Combining different rotational alignment axes with navigation may reduce the need for lateral retinacular release in total knee arthroplasty

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Abstract

Purpose The aim of the study was to compare femoropatellar alignment and the incidence of lateral retinacular release (LRR) in total knee arthroplasty (TKA) in which the rotational alignment of the femoral component was determined using a combination of different rotational alignment axes and navigation or a single reference axis in the standard procedure.

Methods We assessed 66 patients undergoing TKA in whom the rotation of the femoral component was determined on the posterior condylar axis in standard procedures (group A) and 65 patients in whom it was determined by combining the posterior condylar axis, anteroposterior axis and epicondylar axis in navigated procedures (group B). The mean age was 68 and 69 years in groups A and B, respectively. Patellar tracking was assessed after deflation of the tourniquet and LRR performed in the presence of maltracking. Visual analogue scale (VAS), Knee Society Score (KSS), Lonner patellar score and patellar tilt were recorded. **Results** LRR was carried out in 18 cases (27 %) in group A and in four (6 %) in group B ($p=0.003$). The KSS and VAS were improved significantly compared to the preoperative status, but with no significant differences between the two groups. The patellar score showed a greater improvement in the navigated compared to the standard group at the four week follow-up. Patella tilt improved significantly in both groups. The complication rate was similar in the two groups. **Conclusions** Combining different rotational alignment axes with navigation significantly reduces patellar maltracking and the need for LRR compared to the standard procedure

in which the posterior condylar axis is used as single anatomical reference.

Introduction

Rotational alignment of the femoral component has been recognised as one of the factors which may affect the clinical outcomes in total knee arthroplasty (TKA) [1–4]. It has been reported that a poor femoral rotational alignment may lead to an unbalanced knee in flexion, limited range of motion (ROM), patellar maltracking and anterior knee pain [1–4].

Several techniques are commonly used to determine the rotational alignment of the femoral component, including the epicondylar axis, the anteroposterior axis (Whiteside line), the posterior condylar axis and the flexion space balancing technique [1, 5–7]. Although the use of each of these techniques was associated with satisfactory clinical outcomes [2, 5, 8], in vitro investigations have shown that they are often difficult to reproduce [9]. Navigation was found to improve the coronal and sagittal alignment of TKA compared to the standard technique [10], but whether it also leads to a better rotational alignment of the femoral component is debatable [11–13].

A poor alignment of the femoral component is a well-recognised cause of patellar maltracking [1–4]. When the latter is found at the end of surgery, the tracking of the patella in the trochlear groove may be improved by performing a lateral retinacular release (LRR) [14]. However, this surgical step is not free from complications, including haemarthrosis, increased postoperative pain, avascular necrosis, patella fracture and reduced skin viability with delayed wound healing [6, 14, 15].

In this investigation we compared the incidence of LRR in navigated TKA in which the rotational

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alignment of the femoral component was determined by combining different rotational alignment axes with that occurring in standard procedures in which the posterior condylar axis was used as reference axis. Our hypothesis was that the combination of different rotational alignment axes might reduce patellar maltracking and the need for LRR.

Material and methods

We followed prospectively 136 patients who underwent TKA between January 2007 and December 2009. Five patients, who were lost prior to the two year follow-up, were excluded from the study. The remaining group included 131 patients, 72 women and 49 men, with a mean age of 68 years (range 55–83 years). Of these, 66 had undergone a standard (group A) and 65 a navigated (group B) TKA. Group A included all patients operated upon before April 2008 and group B those undergoing surgery subsequently. The investigation was performed according to institutionally approved guidelines, having received informed consent from all the patients.

All operations were performed by a single surgeon using a standard medial parapatellar approach. A cruciate-retaining TKA with fixed bearing was used in all cases using a cementing technique and in no case was a patellar replacement performed. In group A, the coronal tibial alignment was set at 90° to the longitudinal axis using an extramedullary guide and the femoral alignment was set between four and seven degrees of valgus using an intramedullary guide. In group B, the coronal alignment goals were set at 90° to the tibial longitudinal axis and the femoral mechanical axis.

The rotation of the tibial component was set at the medial one third of the tibial tuberosity in both groups. The rotation of the femoral component was determined in group A by using the posterior condylar axis plus 3° of external rotation and in group B by averaging different rotational alignment axes. In particular, the rotational alignment of reference for the navigation system used (OrthoPilot, Aesculap) was the posterior condylar axis plus 3° of external rotation. Once this position was achieved, the femoral rotational alignment guide was lined up to the Whiteside line and the transepicondylar axis. The surgeon could thus read on the computer screen whether those axes were in line with the posterior condylar axis or were externally or internally rotated with respect to it. In the latter instance, the rotational alignment of the femoral guide was determined by averaging the rotation of the posterior condylar axis with the Whiteside line and the transepicondylar axis.

