# THE CORAIL® HIP SYSTEM:

## Clinical and radiographic outcomes at 25 to 30 years of the CORAIL Uncemented Hip Stem

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# Clinical and Radiographic Outcomes at 25 to 30 Years of the CORAIL Uncemented Hip Stem


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## Introduction

Total Hip Arthroplasty (THA) was introduced over 50 years ago, and its long-term survival is well documented in numerous clinical studies[10,27,28,30,40] and registry investigations.[12,16,18,31,38] There are few published studies, however, that report implant survival beyond 20 years.[1-3,23,26,27,43] Even fewer articles report survival survival up to 30 years, and they all concern the Charnley cemented stem design,[5,6,8,29,44,46] with limitations due to long inclusion periods (> 40 years)[46] or high proportions of deceased patients (~90%).[6]

The CORAIL Uncemented Tapered Stem was introduced 30 years ago, incorporating a thick coat of hydroxylapatite (HA).[42] The clinical and radiographic outcomes of this hip stem are well documented in the literature,[7,9,11,13,17,19,32-34,39] which continues to demonstrate its excellent long-term performance in comparison to other cemented and uncemented stem designs.

The authors have already reported the clinical and radiographic outcomes of the first consecutive series of THAs using the CORAIL Stem,[15] including survival at follow-up of 20 to 25 years.[43] The authors therefore aimed to update and report the clinical and radiographic outcomes of this series at a follow-up of 25 to 30 years, and to calculate the survival for different endpoints of interest. The authors also sought to analyse cases in which the stem was revised to better understand its mechanisms of failure in the long term.

## Patients and Methods

The authors reviewed the records of all 347 consecutive THAs performed between 1986 and 1990 by the same surgeon (AM) using the CORAIL Stem (DePuy Synthes, Leeds, UK). The series comprised 320 patients (24 bilateral) aged 63.3 ± 11.3 years (median, 65; range, 20 – 89) at the index operation. The authors updated the records by contacting all patients, unless they had been noted as deceased with specified date and cause of death, with a confirmation whether any of their THA components had been revised. Patients were contacted by telephone and/or mail to enquire about their general health, and to record any adverse events or revisions that they had on the operated hip. For patients that did not respond, the authors contacted their next of kin or their general practitioner, to update the information.

All patients that responded were invited for clinical and radiographic evaluation. Those unable to travel due to limited mobility or poor health were surveyed by telephone or paper questionnaires, and if possible, were asked to send standard x-rays from their nearest radiology centre. The clinical questionnaire included the Harris Hip Score (HHS) as well as general satisfaction with

the operated hip. The radiographic examination included standard coronal and lateral x-rays of the hip. All x-rays were evaluated independently by two surgeons (AM, LJ) who completed identical forms documenting the type, location, and extent of all radiographic signs (subsidence, osteolysis, radiolucencies, granulomas, etc…). Particular attention was given to x-rays and clinical notes of patients in which the femoral stem had been revised.

Survival analysis was performed for three different endpoints: (i) Revision of the femoral stem for any reason; (ii) Revision of the acetabular cup for any reason; (iii) Reoperation or revision of any component for any reason. The authors estimated survival using the Kaplan-Meier (KM) method and using the Cumulative Incidence Function (CIF), both of which were deemed important for this study. The KM survival is the most commonly reported for joint arthroplasty and enables direct comparison to survival data, while the CIF is recommended for reporting survival at 10 or more years[4,14,20,21,35,45], where risks of revision are overestimated due to greater proportions of patients deceased and/or lost to follow-up.

## Results

Of the initial 347 THAs (320 patients), 12 stems (12 patients) had been revised, 225 hips (205 patients) had deceased and 28 hips (27 patients) were lost to follow-up. This left 82 hips (76 patients) on file with the original stem in place at a mean follow-up of 26.8 ± 1.2 years (median, 27; range, 25 – 30). There were 42 hips in 39 men and 40 hips in 37 women. Their mean age at last follow-up was 82.7 ± 9.0 years (median, 84; range, 57 – 101). It is worth noting that of the 82 hips (76 patients) on file, 27 hips (27 patients) had a revised acetabular cup and 8 hips (8 patients) had a revised polyethylene insert and/or femoral head.

