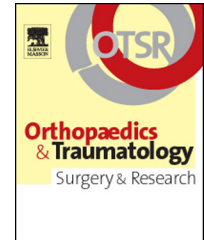




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ORIGINAL ARTICLE

# Outcomes of 447 SCORE<sup>®</sup> highly congruent mobile-bearing total knee arthroplasties after 5–10 years follow-up



F. Châtain<sup>a,\*</sup>, T.H. Gaillard<sup>c</sup>, S. Denjean<sup>d</sup>, O. Tayot<sup>e</sup>

<sup>a</sup> Clinique des Alpes, 31, rue A.-Dumas, 38100 Grenoble, France

<sup>b</sup> Clinique Belledonne, avenue G.-Péri, 38240 Saint-Martin d'Hères, France

<sup>c</sup> Polyclinique du Beaujolais, 120, ancienne route Beaujeu, 69400 Arnas, France

<sup>d</sup> Clinique du Val de Saône, 44, rue Ambroise-Paré, 71000 Macon, France

<sup>e</sup> Clinique du Parc, boulevard Stalingrad, 69006 Lyon, France

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## KEYWORDS

Total knee arthroplasty;  
Mobile-bearings;  
Computer assisted navigation;  
Patellar resurfacing

## Summary

**Introduction:** The goal of mobile-bearing total knee arthroplasties (TKA) with an anatomical trochlea is to reduce polyethylene wear, the risk of loosening, and patellofemoral complications. Rotating mobile-bearing SCORE<sup>®</sup> TKA was designed according to these principles with standard instrumentation for component placement and a specific computer navigation system, Amplivision<sup>®</sup>.

**Hypothesis:** We hypothesized that the results of SCORE<sup>®</sup> TKA would be satisfactory and better using computer navigation with or without patellar resurfacing and that there would be no specific patellofemoral complications associated with this trochlear design.

**Materials and methods:** Four hundred and forty-seven SCORE<sup>®</sup> TKA were performed. Outcome assessment was based on the IKS score, and component survival calculated by Kaplan-Meier analysis.

**Results:** Mean follow-up was 6.6 years (maximum 10.6 years). Six percent of patients were lost to follow-up. Ninety-eight percent of the patients were satisfied or very satisfied. The IKS knee score was 89 points and the function score was 86. The mechanical axis was 180° (174–186), and it was significantly improved if the initial deformity was severe and TKA was computer navigated. There were nine revisions (one for fracture, two for pain, two for stiffness, four for infection).

\* Corresponding author. Des Alpes Private Hospital, 31, rue A.-Dumas, 38100 Grenoble, France. Tel.: +33 4 76 43 49 17.  
E-mail address: [dr.chatain.frederic@wanadoo.fr](mailto:dr.chatain.frederic@wanadoo.fr) (F. Châtain).

*Discussion:* This study confirmed our hypothesis: the results of SCORE® TKA were very satisfying after at least 5 years of follow-up because there was no mechanical loosening, no bearing dislocation and no patellofemoral complications with or without patellar resurfacing. Results were identical whether patellar resurfacing was performed or not. Although clinical results were not better for computer-navigated TKA, radiological results were. At 98 months of follow-up, component survival in relation to the risk of aseptic loosening or patellofemoral complications was 100%.

*Level of evidence:* Level IV continuous retrospective study.

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## Introduction

The first total knee arthroplasties (TKA) in the 1970s had fixed bearings with patellar resurfacing and the components were cemented [1]. At the end of the 1970s Goodfellow [2], Minns [3], then Buechel and Pappas [4] proposed more congruent rotating platforms whose goal was to reduce contact stress peaks and polyethylene wear (PE) as well as contact strain peaks at the bone-implant interface to reduce the risk of loosening [2–4]. At the same time, because of the many patellofemoral complications, the design of the femoral trochlea has become more anatomical to improve patellar stability and reduce the number of patellofemoral complications. [5].

SCORE® TKA (Amplitude, Valence, France) was designed according to these two biomechanical principles using traditional instrumentation and computer navigation (Amplivision®) to control bone cuts, mechanical alignment and ligament balance. The aim of this study was:

- to report the first long-term results of SCORE® total knee arthroscopy;
- to validate the hypothesis that clinical and radiological results of SCORE® TKA were satisfactory and better if computer navigation was used;
- to confirm that there were no specific patellofemoral complications associated with the design of the trochlea with or without patellar resurfacing.

