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ORIGINAL ARTICLE

Uncemented knee arthroplasty: Supervivorship and long-term functional outcome

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KEYWORDS
Uncemented arthroplasty;
Knee Society Score functional;
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Abstract
Purpose: To analyze the long term survivorship and functional results of a model of uncemented knee prosthesis.
Materials and methods: We carried out a prospective observational study of patients implanted between 1989 and 1996 with the Low Contact Stress Mobile-Bearing Total Knee Replacement (Depuy, Warsaw, IN, USA). Variables studied included: age, gender, follow-up, Knee Society Score, implant survivorship and reasons for revision. A total of 96 arthroplasties out of 127 reached the end of follow-up. Mean age was 79 years. Mean follow-up was 14 years. Eleven prostheses were revised (6 following aseptic loosening and 5 because of problems with the mobile bearings). Survivorship curves were obtained considering length of follow-up, time elapsed between the primary and the revision surgery and the "revision following loosening of a metal component" and "need for revision" events.
Results: When "need for revision" was considered as the endpoint, survivorship curves revealed a survivorship rate of 96.45% at 9 years and 92.78% at 12 years. When the endpoint was the "need to revise metal components" 14.5-year survivorship was 93.75% Mean Knee Society Score was 89.2 points.
Conclusion: The use of the uncemented LCS knee has resulted in excellent clinical and functional results as measured by the Knee Society Score, as well as 93.75% survivorship at 14 years and a half, considering the survivorship of the metal implant.

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PALABRAS CLAVE
Artroplastia no cementada;
Knee Society Score funcional;
Supervivencia a largo plazo

Supervivencia y resultado funcional a largo plazo de prótesis de rodilla no cementadas

Resumen
Objetivo: Analizar la supervivencia a largo plazo y el resultado funcional de un modelo de prótesis de rodilla no cementada.
Material y método: Realizamos un estudio prospectivo observacional de pacientes operados entre los años 1989 y 1996 con el modelo Low Contact Stress Mobile-Bearing Total Knee Replacement® (Depuy, Warsaw, IN, EE. UU.). Las variables estudiadas fueron edad, sexo, tiempo de seguimiento, puntuación del Knee Society Score (KSS), supervivencia del implante y motivos de la revisión. Un total de 96 artroplastias de 127 completaron el seguimiento. La media de edad fue de 79 años. La media de seguimiento fue de 14,5 años. Once prótesis se reintervinieron (6 por aflojamiento aséptico de implantes y 5 por problemas de componentes móviles). Se obtuvieron curvas de supervivencia al considerar el tiempo de seguimiento, el tiempo desde la cirugía primaria hasta la reintervención y el episodio "recambio por aflojamiento de componente metálico" y "necesidad de reintervención".
Resultados: Las curvas de supervivencia arrojaron una supervivencia del 96,45% a los 9 años y del 92,78% a los 12 años, y se consideró la "necesidad de reintervención" como punto final. Al considerar la necesidad de recambio de componentes metálicos, la supervivencia a los 14 años y medio fue del 93,75%. La puntuación media del KSS funcional fue de 89,2.
Conclusión: En nuestra experiencia y con el modelo protésico utilizado, las prótesis totales de rodilla no cementadas proporcionan un resultado clínico y funcional excelente, valorado por el KSS, y una supervivencia del 93,75% a los 14 años y medio al considerar la supervivencia del implante metálico.

Introduction

Implant integration with bone surface depends on 3 parameters: bone-implant contact, which must not be greater than 2 μm (the ideal is 0.5 μm); movement at the bone-implant interphase, that must be less than 28 μm since if these values are greater the formation of fibrous tissue predominates over the formation of bone tissue and, lastly, the characteristics of the contact surface of the implant, which can vary according to the model and the manufacturer from spheres or fibres soldered to the surface, sprayed with a film of metal/ceramic, solutions of ceramic or microtextures and macrotextures.[1]

The application of these principles to knee replacement arthroplasty has made it possible to develop uncemented implants. Although series have been published with disheartening survival results,[2-5] there have also been studies with similar values for cemented and uncemented long-term survival.[6-11] On the other hand, it must not be forgotten that the use of cement is not without complications, such as fatty embolism, migration of cement particles or induction of bone resorption.[12-14]

Mobile components have been introduced in uncemented knee arthroplasty models with the aim of improving survival of the implants and decreasing shear forces between bone and implant. Mobile components absorb part of the forces generated by the load, but have the drawback of adding another interface, which could mean an increase in the generation of wear particles. Another drawback is the possibility of luxation of these components.