### Clinical outcomes

Full clinical assessment was performed by one surgeon (LJ) on 17 hips (16 patients), while telephone or paper questionnaires were obtained for the 61 hips (57 patients) who were unable to travel to the clinic. The remaining 4 hips (3 patients) could not be evaluated because the patients were either bed-ridden or confined to nursing homes with impaired mobility, but their general practitioner or next of kin confirmed survival of their original stem and specified whether any reoperations or revisions had been performed.

From a total of 73 patients (78 hips) assessed, 70 patients (96%) responded that they were still satisfied with their operation, while 53 patients (72%) affirmed that their hip was totally pain-free. It was possible to calculate the HHS for 71 patients (75 hips) who had a mean score of 81.1 ± 15.4 (median, 84; range, 37 – 100). The majority of patients scored excellent or good on the HHS (Table 1).

| | Harris Hip Score n = 71 | | |
|---|---|---|---|
| Categories | Score | n | (%) |
| Excellent | > 90 | 12 | (16.9%) |
| Good | ≥ 80 | 27 | (38.0%) |
| Fair | ≥ 60 | 25 | (35.2%) |
| Poor | < 60 | 7 | (9.9%) |

**Table 1:** Clinical scores regrouped per outcome

### Radiographic outcomes

Standard coronal and lateral x-rays were available for 38 hips (37 patients). Those included 17 hips (16 patients) that were x-rayed at our centre, and 21 hips (21 patients) that were x-rayed elsewhere. There were no signs of subsidence, migration, pedestal formation, and neither cortical atrophy nor hypertrophy (Figure 1).

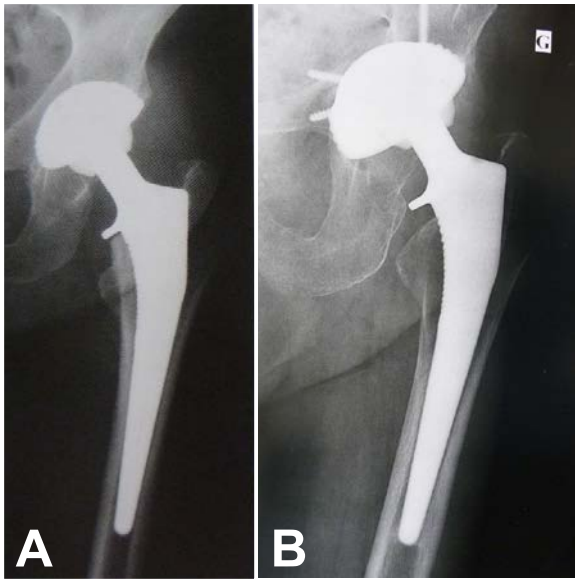


**Figure 1:** (A) Immediate postoperative (patient aged 53 years) and (B) last follow-up (30 years) coronal x-rays showing good osteointegration and no radiographic signs. The patient had undergone revision of the acetabular component 13 years after the index operation, but the original stem is still well-fixed in place.

Radiolucencies were observed around 10 stems (26.3%), all in Gruen zone 1, none exceeding 2 mm in length. Reactive lines were observed around 5 stems (13.1%), 4 in Gruen zone 1, and 1 in Gruen zone 2. Only 1 granuloma was observed in Gruen zone 2 of 1 stem. There were signs of calcar remodelling in 9 hips (23.7%) (Figure 2), as well as calcar lysis (< 5 mm) in 3 hips (7.9%) (Figure 3), and evidence of stress-shielding in only 1 hip (2.6%). Radiographic signs were not correlated with patient age or activity, nor with stem size or positioning (Figure 4). The Sedel score[37] was therefore of grade A in 26 patients, indicating that 68% of patients had 'silent' hips, with both excellent functional outcomes and no radiographic signs (Table 2).

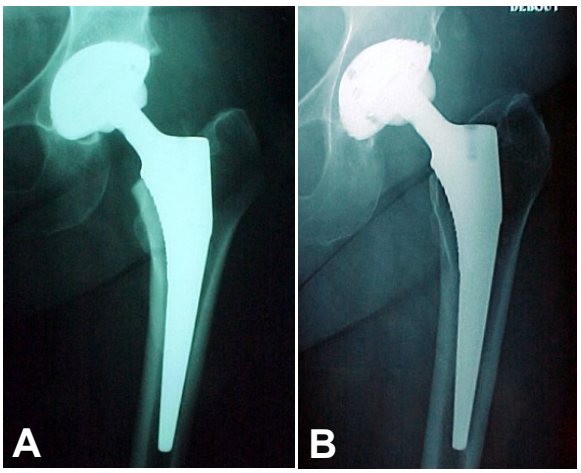


**Figure 2:** (A) Immediate postoperative (patient aged 54 years) and (B) last follow-up (25 years) coronal x-rays showing signs of calcar remodelling without osteolysis.

