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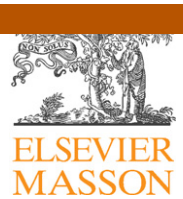

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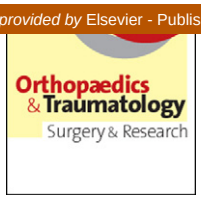

ORIGINAL ARTICLE

Unicompartmental knee arthroplasty modes of failure: Wear is not the main reason for failure: A multicentre study of 418 failed knees

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KEYWORDS
Unicompartmental prosthesis;
Knee;
Failure;
Wear;
Loosening

Summary
Background: This study originated from a symposium held by the French Hip and Knee Society (Société française de la hanche et du genou [SFHG]) and was carried out to better assess the distribution of causes of unicompartmental knee arthroplasty (UKA) failures, as well as cause-specific delay to onset.
Hypothesis: Our working hypothesis was that most failures were traceable to wear occurring over a period of many years.
Materials and methods: A multicentre retrospective study (25 centres) was conducted in 418 failed UKAs performed between 1978 and 2009. We determined the prevalence and time to onset of the main reasons for revision surgery based upon available preoperative findings. Additional intraoperative findings were analysed. The results were compared to those of nation wide registries to evaluate the representativeness of our study population.
Results: Times to revision surgery were short: 19% of revisions occurred within the first year and 48.5% within the first 5 years. Loosening was the main reason for failure (45%), followed by osteoarthritis progression (15%) and, finally, by wear (12%). Other reasons were technical problems in 11.5% of cases, unexplained pain in 5.5%, and failure of the supporting bone in 3.6%. The infection rate was 1.9%. Our results were consistent with those of Swedish and Australian registries.

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Discussion: Our hypothesis was not confirmed. The short time to failure in most cases suggests a major role for surgical technique issues. Morbidity related to the implant per se may be seen as moderate and not greater than with total knee prostheses. The good agreement between our data and those of nationwide registries indicates that our population was representative. A finer analysis is needed, indicating that the establishment of a French registry would be of interest.
Level of evidence: Level IV, retrospective study.

Unicompartmental knee arthroplasty (UKA) remains controversial, because of conflicting interpretations of its medium- and long-term outcomes. Several studies emphasised the better functional outcomes and decreased short-term morbidity compared to total knee arthroplasty (TKA), [1—4] whereas others indicated a shorter prosthesis survivorship with 10-year cumulative survival rates ranging from 53 to 95% [5—16]. Although the causes of UKA failures have been documented, their relative prevalences and the cause-specific times to onset remain unclear. Several authors suggested that wear might be the main complication of UKA [17—20]. In the National Joint Registry in England and Wales, no UKA-specific causes of failure have been identified [8]. In the Swedish registry, loosening is the leading reason for revision, followed by progression of the underlying disease and by wear in third rank [11]). Similarly, loosening and disease progression are the two main causes of failure in the Australian registry [12], in which the prevalence of wear is lower than that of a broad category labelled 'pain'. In patients younger than 65 years of age in both registries, the prevalence of wear as a reason for revision was lower than in older patients.

France does not have a nationwide knee arthroplasty registry. A symposium held by the Hip and Knee French Society (Société française de la hanche et du genou [SFHG]) provided the opportunity for a multicentre study of UKA failures in 25 Knee Institutions (Table 1). The distribution of causes of failure and the times to onset were determined. The working hypothesis was that most revisions occurred because of wear, at least 5 years after the primary procedure.

Material and methods

For this study, failure was defined as any repeat surgical procedure on the knee, according to the terminology used in the Australian registry [12] (total revision, partial revision, or simple reoperation). Clinical and radiological failures that did not lead to surgery were not included.

The main reasons for repeat surgery, with their prevalence and specific times of occurrence were analysed. The main reason was defined as the preoperative diagnosis prompting surgical treatment. Secondary or associated reasons identified during surgery were recorded.

