Cementless fixation in total knee arthroplasty

DOWN THE BOULEVARD OF BROKEN DREAMS – AFFIRMS

C. S. Ranawat,
M. Meftah,
E. N. Windsor,
A. S. Ranawat

*From Hospital for
Special Surgery, New
York, New York
United States*

There has been a recent increase in interest for non-cemented fixation in total knee arthroplasty (TKA), however the superiority of cement fixation is an ongoing debate.

Whereas the results based on Level III and IV evidence show similar survivorship rates between the two types of fixation, Level I and II evidence strongly support cemented fixation. United Kingdom, Australia, Sweden, and New Zealand registry data show lower failure rates and greater usage of cemented than non-cemented fixation. Case series studies have also indicated greater functional outcomes and lower revision rates among cemented TKAs. Non-cemented fixation involves more patellofemoral complications, including increased susceptibility to wear due to a thinner polyethylene bearing on the cementless metal-backed component. The combination of results from registry data, prospective randomised studies, and meta-analyses support the current superiority of cemented fixation in TKAs.

There has been an ongoing debate over the use of cemented versus non-cemented fixation in total knee arthroplasty (TKA) in terms of functional outcomes and survivorship for mechanical failures.¹⁻⁹ The long-term results of TKA, to a very large extent, depend on the design of the prosthesis,^{1,4,5} the restoration of mechanical alignment, soft-tissue balancing,^{2,3} and the type of fixation.^{10,11} Other factors influencing outcomes are the patient age, body weight and activity level.¹²

While cementless fixation is gaining wider acceptance, there is considerable evidence in several meta-analyses and national registry data supporting the superiority of cemented fixation in TKA in terms of improved survivorship.^{6-9,13} Non-cemented fixation may be more sensitive to malalignment, especially on the tibial side, since sheer forces caused by varus or valgus tibial base plate positioning will alter the compressive forces distributed across the implant-bone interface.^{14,15}

The aim of this investigation was to review and critically evaluate the published literature to defend the clinical superiority of cemented fixation in TKA.

Published literature and level of evidence

We reviewed the literature based on the level of evidence, including case series, prospective case control studies, meta-analyses, registry data, and prospective randomised studies.¹⁶

Since 1974, many case series have been published to document safety, efficacy and reliability of cemented fixation in TKA. Various studies have shown that the survivorship for mechanical failure of cemented TKA is between 90% to 97% at 10 to 15 years,^{2,17-19} and is between 85% and 98% at 15 to 20 years follow-up.^{3,20-26}

The results of various case series studies (Level IV evidence) on survivorship of non-cemented fixation for mechanical failure is 76.4% to 98.6% at 10 to 20 years.^{12,25,27-39} In one such case series, cemented fixation was found to show better results at 15-year follow-up as reported by Baker et al.⁴⁰ While the sum total of the results of Level III and IV evidence between cemented and non-cemented survivorship rates is not so dissimilar, the Level I and II evidence strongly suggests the superiority of cemented fixation in TKA.

Registry data

The failure rate for cemented and non-cemented fixation is 3.81% and 4.75% in the UK registry, 5.6% and 6.2% in the Australian registry, 9% and 23% in the Sweden registry, and 4.28% and 6.93% in the New Zealand registry, respectively⁶⁻⁹ (Table I). In addition, registry data on the usage of non-cemented versus cemented TKA supports a trend of preference in use of cemented fixation by surgeons (Table II). According to the National Joint Registry (NJR) in England, cemented fixation

■ C. S. Ranawat, MD, Professor of Orthopaedic Surgery
■ A. S. Ranawat, MD, Associate Professor of Orthopaedic Surgery
Weill Medical College of Cornell University, 1300 York Avenue, New York, New York 10065, USA.

■ M. Meftah, MD, Adult Reconstruction Research Fellow
■ E. N. Windsor, BS, Clinical Research Assistant
Hospital for Special Surgery, 535 E. 70th Street, New York, New York 10021, USA.

Correspondence should be sent to M. Meftah; e-mail: meftahm@hss.edu

©2012 British Editorial Society of Bone and Joint Surgery
doi:10.1302/0301-620X.94B11.30826 \$2.00

J Bone Joint Surg Br
2012;94-B, Supple A:82-4.

Table I. Failure rate of cemented and non-cemented fixation in registry data.