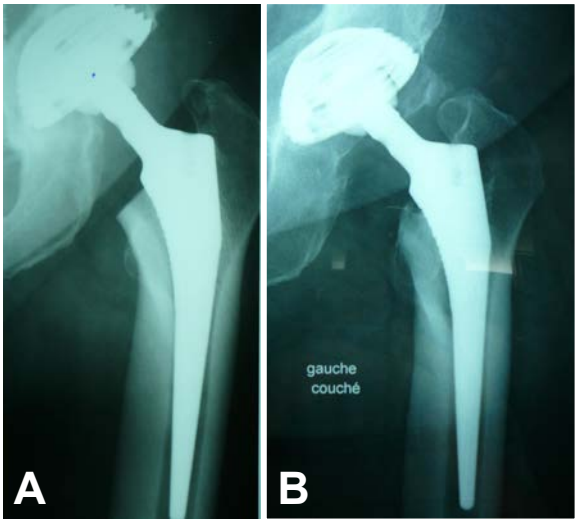


**Figure 3:** (A) Immediate postoperative (patient aged 60 years) and (B) last follow-up (26 years) coronal x-rays showing limited signs of osteolysis.

| Categories | Collared n = 14 n (%) | Collarless n = 24 n (%) | Total n = 38 n (%) |
|---|---|---|---|
| **A** Excellent function and no x-ray symptoms | 12 (86%) | 14 (61%) | 26 (68%) |
| **B** Excellent function with x-ray symptoms | 1 (7%) | 7 (30%) | 8 (21%) |
| **C** Poor function & no x-ray symptoms | 1 (7%) | 1 (4%) | 2 (5%) |
| **D** Poor function with x-ray symptoms | 0 (0%) | 2 (9%) | 2 (5%) |

**Table 2:** Sedel scores for stems with complete clinical and radiographic outcomes

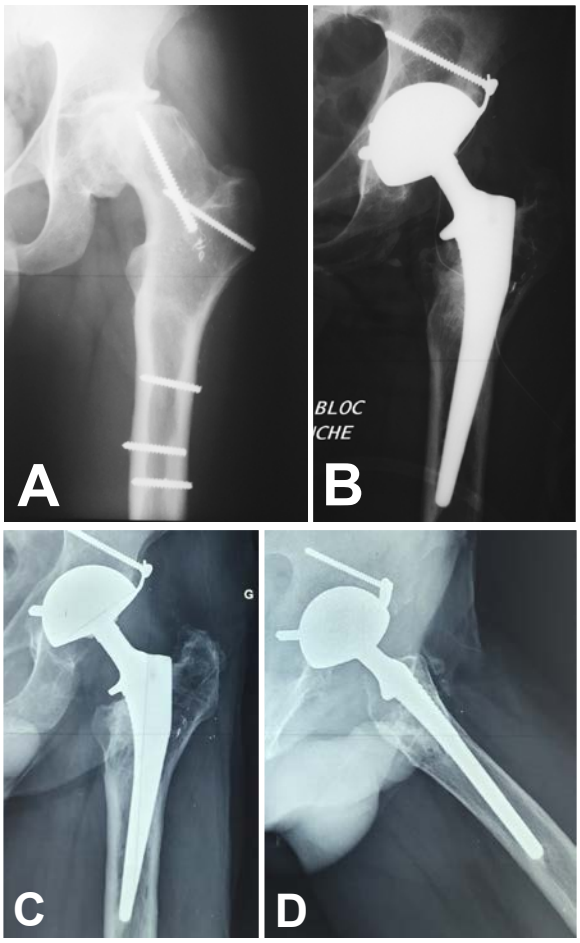


**Figure 4:** (A) preoperative and (B) immediate postoperative (patient aged 41 years) coronal x-rays of a hip corrected by valgus osteotomy; (C) coronal and (D) lateral x-rays at last follow-up (28 years) proving no change in alignment nor any radiographic signs despite initial valgus of stem.

