Poor short-term outcomes after computer-assisted rotating-platform total knee arthroplasty with a deep-trochlear-groove femoral component: Analysis of 19 patients

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Accepted: 23 July 2012

KEYWORDS
Knee prosthesis; Rotating platform; Computer-assisted implant surgery; Patello-femoral; Instability

Summary
Background: Congruent rotating tibial plateaus are designed to minimise wear after total knee arthroplasty (TKA). The Score™ prosthesis has a congruent rotating tibial plateau, a deep trochlear groove, and uses a computer-assisted navigation system for ligament balancing. Although this prosthesis is widely utilized, no accurate data on outcomes are available.
Hypothesis: The innovative features of the Score™ prosthesis, most notably patellar replacement with a highly constrained femoral component, do not jeopardize implant survival.
Patients and methods: In a pilot study, we retrospectively evaluated outcomes of 19 patients treated with Score™ knee replacement between February and October 2006 (mean age, 66.8 years; range, 58–82 years). The evaluation criteria were the International Knee Society (IKS) scores and prosthesis survival rate estimated using Kaplan-Meier plots with failure defined as revision need to change the prosthesis.
Results: Mean follow-up was 35.3 months. The IKS knee score increased from 27.4 (5–60) preoperatively to 81.4 (45–99) at last follow-up (P < 0.0001). Mean mechanical axis was 181.2° (180–186°), with 16 between 180° and 183°. Revision surgery was required in five cases (for patellar complications with combined motion-range limitation in flexion (< 90°) and extension (5–20°) in three cases, isolated motion-range limitation in one case, and recurvatum deformity with instability in one case). Prosthesis survival was 82% (73–91%) after 24 months and 65% (51–78%) after 44 months.
Introduction

To improve functional outcomes of total knee arthroplasty (TKA), unrelenting efforts have been made to improve implant design [1], polyethylene quality [2], and bone fixation [3,4]. Computer-assisted surgery (CAS) was introduced recently as a means of increasing the accuracy of implant positioning [5–7]. There is general agreement that achieving a 180° mechanical axis — the main goal of navigation — improves implant survival [8–10], although recent data challenge this view [11]. The rate of faulty implant positioning during manual TKA is probably underestimated [12]. CAS minimized positioning errors in most case-series studies [9,13].

Rotating-platform knee prostheses enable the use of congruent plateaus to decrease the loads on the tibia [14,15]. The increase in congruence is intended to decrease pressure on the polyethylene, thereby diminishing wear, which is a common problem with flat tibial inserts [16,17]. The simultaneous emergence of CAS and rotating-platform implants prompted designs that combine these two options [18]. Thus, the Score™ knee replacement has a dedicated navigation system (Amplivision™, Amplitude, Neyron, France), which allows joint gap management. Importantly, the highly congruent femoral component of Score™ is designed to maximise patello-femoral stability but may result in increased loads. We are aware of a single study evaluating Score™ but not listed in Current Contents [18]. This study focused on the surgical technique without providing information on outcomes.

The objective of this study was to evaluate the short-term outcomes of Score™ TKA in a small series of patients managed at a teaching centre with experience in knee arthroplasty. Our hypothesis was that the novel features of the Score™ implant, most notably replacement of the patella facing a constrained femoral component, would not affect short-term prosthesis survival.

Patients and methods

Patients

We retrospectively evaluated 19 patients who underwent TKA between February and October 2006. TKAs were performed by one of three senior surgeons. In 2006, 299 TKAs were performed at our centre. Selection of the type of knee replacement was dependent on the availability of the navigation system and of staff members, which support training in CAS.

There were 13 women and six men, with a mean age of 66.8 years (range, 58–82). Mean body mass index was 29.8 ± 4.6 kg/m² and seven patients were obese (body mass index > 30 kg/m²). For 13 knees, there was no history of prior surgery; in the remaining six knees, prior procedures included addition-wedge valgus tibial osteotomy in two cases, surgery for a tibial plateau fracture in one case, anterior cruciate ligament reconstruction in one case, tibial tuberosity medial transfer in one case, and surgery for a gunshot wound of the knee in the remote past in one case. TKA was required for osteoarthritis in 18 patients and rheumatoid arthritis in one patient.