## Patients and methods

This series included 407 patients and 447 SCORE® TKA (39 bilateral TKA) performed between 2002 and April 2006 in two centers by two surgeons. Sixty-one percent of patients were women and 39% men. Mean age was 72 years old (43–92). The mean body mass index (BMI) was 29.7 (20–45). There was a history of surgery with extraarticular malunion in 35 knees: 32 tibial osteotomies, and three femoral osteotomies. The main etiology was medial femorotibial osteoarthritis in 54% of the cases, lateral in 14%, global in 22%. This was associated with patellofemoral osteoarthritis in 36% of the cases. Osteoarthritis was evaluated according to Ahlback's classification [6]. There was stage 1 osteoarthritis in 1%, stage 2 in 21%, stage 3 in 51.5% and stages 4 + 5 in 26.5%.

The mean preoperative International Knee Society (IKS) knee score [7] was 35 points (10–73) and the mean

functional IKS score was 60 points (20–100). Mean preoperative flexion was 114° (median 115°, minimum 40°, maximum 140°). There were varus knees in 68% with a mean Hip-Knee-Ankle (HKA) angle of 176° (164–179), valgus knees in 30% with a mean HKA of 186° (181–195), and knees at 180° in 2%. The mean coronal tibial mechanical angle was 88.5° (70–106), and the mean coronal femoral mechanical angle was 90.6° (78–102). Mean tibial slope was 5.7° (0–20°). The Blackburne and Peel index [8] was 0.82 (0.4–1.2). The patella was centered in 42% of cases, with lateral translation in 57% of the cases with a mean 3° of lateral tilt  $\pm$  3° (1–18°) on an axial view of the patella.

## Surgical technique

In all cases the highly congruent mobile-bearing SCORE® total knee replacement (Amplitude, Valence, France) was used (Fig. 1) with a constant sagittal curvature radius of 0°–98°. The angle of trochlear opening was 142°–0° at 15° flexion, 141° at 30° flexion and 140° at 45° flexion and above.



**Figure 1** Mobile bearing highly congruent SCORE® TKA with a patellar button.

The femoral component and the tibial base plate were not cemented in 93% of the cases and the patella was resurfaced and cemented in 41% of the cases (this was performed systematically by one of the surgeons and only in case of advanced patellar osteoarthritis for the other). Fifty-three percent of TKA were performed with traditional mechanical instruments. Depending on the availability of the instruments, 47% of the TKA were performed with the Amplivision® computer navigation system (Amplitude, Valence, France) developed specifically for this knee replacement [9,10]. The surgical approach was medial parapatellar in 89% of the cases, and lateral parapatellar without raising the anterior tibial tuberosity in 11% when lateral arthritis was predominant.

### Method of assessment

This was a continuous, retrospective study. At the final follow-up clinical assessment of the patients was based on the IKS score [7]. TKA was evaluated by AP and lateral weight-bearing X-rays to identify radiolucent lines at the bone-implant interface. Tibial slope was determined by measuring the angle of intersection of the tangent to the posterior tibial cortex and the tangent to the tibial base plate. A full weight-bearing long-leg film (hip-knee-angle) was performed according to IKS criteria [11] to measure the coronal HKA angle, the coronal femoral mechanical angle and the coronal tibial mechanical angle. The patella was assessed by a tangential view of the patella at 30° flexion to measure patellar centering and tilt and patellar height was measured by the Blackburne and Peel index [8].

Survival was determined by Kaplan-Meier analysis with failure defined as any revision surgery to change all of the implant or certain components. Statistical calculations were made with ‘‘R’’ software version 2.14. The Chi<sup>2</sup> test was used to compare the distribution of qualitative variables, and the Wilcoxon/Kruskal test for quantitative variables. The factors ‘‘computer assisted navigation’’ and ‘‘patellar resurfacing’’ were analyzed by creating four groups of 41 cases each paired for age, gender, BMI, preoperative IKS and arthritis to obtain two cohorts: [patellar resurfacing (PR) + no patellar resurfacing (NPR)] and [computer navigated (CN) + no computer navigated (NCN)].

### Results

Three hundred and sixty-two TKA were reviewed after a minimum follow-up of 5 years (mean=6.6 and maximum=10.6 years). Fifty-nine patients died (all with TKA in place) and there were 26 lost-to-follow patients (6%). At the final follow-up 98% were very satisfied or satisfied. Preoperative IKS scores significantly improved ( $P < 0.0001$ ). Radiographic results showed a mean HKA angle of 180° (174–186°) (Table 1). There were four tibial radiolucencies and six femoral radiolucencies, none of them progressive. No polyethylene wear was noted. Revision surgery to change the prosthesis was performed in nine cases. There were no patellofemoral complications and no mobile-bearing dislocations (Table 2). Survival at 98 months was 96% (91.6–100) with Kaplan-Meier analysis (Fig. 2). The survival rate for the

