The Journal of Arthroplasty xxx (2016) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original article

Hip Resurfacing Using Highly Cross-linked Polyethylene: Prospective Study Results at 8.5 Years

James W. Pritchett, MD *

Hansjörg Wyss Hip and Pelvis Center, Swedish Medical Center, Seattle, Washington 98104

ARTICLE INFO

Article history:
Received 6 January 2016
Received in revised form
2 March 2016
Accepted 7 March 2016
Available online xxx

Keywords:
hip resurfacing
highly cross-linked polyethylene
implant survivorship
polyethylene wear
conservative hip implant arthroplasty

ABSTRACT

Background: Hip resurfacing is an option to consider when treating younger, more active patients. Advantages over total hip arthroplasty include a more normal gait and a lower incidence of thigh pain.
Methods: In this prospective study, 190 hip resurfacing procedures (164 participants) were performed using a cobalt-chromium femoral component and a cementless acetabular cup with a 3.8-mm highly cross-linked polyethylene acetabular liner.
Results: The mean follow-up was 8.5 (range, 7-10) years. Two participants were lost to follow-up and 2 died. One participant underwent successful revision surgery for acetabular loosening. Four participants underwent successful revision to a total hip arthroplasty because of femoral neck fracture (2), femoral loosening, or infection. The Kaplan-Meier survivorship was 97%. Acetabular bone conservation was assessed using computed tomography by measuring the medial acetabular wall. The mean thickness was 9 mm. Femoral bone was well preserved with a mean head:neck ratio of 1.37. There were 4 (2%) osteolytic defects up to 0.9 cm^3 on computed tomography and no instances of impending polyethylene wear-through. Seven polyethylene retrievals had a measured wear rate of 0.05 mm/y.
Conclusion: Hip resurfacing using a highly cross-linked polyethylene acetabular component is a reliable procedure. Both femoral and acetabular bones are reasonably preserved compared with prior resurfacing methods. The low incidence of osteolysis and the low rate of wear found on retrievals suggest that many years of use in highly active patients is possible.

The procedural advantages of hip resurfacing usually have benefitted the femoral side, namely preservation of the femoral bone, the ability to maintain a natural femoral head, better revision options, and limiting stress shielding. The functional advantages of hip resurfacing compared with total hip arthroplasty (THA) have been a more normal gait and a better chance of returning to sports [1,2]. There is no uniform agreement that resurfacing offers all these theoretical advantages compared with THA [3,4]. Concerns about resurfacing include the ability to restore the biomechanics of the hip, femoral neck fracture, osteonecrosis, femoral loosening, and the difficulty of acetabular revision [4-6]. The spatial limitations of the native joint place constraints on the aggregate component thickness.

Attempts to use metal on polyethylene in the past were unsuccessful because of the poor performance of thin, non–wear-resistant polyethylene, and cementless metal backed or cemented fixation that was intrusive to the pelvis resulted in failures that were difficult to reconstruct [7-9]. Prior teaching with conventional polyethylene suggested that minimum acceptable polyethylene thickness was 6 mm, producing composite component thicknesses that were 14-16 mm greater than the retained femoral head, which is typically 40-50 mm [10]. This presented a challenge to bone conservation.

Several iterations of metal-on-metal (MoM) resurfacing devices have produced implants that are quite thin (3-mm-thick monoblock acetabular component and 3-mm-thick femoral component). These implants minimized bone loss and eliminated polyethylene wear debris. For femoral head sizes ≥50 mm, the performance of MoM has been satisfactory, and for the last 15 years, most hip resurfacing procedures have been performed using this technology [3,7,11-13]. Cup fixation remains problematic especially in dysplastic patients.

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.03.013.

The author certifies that he has institutional approval for this study and the investigation was conducted in conformity with ethical principles of research and that informed consent was obtained.

* Reprint requests: James W. Pritchett, MD, 901 Boren Ave #900, Seattle, WA 98104.

http://dx.doi.org/10.1016/j.arth.2016.03.013
0883-5403/© 2016 Elsevier Inc. All rights reserved.

Some disastrous results from adverse reactions to metal wear debris, particularly in the smaller sizes, have reduced the interest in MoM resurfacing [13-15]. MoM hip resurfacing using component sizes ≤46 mm does not meet the National Institutes of Health and Care Excellence guidelines for use [16,17].

With highly cross-linked polyethylene, much thinner acetabular liners can be used [7,18-20]. Ten years ago, a 3.8-mm cross-linked polyethylene liner using a sequential annealing and irradiation process became available. With the metal backing, the composite component thickness is 10 mm. Femoral heads of 40 and 44 mm have been used with this material for THA with a clinical survivorship similar to THA using standard thickness liners [18,19,21-24]. This finding led the author to propose the use of these thin highly cross-linked polyethylene liners for resurfacing using a proven design femoral component in combination with a thin cementless shell.

This study evaluated a highly cross-linked polyethylene acetabular component for hip resurfacing in terms of (1) function and complications, (2) implant survivorship, (3) bone conservation and biomechanics of the resurfaced joint, and (4) osteolysis and polyethylene wear.