Two of the most important elements to achieve long term survival are optimum osteointegration and minimal wear of mobile components.[15] In this study we show our experience with an uncemented model of prosthesis with mobile components in the tibia and patella. This is a prospective study with retrospective data collection, in which survival is assessed and the endpoint events are the need for implant replacement due to loosening of any component and long term functional results.

Patients and methods

We included in this study all patients operated between 1989 and 1996. We carried out a prospective follow-up of patients who received an uncemented Low Contact Stress (LCS) Mobile-Bearing Total Knee Replacement®, Depuy Johnson&Johnson (Warsaw, IN, USA), that was formed by a tibial tray with a central pressure-fit pivot with a continuous porous surface both on the tray and on the pivot. The femoral component also had a contact area with a continuous porous coating. It is 'J' shaped on the lateral plane and has 2 lugs on the condyles to support the fit of the prosthesis. The patellar component is formed by a metal tray, also with a continuous porous surface, with 3 lugs to achieve a pressure-fit. The polyethylene is mobile and has a surface that is congruent with the anterior surface of the femoral component, which gives it self-centring capacity. The design of the articular surfaces makes it possible to achieve stability and congruence on extension, both on the sagittal and the coronal plane. The model has undergone modifications over time. Possibly the most important modification was the change of the mobile menisci in the original design for rotator polyethylene. The cross-shaped anchorage of the patellar component was also modified.

We included 129 total knee replacements (TKR) performed in 117 patients, of which 10 died and 14 did not correctly complete follow-up, which left 93 patients (96 TKR) available for study. In these patients we analysed the variables in the database and drew up implant survival curves, and defined the event marking the end of implant life as the need for re-operation for any reason. To assess uncemented implant survival, we only considered re-operations due to loosening of some metal component as failures. Mean age was 79 years (range: 58 to 98) at the end of follow-up, 88.7% were women and 11.3% were men. The diagnosis was osteoarthritis in 90% of cases. Follow-up was 14 $^{1}/_{2}$ years (range: 12 to 18). As to the survival of the metal implants, 6 loosenings took place. In all cases the loosenings were non-septic and the lack of an infectious complication was determined by culture.

Surgery was performed under spine surgery without ischaemia. Implantation was performed using the standard anterior approach with internal parapatellar arthrotomy. The patients were hospitalized for one week after surgery and underwent assisted rehabilitation during that time. The subsequently came in to consultation after surgery for the removal of their stitches, at one month, at 3 months, at 6 months and then once a year; at each visit an X-ray control was performed and the Knee Society Score (KSS) was filled in. In those cases in which some of the components were replaced, samples were sent to the Microbiology Service to rule out any possible infectious cause of loosening.

The following variables were registered during the study: personal details, age, sex, date of operation and subsequent operations, model of prosthesis used, and KSS.[16] This assessment scale has 2 parts: the first scores mobility, stability and axis articulation, the second functionality, with scores for pain (50: no pain; 45: slight occasional; 40: only on stairs; 30: walking and on stairs; 20: moderate occasional; 10: moderate continuous, and 0: severe), mean distance walked (50: without any limit; 40: more than 1,000m; 30: 500–1,000m; 20: less than 500m; 10: does not leave home, and 0: cannot walk), functionality going up and down stairs (50: goes up and down normally; 40: goes up normally and comes down leaning on banister; 30: goes up and comes down leaning on banister; 15: goes up leaning on banister and cannot come down, and 0: cannot go up or down stairs) and uses an aid to walk (20: uses crutches or a frame; 10: uses 2 walking-sticks; 5: uses one walking-stick and 0: does not use any aid). All the details of each patient were entered into a computerized database (Microsoft Access).

Data was analysed using the SPSS 9 statistical programme. The description of the qualitative data was carried out as absolute frequencies and percentages and quantitative data by means, medians, ranges and typical deviation, according to data distribution. Kaplan-Meier curves were used to study implant survival.

Results

The mean time to re-operation due to metal component loosening was 11 years. Therefore, survival was 93.75% at 14 $^{1}/_{2}$ years of follow-up (fig. 1). We considered the endpoint event "re-operation due to any cause", there were 11 re-operations, so this meant an 88.54% global survival at 14 $^{1}/_{2}$ years. Globally the causes of re-operation (table) were 6 non-septic loosenings (6.25%), 3 tibial polyethylene wears or breakages (3.12%), 1 tibial polyethylene subluxation (1.04%) and 2 patella polyethylene ruptures (2.08%). One of these patients presented 2 patellar polyethylene luxation dissociations, therefore finally the patellar component was removed. The survival curve showed a mean survival of 96.45% at 9 years of follow-up and 92.78% at 12 years of follow-up, with a confidence interval of 95%. Mean time to replacement was 11 years due to failure of the metal component and mean time to re-operation due to any cause was 10 years.