Cases of failure of UKA performed between 1978 and 2009 were included retrospectively at 25 centres. Of the 418 UKA failures included, 416 occurred after primary UKA, one after global UKA revision, and one after partial UKA revision. Mean age at revision was 63.9 years (range, 26—100 years). A predominance of females (66.3%) over males (33.7%) was recorded. The initial aetiology was osteoarthritis in 91.5% of cases, condylar necrosis in 5.3%, a recent fracture in 1.3%, and inflammatory joint disease in 0.9%. Mean body weight was 77 kg (range, 47—125 kg), and 25 (7.6%) patients weighed more than 100 kg; mean body mass index was 28.53 kg/m^2 (range, 17—44.9 kg/m^2). The replacement involved the medial compartment in 88% of cases and the lateral compartment in the remaining 12%. The bearing design was mobile in 20.4% of cases and fixed in 79.6% of cases. Cement was used for 85.5% of the femoral components and 70.1% of the tibial components.

Data were collected online using OrthoWave™ software (ARIA, Bruay Labuissière, France) to record all data pertaining to the primary UKA and to the revision procedures. To assess correlations, we used multivariate analysis, the non-parametric Kruskal-Wallis test, Student's *t* test, and Pierson's Chi^2 test. Values of *P* lower than 0.05 were considered significant.

Table 1 Study centres (all in France).

Surgeon	Centre
Argenson Jean-Noël	Marseille
Bloch Anthony	Aix-en-Provence
Bonnin Michel	Lyon
Callas Philippe	Aix-en-Provence
Cartier Philippe	Paris
Caton Jacques	Lyon
Cazenave Alain	Berck-sur-Mer
Chambat Pierre	Lyon
Chatain Frédéric	Grenoble
Chol Christophe	Dracy-le-Fort
Dejour David	Lyon
Deschamps Gérard	Dracy-le-Fort
Epinette Jean-Alain	Bruay-Labuissière
Hernigou Philippe	Paris
Lerat Jean-Luc	Lyon
Mertl Patrice	Amiens
Migaud Henri	Lille
Mole Daniel	Nancy
Moyen Bernard	Lyon
Pasquier Gilles	Lille
Rouanet Thomas	Lille
Rouvillain Jean-Louis	Fort-de-France
Saragaglia Dominique	Grenoble
Tabutin Jacques	Cannes
Trojani Christophe	Nice

Table 2 Main reasons for failure of unicompartmental knee arthroplasty.

Reason for failure	*n*	%		*n*	%
11 - global loosening	60	14.96	Loosening	184	44.02
12 - femoral loosening	25	6.23			
13 - tibial loosening	99	24.69			
21 - osteoarthritis progression	56	13.97	Disease progression	63	15.07
22 - inflammatory joint disease progression	0	0			
23 - chondrocalcinosis progression	4	1			
24 - necrosis of the other compartment	3	0.75			
31 - isolated PE wear	27	6.73	Wear	53	12.68
32 - wear + metallosis	26	6.48			
33 - isolated osteolysis	0	0			
41 - pathological tibial plateau fracture	10	2.49	Fracture	15	3.59
42 - post-traumatic tibial plateau fracture	5	1.25			
43 - complex post-traumatic fracture	0	0			
51 - isolated deep infection	3	0.75	Infection	8	1.91
52 - septic loosening	5	1.25			
61 - isolated unexplained pain	19	4.74	Pain	23	5.50
62 - overall instability with pain	4	1			
63 - faulty implantation	26	6.48	Technical problems	48	11.48
64 - intra-articular cement; osteophyte	6	1.5			
71 - defective femoral component	7	1.75			
72 - defective tibial component	2	0.5			
73 - defective insert	7	1.75			
81 - other	24	5.74	Other	24	5.74
Total	418	100		418	100

Results

Mean time to failure (Fig. 1) was 6.21 years (range, 0—24.7 years). Time to failure was less than 1 year in 80 (19.1%) knees and less than 5 years in 203 (48.5%) knees; 75.1% of failures occurred within 10 years and 91.4% within 15 years.

