



Inconsistent relationship between body weight/body mass index prior to total knee arthroplasty and the 12-year survival

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ABSTRACT

Background: The primary hypothesis was that body weight (BW) and body mass index (BMI) significantly impact the long-term survival rate after implantation of a mobile bearing total knee arthroplasty (TKA).

Methods: A national, multicentric, retrospective study was performed in France. A total of 1604 TKAs were included. The 10-year follow-up was documented, and the influence of BW and BMI on the survival rate was assessed.

Results: There was a significant influence of the BW on the 12-year survival rate for any reason and for infection; but this influence was not proportional to the BW or BMI. There was no significant influence of the BMI on the 12-year survival rate for any reason, for any mechanical reason or for infection.

Conclusion: Our results suggest that a higher BMI should not be considered as a risk factor for revision for mechanical purpose if a mobile bearing TKA with confirming design is implanted.

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1. Introduction

Total knee arthroplasty (TKA) is considered a highly successful procedure. Survival rates of more than 90% after 10 years are generally reported after implantation of conventional, fixed bearing TKAs [1]. However, complications and revisions may still occur for many reasons, especially polyethylene wear [2]. It has been suggested that patients with higher body weight (BW) [3] or higher body mass index (BMI) may experience more complications and long-term failures due to overload of the polyeth-

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ylene component [4,5]. The use of a mobile bearing has been suggested to decrease polyethylene wear and improve long-term survival [6]. However, clinical relevance of this design change remains debated. The present study was designed to assess the impact of the initial BW and BMI on the long-term survivorship of mobile bearing TKAs.

The primary hypothesis of this study was that BW and/or BMI significantly impact the long-term survival rate after implantation of a mobile bearing TKA.

2. Material and methods

A national, multicentric, retrospective study was performed in France, including eight university or private centres with high volumes in knee surgery. It was conducted according to the Declaration of Helsinki and its last amendments. The local ethical committee of Strasbourg University gave approval to the study, which was registered on clinicaltrials.gov (NCT02651571).

All patients operated between January 2001 and December 2004 in the participating centres for TKA implantation (regardless of the system used) were consecutively included, without exclusion criteria. The usual demographic criteria were collected. The initial coronal deformation was measured on long-leg anteroposterior radiographs by the angle between the mechanical axis of the femur and tibia [7]. Patients were distributed according to the index BW with steps of 10 kg according to Gøttsche [3], and according to the index BMI between normal ($\text{BMI} < 25 \text{ kg/m}^2$), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$), obese ($30 \leq \text{BMI} < 35 \text{ kg/m}^2$) or severely obese or superobese ($\text{BMI} \geq 35 \text{ kg/m}^2$) patients following the World Health Organization (WHO) criteria [8].

All centres were aiming for a coronal angle correction of $\pm 3^\circ$ off the neutral axis and an acceptable ligament balance with standard, visual evaluation. All centres implanted a mobile bearing TKA, and the use of a central or medial pivot was decided by the operating surgeon according to his or her judgement.

The postoperative coronal deformation was measured using the same technique as before implantation. All patients were contacted after 10 years or more to determine the survival of the TKA. The need for, date and cause of revision were noted. Patients who refused physical consultation were interviewed by telephone. For patients lost to follow-up, the family or the general practitioner was contacted to obtain information on the survival of the TKA.

The primary end-point of the study was the occurrence of a revision for any reason. Secondary end-points were the occurrence of a revision for any mechanical reason and for periprosthetic infection. Survival curves were calculated using the actuarial technique for all end-points. The influence of BW and BMI was analysed by a Gray test at a five percent level of significance. A Cox proportional hazards analysis was performed to adjust the analysis for a priori selected variables with potential confounding effects: age, gender, index coronal deformation (more or less than 10°), prosthesis fixation (cemented, cementless, hybrid), and use of a navigation system. *P*-values mentioned were calculated after adjustment.

3. Results

A total of 1604 TKAs were implanted during the study period. There were 545 men (34%) and 1059 women, with a mean age of 69.6 years (standard deviation (SD) 7.7 years), a mean BW of 80.1 kg (SD 14.8 kg) and a mean BMI of 29.6 kg/m^2 (SD 4.5 kg/m^2). Distribution of BW and BMI is reported in Table 1.

There were 962 varus knees (60.0%) with a mean coronal deformation of 8.8° (SD 3.9°) and 330 valgus knees (19.6%) with a mean coronal deformation of 8.9° (SD 4.5°), while 312 knees (19.4%) were considered without coronal deformation.