According to the International Knee Society (IKS) rating system [19], 12 knees were class A, five class B, and two class C. Osteoarthritis stage was evaluated using the modified Ahlbäck classification scheme [20]: no patients were stage I, 10 were stage II, seven were stage III, one was stage IV, and one was stage V. Preoperatively, the mean IKS knee score [21] was 27.4 (range, 5–60) and the mean IKS function score was 37.5 (range, 0–60) (Table 1).

Varus deformity was noted in 16 patients (mean hip-knee-ankle [HKA] angle, 172°; range, 165–178°); and valgus in three patients (mean HKA angle, 186°; range, 185–188°). On the axial patellar view, the patella was centred in 17 patients, tilted laterally by 9° in one patient, and translated laterally over 16 mm in one patient.

Surgical technique

The Score™ knee (Amplitude, Neyron, France) with a congruent rotating platform was used (Fig. 1). The femoral component and tibial base plate were cemented and the patella was resurfaced and cemented. CAS was performed using Amplivision™ software (Amplitude, Neyron, France) developed specifically for Score™. Amplivision™ is a passive navigation system that uses infrared sensors implanted in the bone. After bone morphing of the crucial landmarks to establish the mechanical axis, the navigation system indicated the optimal section planes and provided information for gap management by measuring laxity before and after the cuts. The medial parapatellar approach was used in 16 patients and the lateral parapatellar approach in the three patients with valgus of the knee.

Discussion: The deep trochlear groove femoral component resulted in patellar complications, which were the most common reasons for revision surgery, together with motion-range limitation and instability possibly related to improper use of the navigation system. This small retrospective case-series study showed an unusually low prosthesis survival rate probably related to the implant design. We no longer use the Score™ prosthesis, despite the availability of a dedicated navigation system, and we recommend careful monitoring of patients who have this prosthesis.

Level of evidence: Level IV, retrospective study.

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Table 1  Functional and radiographic data before total knee arthroplasty and at last follow-up. The data are mean ± SD (range).

<table>
<thead>
<tr>
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<th>Preoperatively</th>
<th>At last follow-up</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IKS knee</td>
<td>27.4 ± 15.9 (5–60)</td>
<td>81.4 ± 17.8 (45–99)</td>
<td>0.0001</td>
</tr>
<tr>
<td>IKS function</td>
<td>37.5 ± 15.8 (0–60)</td>
<td>73.6 ± 33 (0–100)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Flexion (degrees)</td>
<td>111.5 ± 24.6 (50–145)</td>
<td>105.8 ± 14.3 (80–120)</td>
<td>0.31</td>
</tr>
<tr>
<td>Coronal laxity (degrees)</td>
<td>5.4 ± 2.2 (0–10)</td>
<td>5 ± 3.4 (0–15)</td>
<td>0.09</td>
</tr>
<tr>
<td>Sagittal laxity (mm)</td>
<td>3.7 ± 1.4 (0–10)</td>
<td>2.8 ± 2.5 (0–10)</td>
<td>0.01</td>
</tr>
<tr>
<td>Fixed flexion (degrees)</td>
<td>7.3 ± 8 (0–20)</td>
<td>3.7 ± 7.6 (0–30)</td>
<td>0.08</td>
</tr>
<tr>
<td>HKA angle overall (degrees)</td>
<td>174.8 ± 6.2 (165–188)</td>
<td>181.2 ± 1.9 (180–186)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Blackburne and Peel index [22]</td>
<td>0.94 ± 0.15 (0.8–1.5)</td>
<td>0.7 ± 0.06 (0.44–1.14)</td>
<td>0.001</td>
</tr>
<tr>
<td>Tibial slope (degrees)</td>
<td>4.2 ± 2.4 (0–8)</td>
<td>2.8 ± 0.9 (1–5)</td>
<td>0.01</td>
</tr>
<tr>
<td>Joint space height (mm)</td>
<td>19.42 ± 3.8 (12–25)</td>
<td>18.1 ± 9.6 (12–27)</td>
<td>0.35</td>
</tr>
<tr>
<td>α angle (degrees)</td>
<td>—</td>
<td>94 ± 4.9 (82–104)</td>
<td>—</td>
</tr>
<tr>
<td>β angle (degrees)</td>
<td>—</td>
<td>88 ± 3.12 (81–94)</td>
<td>—</td>
</tr>
<tr>
<td>γ angle (degrees)</td>
<td>—</td>
<td>1 ± 1.6 (0–6)</td>
<td>—</td>
</tr>
<tr>
<td>σ angle (degrees)</td>
<td>—</td>
<td>89 ± 1.8 (84–93)</td>
<td>—</td>
</tr>
</tbody>
</table>