**Table 1** Overall results of the series at the final follow-up.

	Overall results 447 cases
Subjective (very satisfied-satisfied-disappointed-dissatisfied)	62%-36%-2%-0
IKS knee score	89 (median 93; 43–100)
IKS function score	86 (median 90; 30–100)
Flexion	115° (median 115°; 75–140)
Increase in flexion	1.1° (median 0°; 65–45)
HKA	180° (median 180; 174–186)
TMA	89.7° (median 89°; 87–92)
FMA	90.5° (median 90°; 86–98)
Tibial slope	1° (median 0; 4–5)
Patellar tilt > 2°	23% (2–11°)
Centered patella (axial view)	97%
Blackburne and Peel Index	1.1 (median 1.1; 0.75–1.5)

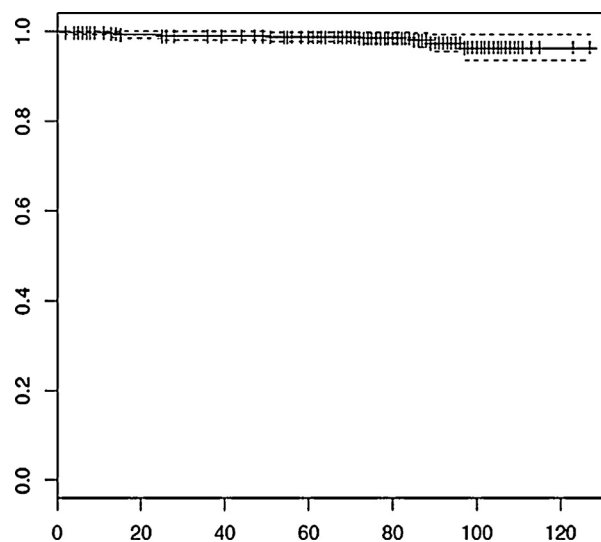
HKA: Hip Knee Ankle score; TMA: coronal tibial mechanical angle; FMA: coronal femoral mechanical angle; IKS: International Knee Score.

risk of ‘‘aseptic loosening’’ or patellofemoral complications was 100%.

Clinical results were identical for both computer navigated and non-navigated TKA whether the patella was resurfaced or not, except that the results for pain were better in the computer navigated group. (Table 3 and Fig. 3). Radiological results (Table 4) were better in computer navigated TKA especially if the initial deformity was severe. There was no correlation between the HKA angle and the IKS score at the final follow up.

### Discussion

The designers of SCORE® TKA evaluated and analyzed the results of this study, creating a bias. That is why clinical results will be discussed in less detail than objective results (failure, radiological measurements). One weakness of this



**Figure 2** Survival curve.

**Table 2** Causes of revision.

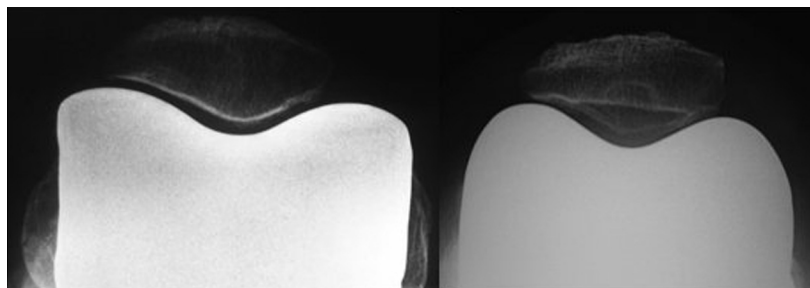
	<i>n</i>	NN series	CN series	NPR series	PR series
Infection	4	1	3	3	1
Pain	2	2	0	1	2
Stiffness	2	0	2	1	1
Femoral fracture	1	0	1	1	0
Total	9	3	6	6	4

CN: computer navigation r; NN: no navigation; PR: patellar resurfacing; NPR: no patellar resurfacing.

**Table 3** Comparative clinical results at the final follow-up.

	NN Series	CN Series	<i>P</i>	NPR Series	PR Series	<i>P</i>
VS + S %	97	95	0.7	97	95	0.7
Disappointed + dissatisfied	3	5		3	5	
Improvement in IKS function	26.9	23.9	0.2	23.5	26.9	0.2
Improvement in IKS knee score	57.7	55.8	0.5	56.9	56.2	0.8
Improvement in flexion	-0.1	-1.1	0.6	-0.5	-0.6	0.3
Improvement in pain	38.7	41.2	0.03	39.1	40.9	0.4

VS: very satisfied; S: satisfied; CN: computer navigation r; NN: no navigation; PR: patellar resurfacing; NPR: no patellar resurfacing; IKS: International Knee Score.

**Figure 3** Axial view of SCORE® bilateral TKA, with and without patellar resurfacing.

study was that laxity was not analyzed. The strong points of this study were the large number of cases, the paired cases and the low rate of lost-to-follow-up patients.

