A Review Paper

Total Hip Arthroplasty in Young Patients With Osteoarthritis

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Abstract

Total hip arthroplasty (THA), an effective treatment for patients with end-stage arthritic hip conditions, provides dramatic pain relief, enhances mobility, and restores function. The success of THA in older patients, in concert with improvements in techniques and biomaterials, has stimulated demand for this procedure in younger, more active patients hoping to regain full activity. Although young age remains a relative contraindication to THA, the weight of this factor has diminished. Several investigators have reported results of low-friction arthroplasty in young patients. Unfortunately, the value of these studies is limited because of heterogeneous hip pathology in the younger groups, particularly given that preoperative pathology has proved to significantly affect implant survival.

In this review of the literature, we focus on THA survival in young, active patients with a preoperative diagnosis of noninflammatory osteoarthritis.

Total hip arthroplasty (THA), an effective treatment for patients with end-stage arthritic hip conditions, provides dramatic pain relief, enhances mobility, and restores function. In the United States alone, the demand for THA has risen steadily; an estimated 208,000+ primary THAs were performed in 2003.[1] The percentage being performed on patients younger than 60 is increasing steadily and is estimated to be more than 40%.

In 1961, Charnley[2] introduced low-friction arthroplasty (LFA) as an operation suitable for managing older patients and patients with rheumatoid arthritis. More specifically, LFA was reserved for patients older than 65 and for patients with severe pain and gross disability. Although Charnley occasionally performed the procedure in middle-aged patients, he did so reluctantly because of concerns regarding long-term survival in younger, more active patients. Some authors have advocated using an osteotomy or arthrodesis as an alternative to THA,[3-6] but, by the time patients seek medical advice, hip joint degeneration is often too extensive for osteotomy to be considered useful, and arthrodesis often leads to patients' dissatisfaction because of reduced mobility and subsequent back and knee deterioration resulting in pain.

The success of THA in older patients, in concert with improvements in techniques and biomaterials, has stimulated demand for this procedure in younger, more active patients hoping to regain full activity. Although young age remains a relative contraindication to THA, the weight of this factor has diminished since 1972, when Charnley[7] reported his first series of patients, whose mean age was 65 years.

Several investigators have reported LFA results in young patients. In patients 18 to 25 years old, overall implant survival rates have ranged from 65% to 78%, femoral component survival rates from 81% to 95%, and acetabular component survival rates from 68% to 84%.[8-10] Unfortunately, the value of these studies is limited because of heterogeneous hip pathology in these young patients.

Charnley[7] recognized the importance of patient factors other than age and suggested that THA outcomes should be compared in groups of patients only if these groups are similar in other respects. Dorr and colleagues[11] (1983) and Sarmiento and colleagues[12] (1990) were among the first to analyze the long-term survival of cemented prostheses as related to age and underlying disease (osteoarthritis, rheumatoid arthritis, avascular necrosis). In spite of their conflicting results, these 2 investigator groups emphasized the importance of preoperative pathology in implant survival. Since then, several other investigator groups have examined the correlation of survival and preoperative diagnosis.

In this review of the literature, we focus on THA survival in young, active patients with a preoperative diagnosis of noninflammatory osteoarthritis.

Early Studies on Cemented Prostheses

Initial cemented THA in young patients with osteoarthritis showed increased risk for revision because of aseptic loosening associated with osteoarthritis and raised concerns of high rates of long-term failure.[3,11,13-15] At a mean follow-up of 4.5 years, Dorr and colleagues[11] found clinically unsatisfactory outcomes in 22% of 108 hips in patients ranging in age from 14 to 45 years; this percentage was significantly higher than the failure rates of 3% to 7% reported by Charnley[7] for older patients. Specifically, they found that patients with osteoarthritis had the worst prog-

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nosis for success and the least satisfactory results—findings attributed to higher levels of activity in this subgroup. Further follow-up by Dorr and colleagues,[3,16] at 9.2 and 16.2 years, revealed that patients with osteoarthritis continued to perform the worst; their revision rates were 38% and 67%, respectively.