IKS: International Knee Score; HKA: hip-knee-angle used to assess the mechanical axis of the lower limb; α angle: medial femoral angle; β angle: medial tibial angle; γ angle: sagittal femoral angle; σ angle: sagittal tibial angle.

Evaluation methods

All patients underwent a clinical evaluation with measurement of the IKS score [21]. In patients undergoing revision surgery, the last score obtained just before the revision was used. TKA quality was assessed on weight-bearing antero-posterior and lateral knee radiographs, an axial patello-femoral view in 30° of flexion, and a weight-bearing long leg view, according to IKS criteria [19] (α angle formed medially by the bicondylar axis and the mechanical axis of the femur, β angle formed by the line tangent to the medial tibial plateau and the mechanical axis of the tibia, γ angle on the lateral view between the supratrochlear cortex and the prosthetic trochlea, and σ angle between the line tangent to the posterior edge of the tibial plateau and the axis of the tibia). Laxity in the coronal and sagittal plane was measured on Telos® stress radiographs. Patellar height was assessed using the Blackburne and Peel index [22,23]; postoperatively, the line perpendicular to the highest point of the tibial plateau and the height of the patellar insert were used. In all patients who required revision surgery, computed tomography (CT) was performed to assess implant position. CT was used [24,25] to measure distal epiphyseal femoral torsion (Fig. 2). The angle formed by the line tangent to the posterior condyles and the trans-epicondylar axis was measured on the CT images by a radiologist who was blinded to the clinical outcomes.

Prosthesis survival was estimated using the Kaplan-Meier method. Failure was defined as the replacement or change in position of any of the three components. The 95% confidence intervals (95% CIs) were computed. Statistical comparisons were performed using non-parametric tests (Mann-Whitney U test, Kruskal-Wallis test, and F test) and XLSTAT 2011 software (Addinsoft™, Paris, France).

Figure 1  The rotating-plateau Score™ knee: the centre of rotation is at the centre of the knee. Three patellar designs are available; in our study, only the inlay design with three pegs (top) was used. Note the deep trochlea.
Results

Mean follow-up was 35.1 ± 13.4 months (range, 9–47 months). At last follow-up, the mean IKS knee score (Table 1) was 81.4 ± 17.8 (range, 45–99), a significant 54-point increase (P<0.0001). The mean IKS function score was 73.6 ± 33 (range, 0–100), a significant 36.1-point increase (P=0.0001).

Mean flexion changed from 111.5 ± 24.6° preoperatively to 105 ± 14.3° at last follow-up (P=0.31). Flexion was 90° or less for five knees. Mean fixed flexion at last follow-up was 3 ± 7.6°. Fixed flexion was noted for six knees postoperatively (5–30°) compared to nine knees preoperatively (5–20°). The mean mechanical axis was 181 ± 1.9° and the mechanical axis was between 180° and 183° for 16 knees. The α, β, γ, and σ angles were satisfactory (Table 1). The overall decrease in joint space height from 19.42 mm to 18.1 mm was not statistically significant (P=0.355). The mean Blackburne and Peel index was 0.7 ± 0.06, a significant decrease compared to the preoperative value (0.94 ± 0.15, P=0.001). For 16 knees, patellar height was normal (index between 0.56 and 1.04); patella baja was noted for two knees and patella alta for one knee.