Different TKA systems were used: E-motion® (Aesculap, Tuttlingen, FRG) [9] in 578 cases (all cemented), ROCC® (Biomet, Warsaw, Indiana, USA) [10] in 391 cases (222 cemented, 169 cementless), Score® (Amplitude, Valence, France) [11] in 306 cases (107 cemented, 134 cementless, 65 hybrid), Profix® (Smith & Nephew, London, UK) [12] in 246 cases (18 cemented, 80 cementless, 148 hybrid), First® (Symbios, Yverdon-les-Bains, Switzerland) [13] in 51 cases (all cemented), NexGen® (Zimmer, Warsaw, Indiana, USA) [14] in 32 cases (all cemented).

The flowchart of the study is reported in Figure 1. Forty-three revisions (2.7%) were performed during the study period, with a postoperative delay from three months to 14 years: 22 for any mechanical reason (1.4%) and 21 for infection (1.3%). The global survival rate at 14 years was 95.0% for any revision, 97.2% for any mechanical revision and 97.7% for revision for infection.

There was a significant influence of the index BW on the 12-year survival rate for any reason ($P = 0.01$) (Figure 2): the highest survival rate was observed for people with 80–89 kg of BW (98.0%), while the lowest was observed for people with 90–99 kg of BW (90.0%). There was no significant influence of the index BW on the 12-year survival rate for any mechanical

Table 1
Index body weight (BW) and body mass index (BMI).

	BW (kg)		BMI (kg/m^2)		
≤59	121	7.5%	≤24.9	253	15.8%
60–69	245	15.3%	25–29.9	741	46.2%
70–79	439	27.4%	30–34.9	417	26.0%
80–89	401	25.0%	≥35	193	12.0%
90–99	225	14.0%	Total	1604	
≥100	173	10.8%			
Total	1604				

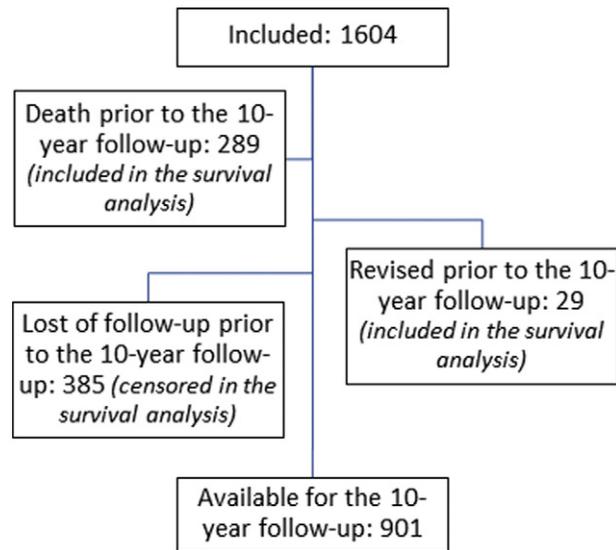


Figure 1. Flow-chart of the study.

reason (Figure 3). There was a significant influence of the index BW on the 12-year survival rate for infection ($P = 0.03$), with the lower survival for people with 90–99 kg of BW (94%) and the higher survival for people under 60 kg of BW (100%) (Figure 4).

There was no significant influence of the index BMI on the 12-year survival rate for any reason (Figure 5), for any mechanical reason (Figure 6) or for infection (Figure 7).

4. Discussion

The primary hypotheses of this study were partially confirmed: BW significantly influenced the occurrence of revision for infection only, while BMI had no significant influence on the survival rate after implantation of a mobile bearing TKA.

Higher BW and BMI are considered to increase the occurrence of periprosthetic infection after TKA [15–18]. The present study partially confirmed this statement, only for BW. Absolute BW might be a more useful prognostic factor, as people with high BW may still have a normal BMI [3]. However, the influence of BW on revision rate for infection was complex: only the group of patients with a BW between 90 and 99 kg had a lower survival rate for infection, while patients with higher BW did not experience this negative influence. Similarly, obese patients had a lower survival rate for infection than superobese patients, although the difference was not significant. This might suggest the presence of a non-identified confounding factor, which may be the statistical method itself [19]. One other possible explanation might be the longer follow-up of the present study (more than 10 years) while