The main causes of failure, in decreasing order (Table 2), were isolated aseptic loosening of the tibial component (24.7%) or both components (15%), progression of the osteoarthritis lesions (14%), polyethylene wear diagnosed radiologically (6.7%) or already accompanied with metallosis (6.5%), and faulty implantation technique (6.5%). In 23 (5.5%) cases, the reason for reoperation was 'unexplained pain', which was isolated in 19 cases and accompanied with 'overall instability' in four cases. Failure of the supporting bone was the cause of failure in 3.6% of cases. In eight (1.9%) cases, failure was due to deep infection, which was either isolated ($n = 3$) or accompanied with loosening ($n = 5$). Of the remaining 24 (5.7%) cases, four were ascribed to 'post-traumatic ligament injury' and 20 were not classifiable in any of the aetio-pathogenic categories.

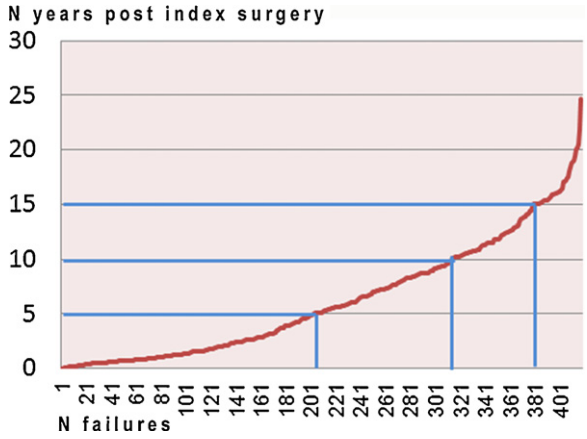

Figure 1 Cumulative prosthesis time to failure.

Of the 184 cases of aseptic loosening, 53.8% were confined to the tibia and 13.6% to the femur, whereas 32.6% affected both components. Aseptic loosening was more common after medial than after lateral UKA (94.6% versus 5.4%), with no significant difference compared to the other causes of failure ($P = 0.9$). Tibial loosening developed significantly earlier (7.1% within 6 months and 37.7% within 2 years) than did femoral and global loosening ($P < 0.001$) (Table 3, Fig. 2). Secondary causes included polyethylene wear in 41 (22.4%) cases, with metallosis in two cases; osteoarthritis progression (2.7%), faulty prosthesis positioning (4.4%), instability (2.7%), and defects in the implant material (1.6%). Overall, sex, age, and body weight were not significant risk factors for aseptic loosening ($P = 0.56$, 0.26, and 0.59, respectively). The 60 knees with loosening

Table 3 Time from unicompartmental knee arthroplasty to loosening.

	Global	Femoral	Tibial	Total	%
< 6 months	1 (0.5%)	2 (1.1%)	13 (7.1%)	16	8.74
< 1 year	2 (1.1%)	1 (0.5%)	19 (10.4%)	22	12.02
1–2 years	3 (1.6%)	7 (3.8%)	21 (11.5%)	31	16.94
3–4 years	12 (6.6%)	5 (2.7%)	16 (8.7%)	33	18.03
5–9 years	20 (10.9%)	5 (2.7%)	19 (10.4%)	44	24.04
10–14 years	21 (11.5%)	4 (2.2%)	8 (4.4%)	33	18.03
15–19 years	0 (0%)	1 (0.5%)	2 (1.1%)	3	1.64
20–24 years	1 (0.5%)	0 (0%)	0 (0%)	1	0.55
Total	60	25	98	183	
%	32.79	13.66	53.55		