Participants and Methods

Our Institutional Review Board approved this single-center prospective study. The option of THA was discussed with all participants, but those included in this study chose hip resurfacing. There were 164 participants (190 hip procedures) who underwent resurfacing using a cemented cobalt-chromium femoral prosthesis and a cementless acetabular shell with a highly cross-linked polyethylene liner (Fig. 1). Inclusion criteria were (1) pain and functional compromise that made a participant a candidate for THA, (2) femoral head diameter 40-46 mm, (3) University of California, Los Angeles (UCLA) score goal of ≥6, (4) age ≤65 years, and (5) satisfactory bone quality and geometry (ie, the bone structure could accommodate the resurfacing components without notching the femoral cortex or overreaming the acetabulum and medial wall thickness >5 mm; Fig. 2A). At the time participants were enrolled in this study, patients presenting for hip resurfacing with femoral head diameters ≥48 mm were treated with MoM hip resurfacing, as only size 40 and 44 acetabular components were available. Currently, highly cross-linked acetabular components up to 52 mm are used in appropriate patients. Patients with less femoral or acetabular bone than necessary underwent THA using cross-linked polyethylene and a cementless titanium femoral stem. Approximately one-third of patients presenting to the author were candidates for polyethylene hip resurfacing with the implants available. Exclusion criteria were (1) poor femoral bone quality as indicated by femoral head cysts >1 cm or osteonecrosis, (2) below normal bone density determined by the radiograph, (3) leg-length discrepancy >3 cm or femoral neck shaft angle <120°, (4) geometry that would not allow stable placement of the prosthesis with at least 5 mm of medial acetabular wall preservation (approximately 5% of presenting patients) and a head:neck ratio of at least 1.29 without notching, and (5) revision of prior implant procedures. Bone quality was assessed qualitatively as within normal range or below normal [25,26]. Enrollment was not affected by the presence of abnormalities in the hip center of rotation, femoral offset, or the shape of the femoral head or neck. We did not use dual-energy X-ray absorptiometry or magnetic resonance imaging scans to determine candidacy for hip resurfacing.

All femoral prostheses were a cast cobalt-chromium stemmed design (CONSERVE Plus Total Hip Resurfacing System; Microport Orthopedics, Memphis, TN), and all were cemented. The 2-piece acetabular components consisted of a porous-coated titanium shell 50 or 54 mm with a 40- or 44-mm highly cross-linked polyethylene liner (Fig. 1). The polyethylene liners were fabricated from GUR 1020 resin (Ticona, Kelsterbach, Germany) highly cross-linked by 3 sequential exposures to gamma irradiation at 3 MRads followed by annealing below the melting temperature and sterilization with gas plasma. The polyethylene thickness was 3.8 mm. The liners were seated into a hydroxyapatite-coated cluster-hole acetabular shell (Trident PSL HA; Stryker Orthopedics, Mahwah, NJ). Both the femoral and acetabular components are Food and Drug Administration cleared, but they have not been cleared for use together. The cross-linked components used were the only devices compatible with a resurfacing procedure.

The 44-mm femoral component was seated on a femoral head prepared to 46 or 44 mm depending on the native size of the femoral head and chosen thickness of the cement mantle. The 40-mm component was seated on a femoral head prepared to 42 or 40 mm [25]. Therefore, only patients with femoral heads of 40-46 mm were enrolled in this study. The author, with many years of experience with polyethylene hip resurfacing from predicate devices, performed all the procedures using a posterior approach.

The goal for acetabular inclination was 40° compared with the native acetabular inclination of between 55° and 65°. The acetabular anteversion was reduced as necessary to achieve a combined femoral and acetabular anteversion of 45°. After impaction, the acetabular component was tested manually, and 1 or 2 screws were placed, if needed, to provide complete stability.

Participants were permitted to bear weight immediately postoperatively and had no limitations after their initial recovery. Using the UCLA Activity Score, we asked participants preoperatively about their goals after hip resurfacing. Follow-up examinations were performed at 8 weeks, 6 months, and annually, and outcomes were assessed using the Modified Harris Hip Score, Western

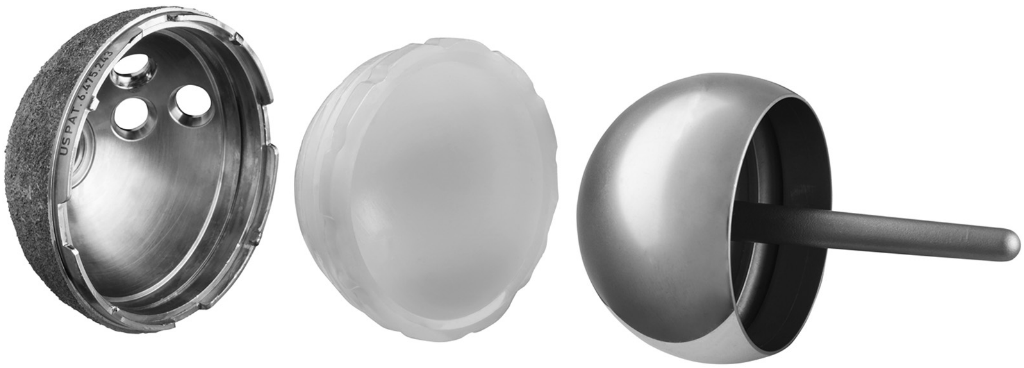

Fig. 1. This photograph shows the resurfacing implants used. They consist of a 2-piece acetabular component with a porous titanium shell and a highly cross-linked polyethylene liner. The femoral component is cobalt-chromium.