In a more comprehensive, long-term study, Berry and colleagues[17] compared 25-year survival rates of 2,000 THAs performed between 1960 and 1971. Eighty-three percent of the hips were osteoarthritic. Implant survival was strongly associated with patient age and diagnosis at time of procedure. Survival rates decreased with each decade of age, from 95.8% for patients older than 80 to 63.7% for patients younger than 40. In addition, a diagnosis of osteoarthritis (particularly osteoarthritis secondary to developmental dysplasia of the hip) had an adverse effect on survival.

Second- and Third-Generation Cementing and Long-Term Outcomes

With improvements being made in cementing and other surgical techniques, the ability to achieve long-term fixation has been enhanced. Cornell and Ranawat[14] reported on 101 hips in patients with osteoarthritis (age 55 or younger, mean 7-year follow-up, Charnley THA and other components). Overall survival rates were 87.6% (10 years) and 70% (13 years). At 13 years, the survival rates of the femoral and acetabular components were 92.9% and 75%, respectively. Similarly, Boeree and Bannister[18] found overall survival rates of 90% (10 years) and 87.3% (12 years) for 46 THAs performed in patients who were 24 to 49 years old and had idiopathic or secondary osteoarthritis.

Yet, results from several studies have indicated an increased risk for aseptic loosening 10 to 20 years after the initial procedure. Joshi and colleagues[10] reviewed 218 arthroplasties performed in patients who were younger than 40 and had osteoarthritis. At 10-year follow-up, the Charnley LFA survival rate was 80% (estimated from curve), the femoral component survival rate was 94%, and the acetabular component survival rate was 88%. At 20-year follow-up, however, the Charnley LFA survival rate was down to 51%. Sochart and Porter,[19] 10 years after performing 66 THAs in patients who were younger than 40 and had degenerative osteoarthritis, found survival rates of 86% (overall), 94% (femoral component), and 84% (acetabular component). At 20 years, these rates were down to 52% (overall), 74% (femoral component), and 59% (acetabular component). Hartofilakidis and colleagues[9] reported THA survival rates of 89.8% (10 years) and 67% (20 years) in 69 patients (84 hips) with a mean age of 46 years (range, 24-55 years) and a diagnosis of osteoarthritis. Similarly, Devitt and colleagues[20] published the results of 118 Charnley LFAs and reported survival rates of 86% (10 years) and 64% (20 years) in patients 50 or younger with primary osteoarthritis.

Thus, long-term results for younger patients have not been as good as for patients older than 60. For these older patients, THAs have proved quite durable; their survival rates have ranged from 85% to 90% at 10 years,[7,21-23] and even the 25-year survival rates have been higher than 80%.[24-26] Although advances in cementing techniques have significantly reduced the incidence of femoral stem loosening, deterioration of acetabular fixation continues to be a problem for patients younger than 55 regardless of prosthesis model used, even more so for patients with osteoarthritis.[14,19,27-32] For osteoarthritic hips, rates of revision for acetabular loosening have ranged from 12% to 41% at a follow-up of 15 to 25 years.[10,14,17,19,31] Patients with osteoarthritis typically have preserved bone that allows for stable fixation of the femoral and acetabular components—bone that is often lacking in patients with inflammatory arthritis. Younger patient age, however, has been associated with more rapid wear, and accelerated polyethylene wear caused by higher levels of activity and strain on the prosthesis may play a significant role in socket loosening.[17,19,20,33-37] These results suggest that acetabular component fixation may be the weak link in long-term survival of cemented THAs, but there continues to be a need for consistent long-term follow-up.

Cementless, Press-Fit Total Hip Arthroplasty

Cementless prostheses were introduced in the early 1980s in an attempt to prevent aseptic loosening of the acetabular cup and the difficulties associated with revision of cemented THAs. Early investigators reported encouraging short-term clinical results with porous-coated THAs.[38-40] First-generation cementless devices, however, were associated with high rates of thigh pain, femoral component subsidence, aseptic loosening, proximal bone loss attributed to adaptive bone remodeling, and osteolysis caused by polyethylene debris. Second-generation stems (eg, Profile stem [DePuy, Leeds, England]) were designed to improve fit, reduce micromotion, and optimize resistance to axial, bending, and rotational forces and thereby minimize some of these complications.[41-45] With these newer designs, patients younger than 50 and with different diagnoses have had survival rates ranging from 84.9% to 100% (femoral component) and from 81.3% to 98% (acetabular component) at a follow-up of 5 to 10 years.[31,46-50]