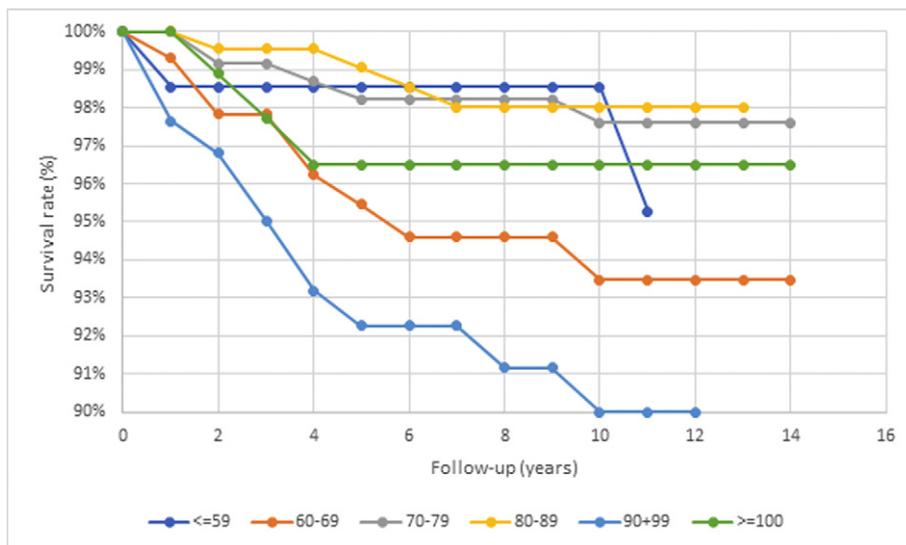


Figure 2. Influence of body weight (kg) on survival rate (end-point = revision for any reason).

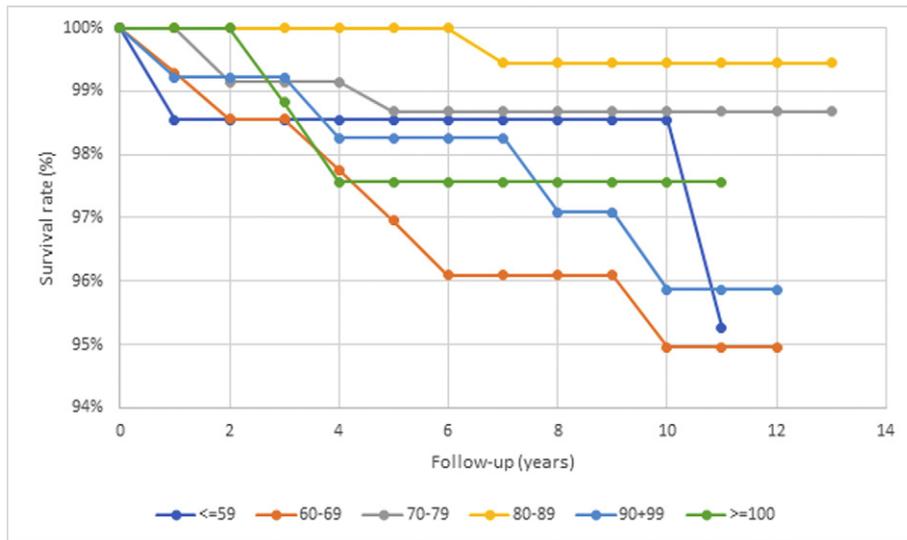


Figure 3. Influence of body weight (kg) on survival rate (end-point = revision for any mechanical reason).

other studies report more frequently shorter follow-up [15,16,20]. The direct influence of BW and BMI on the occurrence of a periprosthetic infection should be further investigated.

Higher BW and BMI are also considered to increase the rate of revision for mechanical purpose after TKA by increasing polyethylene loading and subsequent wear [21]. Zingg et al. reported that revision rate for all causes was doubled for patients with a BMI over 35 kg/m² [5]. In a register study, Gøttsche et al. stated that BW affects survival of TKA; however, the interaction was complex and not proportional [3]. Other authors suggested that obesity is associated with an increased risk of revision after TKA [4,15,22,23]. However, other studies reported opposite conclusions [24–26]. The present study confirmed this latter statement. As per Gaillard et al. [25], the present study reported long-term results of mobile bearing TKAs. A more conforming design with increased contact area may decrease the polyethylene load and compensate for the higher BW and BMI [27]. Our results suggest that a higher BMI should not be considered a risk factor for revision for mechanical purpose if a mobile bearing TKA with confirming design is implanted.