At the end of surgery the tourniquet was deflated and the patellar tracking assessed using the “no touch” technique during flexion-extension of the knee. In the presence of lateral patellar subluxation or patellar tilt, a LRR was performed. The procedure included the retinaculum division from outside the joint, approximately 20 mm laterally to the external patellar border, in a staged fashion. After each step, the patellar tracking was checked and the release extended further distally if the patella was not centred into the trochlear groove. Three grades of release—minor, intermediate and extensive—were carried out. A minor LRR was first performed starting one centimetre proximally to the superior patellar border and extended distally to the middle of the patella. An intermediate LRR involved a caudal extension of the retinacular division up to the distal pole of the patella. An extensive LRR entailed the prolongation of retinacular division, parallel to the patellar tendon, up to the joint line. Care was taken to avoid the lateral superior geniculate artery. Postoperatively, all patients were encouraged to perform flexion-extension exercises on the first postoperative day and to walk on the second day after surgery.

Preoperatively, clinical evaluation was carried out, in both groups, using the visual analogue scale (VAS), Knee Society Score (KSS) and Lonner patellar score [16]. After surgery, patients were followed up at four weeks, six months and two years. At the last follow-up, the radiographic evaluation included the assessment of limb alignment and patellar tilt; the latter was calculated according to Gomes et al. [17] (Fig. 1).

Statistical analysis was used to compare age, preoperative body mass index (BMI), varus-valgus deformity, preoperative and postoperative VAS, KSS, patellar score and ROM. An unpaired two-tailed Student's *t* test and χ^2 analysis were used for comparisons. Statistical significance was set at a

Fig. 1 The patellar tilt was calculated by measuring the angle between a line tangent to the anterior profile of femoral condyles and the equatorial line of the patella

Table 1 Extension of LRR in the two groups

Extension of LRR	Standard group No. of patients	Navigated group
Minor	1	2
Intermediate	11	2
Extensive	6	0

$p=0.04$

p value<0.05. SPSS for Windows (version 9.0, SPSS, Chicago, IL, USA) was used for the statistical analysis.

Results

There were 39 women and 27 men with a mean age of 68 years (range 55–83 years) in the standard group and 40 women and 25 men with a mean age of 69.3 years (range 57–81 years) in the navigated group. There were no significant differences between sex, age and BMI between the two groups. Preoperative diagnosis included osteoarthritis in 63 and 61 patients of groups A and B, respectively, and rheumatoid arthritis in three and four patients of groups A and B, respectively. Preoperative deformity averaged 0.8° of valgus in group A (range 20° of valgus and 13° of varus) and 1.2° of valgus in group B (range 23° of valgus and 12° of varus) with no significant difference between the two groups. A valgus knee greater than ten degrees was present in four knees of group A and in five of group B.

A LRR was performed in 18 patients (27.2 %) in group A and in four patients (6.1 %) in group B ($p=0.003$). The extension of LRR in the two groups is reported in Table 1. In the navigated group, the relationship between the posterior condylar axis, the Whiteside line and the epicondylar

axis was recorded (Fig. 2). In 40 patients (62 %) the posterior condylar axis was internally rotated more than 3° with respect to the Whiteside line and the epicondylar axis; in five (7.6 %) it was externally rotated.

In group A, preoperative and postoperative patellar tilt averaged 7.9° (range 2.3° medial to 25° lateral) and 4.2° (range 2° medial to 14° lateral), respectively ($p=0.001$). In group B, preoperative and postoperative patellar tilt averaged 8.3° (range 1.7° medial to 26° lateral) and 3.9° (range 2.2° medial to 15° lateral), respectively ($p=0.001$). There was no significant difference between preoperative and postoperative patellar tilt between the two groups ($p=0.08$).

KSS and VAS significantly improved after surgery with no significant difference between the two groups (Table 2). A greater improvement in the patellar score was observed four weeks after surgery in group B compared to group A (Table 2). However, such a difference was not present at the one year follow-up. ROM at the two year follow-up averaged 115° (range 103–125°) and 117° (range 107–126°) in groups A and B, respectively ($p=0.6$). There was no significant difference between the clinical results of the patients who did or did not undergo LRR (Table 3).

Postoperative complications included a superficial wound infection in one patient in group A and one deep venous thrombosis in group B, both of which were successfully treated. A delayed wound healing occurred in two patients in group A and in one in group B; one of these had had a LRR. No fracture or osteonecrosis of the patella was observed in either group.

Discussion

Postoperative patellar tracking is affected by patient-related factors including preoperative patellar tilt, Q angle, fixed valgus deformity [18–20] and surgery-related factors

Fig. 2 Percentage of patients in whom the Whiteside line and the epicondylar axis were externally rotated, equal and internally rotated to the posterior condylar axis

Table 2 Clinical scores in the standard and navigated groups

	Standard				Navigated			
	Preoperative	4 weeks	6 months	2 years	Preoperative	4 weeks	6 months	2 years
KSS	36.8	58.3	81.4	92.8	34.4	61.7	82.1	93.9
VAS	8.4	5.3	3.7	2.7	8.1	4.8	3.5	2.8
Patellar score	27	56	77	89	30	66*	80	91

* $p=0.01$

including the rotation of the femoral and tibial component, the shape of femoral trochlear design, the thickness and position of the patella, and surgical approach [1–4, 21–23]. Among these factors, the rotation of the femoral component is thought to be the most important factor affecting patellofemoral tracking [1–4, 7]. As patellofemoral complications have accounted for up to 50 % of revision TKA [1–4, 24], a proper alignment of the patellofemoral joint should be achieved at surgery [1–4, 7, 14].