This is the first study to evaluate SCORE® TKA with a minimum follow-up of 5 years. Versier [10] published the first study reporting 100, all computer navigated, cases of SCORE® TKA after a mean 27 months of follow-up with very satisfying results (no mechanical failures and no complications associated with computer navigation), which we confirmed in a series of 20 unicompartmental revisions with SCORE® TKA after at least 2 years of follow-up [9]. There was no mobile-bearing dislocation, which is a

complication that has been observed in mobile-bearing components (MB) [12]. Woolson and Northrop [13] emphasized the importance of good congruence to obtain satisfactory stability especially on the frontal plane, while Jenny [14] insisted upon well-balanced flexion. A meta-analysis by Carothers [15] observed a 1% rate of dislocation with a highly significant reduction in complications in patients operated on after 1995, because of improved component design and surgical techniques. These two points were also mentioned by Jenny [14]. Our results were similar to most other series of rotating MB TKA which have reported a survival rate of 98.4% at 5 years, 96.5% at 10 years and 96.4% at 15 years

**Table 4** Comparative radiological results at the final follow-up.

Preoperative HKA	NN Series	CN series	<i>P</i>
0–5°	179.2° (SD 3°; 172–190)	180.4° (SD2.2; 174–186)	0.005
> 5°	178.8° (SD 3.1°; 172–190)	180.3° (SD 2.3°; 174–186)	0.0001
> 10°	178.4° (SD 4.3°; 172–190)	180.1° (SD2.1°; 174–184)	<0.00006

CN: computer navigation; NN: no navigation; HKA: Hip-Knee-Ankle; SD: standard deviation.

[13,14,16–19]. Unlike fixed bearing TKA, there were no fractures of the tibial insert reported in these series and the rate of radiolucent lines was less than 1%. Carothers [15], found that purely rotating mobile-bearing TKA had a significantly better survival rate after 15 years of follow-up than other types of mobile-bearing TKA. For Sathasivam and Walker [20], a mobile-bearing surface could not be equated with congruence, and its purpose is to protect the stability of interfaces from excess strain that can result in loosening, which is confirmed by our study, with no failures from mechanical loosening. Most studies comparing fixed and mobile-bearing components did not show any medium term difference in wear [13,16,17,21–25]. We agree with Jenny [14] that the expected improvement in wear requires longer-term follow-up.

On computer navigated TKA: correct component positioning with a mechanical axis close to 180° and well-balanced ligaments in flexion-extension are essential for good long-term results of TKA [26,27]. Computer navigation has been shown to reliably control these parameters [26–29]. Our radiological results were better with computer navigated TKA and remained constant whatever the initial deformity. This study confirms the usefulness of computer-navigation and the reliability of the Amplitude® system. In this study, a correlation was found between the HKA and the IKS score. Parratte [30] and Bonner [31] showed that TKA survival was not always correlated to the HKA angle, which indirectly confirms the importance of ligament balance and shows that the importance of the mechanical axis is relative compared to ligament balance. In our opinion this is another reason to use computer navigated TKA, which is the only way to control ligament balance in relation to a specific axis, especially with mobile TKA.

On patellar resurfacing: there are numerous, contradictory studies on this issue. Although the results of two meta-analyses [32,33] concluded that patellar resurfacing reduced the risk of secondary resurfacing, Schindler [34] felt that the rate of revision for secondary resurfacing was high, and a recent meta-analysis by He [35], which focused on randomized studies, concluded that there was no advantage to patellar resurfacing, even for reducing the risk of revision surgery. Lygre [36] emphasized the variability of results depending on the type of prosthesis. The SCORE® trochlea design has been shown to have one of the highest conformities [37]. Certain authors [34,38] recommend using a prosthesis with an anatomical trochlea if the patella is not resurfaced to limit peaks of strain during flexion which may occur in posterior stabilized TKA or in patients at risk of patellofemoral complications [37]. This explains in part why our clinical results were the same and were as good whether patellar resurfacing was performed or not—and without patellar denervation—which is proposed by certain authors [39].

## Conclusion

This study confirms our hypotheses. The results of SCORE® total knee arthroplasty after at least 5 years of follow-up were very satisfying and there was no mechanical loosening, no rotational instability of the mobile bearing and no patellofemoral complications whether the patella was

resurfaced or not. Results were the same with or without patellar resurfacing. Although clinical results were not better with computer navigated TKA, radiological results were. After 98 months follow-up TKA survival in relation to the risk of “aseptic loosening” or the risk of “patellofemoral complications” was 100%.

## Disclosure of interest

Frédéric Châtain, Stéphane Denjean, Thierry Gaillard and Olivier Tayot designed SCORE® TKA and receive royalties from the company Amplitude®.

## Acknowledgements

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