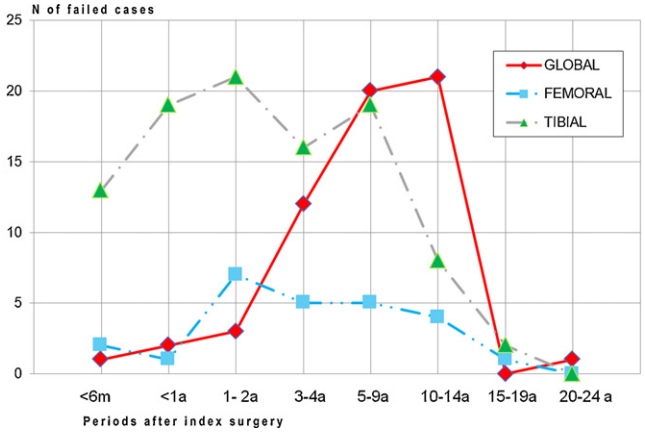

Figure 2 Time to revision for loosening.

of both components were treated with UKA ($n = 3$), posterior cruciate-retaining TKA (CR-TKA, $n = 12$), posterior-stabilised TKA (PS-TKA, $n = 36$) (Fig. 3), or hinged TKA ($n = 9$). The 25 cases of femoral-component loosening were managed with partial femoral revision ($n = 2$) or bipolar revision ($n = 23$: repeat UKA in four cases, CR-TKA in 10 cases, and PS-TKA in 11 cases). Of the 99 cases of tibial loosening, 16 were managed with partial tibial revision and 83 with bipolar

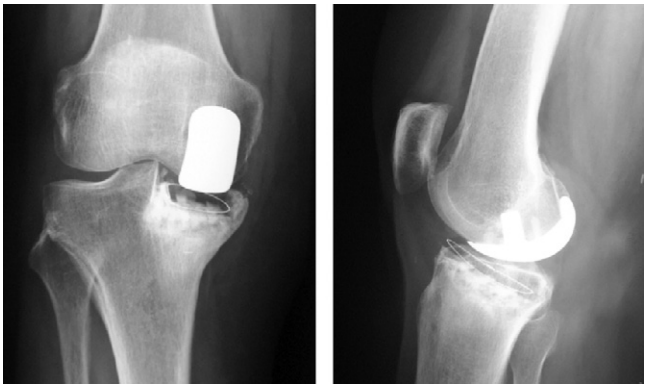

Figure 3 Medial unicompartmental knee arthroplasty in a 66-year-old woman: major tibial loosening with subsidence of the tibial plateau.

Figure 4 Lateral unicompartmental knee arthroplasty; failure after 11 years due to osteoarthritis progression to the medial compartment.

revision (repeat UKA in 16 cases, CR-TKA in 33 cases, PS-TKA in 48 cases, and hinge TKA in two cases).

The cause of failure was isolated progression of the underlying disease in 63 (15%) knees (Fig. 4) that were free of implant loosening or technical problems. The underlying disease was osteoarthritis in 88.9% of cases and chondrocalcinosis in 6.4%; in 4.7% of cases, necrosis occurred in the previously unaffected compartment. Lesion progression was detected within the first year in 8% of cases, during the second year in 6%, and between the third and fifth years in 19%; mean time to failure was 7.75 years. Osteoarthritis progression was more common after lateral than medial UKA ($P = 0.036$). Sex, body weight, and height were not associated with osteoarthritis progression (non-significant P values). A single knee (1.6%) was treated with exploratory arthroscopy and the 62 other knees with knee arthroplasty (UKA of the other compartment in nine [14.3%] cases [medial compartment in three and lateral in six cases], TKA in 52 [82.5%] cases [CR-TKA in 20 cases and PS-TKA in 32 cases], and hinge TKA in 1 [1.6%] case).