### Survival analysis

Of the initial 347 THAs (320 patients), 86 (24.8%) had a reoperation or revision procedure, of which 37 hips were in deceased patients. The revisions included 12 (3.5%) exchanges of femoral stem (in which the acetabular component was also revised), 55 (15.9%) exchanges of acetabular component, and 17 (4.9%) exchanges of polyethylene insert.

There were only 2 (0.6%) reoperations for simple lavage and/or debridement without any implant removal.

Considering revision of the femoral stem as endpoint, the revision risk (reciprocal of survival) calculated following the KM method was 6.4% (CI, 3.6 – 11.2), while using the CIF it was 3.7% at 30 years (CI, 1.6 – 5.8) (Figure 5). Of the 12 revised stems, the causes of revision were: aseptic loosening (n=1), sepsis (n=1), and size-matching with a revised head-cup combination (n=1), peri-prosthetic fracture (n=4), and granulomas limited to the metaphyseal region without loosening (n=5).

Considering revision of the acetabular cup as endpoint, the revision risk (reciprocal of survival) calculated following the KM method was 32.6% (CI, 26.2 – 40.1), while using the CIF it was 21.0% at 30 years (CI, 16.2 – 24.5%) (Figure 6). The majority of acetabular cups were revised for wear of the polyethylene insert which led to loosening of the acetabular component, but rarely affected fixation of the femoral stem.

Considering any reoperation or revision of any component as endpoint, the revision risk (reciprocal of survival) calculated following the KM method was and was 41.5% (CI, 34.5 – 49.4), while using the CIF it was 26.0% at 30 years (CI, 21.2 – 30.8) (Figure 7).

## Discussion

The aim of the present study was to update and report the long-term outcomes and survival of the CORAIL Hip Stem. By virtue of their advanced age at index operation (63.3 ± 11.3 years; 20 – 89), and because of the long follow-up period (26.8 ± 1.2 years; 25 – 30), large proportions of the patients had died (64.1%) or were lost to follow-up (8.4%). The remaining patients represent just under a quarter of the initial cohort (23.8%), some of whom have

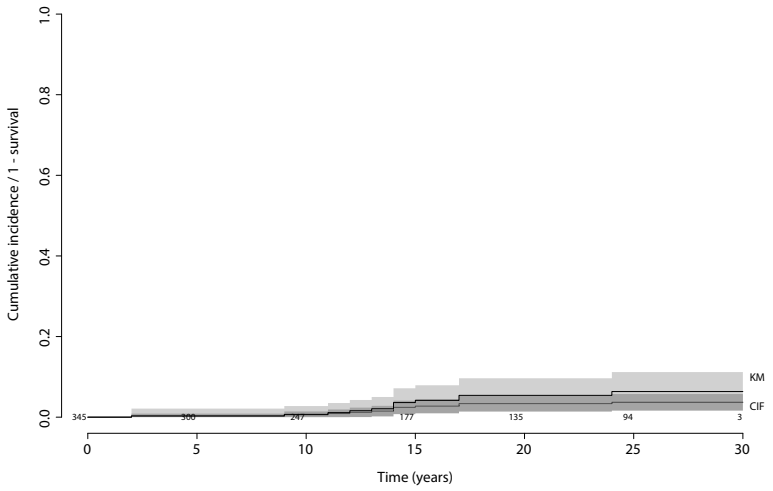


**Figure 5:** Risk of revision (reciprocal of survival) calculated following the KM and CIF considering revision of the femoral stem as endpoint.

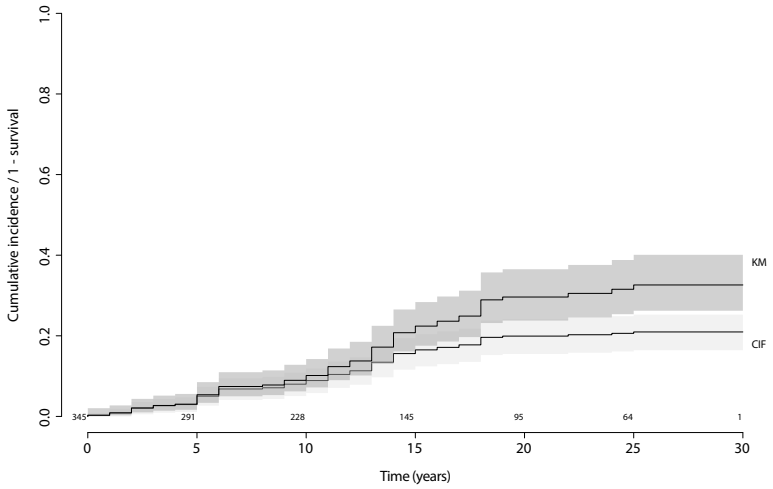


**Figure 6:** Risk of revision (reciprocal of survival) calculated following the KM and CIF considering revision of the acetabular component as endpoint.