As to the functional result, for the patients in our series the mean KSS was 89.2 out of a total of 100. Analysing these by item, for pain the mean value was 43 out of 50 (absence of pain was 50), for distance walked it was 36 out of 50. And 39.78% of patients needed to use a walking-stick by the end of the study and 1.07% needed a frame.

Discussion

Uncemented knee prosthesis first began to be used in the 1980s. Buechel and Pappas[12] designed the model used in this

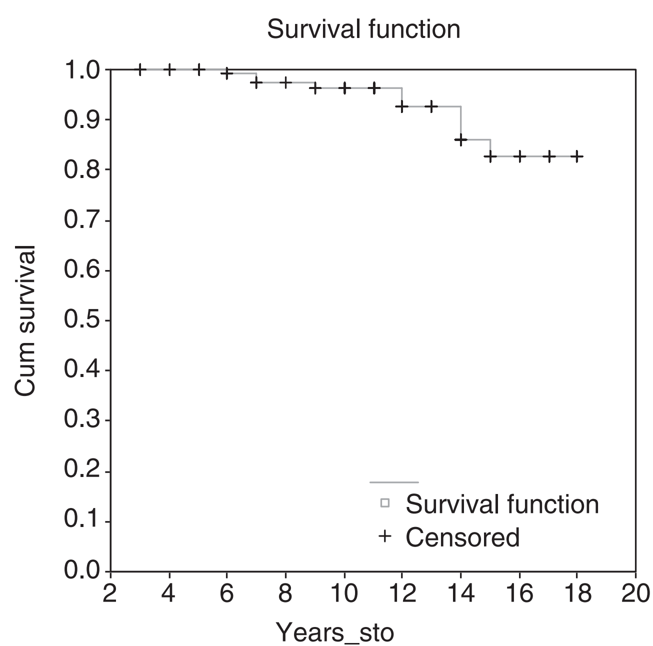

Figure 1 Survival curve according to the need for re-operation due to any cause.

Table List of re-operated patients due to metal component loosening

	Cause of revision	Time to re-operation, years	Age, years
1	Non-septic loosening of tibial and femoral components	14	70
2	Non-septic loosening of tibial and femoral components	15	75
3	Non-septic loosening of tibial and femoral components	6	72
4	Non-septic loosening of tibial component	13	78
5	Non-septic loosening of tibial and femoral components	8	71
6	Non-septic loosening of tibial component	13	73

study, and, currently, this is the uncemented model of most extended use. The creators themselves have published good results obtained by the cemented version of this model on several occasions.[17,18]

A continuous porous surface has been added to uncemented prosthesis models, since with partial porous surfaces secondary loosening occurred due to the formation of fibrous bridges in non-porous areas,[12] the design of congruent surfaces and mobile components, both in the tibia (mobile menisci and later a rotating platform) as in the patella.[19] Berger et al[4] found in 131 TKR, followed-up for 11 years, that they had to revise 48% of the patellar components and almost 10% of the tibial components. The authors concluded that it was necessary to abandon uncemented TKR, but they also recognized that the high failure rate was due to a poor design (the metal platform patella had no mobile platform) and a poor surgical technique, since the femoral components were in slight internal rotation, which caused impaction of the lateral part of the patella on the femur. In the Swedish register,[20] the authors found a relative risk of revision of 1.4 of uncemented tibial components and, on stratifying by disease, this higher risk was only seen in patients with arthritis and not other pathological conditions such as rheumatoid arthritis. This has led some authors to recommend hybrid models[21] in which there is only tibial cementation.

