Acta Orthop. Belg., 2010, **76**, 69-73

ORIGINAL STUDY

Femoral component rotation and Laurin angle after total knee arthroplasty

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One of the main problems after total knee arthroplasty is pain in the patellofemoral joint, which in some cases leads to revision surgery. Rotation of the femoral component has a significant influence on the path followed by the patella within the patellofemoral joint. We examined the influence of rotation of the femoral component after total knee arthroplasty on patellar tilt.

We retrospectively analysed the radiographs of 48 patients who underwent primary LCS total knee arthroplasty without patella resurfacing and without lateral release. Rotation of the femoral component was determined using Kanekasu's technique and patellar tilt assessment according to Laurin on Merchant's views.

This radiographic study confirmed a highly significant correlation between external rotation of the femoral component and a decrease in patellar tilt following TKA. Furthermore, we found a highly significant correlation between pre- and postoperative patellar tilt angle.

Keywords : knee arthroplasty ; femoral rotation ; patellar tilt ; radiographs.

INTRODUCTION

Knee arthroplasty is one of the most successful surgical procedures ; it results in a major increase in well-being and satisfaction of patients. Long-term studies of primary knee replacement show that the outcome is good to excellent in 90% of cases (*7,19*). The most serious complications are infection, aseptic loosening, joint instability and patella problems (*3,8,16*). Pain and discomfort in the patellofemoral joint are mainly attributed to malalignment of the tibial or femoral implant components, and in particular to their incorrect rotation (*1,3,5,14*). Rotational alignment of the femoral component greatly influences patellar tracking. Increased internal rotation results in lateralisation of the patella and therefore in greater load on the patellofemoral joint. In some patients this can result in patella subluxation and a risk of patella fracture (*1,2,9,13,18*).

Conventional radiographic views allow monitoring leg alignment in the coronal plane after knee replacement, but rotational alignment of the femoral component generally requires computed tomography. Computed tomography is only used to investigate specific conditions as it involves a high dose of radiation for the patient and is cost-, time-

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No benefits or funds were received in support of this study

and work-consuming (*4*). A new radiographic technique makes it possible to determine the rotational alignment of the femoral component on conventional radiographs in a simple, low-radiation and inexpensive way (*10*). Furthermore, the quality of the images is not impaired by metallic artefacts as is the case in computed tomography.

Forty eight primary knee arthroplasties performed in our institution were studied for rotational alignment of the femoral component using a radiographic technique developed by Kanekasu (*10*). The Laurin patellar tilt angle was measured on tangential radiographs (*11*).

MATERIALS AND METHODS

A total of 71 patients who had received an LCS knee implant between March and September 2008 were retrospectively evaluated. The study only included patients with a primary fully cemented knee prosthesis implanted through a medial approach. Patients who had undergone revision or surgery by a lateral approach, tibial or femoral displacement osteotomy or had suffered trauma were excluded. We also excluded cases with lateral retinacular release or patellar resurfacing and posttraumatic TKA's .Those knees which could not flex 90° as required for Kanekasu's technique were also excluded. Finally, the radiographs of 48 patients were available for evaluation.

We used the Tibial-Cut-First technique. The tibial resection surface was used as a reference for a femoral positioning guide and rotational alignment of the femoral component. Anatomical landmarks were used for additional orientation. Preparation of the patella was limited to removal of osteophytes.

Radiographs were taken ten days postoperatively. Kanekasu radiographs and patella tangential views were part of the final radiographic monitoring. For the Kanekasu technique the patients sit on a radiolucent wooden table with their legs hanging over the edge, the knee flexed at 90° with relaxed muscles and touching the vertical cassette stand. The central X-ray beam is aimed from behind the sitting patient in an upward angle of 15° into the centre of the patella with a film-focus distance of one metre (*10*). The patella tangential views were taken with the patients supine, their knees flexed at 45°.