Wear was only the third most common main cause of failure, with 53 (12.68%) cases. In 27 (50.9%) of these 53 cases, surgery was performed preventively for isolated wear without clinical symptoms or radiological evidence of loosening. In the remaining 26 cases, the patients were symptomatic and metallosis was found intraoperatively (Fig. 5). Evidence of wear was found intraoperatively in 20.6% of cases (38 knees) with loosening, yielding a total of 21.8% of cases (91 knees) in which wear was involved in implant failure (Fig. 6). Time to polyethylene wear onset was consistently longer than 2 years (mean, 9.3 years) and the frequency peaked between 5 and 10 years. The rate of occurrence was similar between the medial and lateral compartments. Wear was more common in men than in women ($P = 0.03$), whereas neither body weight nor BMI were associated with wear. Of the 53 cases, two were managed by

Figure 5 Medial unicompartmental knee arthroplasty: severe wear with metallosis after 4 years, related to lateral malposition of the femoral component.

changing the polyethylene insert and 51 by revision (UKA in five cases of medial arthroplasty, CR-TKA in 22 cases, PS-TKA in 23 cases, and hinge TKA in one case).

Technical reasons explained 48 (11.5%) of the failures. They consisted in faulty prosthesis implantation in 26 cases, defective material in 16 cases (involving the femoral component in seven cases, the tibial plateau in one case, and the insert in eight cases), and arthroscopic reoperation in six cases (removal of a cement fragment in five cases and of an osteophyte in one case). Of the 26 cases with faulty prosthesis implantation, 15 (57.7%) consisted in inadequate positioning of the components resulting in impingement of the condyle on the tibial spines or in subluxation of the tibia under the femur. In six (23.1%) cases, major under- or overcorrection was noted. In four (15.4%) cases, impingement on the adjacent soft tissues was ascribed to the use of oversized implants. Malposition was not accurately documented. Time to failure for technical reasons ranged from 6 months to 18 years; 53.8% of cases occurred between 1 and 4 years (mean, 4.13 years). No significant difference was found between the medial and lateral compartments ($P = 0.435$). All 26 cases of faulty prosthesis implantation were managed by revision surgery (UKA in six cases, CR-TKA in five cases, and PS-TKA in 15 cases).

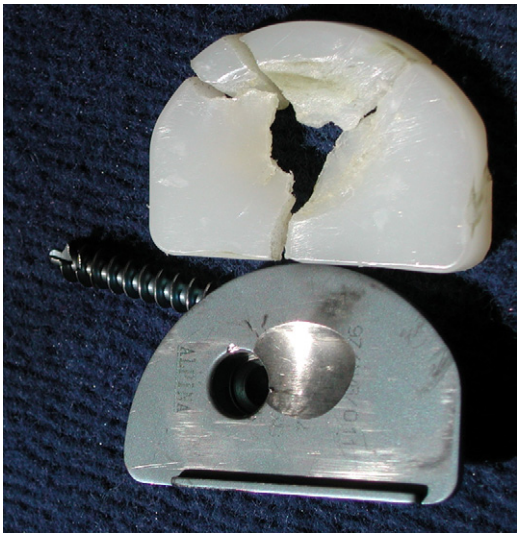

Figure 6 Medial unicompartmental knee arthroplasty: after 4 years, the tibial component is entirely destroyed due to wear of the polyethylene insert with severe metallosis.

Implant defects explained 16 failures. The femoral component was defective in seven cases: wear related to implant deterioration occurred between 5 and 14 years after implantation in five cases (including one titanium-coated implant) and delayed rupture of the femoral component in two cases. In one case, the metal cerclage wire around the tibial polyethylene plateau ruptured. In the remaining eight cases, the insert was defective. The mobile-bearing insert of an Oxford plateau was involved in four cases. Of the four cases with fixed-bearing tibial components, two had rupture of the polyethylene insert and two defective locking with a pumping effect and early osteolysis under the tibial plateau, requiring replacement of the tibial component.

