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Original article

Mid-term results of large diameter heads on cross-linked polyethylene liners in total hip replacement

Bhavesh Sachde^a, Nikunj D. Maru M.S. Ortho^{b,*}

^a Professor and HOD, Orthopedics Department, P.D.U. Medical College and Hospital, Rajkot 360001, India

^b Assistant Professor, Orthopedics Department, P.D.U. Medical College and Hospital, Rajkot 360001, India

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ABSTRACT

Background: Highly cross-linked polyethylene liners in total hip replacement (THR) have allowed the use of larger diameter femoral heads. Larger heads allow for increased range of motion, decreased implant impingement, and protection against dislocation. The purpose of this study is to assess the clinical and radiographic outcomes of patients with large femoral heads THR at 4 years postop.

Materials and methods: Study includes 28 patients who had a primary THR with a 36 mm larger femoral head were retrospectively for minimum 4 years follow-up. All patients received a cementless acetabular shell and a highly cross-linked polyethylene liner with an inner diameter of 36 mm. The median radiographic follow-up was 4 years (range 2.0–6.0), and patients were assessed clinically by Harris hip score.

Results: The mean follow-up is minimum 4 years (range 2–6 years) results in all operated patients showed marked improvement in Harris hip score from preoperative mean 49.1 to 89.9 at 4 years or more follow-up. The complications include superficial infection ($n = 2$). No dislocation, or no osteolysis was seen in the pelvis or proximal femur, and no components failed due to aseptic loosening. There was no evidence of cup migration, screw breakage, or eccentric wear on the liner.

Conclusion: The mid-term results in this series of patients with LDH using 36 mm femoral head articulating with highly cross linked polyethylene showed excellent clinical, and radiological results, in terms of, joint restoration that replicates the natural anatomy, optimized range of motion without impingement & reduced opportunity for postoperative dislocation.

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1. Introduction

Total hip arthroplasty is a cost-effective and one of the most successful orthopaedic surgery of 20th century with largest follow-up up to 35 years using, Charnley's cemented low frictional arthroplasty. Total hip arthroplasty substantially

improves quality of life in patients with degenerative joint disease. Despite constant advances in prosthetic component design, dislocations and late-stage prosthetic loosening remain the 2 most common complications.¹

Dislocation after primary THA has been reported in various publications to be in the range of 4%, with rates as high as 11%

* Corresponding author. Tel.: +91 9879681202 (mobile).

E-mail address: dr.nikunj83@gmail.com (N.D. Maru).

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reported by some authors.^{1,2} Dislocation rates in revision THA have been reported to range from 10% to 20%, with many factors implicated, including those related to the patient, surgical technique, or the position and design of the prosthetic implants.¹ Patient factors not directly under the control of the surgeon, such as age, cognitive function, sex, previous surgical history, obesity, and preoperative diagnoses, have all been shown to relate to dislocation.³ In contrast, the surgeon can control operative technique and implant choice to a certain degree.

The use of constrained acetabular liner in THR gains popularity in high risk patients of dislocations however associated with restricted range of motion (ROM) due to impingement of neck on the liner and real and potential dislocation of components, which requires subsequent reoperation.⁴

Although the natural anatomic femoral head is large, the femoral head component typically used in THA is smaller.^{5,6} In vitro laboratory studies, Burroughs et al, postulated that larger diameter head reduce the risk of dislocations for the following reasons: (1) they improve the head-to-neck ratio, thereby increasing the range of motion (ROM) prior to impingement; (2) they increase the jump distance prior to dislocation; and (3) the soft tissues provide greater resistance to dislocation, as the larger femoral head is better contained within the surrounding soft tissue.^{7,8}

The prosthesis in the present study allows for a 6-mm differential between the size of the acetabular implant and the femoral head size, thereby permitting the use of a large femoral head. Modular neck prostheses allow surgeons a greater ability to correct for leg length discrepancy and femoral offset, which allow even greater soft tissue balance and hip stability.⁹ This can be done without “overstuffing” the joint, i.e. leg length and offset can be done correctly without trying to add excessive pressure to prevent dislocation.

This study reviews the mid-term results of patients who have received large diameter femoral heads optimized with modular necks for stability.

2. Materials and methods

In this retrospective study the cohort comprised 28 patients. 20 males and 8 females, who had been operated for total hip replacement year 2005 onwards, were evaluated retrospectively with minimum follow-up for 4 years. The mean age of patients was 60.7 years (range 37–82 years). There were 20 cases of secondary osteoarthritis due to avascular necrosis of femoral head (71.24%), two case of sero-positive rheumatoid arthritis (7.14%), one case of healed tuberculosis of the hip joint (3.57%), two cases of posttraumatic degenerative osteoarthritis (7.14%), two cases of Ankylosing spondylitis (7.14%) and one case of neglected femoral neck fractures with degenerative changes (3.57%).