There are several limitations to this study. This is a retrospective study, with all the risks of bias inherent in this type of study. It was not possible to analyse the potential impact of BW or BMI on superobese patients because of too small a sample, and results might be different for this sub-group of patients [28]. Adjustment was performed to compensate for some biases. However, only some variables were used for adjustment, and it is still possible that other confounding variables were not included in the

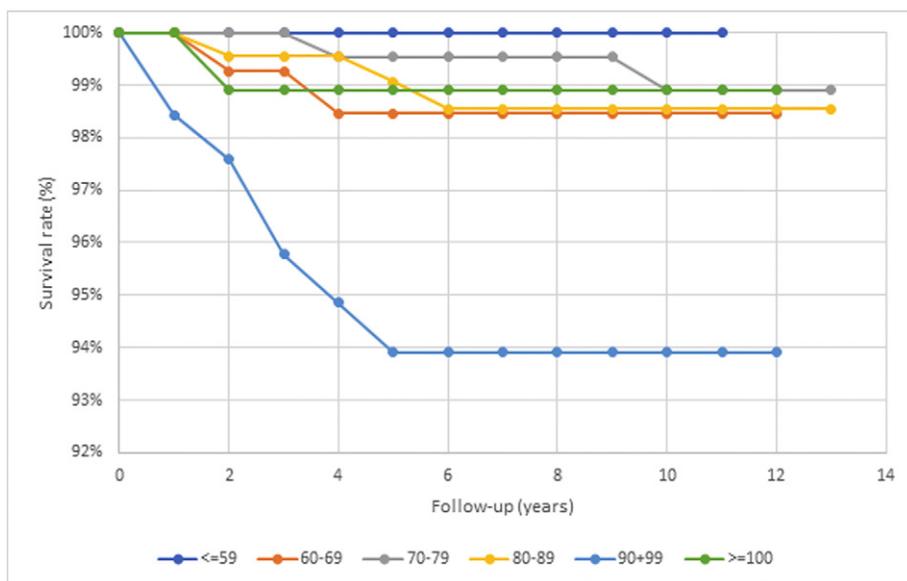


Figure 4. Influence of body weight (kg) on survival rate (end-point = revision for infection).

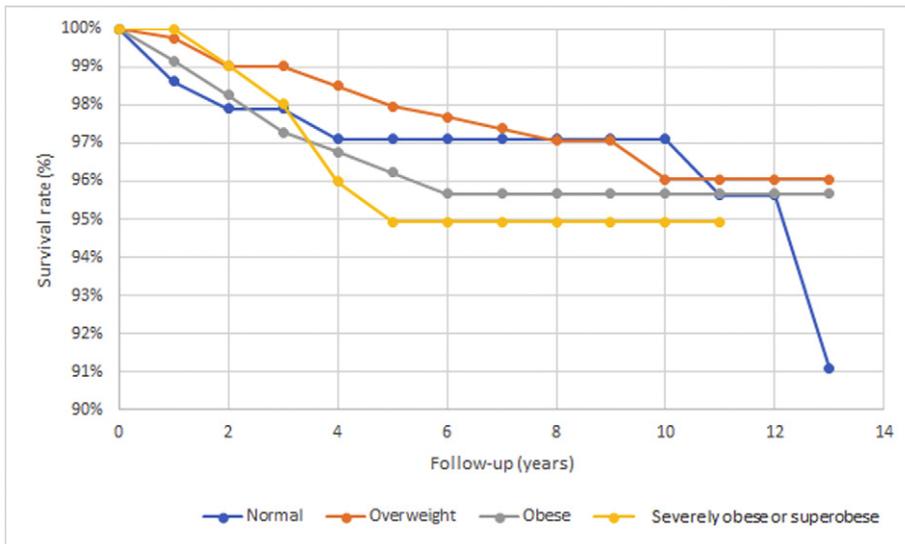


Figure 5. Influence of body mass index (kg/m^2) on survival rate (end-point = revision for any reason).

adjustment process. Survival was analysed retrospectively, explaining the high percentage of patients lost to follow-up. However, this may also be explained by the high age of the patients during the procedure and the long delay after the procedure. In fact, the percentage of patients lost to follow-up is consistent with other studies with similar follow-up times [29]. Furthermore, we showed that there was no significant difference in all preoperative data between these patients and those with available 10-year follow-up. The multicentric nature of the study involves the use of different implants and variable surgical techniques. However, no significant differences between the different participating centres were found.

