The Journal of Arthroplasty xxx (2017) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Constrained Acetabular Components Used in Revision Total Hip Arthroplasty: A Registry Analysis

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ARTICLE INFO

Article history:
Received 21 October 2016
Received in revised form
6 April 2017
Accepted 20 April 2017
Available online xxx

Keywords:
THA
constrained acetabular components
nonconstrained components
dislocation
revision

ABSTRACT

Background: Constrained acetabular components have a mechanism to lock in the femoral head. They have been developed to control postoperative dislocation, particularly in revision total hip arthroplasty (THA). Although these components may reduce dislocation, there are durability concerns: with reports of locking mechanism failures and loosening. We wanted to determine the outcome of constrained components in controlling dislocation, and if these components had a higher rate of second revision when compared with standard nonconstrained components.

Methods: Revision THA procedures from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) with a recorded primary procedure and initial diagnosis of osteoarthritis were used to compare constrained and standard nonconstrained components. Kaplan-Meier estimates of survivorship were calculated, and hazard ratios using Cox proportional hazard models were used to compare groups.

Results: There were 9509 THA first-revision procedures and 700 constrained components. Constrained components had a significantly higher revision rate after 3 months when large-head metal-on-metal components were included (hazard ratio = 1.37; $P = .005$). When large-head metal-on-metal components were excluded, there was no difference in the rate of second revision between the 2 groups. When the analysis was limited to first revision for dislocation, constrained components had a higher second revision rate for further dislocation after 9 months.

Conclusion: Constrained acetabular components had similar second-revision rates when compared with standard nonconstrained components, both for all first-revision reasons and when used to treat dislocation. Although possibly used for the more difficult unstable hips, constrained components had a higher rate of second revision for further dislocation.

Constrained acetabular components have been defined as those polyethylene cups or inserts that include a mechanism that locks the femoral head into the acetabular component [1]. Although these can be used in unusual circumstances for a difficult primary hip arthroplasty, where the abductor mechanism is deficient [2] or in the presence of neurologic disease [3], use has been predominately in revision hip arthroplasty for treatment of recurrent dislocation [4,5].

Dislocation is the most common reason for revision in the first 5 years after total hip arthroplasty (THA) and is responsible for 24.2% of all the revisions of primary conventional THA according to the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) [6]. Treatment for recurrent dislocation, however, has not been as successful as hoped. A recent assessment of the risk of redislocation after revision for instability found it to be 34.5% at 15 years [7]. Recurrent dislocation may be due to malpositioning of acetabular or femoral components, abductor deficiency,

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2017.04.043.

The Australian Government funds the Australian Orthopaedic Association National Joint Replacement Registry through the Department of Health and Ageing.

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http://dx.doi.org/10.1016/j.arth.2017.04.043
0883-5403/

impingement, late wear, or unresolved etiology [8]. Where these are detected, revision surgery should aim to correct those aspects. Constrained acetabular components have been promoted particularly for use in those patients who also are elderly, low demand, cognitively impaired, or with deficient abductors and in those patients where no identifiable cause for instability is found [5].

Reports of these constrained devices have raised concern about their durability in the longer term [9–14]. Among failure mechanisms are liner dissociations, locking ring failures, and component loosening. It has been suggested that these are the results of mechanical overload [11]. A literature review containing 8 reports of constrained components showed in 1199 hips at a mean follow-up of 51 months that there was a redislocation rate of 10% and a further reoperation rate of 4% [5]. Others have suggested that these devices are inadequate in the current form and that alternate treatments for recurrent dislocation should be used [15,16].

The purpose of this study was to analyze data from the AOANJRR to determine the outcome of constrained devices used for revision hip arthroplasty. More specifically, we wanted to determine (1) if constrained acetabular components had a higher rate of second revision when compared with standard nonconstrained components when used in revision THA and (2) if constrained components could control further dislocation.

Materials and Methods

The AOANJRR commenced data collection on September 1, 1999, achieving complete national implementation by mid-2002. Since then, the AOANJRR has collected data on almost 100% of hip and knee arthroplasty procedures performed in Australia. AOANJRR data are externally validated against patient-level data provided by all Australian state and territory health departments. A sequential, multilevel, matching process is used to identify any missing data which are subsequently retrieved by contacting the relevant hospital. Each month in conjunction with internal validation and data quality checks, all primary procedures are linked to any subsequent revision involving the same patient, the same joint, and the same side. Data are also matched biannually with the Australian Government's National Death Index to obtain information on the date of death. Linking revision and death to the primary procedure enables revision rates to be determined.