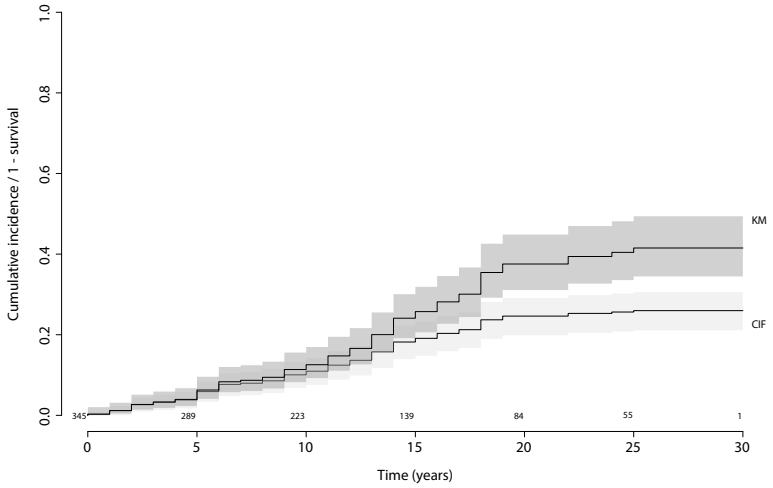


**Figure 7:** Risk of revision (reciprocal of survival) calculated following the KM and CIF considering any révision or reoperation as endpoint.

impaired function and mobility due to pathologies unrelated to the hip. Nearly half of the patients on file had undergone revision of the acetabular cup or liner (46.0%), though most patients remain satisfied (96%) and pain-free (72%).

The only published studies reporting survival of THA at 25 years or longer are on the CHARNLEY Cemented Stem,[5,6,8,29,44,46] with common limitations due to long inclusion periods (> 40 years)[46] or high proportions of deceased patients (~90%).[6] The orginal series of CHARNLEY THAs had 51 of the original 262 patients (19.5%) living and available for follow-up at a minimum of 25 years.[5] The high incidence of deaths and loss to follow-up in survival studies that extend beyond 10 years renders traditional Kaplan-Meyer (KM) estimates somewhat invalid, because the competing risks falsely exaggerate the revision rates.[4,14,20,21,35,45] For this reason, the Cumulative Incidence Function (CIF) is recommended as an alternative or complement, though this method was only recently introduced in orthopaedic research.[21,23,45]

Using the KM method, the 30-year survival of our present series is 93.6% considering stem revision as end point, 67.4% considering acetabular revision as end point, and 58.5% considering any reoperation or revision as end point. Our estimates compare favourably with the 30-year survival of the CHARNLEY THA[5] which were 91% considering stem revision for aseptic loosening as end point, 87% considering acetabular revision for aseptic loosening as end point, and 76% considering revision for any reason as end point. It is important to note the differences in endpoints used in the present study that considers all component revisions, compared to the endpoints used in the CHARNLEY Implant that consider only revisions for aseptic loosening, and could therefore underestimate real revision rates considerably.

Comparing revision rates for the present series using the KM and CIF estimates reveals that the former exaggerates revision rates by 55% to 73%. Nevertheless, the KM estimate is the most frequently reported in the literature so far, and remains the only option for comparison with other THA survivals reported in the literature. To our knowledge, there are few studies reporting outcomes and survival of uncemented stems beyond 20 years of follow-up.[2,10,22,25,27,36,40,41] Streit et al.[41] reported 22-year survival of 86% in 354 CLS stems (Zimmer) without reporting clinical scores. Lombardi et al.[22] reported 20-year survival of 99% in 196 Mallory-Head stems (Biomet) with mean HHS of 83 (range, 18–100) at last follow-up. Corten et al.[10] also reported 20-year survival on 126 Mallory-Head stems (Biomet) of 99% without clinical scores. McLaughlin and Lee[24] published 2-year surivival rate of 99% in 145 Taperloc stems (Biomet) with a mean HHS of 83 (range, 18–100) at last follow-up. Belmont et al.[2] reported 20-year survival of 98% in 223 AML uncemented stems without clinical scores. Finally, Meding et al.[27] reported 20-year survival of 89% on 157 Bi-Metric (Biomet) stems with mean HHS of 87 (range 57-100). Nationwide arthroplasty data is rarely available at follow-up longer than 15 years, but it is worth mentioning the recent study of Hailer et al.[16] who analysed 116,069 THAs performed using 11 different brands of uncemented stems, from the Nordic Arthroplasty Registry Association (four countries). The reported unadjusted 10-year survival was 92% considering revision of any component for any reason as end point, and 97.8% considering stem revision as endpoint.