5. Conclusion

Our results suggest that a higher BMI should not be considered as a risk factor for revision for mechanical purpose if a mobile bearing TKA with confirming design is implanted. But the exact influence of BW and BMI on the occurrence of a periprosthetic infection should be further investigated.

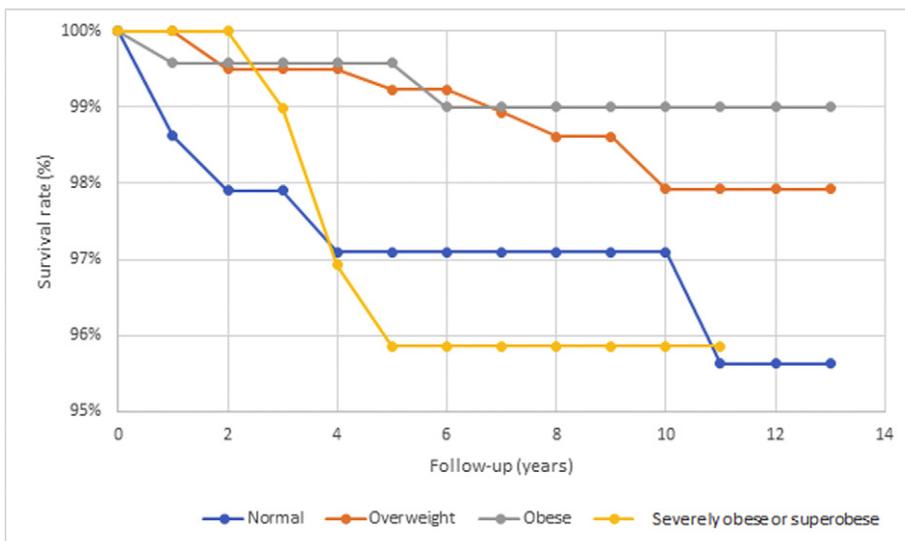


Figure 6. Influence of the body mass index (kg/m^2) on survival rate (end-point = revision for any mechanical reason).

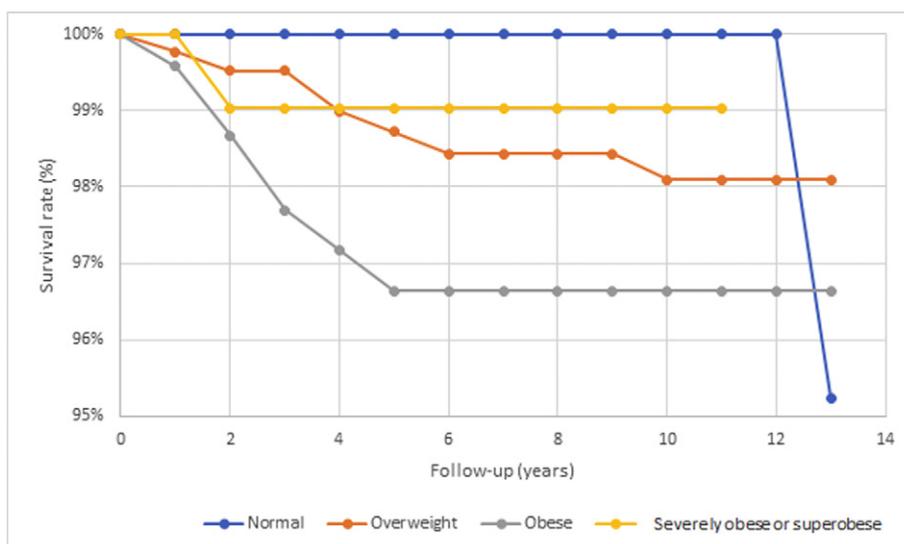


Figure 7. Influence of the body mass index (kg/m^2) on survival rate (end-point = revision for infection).

Author contributions

J.Y.J. designed the study, monitored data collection, performed data analysis, drafted the manuscript and wrote the final manuscript. D.S. designed the study, supervised data collection and analysis, and reviewed the drafted manuscript and the final manuscript. All authors monitored data collection in their own centres. All authors reviewed the drafted manuscript. All authors read and accepted the final manuscript.

Declaration of competing interest

J.Y.J. receives royalties from B-Braun, is a paid consultant for FH Orthopedics, and is a member of the board of CAOS-International and ISTA. D.S. receives royalties from B-Braun. M.B. receives royalties from Zimmer-Biomet. T.G. receives royalties from Amplitude. F.C. receives royalties from Amplitude and Dediene. A.C., B.J. and J.L.R. have nothing to disclose.

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