Jikeikai Med J 2007 ; 54 : 141-5

Usefullness of the Anterior Surface and Supracondylar Region of the Femur as a Landmark for Femoral Rotational Alignment in Knee Surgery

Takaaki TANAKA[1,2], Yoshio KUMAGAE[1,2], Mitsuru SAITO[2], Toshiyuki OMORI[2], and Keishi MARUMO[2]

[1]*Department of Orthopaedic Surgery, NHO Utsunomiya National Hospital*
[2]*Department of Orthopaedic Surgery, The Jikei University School of Medicine*

ABSTRACT

We investigated the possibility that a line tangential to the anterior surface of the femur could serve as a landmark for rotational alignment of the femoral component in total knee arthroplasty (TKA). The subjects were 37 women treated with TKA for medial knee osteoarthritis. Before surgery X-ray films and computed tomography scans were obtained. The three axes—the posterior condylar axis, the transepicondylar axis, and the anterior surface at the supracondyle—were constructed on each CT scan, and the angles between two axes were measured with the X-Caliper system. The results obtained from 35 subjects showed that the angle between the transepicondylar axis and the posterior condylar axis ranged from 3.1 to 10.7 degrees and had a mean value of 6.35±1.93 degrees. The angle between the transepicondylar axis and the anterior femoral surface at the supracondyle ranged from 6.1 to 15.4 degrees and had a mean value of 11.21±2.48 degrees. The anterior surface was internally rotated relative to the posterior condylar axis in all cases, and its value indicated the degree of anterolateral notching. The anterior femoral surface at the supracondylar level is easy to identify during surgery. Thus, it may be a useful landmark for determining the correct rotational alignment of the femoral component in TKA.

(Jikeikai Med J 2007 ; 54 : 141-5)

Key words : total knee arthroplasty, landmark, alignment, femoral component, osteoarthritis

INTRODUCTION

The landmark most often used to obtain correct rotational alignment of the femoral component in total knee arthroplasty (TKA) has been the posterior condylar axis[5]. However, this axis is not reliable when the condyle is hypoplastic or when cartilage remains on the ipsilateral condyle. The transepicondylar axis[3] has been suggested to be a more reliable landmark. However, accurately identifying the peaks of the epicondyles is difficult. A third method of determining correct rotational alignment is to draw a line perpendicular to the anteroposterior axis[2]. However, this axis is also unreliable when the patellar groove or intercondylar notch is severely deformed. When the femoral component is placed in 3 degrees of external rotation relative to the posterior condylar axis, anterolateral notching, in which the anterior cutting surface of the lateral condyle is wider than that of medial condyle, becomes apparent. This find-

Received for publication, February 23, 2007
田中 孝昭，熊谷 吉夫，斎藤 充，大森 俊行，丸毛 啓史
Mailing address : Takaaki TANAKA, Department of Orthopaedic Surgery, NHO Utsunomiya National Hospital, 2160, Shimookamoto, Utsunomiya City, Tochigi 329-1193, Japan.
E-mail : tanakat@e-utunomiya.hosp.go.jp