In this study, all revision THAs performed for osteoarthritis (OA) reported to the AOANJRR between September 1999 and December 31, 2014, and with a known primary procedure, were analyzed. First revisions for infection were excluded.

Constrained acetabular components were defined in the Registry database according to the definition of Lachiewicz and Kelley [1]. It included all polyethylene cups or inserts that have a mechanism that locks the femoral head into the acetabular component. These include both constrained 1-piece cups and constrained liners that are inserted into a metal shell. Constrained devices can be classified as either fixed, where the acetabular component is a simple polyethylene component with a locking mechanism, or mobile, where a femoral head articulates with a metal-backed polyethylene that can move within a further polyethylene insert.

The unadjusted cumulative percent revision, with an accompanying 95% confidence interval, was calculated with use of unadjusted point-wise Greenwood estimates. The unadjusted cumulative incidence functions of the reasons for second revision of the constrained and conventional components were also calculated. Hazard ratios (HRs) were calculated with use of Cox proportional hazards models, adjusting for age (at the time of the first-revision procedure) and gender, and were used to make statistical comparisons of the revision rates between groups. The assumption of proportional hazards was checked analytically for each model; if the interaction between the predictor and the log of the postoperative time was significant in the standard Cox model, then a time-varying model was used. All tests were 2 tailed at the 5% level of significance. Statistical analysis was performed using SAS software, version 9.4 (SAS Institute Inc, Cary, NC).

Results

A total of 9509 revision hip arthroplasty procedures of known primary THAs performed for OA were included. Of these, 700 used constrained acetabular components. These included 72 constrained cups and 628 constrained acetabular liners.

When the large-head metal-on-metal (MoM) components were included, constrained components had a significantly higher rate of revision after 3 months (HR = 1.37 [1.10-1.70]; $P = .005$). When large-head MoM components were excluded from the analysis, constrained hips showed no difference in the rate of second revision when compared with nonconstrained other revision hips (HR = 1.20 [0.97-1.47]; $P = .093$; Fig. 1).

When broken down by age <70 and ≥70 years, neither age category showed a difference when constrained devices were compared with nonconstrained other hips (Fig. 2).

Dislocation was the first-revision diagnosis for 77.7% of the constrained hips, whereas only 17.7% of the nonconstrained hips had this diagnosis. In this nonconstrained group, loosening and lysis was the most frequent first revision diagnosis with 35.2% compared with only 12.6% of the constrained hips.

Dislocation was also the most common reason for second revision in the constrained group accounting for 48.2% of second revisions compared with 29.1% of second revisions in the nonconstrained group. However, when the initial revision diagnosis was dislocation, the rate of second revision for any reason was similar when constrained hips were compared with other revision hips (HR = 1.00 [0.78-1.28]; $P = .980$; Fig. 3). When these first revisions for dislocation are followed, the rate of second revision for further dislocation is higher in the constrained group after 9 months (HR = 2.13 [1.31-3.44]; $P = .002$; Fig. 4).

Loosening/lysis was the reason for second revision in 21.8% and 28.2% of the constrained and nonconstrained revision hip groups, respectively. There were proportionally more second revisions for acetabular component breakage in the constrained group (7.3% compared with 1.0%).

Screw fixation of the constrained acetabular component led to a lower rate of second revision compared with when screws were not used (HR = 1.57 [1.04-2.39]; $P = .032$), while cement fixation gave similar results to when screws were used (Fig. 5).

There were 395 fixed constrained implants and 305 mobile constrained implants in the analysis. There was no difference between the 2 styles of constrained hips (Fig. 6).

Discussion

This large Registry analysis has shown that when used in revision hip arthroplasty, constrained devices have similar results when compared with revisions using nonconstrained components. Studies reporting good results for constrained devices often have short follow-up periods with mean of <4 years [4,17–24], while 10-year minimum follow-up reports showed poorer results with a rerevision rate of 21%-42.1% [16,25,26]. In this study, constrained hips had a cumulative percent rerevision of 26.9% at 10 years.

As far as we are aware, this is the first Registry study examining the outcome of these devices. Previous reports on the use of constrained implants have involved much smaller data sets, with only 1 meta-analysis [5].