After thorough history taking, clinical evaluation, investigations and necessary preoperative surgical planning was done. Standard radiological assessment was done using radiographs of pelvis with both hips in anteroposterior (AP) and cross leg lateral views with magnification markers. The same X-rays were used for overlay templating using Capello's

technique.¹⁰ The centre of acetabulum was marked with the help of acetabular template. Centre of femoral head and size of prosthesis and neck cut were marked using femoral template. Minor adjustments in offset were made at the time of surgery either by using the implant of different offset or a modular component. Fitting of medullary femoral component in lateral view was also preoperatively planned.

2.1. Surgical technique

Routine preoperative planning included appropriate implant selection to optimize the anatomical result of the replaced hip with respect to offset, rotation and limb length. The epidural anaesthesia and lateral position was used. All surgeries were performed by the senior surgeon with the use of a Modified Gibson's approach was used in all the patients. The components used in all patients were a collarless, tapered, proximally hydroxyapatite-coated femoral stem (Accolade; Stryker Orthopaedics) and an uncemented hemispherical acetabular component (Trident; Stryker Orthopaedics). The type of bearing surface used was a highly cross-linked polyethylene – on – metal in all cases.

2.2. Postoperative course

All postoperative care was standard and the same for all patient groups. A second-generation cephalosporin was administered for 24 h postoperatively. Thromboembolic prophylaxis included postoperative low-molecular-weight heparin was prescribed and compressive stockings postoperatively. Patients were limited to partial weight bearing (50%) for the first 6 weeks and then permitted to advance to full weight bearing as tolerated. Physiotherapy was commenced at 6 weeks postoperatively to build up the hip musculature.

Clinically, patients were assessed at 1 week, 2 weeks, 1 month, 6 months and then at yearly intervals for pain, range of movement and function. The radiological assessment was done in the immediate postoperative period, at 6 months and then at yearly intervals. Loosening was assessed for the femoral and acetabular component. Protrusion was measured by distance between cup and ilioischial line.

Functional assessment was done by Harris hip score system.¹¹ The preoperative, immediate postoperative and long term complications were recorded.

3. Results

3.1. Clinical outcomes

The comparison of the pre and postoperative clinical scores and their statistical analysis had been made in Table 1. The mean improvement in pain score was (it was done according to pain component of Harris hip scoring system) from 16.4 to 41.7 at 1 year which fell down to 40.9 at 4 years.

18 had minimal or no pain, while 10 had moderate pain requiring occasional analgesics. 24 (80%) had good range of movement (flexion 90° or more, abduction 20° or more), 4 had mild restriction of movement (flexion <90°, abduction <20°).

Table 1 – Clinical outcome on basis of Harris hip score.

Variables	Evaluation period	n (no of hips)	Mean
Harris hip score	Preoperatively	28	49.1
	Postoperatively	28	89.9
Range of motion	Preoperatively	28	92.6°
	Postoperatively	28	161.4°
Pain	Preoperatively	28	16.4
	Postoperatively	28	40.9
Function	Preoperatively	28	24.3
	Postoperatively	28	39.9

Mean Harris hip score preoperatively was 49.1 point and postoperatively 89.9. We categorized our results as good in 85%, fair in 11% and poor in 4% cases.

3.2. Radiographic outcomes

Radiographic evaluation of the patients showed no evidence of osteolysis or implant loosening. Four patients have questionable signs of bone changes around the acetabular shell with future CT scans scheduled to help reach a final determination. The median acetabular shell abduction and anteversion were 44° (30–66°) and 13° (3–33°) respectively. There was no evidence of cup migration, screw breakage, or eccentric wear on the liner. Regarding the femoral component, there were no episodes of loosening, migration, osteolysis or fracture. No cases of heterotrophic ossification were noted.

3.3. Complications

There were 2 events of postoperative superficial wound problem. All were healed. 2 patients have limp while walking, 1 patient was not seated cross leg. 1 patient has difficulty in tying shoe knots. There were no recognized clinically evident DVT, no pulmonary embolism, and infections. No dislocations or no hips required second surgery.

4. Discussion

In the present era, total hip arthroplasty is not the operation of the elderly alone. Due to immense research on this subject in operative technique, technology and biomaterial, it is now very much possible to perform this operation in the younger age group patients depending upon the patient's age, activity, occupation and other social obligations.

Total hip replacement is performed to achieve painless, mobile, stable hip with restoration of limb length. Implant designers have sought to develop new methods after immense biomechanical research, to prevent dislocation, one of the primary complications following THA.^{12,13} Larger diameter heads more accurately replicate the natural femoral head excised during THA. Theoretically, a closer replication of the body's natural anatomy should provide a stronger soft tissue envelope to retain the implanted components. Although use of a larger femoral head may be advantageous in reducing the chance of dislocation, the importance of precise

component positioning and adequate soft tissue tensioning cannot be overemphasized.