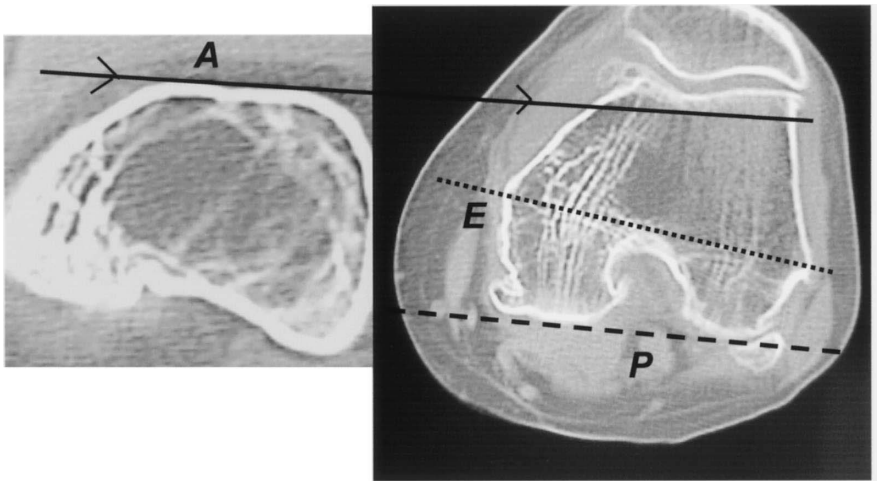
ing demonstrates that slight anterolateral notching does not prevent correct placement of the femoral component in terms of rotational alignment. Furthermore, the anterior surface of the supracondylar distal femur is nearly flat; thus, a tangential line to the anterior surface of the femur is easily obtained during surgery as well as on computed tomography (CT) scans. In the present study, we compared the anterior surface plane of the supracondylar distal femur with other axes as landmarks for rotational alignment.

Materials and Methods

The subjects were 37 women with medial compartmental knee osteoarthritis (OA). They ranged in age from 66 to 84 years. Patients with rheumatoid arthritis were excluded. Standing anteroposterior and lateral radiographs and CT scans of the knees were obtained before surgery. The anterior surface of the supracondylar distal femur was nearly flat; thus, a tangential line to the anterior surface of the femur was easily obtained during surgery as well as on CT scans (Fig. 1A and 3). The three axes—the posterior condylar axis, transepicondylar axis (peak to peak of both epicondyles), and the supracondylar anterior surface—were constructed on each CT scan. The angle of the posterior condylar axis relative to the transepicondylar axis and the angle between the anterior surface of the femur at supracondyle and transepicondylar axis were determined with a digital measuring device (X-Caliper, Eisenlohr Technologies, Inc, Davis, CA, USA; Fig. 1.). Measurements on each CT scan were made by a single surgeon.

Results

The standing femorotibial angle ranged from 182 to 194 degrees. In two subjects obtaining a tangential line to the anterior surface of the femur at the supracondyle level on each CT scan was difficult (Fig. 1A, 2) because the anterior surface was not completely flat. These two subjects were excluded. The remaining 35 subjects were used for radiographic examination. The angle between the transepicondylar axis and the posterior condylar axis ranged from 3.1 to 10.7 degrees and had a mean value of 6.35 ± 1.93 degrees (Fig. 2B). The angle between the transepicondylar axis and the anterior surface at the supracondylar region ranged from 6.1 to 15.4 degrees and had a mean value of 11.21 ± 2.48 degrees (Fig. 2B). The anterior surface was internally rotated relative to



A B

Fig. 1. Sequential CT in a patient with medial compartmental knee OA (left knee). Three anatomical axes are drawn in Figures 1A and 1B. The angle between the posterior condylar axis (P) and the supracondylar anterior surface of the distal femur (A) is approximately 3 degrees. Therefore, line A is 3 degrees internally rotated relative to the posterior condylar axis. Line A shows the extension of the anterior surface of the supracondylar distal femur. E indicates the transepicondylar axis.