The radiographs were digitised and measurements made by two observers independently using the computer-based system MediCAD II (Hectec, Niederviehbach, Germany), which is also used for preoperative prosthesis planning, First, the angle of rotation A of the femoral component was drawn on the Kanekasu radiographs by drawing two lines, the posterior condylar axis (PCA) and the clinical epicondylar axis (CEA). The PCA is the tangent to the posterior medial and lateral femoral condyles. The CEA is a line through the tip of the medial and lateral femoral epicondyle (*10*) (fig 1). The angle between the two axes represents the rotational alignment of the femoral component. The angle which can be measured intraoperatively between the surgical epicondylar axis (SEA) and the PCA generally diverges by 4° of internal rotation when compared to the CEA/PCA angle measured on radiographs (*10*).

The angle of tilt of the patella was determined on tangential radiographs pre- and postoperatively using the Laurin method (*11*). Line A is the tangent to the medial

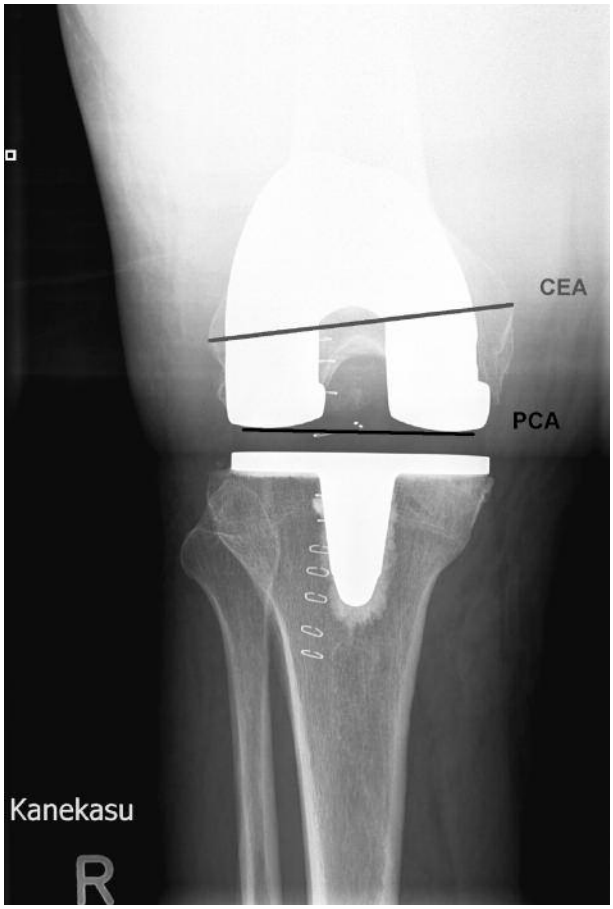

Fig. 1. — Kanekasu's radiographical technique to measure rotational alignment of the femoral component. CEA : clinical epicondylar axis. PCA : posterior condylar axis.

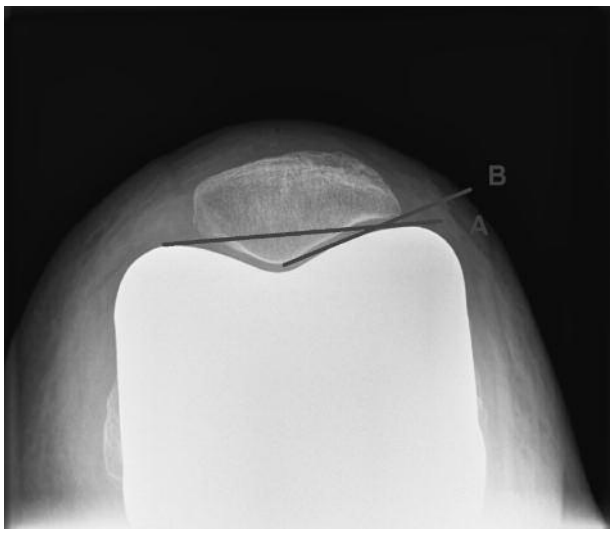

Fig. 2. — Postoperative patella tangential view to determine the angle of tilt according to Laurin. Line A : Tangent on the medial and lateral femoral condyle. Line B : Tangent on the edge of the lateral facette of the patella.

and lateral femoral trochlea ; line B is drawn between the margins of the lateral facet of the patella. The angle between lines A and B or the patellar tilt is normally open laterally (fig 2).

The data were collected in an Excel file (Microsoft, Redmond, USA) and then assessed for correlation of the rotational alignment of the femoral component with the patella tilt according to Laurin. Statistical analysis was performed using SPSS 15.0 (SPSS Inc., Chicago, USA).