Cemented prosthesis models have extensive medical literature supporting their long-term survival and functional results. Bozic et al[22] analysed, at 8 years, 344 cemented TKR with a survival of 95.9% including re-operations due to any cause, and 99.5% considering only non-septic loosening. Vessely et al[23] followed-up for 16 years 331 TKR that had a 95.9% global survival, which was 97% if only mechanical failure was considered and 98.8% if only non-septic loosening was considered to be implant failure. In our study, global survival was 92.78% at 12 years and 93.75% at 14 $^1/_2$ years if we only consider re-operations due to non-septic loosening of any metal component, results which are comparable to the series mentioned. The existence in the medical literature of studies that have shown good survival rates for uncemented implants must also be taken into account.[7,9,10,22] These are extensive series that have had good survival figures, both for gonarthrosis and rheumatoid arthritis. Amongst these, Sorrels et al[9] saw that, in spite of the fact that radiolucent lines can be seen in the tibial tray, these do not necessarily mean there is loosening and they are not progressive. The survival rates obtained in our series are similar to those shown by these authors, if we compare them with studies with more years of follow-up: 88.54% at 14 $^1/_2$ years in our series, in comparison with 89%[9] and 89.5%[10] at 12 years and 94% at 8 years.[25]

Rand et al[24] analysed predictive factors for TKR survival and amongst these included cemented fixation in comparison with uncemented fixation. Although it is true that in their study there were more than 11,000 cemented implants and only 259 uncemented implants, therefore the volume of data and experience of the surgeons with one and the other type of implant was not balanced. The designers of LCS[18] themselves saw a similar survival at 10 years (97.4%), between cemented and uncemented implants, but that later improved slightly in the case of uncemented implants (98.3% at 18 years in comparison with 97.7% at 20 years in cemented implants).

When comparing functional results using the KSS, the results obtained in our study (mean 89.2 with the functional KSS) are similar to those of other series.[7,8,10] Bassett[11] in 1,000 TKR (516 cemented and 84 uncemented) an objective and functional KSS of 91.1 and 90.2 in uncemented and 89.6 and 83.5 in cemented TKR, respectively.

The causes of re-operation are very varied according to the studies. In the concrete case of the LCS, since this was a model with mobile components, the complications these may cause (fracture, metal tray dissociation, wear, breakage, etc.) have affected a significant percentage of re-operated patients. This is the case for our series, in which almost half the cases re-operated were due to problems related to mobile parts. The first LCS version used a model with mobile menisci that generated problems until it was substituted by a rotating platform. Huang et al[10] in a study of 598 TKR (276 mobile menisci and 322 rotating platforms) had 8 cases of failure of tibial polyethylene, all of them with models of mobile menisci. They attributed this to an insufficient thickness of the lateral facet of the meniscus that generated greater wear. Furthermore, they consider that failures in mobile parts are due to 3 main causes: insufficient polyethylene thickness, malposition of the tibial tray and soft-tissue interposition in the patellar polyethylene**.** However, Bert et al[26] had 6% of this type of complications with rotating platforms and only 1.3% with mobile menisci, all during the first 6 months. For these authors, it is fundamental to carefully measure the spaces during flexion and extension and soft tissue balance. Weaver et al[27] believe that sacrificing the posterior cruciate ligament in a mobile platform system is risky because it grants too much freedom of movement. In our experience, problems with mobile components have been the cause of some cases of re-operation: cases of polyethylene rupture, polyethylene wear or luxation-disassociation after trauma. In our series, therefore, we performed a total of 6 re-operations, a percentage that is in line with the studies of the above mentioned authors.

In spite of greater experience and the many scientific publications on cemented TKR, uncemented TKR constitutes, in our experience, a valid option both as to survival and functional results.