Discussion

A major strong point of this study is the large number of failures ($n = 418$) collected in 25 centres over a 31-year period. The limitations are inherent in the multicentre retrospective design and in the long time (up to 31 years) since some of the UKA procedures. This last point explains that the baseline radiographs, postoperative goniometry data, and details on implantation modalities were missing for some patients; in some of the oldest cases in which implantation occurred outside the study centres, the brand name of the implant was unknown. Another limitation is that data were collected only on failed cases. No follow-up information was obtained on the surviving prostheses, and the number of failures may therefore have been underestimated. However, our results are consistent with those of the Australian and Swedish registries, both for the overall patient population (Table 4) [11,12] and for the population younger than 65 years of age (Table 5) studied by Dahl et al. [21].

Our working hypothesis was that failure occurred late after UKA. However, nearly one-fifth of the failures (19.1%) occurred within the first year and nearly one half (48.5%) within the first 5 years. Again, these data are consistent with findings from nationwide registries showing a large proportion of failures within the first 5 years.

Furthermore, wear was not the leading cause of UKA failure. This finding invites a reappraisal of arguments put forward about 15 years ago to warrant the use of mobile-bearing prostheses [17—20]. Wear admittedly occurred as the main or associated cause of failure in 22% of the overall series, and in one fifth of aseptic loosening cases, but was found in only 10% of the 105 cases of tibial loosening (with or without femoral loosening) diagnosed within the first 5 years. The long time since UKA and absence of details on implant design precluded an analysis of the respective contributions of mobile-bearing and fixed-bearing designs to the development of wear.

Table 4 Comparison of reasons of failure in the Swedish registry, Australian registry, and present study, in the overall populations.

Overall population (%)	Swedish registry $n = 1576$	Australian registry $n = 2882$	Present study $n = 418$
Loosening	37.3	48.3	44.0
Disease progression	27.4	21.2	15.1
Wear	13.5	1.7	12.7
Technical problems	—	3.8	11.5
Pain	4.8	11.5	5.5
Fractures	2.0	2.7	3.6
Infection	2.3	4.6	1.9
Other	12.7	6.2	5.7
Total (%)	100	100	100

Table 5 Comparison of reasons of failure in the Swedish registry, Australian registry, and present study, in the population younger than 65 years of age.

Patients < 65 years (%)	Swedish registry $n = 936$	Australian registry $n = 366$	Present study $n = 120$
Loosening	54.1	38.8	50.8
Disease progression	14.3	26.0	10.8
Wear	2.0	3.6	5.8
Technical problems	7.4	—	19.2
Pain	13.1	6.8	5.8
Tibial fractures	2.1	2.5	5.0
Infection	4.3	2.5	2.5
Other	2.7	19.8	0
Total (%)	100	100	100

The leading cause of failure was loosening, followed by progression of the underlying disease in the previously unaffected compartments. Wear was only the third most common cause of failure [22]. In addition, our results confirm the critical importance of high-quality material and impeccable surgical technique. Problems related to material issues or poor surgical procedures were indeed the main cause of failure in 11% of cases, which obviously emphasizes surgical technique as of utmost importance in UKA [23–25].

Conclusion

Our study provided valuable information on time to failure in UKAs, which was surprisingly short in some cases. Early failure can be caused by defective material or faulty surgical technique [26–29]. Systematic data collection in a nationwide registry is needed to allow a more accurate analysis.

Disclosure of interest

None of the authors reported any conflicts of interest related to this article. Apart from the current study, Jean-Alain Epinette discloses a consultancy agreement with Stryker Orthopaedics, an expert testimony for Boehringer Ingelheim, and educational presentations at a De Puy meeting. Patrice Mertl discloses consultancy agreements with Stryker Orthopaedics and De Puy. Daniel Mole participated in a De Puy educational meeting. Alain Cazenave discloses a consultancy agreement with Adler Orthopaedics. Benoit Brunschweiler has no disclosure of interest.

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