Registry	Cemented fixation	Non-cemented fixation
NJR-England ⁶	3.81%	4.75%
Australian ⁷	5.6%	6.2%
Swedish (up to 1994) ⁸	9%	23%
New Zealand ⁹	4.28%	6.93%

Table II. Percentage rate of preference usage by surgeons in cemented and non-cemented fixation based on registry data

Registry	Cemented fixation	Non-cemented fixation
NJR-England ⁶	85%	5%
Australian ⁷	55%	29%
Swedish (up to 1994) ⁸	95%	3%
New Zealand ⁹	89%	4%

is used 85% of the time, whereas non-cemented is used only 5% of the time.⁶ The Australian registry report shows that the usage of cemented fixation is 55% compared to 29% for non-cemented fixation.⁷ The Swedish registry up to 1994 shows the greatest usage of cemented fixation at 95% as opposed to only 3% for non-cemented fixation.⁸ According to the New Zealand registry, cemented fixation is preferred 89% of the time compared to their non-cemented usage rate of only 4%.⁹

Level I and II studies

Two prospective, randomised studies further document superior results for cemented fixation in TKA. Park et al⁴¹ showed better results for cemented fixation over non-cemented fixation at 14-year follow-up. A recent meta-analysis concluded that cemented fixation has better survivorship.¹²

Functional outcomes

In our own case series on a Quality of Life Analysis after Cemented TKA, excellent functional outcomes were found for cemented fixation. We identified 81 matched-pairs of rotating-platform *versus* fixed-bearing metal-backed designs in patients matched for age, BMI, and gender.⁴² Our results indicated an improved range of motion (ROM) from 110° prior to surgery to 125° following cemented fixation. A total of 50% of patients were able to participate in various types of sporting activities, based on a validated self reported patient administered questionnaire (PAQ), confirming that quality of function is excellent following cemented fixation in both fixed and rotating-platform TKA (Table III). In our most recent study of rotating platform TKA, 117 patients were followed prospectively for ten years. The mean Knee Society pain score had improved from 44.1 points pre-operatively to 94.3 points post-operatively, and the mean Knee Society function score had improved from 39.4 to 90.2 points.¹⁷

Table III. Sporting activity following cemented fixation in both rotating platform and fixed bearing TKAs.⁴⁰

Activity	RP (%)	FB (%)
Walking*	88	86
Swimming	27	17
Golf	21	11
Tennis	8	2
Gym	33	18

*Walking = More than 4 blocks/day

Comparative survivorship

In a comparative case series survivorship analysis of cemented versus non-cemented Press Fit Condylar TKAs at ten years follow-up, Duffy et al²⁹ found a significantly higher revision rate in the non-cemented group. They found 72% survivorship for femoral or tibial aseptic loosening or osteolysis (10 revisions) in the non-cemented *versus* 94% (2 revisions) in the cemented group.

Patellofemoral complications

The long-term results of cemented all-polyethylene patellar buttons have demonstrated excellent long-term survivorship.⁴³ However, patellofemoral complications are different in cementless patellar resurfacing. Whereas most cementless TKA procedures incorporate cementless femoral and tibial component fixation with cemented all-polyethylene buttons, some make use of a metal-backed component that is either fixed to the polyethylene articular surface or permits rotation of a polyethylene bearing that is a snap-fit onto the metal prosthesis. The polyethylene thickness on a metal-backed prosthesis is thinner, making the implant more susceptible to wear over the long term. Wear-through of the polyethylene surface causes eventual metal-on-metal wear of the femoral and patellar components. Rotating polyethylene-on-metal patellar implants are also associated with component dissociation of the polyethylene from the metal backing. If later revision is necessary, removal of a metal-backed cementless component is associated with greater patellar bone-stock loss.⁴⁴

Conclusion

Based on level I and II studies, registry data and meta-analyses, cemented fixation in TKA has superior and more durable fixation with better survivorship for mechanical failure as compared to non-cemented fixation. Moreover, registry data clearly indicates a greater usage of cemented TKA. Further advancements in non-cemented implant design are needed to achieve better and more reproducible biologic fixation. At present, cemented fixation in TKA is the gold standard.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

This paper is based on a study which was presented at the Winter 2011 Current Concepts in Joint Replacement meeting in Orlando, Florida, 7th – 10th December.