In the present series using the CORAIL Stem, despite the incidence of acetabular osteolysis due to wear of polyethylene inserts, the femoral fixation was seldom affected beyond the proximal calcar region. Peri-prosthetic bone remodelling was limited, and in most cases proved natural, by comparison to the intact contra-lateral hip. Comparison of serial radiographs revealed great stability of stem fixation beyond 20 postoperative years with no signs of radiolucency, migration nor pedestal formation. Considering both clinical and radiographic outcomes in combination, the Sedel score[37] for our series was of grade A, i.e. clinically and radiographically 'silent' hips, in 68% of patients, which is remarkable considering the very long follow-up of the study.

## Conclusion

The present study is the first to report outcomes and survival of an HA-coated uncemented hip stem beyond 25 years of follow-up. Our results demonstrate excellent survival of the stem and of

the total arthroplasty, in comparison to the world reference CHARNLEY Cemented Stem , and by comparison to shorter-term arthroplasty registry studies. Using the KM method, the 30-year survival of our present series is 93.6% considering stem revision as end point, 67.4% considering acetabular revision as end point, and 58.5% considering any reoperation or revision as end point. It is worth noting that the KM method revision overestimates the revision rates by 55% to 73% due to large proportions of patients deceased and lost to follow-up.

## References


1. Ateschrang A, Weise K, Weller S, Stockle U, de Zwart P, Ochs BG (2014) Long-term results using the straight tapered femoral cementless hip stem in total hip arthroplasty: a minimum of twenty-year follow-up. J Arthroplasty 29 (8):1559-1565.
2. Belmont PJ, Jr., Powers CC, Beykirch SE, Hopper RH, Jr., Engh CA, Jr., Engh CA (2008) Results of the anatomic medullary locking total hip arthroplasty at a minimum of twenty years. A concise follow-up of previous reports. J Bone Joint Surg Am 90 (7):1524-1530.
3. Berry DJ, Kessler M, Morrey BF (1997) Maintaining a hip registry for 25 years. Mayo Clinic experience. Clin Orthop Relat Res (344):61-68.
4. Biau DJ, Latouche A, Porcher R (2007) Competing events influence estimated survival probability: when is Kaplan-Meier analysis appropriate? Clin Orthop Relat Res 462:229-233.
5. Callaghan JJ, Albright JC, Goetz DD, Olejniczak JP, Johnston RC (2000) Charnley total hip arthroplasty with cement. Minimum twenty-five-year follow-up. J Bone Joint Surg Am 82 (4):487-497.
6. Callaghan JJ, Bracha P, Liu SS, Piyaworakhun S, Goetz DD, Johnston RC (2009) Survivorship of a Charnley total hip arthroplasty. A concise follow-up, at a minimum of thirty-five years, of previous reports. J Bone Joint Surg Am 91 (11):2617-2621.
7. Cantin O, Viste A, Desmarchelier R, Besse JL, Fessy MH (2015) Compared fixation and survival of 280 lateralised vs 527 standard cementless stems after two years (1-7). Orthop Traumatol Surg Res 101 (7):775-780.
8. Caton J, Prudhon JL (2011) Over 25 years survival after Charnley's total hip arthroplasty. Int Orthop 35 (2):185-188.
9. Cawley DT, Curtin PD, Lohan D, O'Sullivan M, Curtin W (2011) The CORAIL stem for the treatment of displaced femoral neck fractures - a viable alternative. Hip Int 21 (2):243-250.
10. Corten K, Bourne RB, Charron KD, Au K, Rorabeck CH (2011) What works best, a cemented or cementless primary total hip arthroplasty?: minimum 17-year followup of a randomized controlled trial. Clin Orthop Relat Res 469 (1):209-217.
11. Dawson-Bowling SJ, Jha S, Chettiar KK, East DJ, Gould GC, Apthorp HD (2014) A multidisciplinary enhanced recovery programme allows discharge within two days of total hip replacement; three- to five-year results of 100 patients. Hip Int 24 (2):167-174.
12. Eskelinen A, Paavolainen P, Helenius I, Pulkkinen P, Remes V (2006) Total hip arthroplasty for rheumatoid arthritis in younger patients: 2,557 replacements in the Finnish Arthroplasty Register followed for 0-24 years. Acta Orthop 77 (6):853-865.
13. Faisal M, Thomas G, Young SK (2011) Subsidence of the CORAIL femoral component in the elderly. A retrospective radiological review. Hip Int 21 (3):325-329.
14. Fennema P, Lubsen J (2010) Survival analysis in total joint replacement: an alternative method of accounting for the presence of competing risk. J Bone Joint Surg Br 92 (5):701-706.