There are only a few published reports on the long-term outcomes of cementless THA in young patients with osteoarthritis. Eskelinen and colleagues,[51] using the Finnish Arthroplasty Register, evaluated 5,607 hip arthroplasties performed for primary osteoarthritis in patients younger than 55. At 10-year follow-up, modern second-generation cementless stems (ABG I [Stryker, Mahwah, NJ], Anatomic Mesh [Stryker, Mahwah, NJ], Bi-Metric [Biomet, Inc., Warsaw, IN], CLS Spotorno [Zimmer, Inc., Warsaw, IN], PCA Standard [Stryker, Mahwah, NJ], Profile Porous [DePuy, Leeds, England]) had survival rates higher than 90%; with the exception of the Harris-Galante (Zimmer, Inc., Warsaw, IN; 10-year survival rate, 89%), press-fit porous cups performed below 80%. D'Antonio and colleagues[52] reported results for 314 cementless Omnifit (Stryker, Mahwah, NJ) hydroxyapatite stems in patients younger than 50, the majority of whom had a diag-

nosis of osteoarthritis. At a follow-up of 10 to 13 years, the femoral stem survival rate was 98.7%, and the acetabular cup survival rate was 87%. Depending on individual socket type, however, there was significant variability in failure rates: 6% for press-fit porous cups, 25.7% for press-fit hydroxyapatite cups, and 7% for threaded hydroxyapatite cups. Unfortunately, though 63.7% of patients had a diagnosis of osteoarthritis, 16.6% of patients had a diagnosis of avascular necrosis, and these cases were included as well, so results are less conclusive.

Survival of a limited number of superior cementless THA designs, therefore, seems to parallel survival of cemented THAs. The difference is that use of cemented THAs has been common practice for more than 40 years, whereas there is a dearth of press-fit arthroplasty studies with follow-up into the second decade. Nevertheless, preliminary 15-year follow-up data suggest that cementless models may be at increased risk for revision after the 15- to 20-year postoperative period, as is the case with their cemented counterparts. In a study not limited to patients with osteoarthritis, McAuley and colleagues[31] found that, for 561 hip replacements performed in patients younger than 50, the survival rate dropped from 89% at 10 years to 60% at 15 years.

Evidently, failure rates for cementless acetabular and femoral components are not dramatically better than failure rates for cemented components. Increased wear rates have been associated with cementless acetabular fixation,[41,53,54] which is a concern, as survival curves in cemented THAs demonstrated an increase in rates of loosening and revision in the second decade. Stress shielding, aseptic loosening, osteolysis, and thigh pain still remain problems with certain models as well.[8,41,43,55-61] In addition, as with cemented arthroplasty, femoral fixation outperforms acetabular fixation.[62] Furthermore, little is known about whether bone geometries differ in their effects on biological fixation. As suggested by Mohler and colleagues[63] and D'Antonio and colleagues,[52] component biomechanics and coating may influence bone remodeling around the implant. Changes in bone morphology resulting from developmental dysplasia, osteotomy, or trauma, which occur most often in younger patients, may alter the ability of the cup to withstand applied loading forces. As a result, further assessment of the effect of a patient's diagnosis on activity levels and long-term fixation is critical before any conclusive comparisons can be made between cemented and cementless implant durability in younger patients.

Hybrid Total Hip Arthroplasty

The consistent long-term durability of cemented femoral stems in young active patients along with poor acetabular performance has led some surgeons to advocate using a press-fit acetabular component with a cemented femoral component.[43,64-66] Swedish Total Hip Replacement Register data suggest that the survival rate for hybrid THA in osteoarthritis patients younger than 55 is marginally superior to that for cemented THA alone or cementless THA alone (9-year survival rates were 93%, 89.9%, and 95.2%, respectively).[67] More recently, Bizot and colleagues[68] found a 9-year survival rate of 93.7% for 71 hybrid alumina-on-alumina hip arthroplasties in a heterogeneous group of patients (23 cases of osteoarthritis, 22 of atraumatic osteonecrosis, 10 of congenital dislocated hip, 9 of fracture, 4 of inflammatory disease) with a mean age of 46 years (range, 21-55 years). Thus, as more studies on cementless and hybrid implants emerge, results may further support the preferential use of hybrid or reverse hybrid implants for younger patients.