References

1. Vessely MB, Whaley AL, Harmsen WS, et al. Long term survivorship and failure modes of 1000 cemented condylar total knee arthroplasties. *Clin Orthop Relat Res* 2006;452:28–34.
2. Rasquinha VJ, Ranawat CS, Cervieri CL, Rodriguez JA. The press-fit condylar modular total knee system with a posterior cruciate-substituting design: a concise follow-up of a previous report. *J Bone Joint Surg [Am]* 2006;88-A:1006–1010.
3. Font-Rodriguez DE, Scuderi GR, Insall JN. Survivorship of cemented total knee arthroplasty. *Clin Orthop Relat Res* 1997;345:79–86.
4. Buechel FF Sr. Long-term followup after mobile-bearing total knee replacement. *Clin Orthop Relat Res* 2002;404:40–50.
5. Stiehl JB, Hamelynck KJ, Voorhorst PE. International multi-centre survivorship analysis of mobile bearing total knee arthroplasty. *Int Orthop* 2006;30:190–199.
6. No authors listed. National Joint Registry for England and Wales: 8th Annual report, 2011. <http://www.njrcentre.org.uk> (date last accessed 4 September 2012).
7. No authors listed. Australian Orthopaedic Association National Joint Replacement Registry. Annual Report 2009. www.dmac.adelaide.edu.au/aoanjjr (date last accessed 4 September 2012).
8. Sundberg M, Lidgren L, W-Dahl A, Robertsson O. The Swedish Knee Arthroplasty Register: annual report, 2011. http://www.knee.nko.se/english/online/uploadedFiles/115_SKAR2011_Eng1.0.pdf (date last accessed 4 September 2012).
9. Rothwell A, Hobbs T, Frampton C. New Zealand Orthopaedic Association: New Zealand Joint Registry: Twelve Year Report January 1999 to December 2010. 2011. www.cdhb.govt.nz/NJR (date last accessed 4 September 2012).
10. Dodd CA, Hungerford DS, Krackow KA. Total knee arthroplasty fixation: comparison of the early results of paired cemented versus uncemented porous coated anatomic knee prosthesis. *Clin Orthop Relat Res* 1990;260:66–70.
11. Akizuki S, Takizawa T, Horiuchi H. Fixation of a hydroxyapatite-tricalcium phosphate-coated cementless knee prosthesis: clinical and radiographic evaluation seven years after surgery. *J Bone Joint Surg [Br]* 2003;85-B:1123–1127.
12. Dahm DL, Barnes SA, Harrington JR, Sayeed SA, Berry DJ. Patient-reported activity level after total knee arthroplasty. *J Arthroplasty* 2008;23:401–407.
13. Gandhi R, Tsvetkov D, Davey JR, Mahomed NN. Survival and clinical function of cemented and uncemented prostheses in total knee replacement: a meta-analysis. *J Bone Joint Surg [Br]* 2009;91-B:889–895.
14. Efe T, Figiel J, Danek S, et al. Initial stability of tibial components in primary knee arthroplasty: a cadaver study comparing cemented and cementless fixation techniques. *Acta Orthop Belg* 2011;77:320–328.
15. McCaskie AW, Deehan DJ, Green TP, 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:971–975.
16. Wright JG, Swiontkowski MF, Heckman JD. Introducing levels of evidence to the journal. *J Bone Joint Surg [Am]* 2003;85-A:1–3.
17. Meftah M, Ranawat AS, Ranawat CS. Ten-year follow-up of a rotating-platform, posterior-stabilized total knee arthroplasty. *J Bone Joint Surg [Am]* 2012;94-A:426–432.
18. Ranawat CS, Flynn WF Jr, Deshmukh RG. Impact of modern technique on long-term results of total condylar knee arthroplasty. *Clin Orthop Relat Res* 1994;309:131–135.
19. Ranawat CS, Flynn WF Jr, Saddle S, Hansraj KK, Maynard MJ. Long-term results of the total condylar knee arthroplasty: a 15-year survivorship study. *Clin Orthop Relat Res* 1993;286:94–102.
20. Rodriguez JA, Bhende H, Ranawat CS. Total condylar knee replacement: a 20-year followup study. *Clin Orthop Relat Res* 2001;388:10–17.
21. Lachiewicz PF, Soileau ES. Fifteen-year survival and osteolysis associated with a modular posterior stabilized knee replacement: a concise follow-up of a previous report. *J Bone Joint Surg [Am]* 2009;91-A:1419–1423.
22. Abdeen AR, Collen SR, Vince KG. Fifteen-year to 19-year follow-up of the Insall-Burstein-1 total knee arthroplasty. *J Arthroplasty* 2010;25:173–178.
23. Callaghan JJ, O'Rourke MR, Iossi MF, et al. Cemented rotating-platform total knee replacement: a concise follow-up, at a minimum of fifteen years, of a previous report. *J Bone Joint Surg [Am]* 2005;87-A:1995–1998.