The outcome of TKA was described by the patients as excellent in 11 cases, good in two cases, fair in two cases, and poor in four cases. Of the six dissatisfied patients (fair and poor), five underwent revision surgery with a switch to either a higher-constraint prosthesis or a hinged prosthesis. In these patients, CT showed no rotational abnormalities (Fig. 2). Patello-femoral complications prompted revision surgery in three cases (Figs. 3 and 4), one with a fracture on a loosened patellar insert (Fig. 4) and two with subluxation (Table 2); none of these knees had preoperative patellar malalignment.

Mean laxity was 5.1° (range, 0–10) in the coronal plane and 2.8 mm (range, 0–10) in the sagittal plane, with surgery for re-tensioning of the medial retinaculum after 3 months was unsuccessful. Distal epiphyseal femoral torsion was 5° postoperatively. A Rotating Knee Hinge prosthesis was implanted 8 months later.
Poor short-term outcomes with the Score™ rotating-platform knee

Figure 4  Patient #5: a: periprosthetic patellar fracture with lateral translation; b: displacement of the fracture fragments leading to patellar implant loosening after 21 months.

Table 2  Details on the reasons for the five revision procedures.

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Reason for Revision</th>
</tr>
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<tbody>
<tr>
<td>#1</td>
<td>Aseptic loosening of the femoral, tibial, and patellar implants; 10° of lateral patellar tilt</td>
</tr>
<tr>
<td>#2</td>
<td>Permanent stiffness at 90° of flexion and −30° of fixed flexion deformity; residual valgus with a HKA angle of 6°</td>
</tr>
<tr>
<td>#3</td>
<td>Lateral 32° patellar subluxation, permanent stiffness at 80° of flexion and −20° of fixed flexion deformity, medial laxity</td>
</tr>
<tr>
<td>#4</td>
<td>Medial and lateral laxity, recurvatum deformity, patella alta</td>
</tr>
<tr>
<td>#5</td>
<td>Aseptic loosening of the patella related to a periprosthetic patellar fracture, flexion limited to 90°, 5° of residual valgus</td>
</tr>
</tbody>
</table>

recurvatum deformity of one knee (Fig. 5). Tibio-femoral instability was noted in three knees and, together with patellar problems, required revision surgery in two knees (Table 2). Excessive stiffness with no more than 90° of flexion and fixed flexion greater than 20° warranted revision surgery in two cases. Aseptic loosening of the femoral and tibial components occurred in 1 case. For revision surgery, a high-constraint prosthesis (Constrained Condylar Knee) was used in two cases and a hinged prosthesis (Rotating Hinge Knee type) in three cases; the outcomes were favourable at last follow-up.

The Kaplan-Meier curves (Fig. 6) indicated that the 24-month prosthesis survival rate was 0.82% (95% CI, 0.73—0.91) and the 44-month survival rate 0.65% (95% CI, 0.51—0.78).

Discussion

At last follow-up, nearly one-third of patients were dissatisfied despite significant increases in the IKS knee and function scores. Our clinical results are at variance with those obtained using the same prosthesis in the study by

Figure 5  Patient #4: Patella alta and recurvatum deformity with medial and lateral laxity on stress radiographs. Revision after 44 months with implantation of a rotating-hinge prosthesis.
Versier et al. [18], who reported that 96% of patients were satisfied or very satisfied, with a mean IKS score increase of 77 points after a mean follow-up of 27 months [18]. Mean flexion in our patients (105 ± 14.3°) was similar to that in the earlier study [18]. Fixed flexion was noted for one-third of knees, with a mean value of 3 ± 7.6°. This parameter is not reported in the study by Versier et al. [18].