15. Froimson MI, Garino J, Machenaud A, Vidalain JP (2007) Minimum 10-year results of a tapered, titanium, hydroxyapatite-coated hip stem: an independent review. J Arthroplasty 22 (1):1-7.
16. Hailer NP, Lazarinis S, Makela KT, Eskelinen A, Fenstad AM, Hallan G, Havelin L, Overgaard S, Pedersen AB, Mehnert F, Karrholm J (2015) Hydroxyapatite coating does not improve uncemented stem survival after total hip arthroplasty! Acta Orthop 86 (1):18-25.
17. Havelin LI, Espehaug B, Vollset SE, Engesaeter LB (1995) Early aseptic loosening of uncemented femoral components in primary total hip replacement. A review based on the Norwegian Arthroplasty Register. J Bone Joint Surg Br 77 (1):11-17.
18. Havelin LI, Fenstad AM, Salomonsson R, Mehnert F, Furnes O, Overgaard S, Pedersen AB, Herberts P, Karrholm J, Garellick G (2009) The Nordic Arthroplasty Register Association: a unique collaboration between 3 national hip arthroplasty registries with 280,201 THRs. Acta Orthop 80 (4):393-401.
19. Jameson SS, Baker PN, Mason J, Rymaszewska M, Gregg PJ, Deehan DJ, Reed MR (2013) Independent predictors of failure up to 7.5 years after 35 386 single-brand cementless total hip replacements: a retrospective cohort study using National Joint Registry data. Bone Joint J 95-b (6):747-757.
20. Keurentjes JC, Fiocco M, Schreurs BW, Pijls BG, Nouta KA, Nelissen RG (2012) Revision surgery is overestimated in hip replacement. Bone Joint Res 1 (10):258-262.
21. Lacny S, Wilson T, Clement F, Roberts DJ, Faris PD, Ghali WA, Marshall DA (2015) Kaplan-Meier Survival Analysis Overestimates the Risk of Revision Arthroplasty: A Meta-analysis. Clin Orthop Relat Res 473 (11):3431-3442.
22. Lombardi AV, Jr., Berend KR, Mallory TH, Skeels MD, Adams JB (2009) Survivorship of 2000 tapered titanium porous plasma-sprayed femoral components. Clin Orthop Relat Res 467 (1):146-154.
23. Martin CT, Callaghan JJ, Gao Y, Pugely AJ, Liu SS, Warth LC, Goetz DD (2016) What Can We Learn From 20-year Followup Studies of Hip Replacement? Clin Orthop Relat Res 474 (2):402-407.
24. McLaughlin JR, Lee KR (2008) Total hip arthroplasty with an uncemented tapered femoral component. J Bone Joint Surg Am 90 (6):1290-1296.
25. McLaughlin JR, Lee KR (2010) Uncemented total hip arthroplasty with a tapered femoral component: a 22- to 26-year follow-up study. Orthopedics 33 (9):639.
26. McLaughlin JR, Lee KR (2015) Total Hip Arthroplasty With an Uncemented Tapered Femoral Component in Patients Younger Than 50 Years of Age: A Minimum 20-Year Follow-Up Study. J Arthroplasty.
27. Meding JB, Ritter MA, Keating EM, Berend ME (2015) Twenty-year followup of an uncemented stem in primary THA. Clin Orthop Relat Res 473 (2):543-548.
28. Mesnil P, Vasseur L, Wavreille G, Fontaine C, Duquennoy A, Migaud H (2014) Is cemented metal-polyethylene 22.2mm hip arthroplasty a gold standard? Results of a series of 105 primary arthroplasties at a minimum of ten years follow-up. Orthop Traumatol Surg Res 100 (4):369-373.
29. Mullins MM, Norbury W, Dowell JK, Heywood-Waddington M (2007) Thirty-year results of a prospective study of Charnley total hip arthroplasty by the posterior approach. J Arthroplasty 22 (6):833-839.
30. Older J (2002) Charnley low-friction arthroplasty: a worldwide retrospective review at 15 to 20 years. J Arthroplasty 17 (6):675-680.
31. Paxton E, Cafri G, Havelin L, Stea S, Palliso F, Graves S, Hoeffel D, Sedrakyan A (2014) Risk of revision following total hip arthroplasty: metal-on-conventional polyethylene compared with metal-on-highly cross-linked polyethylene bearing surfaces: international results from six registries. J Bone Joint Surg Am 96 Suppl 1:19-24.