Several techniques are currently used to obtain a correct rotational alignment of the femoral component, none of which was found to be clearly superior to the others [1, 4–8]. The epicondylar axis is potentially the most accurate reference axis since it approximates to the centre of rotation of the knee joint in flexion [25]; however, high variability has been reported in the correct palpation of femoral epicondyles [26]. The Whiteside line is more easily identified at surgery [3, 5] providing intercondylar osteophytes and trochlear erosion are not present [27]. The posterior condylar axis is also an effective reference axis [8], but a routine use of 3° of external rotation may not consistently lead to correct femoral alignment due to the anatomical variability of posterior condyles in arthritic knees [28].

In navigated TKA the femoral rotation alignment is determined by digitising the epicondyles with an optically tracked stylus or positioning the cutting guide with reference to the posterior condylar axis or the Whiteside line, i.e. the same anatomical landmarks used in the standard procedure. As a result, using these methods, no substantial difference may be expected between navigated and standard TKA in terms of femoral rotational alignment [9]. An alternative approach is to determine the rotational alignment of the femoral component by averaging different anatomical reference axes, i.e. the epicondylar axis, the Whiteside line and the posterior condylar axis. Siston

et al. analysed, in vitro, the accuracy of femoral rotational alignment using combined anatomical axis versus single anatomical axis [29]. They found a rotational alignment within five degrees from the epicondylar axis in 37 % of the procedures performed using single anatomical references and in 58 % of those performed with combined anatomical references [29]. The best results were reported combining the digitised epicondyles with the Whiteside line and combining the digitised epicondyles with the patellar kinematic technique [29]. However, the authors did not use more than two anatomical references concomitantly nor did they evaluate the combination of the posterior condylar axis with another anatomical reference axis.

In this study, we used the posterior condylar axis as anatomical reference for the standard procedure, while in the navigated group the rotational alignment was determined by averaging the posterior condylar axis, the Whiteside line and the epicondylar axis. The two groups were similar in terms of preoperative deformity, age, sex and patellar alignment; all patients were operated upon by the same surgeon using the same surgical approach and patellar tracking was evaluated once the tourniquet was deflated. We found that averaging different alignment axes improves patellar tracking, as observed during knee flexion-extension at the end of surgery, and significantly reduces the need for LRR. In 62 % of the patients the navigator showed that the posterior condylar axis was internally rotated more than 3° compared with the Whiteside line and the digitised epicondyles; in some of these patients, an internally rotated femoral component would probably have occurred if the posterior condylar axis had been used as the only anatomical reference.

The clinical scores were significantly improved in both groups with no significant difference between them, except for the patellar score, which was higher in the navigated

Table 3 Clinical scores in patients with and without LRR

	Released			Non-released		
	Preoperative	4 weeks	2 years	Preoperative	4 weeks	2 years
KSS	35.1	59.4	93.6	36.1	60.6	93.1
VAS	8.6	4.9	2.6	8.3	5.2	2.9
Patellar score	25	59	90	32	63	90

compared to the standard group at the first month follow-up. The radiographic assessment showed a significant improvement in the patellar tilt with no significant difference between the two groups.

LRR is considered an invasive surgical procedure which should be performed only when strictly necessary since it may increase the complication rate of TKA [14, 15, 30]. Nevertheless, the incidence of LRR in TKA has been reported to range from 3 to 100 % [21, 30, 31]. In our two groups, 22 patients underwent LRR. In keeping with a previous investigation [17] we did not observe a higher complication rate, or lower clinical scores, in the released compared to the non-released group. However, no patient in our series underwent patellar replacement and this may have limited the complication rate in the LRR group.

Limitations of the study include the criteria used to decide intraoperatively whether an LRR was needed or not. Despite the guidelines used to evaluate patellar tracking intraoperatively, such a decision is subjectively taken and in borderline cases with no evidence of manifest patellar subluxation it may be difficult to standardise whether a LRR should be performed. However, patellar tracking was always assessed by the same operating surgeon who avoided LRR unless strictly necessary. Second, our results apply to the standard procedure in which the posterior condylar axis is used as anatomical reference for femoral rotational alignment; as a consequence, the results could be different when digitised epicondyles or the Whiteside line are used as reference axes.

In conclusion, the use, in standard TKA, of the posterior condylar axis as the only anatomical axis to determine the rotation of the femoral component results in a higher incidence of patellar maltracking and LRR compared to the use, in navigated TKA, of a combination of different anatomical axes. Navigation may be helpful to directly visualise the difference in rotational alignment achievable with different alignment techniques and to select an intermediate rotational position of the femoral component. Since patellar maltracking depends, to a large extent, on an inadequate rotational alignment of the femoral component, navigation may allow the incidence of maltracking of the patella and the need for LRR to be reduced.

Conflict of interest The authors declare that they have no conflict of interest.

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