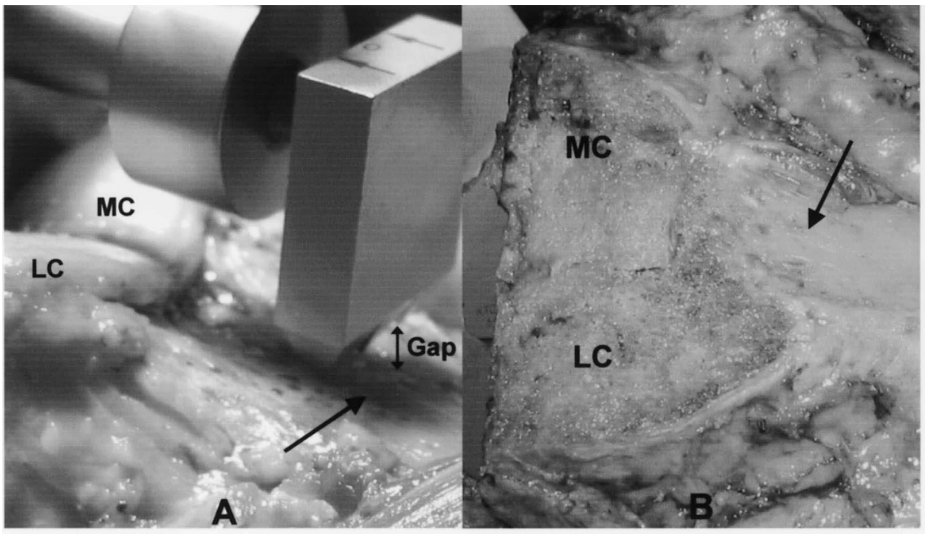


Fig. 2. Macroscopic findings of the same knee described in Figure 1 during surgery (left knee). When the distal femur was cut in the 3-degree externally rotated position, a gap occurred between the anterior surface of the medial condyle and the gauge (A). This gap caused the anterior cutting surface of the lateral condyle to be wider than that of the medial condyle, i.e., anterolateral notching (B). "LC" and "MC" indicate lateral condyle and medial condyle, respectively. The arrow indicates the anterior surface of the distal femur.

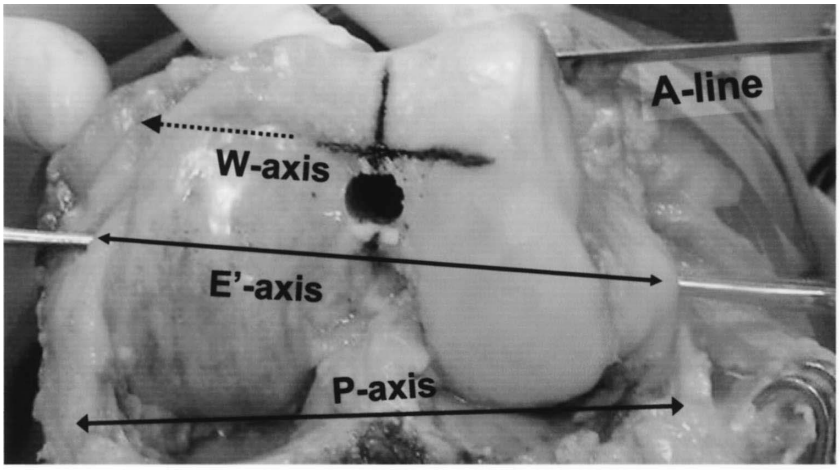


Fig. 3. A photograph of a patient with medial compartmental knee OA during surgery. "P," "E'," "W-axis," and "A-line" indicate the posterior condylar axis, the surgical epicondylar axis, the line drawn perpendicular to the anteroposterior axis, and the tangential line to the supracondylar anterior femoral surface, respectively.

the posterior condylar axis in all cases (Fig. 3).

Discussion

Rotational alignment of the femoral component affects patellar tracking, patellofemoral contact points and pressure, varus-valgus anteroposterior, and rotational alignment of the knee[1]. In a knee with normal bone anatomy, slight external rotation of the femoral component relative to a line connecting the medial and lateral posterior condyles places the component in correct rotational position relative to the upper surface of the tibia when tibial surface resection is perpendicular to the long axis of the tibia.

The transepicondylar line is the most reliable axis to obtain the correct rotational alignment of the femoral component in TKA[3,4,7]. In addition, the transepicondylar line is the only axis that can be used in

revision total knee replacement. However, defining the peaks of the epicondyles, especially the peak of the medial epicondyle, can be difficult because they are obscured by overlying ligaments and other soft tissues. In this study, defining the medial epicondyle was difficult, even on CT.

