tilt was positive value. Medial tilt was negative value.