Highly Cross-Linked Polyethylene and Alternative Bearing Surfaces

Inflammation incited by polyethylene wear particles plays a role in implant durability.[69,70] Trying to limit wear and subsequent osteolysis secondary to bioactive wear particles, surgeons are increasingly using improved polyethylene and alternative bearings for THA in younger patients in whom wear is a significant concern. Bearing materials include highly cross-linked ultra-high-molecular-weight polyethylene (UHMWPE), metal on metal, ceramic on ceramic, and combinations thereof.

In vitro laboratory tests with hip simulators and clinical retrieval studies have shown significant improvements in the wear properties of newer bearing surfaces (metal on highly cross-linked UHMWPE,[71,72] ceramic on ceramic,[73,74] metal on metal[75,76]) over traditional bearing surfaces. Cross-linking of UHMWPE has been particularly effective in reducing wear (by 42%-100%[77,78]). Clinical results for ceramic and metal-on-metal bearings have been equally promising. Urban and colleagues[79] reported survival rates of 95% (10 years) and 79% (20 years) in a retrospective study of 64 THAs using a modular alumina femoral head and a UHMWPE cup in patients with a mean age of 69 years (range, 51-84 years), 84% of whom had a primary diagnosis of osteoarthritis. Dorr and colleagues[80] studied 56 Metasul (Zimmer, Inc., Warsaw, IN) metal-on-metal THAs in patients with a mean age of 70 years (range, 35-85 years), 87.5% of whom had a diagnosis of primary osteoarthritis. At a mean follow-up of 6.8 years, the survival rate was 98.2%, and the rate of acetabular loosening in cemented cups was equivalent to that of metal-on-polyethylene articulations.

However, in vivo studies on the long-term durability of various models and bearing combinations are still limited. Long-term data directly correlating lower wear rates with the clinical benefit of lower overall revision rates are lacking. Studies on the rate of revisions in particular patient cohorts, such as patients with primary osteoarthritis and young patients, have yet to be conducted. Furthermore, as survival rates have varied with cemented and cementless fixation and traditional bearings, the effects of fixation of both femoral and acetabular components need to be more extensively examined for alternative bearings as well.

Conclusions

Despite improvements in component designs and techniques, THA has proved not to perform as well in younger, more active patients, particularly those with osteoarthritis.

Results from many studies on cemented and cementless hip arthroplasties have shown higher rates of osteolysis, which has been attributed to increased polyethylene wear and eventually leads to component failure. Furthermore, lower survival rates in younger patients with osteoarthritis reflect increased biomechanical demands on prostheses, increased wear, and subsequent failure.

Continued improvements in surgical techniques and biomaterials (including metallurgy) are likely to translate into better performance of THAs. In addition, innovations in bearing surface materials, such as more durable polyethylene, are predicted to result in lower levels of wear.[81] With these advances, survival rates in younger, more active patients may begin to approach those of patients older than 60.

Conclusions cannot be drawn until the significant gap in the literature is addressed. As suggested by Dorey,[82] multivariate survival-rate analysis is critical in making comparisons between surgical treatments in different populations. A solely age-based analysis of THA survival in a heterogeneous group of patients is not sufficient for effective evaluation of this procedure. Age cohorts in patients younger than 55 can show significant differences in long-term fixation.[31] Patient activity, sex, weight, and diagnosis are also key prognostic variables. Thus, consistent clinical and radiographic follow-up will be critical in further evaluations of long-term wear, loosening, and revision in young patients.

Reports of THA durability have not been as convincing for younger patients as for older patients. However, it is evident that, for these younger patients, THA survival can be improved over what it has been the past 4 decades. Surgeons and engineers should continue to search for bone-preserving alternatives to traditional THA, as the number of young, active patients with osteoarthritis undergoing hip arthroplasty is quickly rising. THA in younger patients should be performed with caution and only after consideration of age, activity level, diagnosis, and bone quality and morphology and critical deliberation on the components used.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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