References

1. Bellemans J. Osseointegration in porous coated knee arthroplasty. The influence of component coating type in sheep. Acta Orthop Scand Suppl. 1999;288:1-35.
2. Cloke DJ, Khatri M, Pinder IM, McCaskie AW, Lingard EA. 284 press-fit Kinemax total knee arthroplasties followed for 10 years: Poor survival of uncemented prostheses. Acta Orthop. 2008;79:28-33.
3. Hartford JM, Hunt T, Kaufer H. Low contact stress mobile bearing total knee arthroplasty: Results at 5 to 13 years. J Arthroplasty. 2001;16:977-83.
4. Berger RA, Lyon JH, Jacobs JJ, Barden RM, Berkson EM, Sheinkop MB, et al. Problems with cementless total knee arthroplasty at 11 years followup. Clin Orthop Relat Res. 2001;392:196-207.
5. Carlsson A, Björkman A, Besjakov J, Onsten I. Cemented tibial component fixation performs better than cementless fixation: A randomized radiostereometric study comparing porous-coated, hydroxyapatite-coated and cemented tibial components over 5 years. Acta Orthop. 2005;76:362-9.
6. McCaskie AW, Deehan DJ, Green TP, Lock KR, Thompson JR, Harper WM, et al. Randomised, prospective study comparing cemented and cementless total knee replacement: Results of press-fit condylar total knee replacement at five years. J Bone Joint Surg Br. 1998;80-B:971-5.
7. Ali MS, Mangaleshkar SR. Uncemented rotating-platform total knee arthroplasty: A 4-year to 12-year follow-up. J Arthroplasty. 2006;21:80-4.
8. Sharma S, Nicol F, Hullin MG, McCreath SW. Long-term results of the uncemented low contact stress total knee replacement in patients with rheumatoid arthritis. J Bone Joint Surg Br. 2005;87-B:1077-80.
9. Sorrells RB, Voorhorst PE, Murphy JA, Bauschka MP, Greenwald AS. Uncemented rotating-platform total knee replacement: A five to twelve-year follow-up study. J Bone Joint Surg Am. 2004;86-A:2156-62.
10. Huang CH, Ma HM, Lee YM, Ho FY. Long-term results of low contact stress mobile-bearing total knee replacements. Clin Orthop Relat Res. 2003;416:265-70.
11. Bassett RW. Results of 1,000 performance knees: Cementless versus cemented fixation. J Arthroplasty. 1998;13:409-13.
12. Whiteside LA. Modelos de prótesis de rodilla no cementados. In: Insall JN, Scott WN, editors. Rodilla. Tomo 2. Madrid. Ed. Marbán; 2006. p. 1705-16.
13. O'Rourke MR, Callaghan JJ, Goetz DD, Sullivan PM, Johnston RC. Osteolysis associated with a cemented modular posterior-cruciate-substituting total knee design: Five to eight-year follow-up. J Bone Joint Surg Am. 2002;84-A:1362-71.
14. Ryd L, Hansson U, Blunn G, Lindstrand A, Toksvig-Larsen S. Failure of partial cementation to achieve implant stability and bone ingrowth: A long-term roentgen stereophotogrammetric study of tibial components. J Orthop Res. 1999;17:311-20.
15. Dennis DA, Komistek RD. Mobile-bearing total knee arthroplasty: Design factors in minimizing wear. Clin Orthop Relat Res. 2006;452:70-7.
16. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res. 1989;248:13-4.
17. Buechel FF Sr, Buechel FF, Pappas MJ, Dalessio J. Twenty-year evaluation of the New Jersey LCS Rotating Platform Knee Replacement. J Knee Surg. 2002;15:84-9.
18. Buechel FF, Buechel FF, Pappas MJ, D'Alessio J. Twenty-year evaluation of meniscal bearing and rotating platform knee replacements. Clin Orthop Relat Res. 2001;388:41-50.
19. Landon GC, Galante JO, Maley MM. Noncemented total knee arthroplasty. Clin Orthop Relat Res. 1986;205:49-57.
20. Robertsson O, Knutson K, Lewold S, Lidgren L. The Swedish Knee Arthroplasty Register 1975–1997: An update with special emphasis on 41.223 knees operated on in 1988–1997. Acta Orthop Scand. 2001;72:503-13.
21. Sánchez-Sotelo J, Ordoñez JM, Prats SB. Results and complications of the low contact stress knee prosthesis. J Arthroplasty. 1999;14:815-21.
22. Bozic KJ, Kinder J, Meneghini RM, Zurakowski D, Rosenberg AG, Galante JO. Implant survivorship and complication rates after total knee arthroplasty with a third-generation cemented system: 5 to 8 years followup. Clin Orthop Relat Res. 2005;430:117-24.
23. Vessely MB, Whaley AL, Harmsen WS, Schleck CD, Berry DJ. Long-term survivorship and failure modes of 1000 cemented condylar total knee arthroplasties. Clin Orthop Relat Res. 2006;452:28-34.
24. Rand JA, Trousdale RT, Ilstrup DM, Harmsen WS. Factors affecting the durability of primary total knee prostheses. J Bone Joint Surg Am. 2003;85-A:259-65.
25. Jordan LR, Olivo JL, Voorhorst PE. Survivorship analysis of cementless meniscal bearing total knee arthroplasty. Clin Orthop Relat Res. 1997;338:119-23.
26. Bert JM. Dislocation/subluxation of meniscal bearing elements after New Jersey low-contact stress total knee arthroplasty. Clin Orthop Relat Res. 1990;254:211-5.
27. Weaver JK, Derkash RS, Greenwald AS. Difficulties with bearing dislocation and breakage using a movable bearing total knee replacement system. Clin Orthop Relat Res. 1993;290:244-52.