Surgical Approaches to OA Therapy: Osteotomy and Arthroplasty

John J. Callaghan, MD

Received: 26 August 2011/Accepted: 1 November 2011/Published online: 28 December 2011
© Hospital for Special Surgery 2011

Keywords osteoarthritis · total hip arthroplasty

Introduction

Total hip and knee replacement are among the most successful surgical procedures in medicine. The long-term survival of total hip replacements for which both the femoral and acetabular components were fixed to the surrounding bones with cement demonstrates durable results [1, 3], even in young patients [11]. For example, 35-year follow-up of cemented total hip replacements revealed a survival rate of 78% with the need for revision surgery for any reason as the end point [3]. In younger patients, the 25-year survival is 93% for the femoral component, though only 77% for the cemented acetabular component [11].

The introduction of newer designs that relies on biologic fixation through bone ingrowth into porous coatings on the metallic components has also proven durable. Twenty-year survival of porous-coated acetabular components has been reported at 86% [6] with revision for any reason associated with the acetabular component as the end point. In a direct comparison of cemented and cementless acetabular components performed by the same surgeon [8], survival at 18 years improved from 81% to 94%. Long-term results for porous-coated femoral components are just as impressive [2, 7, 9].

Joint replacement patients enjoy function which is comparable to their peers without osteoarthritis. Patient-reported outcomes such as the short-form health outcomes survey (the SF-36), together with objective functional measures, such as the 6-min walk, show no meaningful differences between total hip patients and normative values (Fig. 1).

The major problem remaining in total hip replacement is the bearing surface. Osteolysis caused by the biological reaction to wear debris remains a common mode of failure. Considerable improvement has been made in the wear resistance of bearing surfaces, most recently by the widespread adoption of highly

cross-linked polyethylene for acetabular components. Randomized clinical trials comparing cross-linked to conventional polyethylene show reductions in wear and osteolysis [13], though follow-up is not long enough at this time to determine the impact of these improvements on the need for revision surgery.

Like total hip replacement, total knee replacement has similar durable results up to 10 to 20 years [4, 8–20]. Unicondylar knee replacement, in which only one compartment is replaced, has similar outstanding results, at least in older patients, though younger patients have not fared as well at long-term follow-up [17]. As with hip replacement, wear and osteolysis are major issues, particularly with modular designs for which backside wear between the polyethylene insert and the metallic tray provides an added source of debris [14]. This appears to apply especially in young, active osteoarthritis patients [16]. Similarly, mobile-bearing designs which incorporate a second bearing surface between the tibial insert and the tibial tray have an excellent long-term survival, but osteolysis secondary to an increased burden of wear debris appears to increase with time [4]. Cementless fixation has not gained acceptance in total knee replacement as it has in total hip replacement, despite promising long-term results [10].

Osteotomies are another surgical treatment for osteoarthritis, aimed at realigning joint surfaces and thus delaying disease progression. Newer procedures for osteotomies around the hip are encouraging at mid-term follow-up, with acceptable complications when performed by well-trained surgeons [5]. Knee procedures include closing and opening wedge osteotomies performed in the proximal tibia. Closing wedge osteotomies have produced unpredictable results that are not always durable [15]. Newer opening wedge osteotomies may provide more durable and more predictable results, but no long-term follow-up is available.

Incomplete Evidence of Outcome in the Surgical Treatment of OA

For hip replacement, the challenge remains to determine the optimal bearing surface and the clinical factors that may affect the choice of bearing surface. Another overriding

J. J. Callaghan, MD (✉)
Department of Orthopaedics,
University of Iowa, VA Medical Center,
200 Hawkins Drive, UIHC, 01029 JPP,
Iowa City, IA 52242, USA
e-mail: john-callaghan@uiowa.edu

Fig. 1. SF-36 scores for total hip replacement patients (“Study”), those patients with two or more comorbidities, and normative values (“Norm”) demonstrate that total hip patients reach levels found in the normal age-matched population after their surgery

concern that affects new bearing surfaces as well as many other innovations in orthopedic implants and instrumentation is the way in which new technologies introduced into the orthopedic marketplace.

For knee replacement and knee osteotomy, additional data are required to help patients and surgeons make decisions regarding the choice and the compromises among high tibial osteotomy, unicondylar knee replacement, and total knee replacement. Additional studies are required to establish the outcomes and performance of knee replacement in younger patients. Studies should also explore the benefits of newer techniques of high tibial osteotomy. Do they burn bridges in that they make subsequent surgical choices more difficult should the osteoarthritis continue to progress?

For hip osteotomy, durability of the construct is of paramount importance, since only short-term follow-up results have been reported thus far. As with high tibial osteotomy, what bridges are burned by performing osteotomies about the hip, if subsequent hip replacement is required to treat progression of osteoarthritis?

Directions of Future Research

Because a huge number of patients will be seeking joint replacement for their end-stage osteoarthritis [12], we must develop cost-effective strategies that are evidence based. Unfortunately, the long-term follow-up studies to date provide us with limited data concerning what are the most durable designs and materials for joint replacement. Future studies to determine optimal designs and materials must emphasize young age group cohorts, which will probably require multicenter studies to accumulate enough reliable data. Prospective randomized studies in these cohorts would be optimal, but as a minimum, some form of prospective practice surveillance (including patient registries) will be needed. New technology must be introduced cautiously, while in a manner that does not slow the pace of innovations that could improve patient care.