RESULTS

The results are summarised in tables I and II. The mean Laurin angle was 13.63° ± 4.00° preoperatively and 15.92° ± 2.97° postoperatively (mean difference between pre- and postoperative Laurin angle was 2.29° ± 3.24°). The correlation coefficient between rotational alignment of the femoral component and postoperative Laurin angle was -0.002, which was not significant ($p > 0,05$). The mean postoperative external rotation of the femoral component was 4.21° ± 3.10°. Slight overcorrection into external rotation of the femoral component did not lead to medial patellar tilt.

There was a highly significant correlation between the pre- and postoperative Laurin angle, with a correlation coefficient of 0.6 ($p < 0,001$). There was also a highly significant correlation ($p < 0,01$) between this change in Laurin angle and the rotational alignment of the femoral component (correlation coefficient : 0.44).

Table I. — Mean values and standard deviations of the rotation of the femoral component, the pre- and postoperative patella tilt and the change in patella tilt

	Mean value	SD
External Rotation of the femoral component	4.21°	3.1°
Preoperative Laurin angle	13.63°	4°
Postoperative Laurin angle	15.97°	2.97°
Change in Laurin angle	2.29°	3.24°

Table II. — Correlation of the rotation of the femoral component with the postoperative patella tilt and the change in the patella tilt

	Correlation coefficient	Significance
Postop. Laurin angle	-0.002	0.99
Change in Laurin angle	0.44	0.003

DISCUSSION

Despite the very good outcomes achieved in primary knee arthroplasty, a number of problems remain unsolved, particularly regarding the patellofemoral joint. Incorrect rotational alignment of the prosthesis components is one of the causes (*1,3,5,14*). In this study the correlation between the patella tilt according to Laurin and the rotational alignment of the femoral component was investigated. To determine the rotational alignment of the femoral component, radiographs were taken according to Kanekasu's technique. The advantage of this radiographic technique is that the rotation of the femoral component can be determined without the need for computer tomography, i.e. with a much lower radiation dose, at much lower cost and without impairment of the images by metallic artefacts. Evaluation of the radiographs according to Kanekasu presented no great difficulties, especially as there were no metallic artefacts. Evaluation of

the tangential radiographs of the patella also presented no problems. In some cases, however, preoperative evaluation was difficult due to marked osteophyte formations on the patella. The problem was solved by comparing the images with the postoperative radiographs.

To minimise the influence of other factors we selected a patient cohort that was as homogeneous as possible (see M&M). Our results revealed a significant correlation between external rotational alignment of the femoral component with the pre to postoperative increase of the Laurin angle. This largely corresponds to the results of previous studies. *In vitro* studies have shown that increased internal rotation of the femoral component leads to incorrect loading on the patellofemoral joint (*2,18*). *In vivo* studies, especially regarding rotational alignment of the femoral component, have so far been difficult and complex, as computed tomography was necessary (*1*). Furthermore, in other studies the patient cohorts were often small and not homogeneous (*13*), and rotational alignment was determined intraoperatively without imaging or by means of a navigation system (*12,15*).

This study, however, did not reveal any significant correlation between the rotational alignment of the femoral component and the postoperative Laurin angle. This might be due to the fact that rotational alignment of the femoral components in the investigated knees tended towards slight external rotation. Slight external rotation is recommended because it minimises the forces exerted on the patella and achieves very close to physiological patellar tracking (*1,2,17*). The effect of femoral rotation on patellar tracking in the patellofemoral joint, however, mainly becomes noticeable when internal or external rotational malalignment is more pronounced (*13,18*).

Bindelglass *et al* were able to show a correlation between the pre- and postoperative patella tilt, and this is confirmed by the results of our study (*6*). The correlation between the pre- and postoperative Laurin angle revealed in our study was highly significant.

Problems with the patellofemoral joint remain one of the most frequent complications after knee arthroplasty and are responsible for a large number of revision operations. Incorrect rotational alignment of the femoral component is considered to be one of the main causes. This study shows that there is a significant correlation between rotation of the femoral component and postoperative changes in Laurin angle. However, a femoral component implanted with a slight external rotation, as in the patients in this study, does not lead to a medial postoperative patella tilt.

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