32. Pennington M, Grieve R, Black N, van der Meulen JH (2013) Functional outcome, revision rates and mortality after primary total hip replacement--a national comparison of nine prosthesis brands in England. PLoS One 8 (9):e73228.
33. Pennington MW, Grieve R, van der Meulen JH (2015) Lifetime cost effectiveness of different brands of prosthesis used for total hip arthroplasty: a study using the NJR dataset. Bone Joint J 97-b (6):762-770.
34. Philippot R, Meucci JF, Boyer B, Farizon F (2013) Modern dual-mobility cup implanted with an uncemented stem: about 100 cases with 12-year follow-up. Surg Technol Int 23:208-212.
35. Porcher R (2015) CORR Insights((R)): Kaplan-Meier Survival Analysis Overestimates the Risk of Revision Arthroplasty: A Meta-analysis. Clin Orthop Relat Res 473 (11):3443-3445.
36. Saito S, Ishii T, Mori S, Hosaka K, Tokuhashi Y (2011) The Harris-Galante cementless THA: a 19- to 25-year follow-up study. Orthopedics 34 (1):12.
37. Sedel L (1995) Long-term results of cemented total hip arthroplasty in patients 45 years old or younger: a 16-year follow-up study. J Arthroplasty 10 (2):255-256.
38. Sedrakyan A, Graves S, Bordini B, Pons M, Havelin L, Mehle S, Paxton E, Barber T, Cafri G (2014) Comparative effectiveness of ceramic-on-ceramic implants in stemmed hip replacement: a multinational study of six national and regional registries. J Bone Joint Surg Am 96 Suppl 1:34-41.
39. Selvaratnam V, Shetty V, Sahni V (2015) Subsidence in Collarless CORAIL Hip Replacement. Open Orthop J 9:194-197.
40. Smith SE, Estok DM, 2nd, Harris WH (2000) 20-year experience with cemented primary and conversion total hip arthroplasty using so-called second-generation cementing techniques in patients aged 50 years or younger. J Arthroplasty 15 (3):263-273.
41. Streit MR, Innmann MM, Merle C, Bruckner T, Aldinger PR, Gotterbarm T (2013) Long-term (20- to 25-year) results of an uncemented tapered titanium femoral component and factors affecting survivorship. Clin Orthop Relat Res 471 (10):3262-3269.
42. Vidalain JP (1997) HA coating. Ten-year experience with the CORAIL system in primary THA. The Artro Group. Acta Orthop Belg 63 Suppl 1:93-95.
43. Vidalain JP (2011) Twenty-year results of the cementless CORAIL stem. Int Orthop 35 (2):189-194.
44. Warth LC, Callaghan JJ, Liu SS, Klaassen AL, Goetz DD, Johnston RC (2014) Thirty-five-year results after Charnley total hip arthroplasty in patients less than fifty years old. A concise follow-up of previous reports. J Bone Joint Surg Am 96 (21):1814-1819.
45. Wongworawat MD, Dobbs MB, Gebhardt MC, Gioe TJ, Leopold SS, Manner PA, Rimnac CM, Porcher R (2015) Editorial: Estimating survivorship in the face of competing risks. Clin Orthop Relat Res 473 (4):1173-1176.
46. Wroblewski BM, Siney PD, Fleming PA (2007) Charnley low-friction arthroplasty: survival patterns to 38 years. J Bone Joint Surg Br 89 (8):1015-1018.

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