For knee replacement surgery, work must be done to determine why a cohort of patients (up to 15% in some studies) is dissatisfied with the procedure. For osteotomy procedures, we must define who are the optimal candidates and seek to understand if there are cohorts of patients that do worse with conversion from an osteotomy to total joint replacement.

Disclosure The author reports the disclosure of receiving royalties (from DePuy) for intellectual property transfer for hip and knee implant designs and royalties (from Lippincott Williams & Wilkins) for books edited.

References

1. Berry DJ, Harmsen WS, Cabanela ME, Morrey BF. Twenty-five-year survivorship of two thousand consecutive primary Charnley total hip replacements: factors affecting survivorship of acetabular and femoral components. *J Bone Joint Surg Am.* 2002 Feb;84-A(2):171–7.
2. Bojescul JA, Xenos JS, Callaghan JJ, Savory CG. Results of porous-coated anatomic total hip arthroplasty without cement at fifteen years: a concise follow-up of a previous report. *J Bone Joint Surg Am.* 2003 Jun;85-A(6):1079–83.
3. Callaghan JJ, Bracha P, Liu SS, Piyaworakhun S, Goetz DD, Johnston RC. 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.* 2009 Nov;91(11):2617–21.
4. Callaghan JJ, Wells CW, Liu SS, Goetz DD, Johnston RC. Cemented rotating-platform total knee replacement: a concise follow-up, at a minimum of twenty years, of a previous report. *J Bone Joint Surg Am.* 2010 Jul 7;92(7):1635–9.
5. Clohisy JC, St John LC, Schutz AL. Surgical treatment of femoroacetabular impingement: a systematic review of the literature. *Clin Orthop Relat Res.* 2010 Feb;468(2):555–64.
6. Della Valle CJ, Mesko NW, Quigley L, Rosenberg AG, Jacobs JJ, Galante JO. Primary total hip arthroplasty with a porous-coated acetabular component. A concise follow-up, at a minimum of twenty years, of previous reports. *J Bone Joint Surg Am.* 2009 May;91(5):1130–5.
7. Engh CA Jr, Claus AM, Hopper RH Jr, Engh CA. Long-term results using the anatomic medullary locking hip prosthesis. *Clin Orthop Relat Res.* 2001 Dec;(393):137–46.

8. Gaffey JL, Callaghan JJ, Pedersen DR, Goetz DD, Sullivan PM, Johnston RC. Cementless acetabular fixation at fifteen years. A comparison with the same surgeon's results following acetabular fixation with cement. *J Bone Joint Surg Am*. 2004 Feb;86-A(2):257–61.
9. Hennessy DW, Callaghan JJ, Liu SS. Second-generation extensively porous-coated THA stems at minimum 10-year followup. *Clin Orthop Relat Res*. 2009 Sep;467(9):2290–6.
10. 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 Jul;(388):85–94.
11. Keener JD, Callaghan JJ, Goetz DD, Pederson DR, Sullivan PM, Johnston RC. Twenty-five-year results after Charnley total hip arthroplasty in patients less than fifty years old: a concise follow-up of a previous report. *J Bone Joint Surg Am*. 2003 Jun;85-A(6):1066–72.
12. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am*. 2007 Apr;89(4):780–5.
13. Kuzyk PR, Saccone M, Sprague S, Simunovic N, Bhandari M, Schemitsch EH. Cross-linked versus conventional polyethylene for total hip replacement: a meta-analysis of randomised controlled trials. *J Bone Joint Surg Br*. 2011 May;93(5):593–600.
14. Malin AS, Callaghan JJ, Bozic KJ, Liu SS, Goetz DD, Sullivan N, Kelley SS. Routine surveillance of modular PFC TKA shows increasing failures after 10 years. *Clin Orthop Relat Res*. 2010 Sep;468(9):2469–76.
15. Naudie D, Bourne RB, Rorabeck CH, Bourne TJ. The Install Award. Survivorship of the high tibial valgus osteotomy. A 10- to –22-year followup study. *Clin Orthop Relat Res*. 1999 Oct;(367):18–27.
16. Odland AN, Callaghan JJ, Liu SS, Wells CW. Wear and lysis is the problem in modular TKA in the young OA patient at 10 years. *Clin Orthop Relat Res*. 2011 Jan;469(1):41–7.
17. O'Rourke MR, Gardner JJ, Callaghan JJ, Liu SS, Goetz DD, Vittetoe DA, Sullivan PM, Johnston RC. The John Insall Award: unicompartmental knee replacement: a minimum twenty-one-year followup, end-result study. *Clin Orthop Relat Res*. 2005 Nov;440:27–37.
18. Pavone V, Boettner F, Fickert S, Sculco TP. Total condylar knee arthroplasty: a long-term followup. *Clin Orthop Relat Res*. 2001 Jul;(388):18–25.
19. Rodriguez JA, Bhende H, Ranawat CS. Total condylar knee replacement: a 20-year followup study. *Clin Orthop Relat Res*. 2001 Jul;(388):10–7.
20. Sextro GS, Berry DJ, Rand JA. Total knee arthroplasty using cruciate-retaining kinematic condylar prosthesis. *Clin Orthop Relat Res*. 2001 Jul;(388):33–40.