The posterior condylar axis was used, because it was easy to obtain during surgery. Although the posterior condylar axis serves as reliable rotational alignment landmark for the healthy knee, it produces a transverse reference axis that is internally rotated in the valgus knee. In addition, degenerative changes or hypoplasia of the posterior part of the medial condyle may make the posterior condyle an unreliable rotational landmark[2,7]. The present study showed that the posterior axis was approximately 6.4 degrees internally rotated relative to the transepicondylar axis. This finding was consistent with previous studies[6]. Another landmark, the axis drawn perpendicular to the anteroposterior line[2], sometimes showed incorrect rotational alignment in cases of severe deformity of patellar groove and hypoplastic condyles. Thus, the rotational positioning of the femoral component should be confirmed by examining multiple axes.

When the anterior surface of the lateral condyle is selected as the anterior cutting level, a gap will be present between the anterior surface of the medial condyle and the gauge (Fig. 2A). After cutting the anterior surface of the distal femur in the externally rotated position, we have noticed that the anterior cutting surface area of the lateral condyle was wider than that of the medial condyle, a condition known as anterolateral notching (Fig. 2B). This finding resulted in more bone being removed from the anterolateral femur than when a neutrally rotated cut is made, and excessive notching may cause supracondylar femoral fracture. Anterolateral notching was dependent on the angle between the anterior surface at the supracondyle and the posterior condylar axis. Thus, when the cutting area of the anterior surface of the medial condyle is the same as or wider than that of the lateral condyle, the femoral component will be placed in an internally rotated position. In other words, the anterior surface of the distal femur was consistently internally rotated relative to the posterior condylar axis.

The present study showed that the anterior surface of the supracondylar femur was approximately 5 degrees internally rotated relative to the posterior condylar axis. The angle between the supracondylar anterior femoral surface and the transepicondylar axis was 11.21 ± 2.48 degrees, and the angle between the posterior condylar axis and the transepicondylar axis was 6.35 ± 1.93 degrees. The standard deviation was greater for the former angle than for the latter angle, but there was not significant difference ($p < 0.01$, F-test).

In conclusion, in the present study, we could not obtain the axis of the supracondylar anterior surface of the femur in 2 subjectys because the surface was not flat. However, the anterior femoral surface is easy to obtain during surgery. Thus, we have usually used 3 axes—the posterior condylar line and the line drawn perpendicular to the anteroposterior axis, and the anterior surface of the femur—to assess femoral rotational alignment. When the relationship among these 3 axes was unclear, we also examined the transepicondylar axis. The results obtained from radiographic examinations and CT scans suggest that the anterior surface of the supracondylar distal femur can serve as a landmark to obtain correct rotational alignment of the femoral component in TKA.

REFERENCES

1. Anouchi YS, Whiteside LA, Kaiser AD, Milliano MT. The effects of axial rotational alignment of the femoral component on knee stability and patellar tracking in total knee arthroplasty demonstrated on autopsy specimens. Clin Orthop 1993; 287: 171–7.
2. Arima J, Whiteside LA, McCarthy DS, White SE. Femoral rotational alignment based on the anteroposterior axis in total knee arthroplasty in a valgus knee. J Bone Joint Surg 1995; 77A: 1331–4.
3. Berger RA, Rubash HE, Seel MJ, Thiopson WH, Crossett LS. Determining the rotational alignment of the femoral component in total knee arthroplasty using the epicondylar axis. Clin Orthop 1993; 286: 40–7.
4. Chauhan SK, Scott RG, Breidahl W, Beaver RJ. Computer-assisted knee arthroplasty vers conventional jig-based technique. J Bone Joint Surg 2004; 86B: 372–7.
5. Hungerford DS, Krackow KA. Total joint arthroplasty

of the knee. Clin Orthop 1985 ; 192 : 23-33.
6. Matsuda S, Matsuda H, Miyagi T, Sasaki K, Iwamoto Y, Miura H. Femoral condyle geometry in the normal and varus knee. Clin Orthop 1998 ; 349 : 183-8.
7. Yoshioka Y, Siu D, Cooke DV. The anatomy and functional axes of the femur. J Bone Joint Surg 1987 ; 69A : 873-80.