For this cohort of patients with mid-term follow-up, the results so far are encouraging. Smith et al in⁷ 2005 reported on 377 patients implanted with large femoral head prostheses with an average follow-up of 4 months with no dislocations. Although longer-term follow-up of this patient group is required to draw definitive conclusions, most patients who have recurrent dislocations experience their first dislocation within 90 days of the index procedure.⁷ Other studies have shown that dislocation can occur at any time during the life of the THA, which translates into a cumulative risk of dislocation over time. Longer-term follow-up studies of this patient population are planned to determine if the larger femoral heads reduce the overall dislocation risk in THA. Similarly, results of our cohort of patients was also comparable with other standard international series operated with large diameter head, Steven et al¹⁴ 2008, with series of 34 patients, long series of 100 patients by Berton et al¹⁵ 2010. Even results of large diameter head are encouraging in cases of recurrent dislocation as shown in series of Paul et al, 2002 and recently results of large diameter head are comparable to hip resurfacing in series by Antoniou et al.¹⁶

Dislocations are cause for substantial pain, dissatisfaction for patients and increase hospital cost. In our series no dislocation were noted which is comparable with Steven et al¹⁴ and Berton et al¹⁵ series, but in the long series of traditional THA like, Cupic and Zoran¹⁷ series the dislocation rate was 1.6% whereas in the Callaghan and Albright series it was 4%.

Eighty-four per cent patients were absolutely pain-free, 12% patients had moderate pain and 4% patients had severe pain, which is comparable with Steven et al¹⁴ and Berton et al¹⁵ series and even comparable to traditional THA series Cupic and Zoran¹⁷ reported 91.3% ($n = 106$) patients with pain-free hip and moderate pain in 8.7%.

No osteolysis was seen in the pelvis or proximal femur, and no components failed due to aseptic loosening. Four patients have questionable signs of bone changes around the acetabular shell with future CT scans scheduled for final determination. In the Cupic and Zoran¹⁷ the incidence of aseptic loosening was 2%.

The improvement in the overall mean Harris hip score was from 49.1 to 89.9 at 10 years. Studies by Young-Hoo Kim¹⁸ have shown improvements in Harris score of more than 90 points in cases of avascular necrosis. Young-Hoo Kim et al,¹⁸ had performed his study on 170 total hips of which 47 were cemented and had also shown an overall improvement in Harris hip score from 50 to 89 at more than 10 years follow-up. Using Harris hip score, we graded our results as good in 85% cases, fair in 11% cases and poor in 4% cases. Cupic and Zoran¹⁷ reported had 91% patients classified as good, 6% as fair and 3% as poor.

There were two cases of superficial infection which were identified in the second week of surgery. They were managed by regular dressing of the wound and antibiotics. Charnley and Cupric¹⁹ observed superficial infection even after strict maintenance of asepsis in 6.6% cases.

With large diameter femoral components, there may be a perceived potential for increased wear as a result of the larger contact areas of the articulating surfaces, and the importance of a low wear rate as a factor in the durability of total hip

replacement is well-accepted. Recent advances in minimizing the production of wear debris include the use of highly cross-linked polyethylene bearing surfaces and improvements in the tapers and locking mechanisms of modular implants.²⁰

Additional benefits of the large femoral head are numerous. Eliminating a substantial number of postoperative rules and increasing head-to-neck ratios provides the patients the potential for a larger ROM which, along with the ability to resume activities earlier, may lead to a decreased incidence of deep venous thrombosis. The effect of large femoral head potentially decreasing dislocations is especially beneficial to elderly patients who may become confused in the hospital or nursing home and not follow protocol. The larger femoral head allows patients to increase their activities at an earlier and more efficient rate than was previously possible with small femoral heads. Because of the absence of dislocations, postoperative hip ROM precautions have been eliminated. This is especially helpful in the elderly, who may benefit from earlier mobilization.

5. Conclusion

There have been no dislocations in this series of 28 THA patients. The large femoral head may, therefore, be indicated for the youngest patients as well as the oldest for the multiple reasons stated, especially for the ability to return to activities earlier in all age groups and for a reduced likelihood of dislocation, particularly in a noncompliant patient group. This improvement is in addition to any other techniques to reduce rates of dislocation. Longer-term follow-up is needed to definitively confirm that the larger, anatomically sized heads used in this series reduce the potential for dislocation. Nonetheless, The mid-term results on this series of patients with THA with a 36 mm femoral head articulating with highly cross-linked polyethylene showed excellent clinical, radiographic, and wear results, in terms of joint restoration that replicates the natural anatomy, optimized range of motion and reduced opportunity for postoperative dislocation.

Conflicts of interest

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.

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