Of the five knees that required revision surgery, three had patello-femoral complications unrelated to preoperative patello-femoral abnormalities. Patello-femoral complications are among the most common reasons for revision surgery [26–29]. Faulty implant positioning with rotation of the femoral component correlated with patello-femoral joint dysfunction in a study by Berger et al. [30]. However, in our patients, CT showed no evidence of abnormal rotation. Galaud et al. [24] found no reliable direct or indirect intra-operative method for measuring distal epiphyseal femoral torsion by CAS. The high rate of patello-femoral dysfunction in our study was not related to abnormal implant rotation. We believe a more likely mechanism may be high loads on the patellar implant with protrusion of the trochlea (Fig. 1). In an experimental study, Courage et al. [31] showed that the shape of the Score™ trochlear component places excessive tension on the lateral retinaculum of the patella when the knee is flexed at 30°. A randomised trial reported by Pagnano et al. showed that a rotating-platform tibial component failed to decrease the prevalence of patellar complications compared to a fixed-bearing knee, in particular due to the occurrence of paradoxical rotational movements [32]. Given that implant design influences the rate of patello-femoral complications, successful reconstruction of the patello-femoral joint may be related not only to the intra-operative management of the patella itself, but also to the design of the prosthetic trochlear surface [33].

In keeping with earlier studies [10,34,35], CAS allowed restoration of a satisfactory mechanical axis in our study. CAS was not the main factor involved in TKA failure, except in one patient with recurvatum deformity, in whom navigated gap management was inadequate. Instability was believed to be among the reasons for revision in three cases in our case-series; instability is an established factor of TKA failure and revision [29,36]. Based on a study of early failed rotating-plateau TKA, Woolson et al. [16] advocated the use of 'deep-dish' inserts providing greater levels of constraint in patients with several degrees of laxity during intra-operative testing. Thus, obtaining good outcomes with rotating-plateau implants may require the complete absence of instability, which must be obtained without excessive tension, to avoid postoperative motion-range limitation.

Saragaglia et al. [34] reported a 90% prosthesis survival rate after 98.2 months with the Aesculap™ prosthesis using dedicated CAS. In a meta-analysis of mobile-bearing knee replacement, Carothers et al. [37] found 5-year survival rates greater than 95% in three different patient cohorts treated using a variety of designs and mobile-bearing plateaus, without CAS. With other mobile-bearing knee replacements implanted without CAS, 10-year survival rates were greater than 90% [38,39]. With Score™, we found considerably lower survival rates, of only 82% (95% CI, 0.73–0.91) after 2 years and 65% (95% CI, 0.51–0.78) after 44 months. These results indicate poor performance for an innovative prosthesis implanted using CAS.

The main limitations of our study are the retrospective design and small number of patients. However, all TKA procedures were performed by experienced surgeons, each with nearly 300 TKA procedures per year. In addition, the TKA procedures were performed in the presence of an observer experienced in the use of the Amplivision™ navigating system. CAS was used to achieve ligament balancing without excessive tension, which should have contributed to decrease the episodes of stiffness that were recorded very early during follow-up in our case-series.

Conclusion

In our study, the main reason for early failure was patello-femoral dysfunction, although the postoperative evaluation showed good mechanical axis alignment and satisfactory rotation by CT imaging. Implant design features (highly
constrained patella and prominent trochlea), together with the use of a rotating plateau, contributed to the high rate of early failure. Given the low 4-year survival rate, we no longer use this prosthesis in our centre. Our study emphasizes the need to evaluate each new implant, at least in the short term, particularly when there are substantially innovative features.

**Disclosure of interest**

Henri Migaud and Gilles Pasquier report no direct conflicts of interest related to this study but work as occasional research and education consultants for Zimmer. Henri Migaud is a research consultant for Tornier and receives royalties from Tornier. Anani Akapko, Nicolas Fouilleron, and Grégoire Dereude declare no conflicts of interest directly related, or unrelated, to this study.

**References**