24. Dixon MC, Brown RR, Parsch D, Scott RD. Modular fixed-bearing total knee arthroplasty with retention of the posterior cruciate ligament: a study of patients followed for a minimum of fifteen years. *J Bone Joint Surg [Am]* 2005;87-A:598–603.
25. Buechel FF Sr, Buechel FF Jr, Pappas MJ, Dalessio J. Twenty-year evaluation of the New Jersey LCS Rotating Platform Knee Replacement. *J Knee Surg* 2002;15:84–89.
26. Ritter MA, Worland R, Saliski J, et al. Flat-on-flat, nonconstrained, compression molded polyethylene total knee replacement. *Clin Orthop Relat Res* 1995;321:79–85.
27. Demey G, Servien E, Lustig S, Ait Si Selmi T, Neyret P. Cemented versus uncemented femoral components in total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1053–1059.
28. Gao F, Henricson A, Nilsson KG. Cemented versus uncemented fixation of the femoral component of the NexGen CR total knee replacement in patients younger than 60 years: a prospective randomized controlled RSA study. *Knee* 2009;16:200–206.
29. Duffy GP, Berry DJ, Rand JA. Cement versus cementless fixation in total knee arthroplasty. *Clin Orthop Relat Res* 1998;356:66–72.
30. Gicquel P, Kempf JF, Gastaud F, Schlemmer B, Bonnet F. Comparative study of fixation mode in total knee arthroplasty with preservation of the posterior cruciate ligament. *Rev Chir Orthop Reparatrice Appar Mot* 2000;86:240–9 (in French).
31. Albrektsson BE, Carlsson LV, Freeman MA, Herberts P, Ryd L. Proximally cemented versus uncemented Freeman-Samuels knee arthroplasty: a prospective randomized study. *J Bone Joint Surg [Br]* 1992;74-B:233–238.
32. Delaunay C, Blatter G, Canciani JP, et al. Survival analysis of an asymmetric primary total knee replacement: a European multicenter prospective study. *Orthop Traumatol Surg Res* 2010;96:769–776.
33. Ritter MA, Meneghini RM. Twenty-year survivorship of cementless anatomic graduated component total knee arthroplasty. *J Arthroplasty* 2010;25:507–513.
34. Chana R, Shenava Y, Nicholl AP, et al. Five- to 8-year results of the uncemented Duracon total knee arthroplasty system. *J Arthroplasty* 2008;23:677–682.
35. Hardeman F, Vandenneucker H, Van Lauwe J, Bellemans J. Cementless total knee arthroplasty with Profix: a 8- to 10-year follow-up study. *Knee* 2006;13:419–421.
36. Oliver MC, Keast-Butler OD, Hinves BL, Shepperd JA. A hydroxyapatite-coated Insall-Burstein II total knee replacement: 11-year results. *J Bone Joint Surg [Br]* 2005;87-B:478–482.
37. Hofmann AA, Evanich JD, Ferguson RP, Camargo MP. Ten- to 14-year clinical followup of the cementless Natural Knee system. *Clin Orthop Relat Res* 2001;388:85–94.
38. Schroder HM, Berthelsen A, Hassani G, Hansen EB, Solgaard S. Cementless porous-coated total knee arthroplasty: 10-year results in a consecutive series. *J Arthroplasty* 2001;16:559–567.
39. Whiteside LA. Cementless total knee replacement: nine- to 11-year results and 10-year survivorship analysis. *Clin Orthop Relat Res* 1994;309:185–192.
40. Baker PN, Khaw FM, Kirk LM, Esler CN, Gregg PJ. A randomized controlled trial of cemented versus cementless press-fit condylar total knee replacement: 15-year survival analysis. *J Bone Joint Surg [Br]* 2007;89-B:1608–1614.
41. Park JW, Kim YH. Simultaneous cemented and cementless total knee replacement in the same patients: a prospective comparison of long-term outcomes using an identical design of NexGen prosthesis. *J Bone Joint Surg [Br]* 2011;93-B:1479–1486.
42. Ranawat CS, Luessenhop CP, Rodriguez JA. The press-fit condylar modular total knee system: four-to-six-year results with a posterior-cruciate-substituting design. *J Bone Joint Surg [Am]* 1997;79-A:342–348.
43. Meftah M, Jhurani A, Bhat JA, Ranawat AS, Ranawat CS. The effect of patellar replacement technique on patellofemoral complications and anterior knee pain. *J Arthroplasty* 2012;27:1075–1080.
44. Dodd CA, Hungerford DS, Krackow KA. Total knee arthroplasty fixation: comparison of the early results of paired cemented versus uncemented porous coated anatomic knee prosthesis. *Clin Orthop Relat Res* 1990;260:66–70.