CPQ Orthopaedics (2019) 1:6
Research Article

A Way to Eliminate Luxation After Primary Hip Replacement - a Single Centre Experience with 1000 Cases of Dual Mobility Cups

Klemen Bedencic*, Gregor Kavcic & Jure Tumpej

Department of Orthopaedics, General Hospital Novo Mesto Šmihelska Cesta, Slovenia

***Correspondence to:** Dr. Klemen Bedencic, Department of Orthopaedics, General Hospital Novo Mesto Šmihelska Cesta, Slovenia.

Received: 18 February 2019

Published: 04 March 2019

Keywords: *Luxation After THA; Aseptic Loosening; Dual Mobility Cup*

Abstract

Introduction and Methods

We analysed a series of 1000 consecutive dual mobility cups used for THA in 901 patients for various pathologies (fracture of the femoral neck, osteoarthritis and avascular necrosis). There were 612 females and 289 males with a mean age of 76.8 years at the time of their operation (from 29 to 98). 808 patients with a total of 883 dual mobility cups were available for the final analysis.

Results

There were no dislocations recorded at the mean follow-up of 8,9 years. There were also no cases of aseptic loosening (longest follow up 14 years). Harris Hip Score has significantly increased for cases of osteoarthritis and avascular necrosis (from 44,9 to 90,4). We recorded 9 (1%) deep prosthetic joint infection, 1 femoral nerve palsy, 10 (1,1%) periprosthetic fractures and 1 case of acute thromboembolic event.

Conclusions

Our results confirm the benefits of dual mobility cups regarding prevention of luxation. We found no difference in luxation rate between different approaches when using dual mobility cups. We have not encountered the problem of early aseptic loosening thought to be associated with dual mobility design. Other complication rates were comparable to those occurring with standard acetabular designs.

Introduction and Epidemiology of THA Instability

Hip replacement is one of the most successful operations of musculoskeletal system. During its long history of trial and error many problems have been overcome, but some still persist. Dislocation is a serious problem that is debilitating for a patient and a source of anxiety for a surgeon. The analysis of the Swedish, Australian and British national register data shows that THA dislocation is one of the main reasons for revision surgery [1]. Currently, approximately 10% of the annually performed hip surgeries are revision procedures; of these, 11 to 24% are performed to treat THA dislocations [1-3]. In literature the data on annual THA dislocation rates following primary implantation varies between 0.2% and 10% [4,5]. This big variance is expected because dislocation rate changes with time after surgery, approach, implant design, patient specific factors, surgeons' proficiency, etc. [6]. Woo and Morrey analysed a series of 10500 primary total hip arthroplasties and reported that 59% (196 hips) of the dislocations occurred within the first three months after surgery and 77% (257 hips) within the first year. In their study the dislocation rate within the first year was about 2.5%, which makes dislocation the most common early complication following primary implantation and a major reason for early revision surgery [7]. After the first year the risk drops significantly to about 1% per year. It then rises steadily at a relatively constant rate of 1% per 5-year period for the life of the arthroplasty [8]. There is a lot of literature regarding different approaches and their effect on dislocation rates. An analysis of 22237 hips performed through posterior, anterolateral, direct lateral, and anterior approaches found that anterolateral and anterior approaches had lower dislocation rates compared to the posterior. It is postulated that inherent stability exists with anterior approaches, as muscles are not detached posteriorly or anteriorly [9]. Among 42438 hips analysed for revision, there was no difference between approaches [10]. In another study of 13000 primary THA the dislocation rate for direct anterior approach was 0.8%, for the posterior approach 3.23%, while the rates for the lateral transgluteal approach and the anterolateral approach were 0.55% and 2.18%, respectively [10]. However, the dislocation rates for the posterior approach can be significantly reduced to as low as 0.7% by anatomical repair of the posterior capsule and external rotators combined with increased anteversion of the cup component [11].

The dual mobility cup was developed by Professor Gilles Bousquet almost 50 years ago to combine the "low friction" principle of THA popularized by Charnley with the McKee-Farrar concept of using a larger diameter femoral head to enhance implant stability [12]. This design has two different articulations, each performing a specific function. In the first articulation a small diameter (22-28mm) head is "engaged" but mobile within the polyethylene (PE) liner and behaves as a typical hard-on-soft bearing in a standard THA. This accounts for the majority of movement during a normal gait cycle. However, in positions nearing the limits of range of motion the femoral neck and the rim of the PE liner come into contact. This is when a

second articulation begins to function and consists of the back of the PE liner and the highly polished metallic acetabular shell. It increases the effective range of motion until impingement of the femoral neck against the rim of the acetabulum occurs. This head-liner complex functions as a very large femoral head, increasing the head-neck ratio and subsequently the jump distance needed for dislocation to occur [12].

The aim of this single-centre retrospective study is to present our experience and the results we have achieved after incorporating a dual mobility cup into our daily practice for primary hip replacement.

Methods

Our objective was to evaluate early and mid-term postoperative luxation rate in a cohort of 1000 consecutive cases of dual mobility cups in primary total hip replacement (THA).

There were 612 females and 289 males with a mean age of 76.8 years (from 29 to 98). They had different conditions requiring THA (fracture of the femoral neck, osteoarthritis and avascular necrosis). Mean follow-up was 8,9 years, ranging from 3 months to 14 years.

All the cups used in the series were Avantage Dual Mobility cups (cemented or cementless). They are designed in a spherical-cylindrical shape, which is emulating the anatomical structure of a normal acetabulum. The top outer part of the cup is flattened with fine protrusions on its outer circumference. It is composed of a metal acetabular shell which is highly polished on the inner side providing a low friction bearing surface. A polyethylene insert fits into the outer shell and contains a small, metal or ceramic, femoral head (22mm or 28mm diameter). Movement is allowed on 2 levels: the 1st movement occurs between the polyethylene insert and the metal femoral head and the 2nd movement between the polyethylene insert and the acetabular shell.

Operations were performed by 4 different surgeons using 3 different approaches - classic anterolateral, minimally invasive anterolateral and minimally invasive direct anterior approach. We used three different types of femoral stems (Alta, Aura and Exception - Biomet).

Postoperatively patients were mobilized the day after surgery or when the general health condition allowed. We did not restrict any movements or activities that are usually forbidden in the early postoperative period after THA.

Patients returned for regular evaluations after 1 month, 3 months, 1 year and every 3-5 years thereafter. On the follow-up examinations we recorded Harris Hip Score (HHS) of every patient, except femoral neck fracture cases, to measure their outcome [13]. We also took standard anteroposterior radiographs at every visit and recorded all complications that might have occurred. Analysis of the radiographs was done by a senior surgeon using the method of DeLee and Charnley [14] to evaluate any radiolucency on the cup side and the Gruen method to assess any radiological evidence of stem loosening. The preoperative HHS scores of non-fracture cases were compared with HHS scores recorded at the last follow-up using the paired Student's t-test for parametric data and the Wilcoxon signed-rank test for nonparametric data. Survivorship analysis of the implants was done using the Kaplan Meier method [15]. The end point criterion being revision surgery with cup replacement for any reason.

Results

From March 2004 to August 2014 we implanted a 1000 dual mobility acetabular cups (Avantage - Biomet) in 901 patients. There were 612 females and 289 males with a mean age of 76.8 years at the time of their operation (from 29 to 98). 71% of them were cases of osteoarthritis, 23% were femoral neck fractures and 6% were avascular necrosis. 93 patients were lost to follow-up leaving 808 with a total of 883 dual mobility cups for the final analysis.

At the last follow-up, 103 patients had died of unrelated causes. None of the deceased were known to have a dislocation at their last review. Among the remaining 705 patients (775 cups) we have recorded no dislocations at the mean follow-up of 8,9 years (ranging from 3 months to 14 years). We recorded 9 (1%) cases of deep prosthetic joint infection and 3 cases of infection of subcutaneous tissue above the muscular fascia, 1 case of femoral nerve palsy, 10 (1,1%) cases of periprosthetic fractures and 1 case of deep vein thrombosis with pulmonary embolism.

The average HHS score, which was recorded for cases of osteoarthritis and avascular necrosis, has increased from the initial value of 44,9 (ranging 20 to 81) to 90,4 (ranging 32-100) at the last follow-up (Student's t-test, $p<0.0001$).

Radiographic analysis showed no major radiographic findings at the last follow-up. All the acetabular components were well fixed with no radiolucency, progressive osteolysis or component migration.

Discussions

The risk of hip dislocation following THA is a major cause of revision in primary THA [5]. What we have been striving for in our institution for the last 15 years is to reduce the chance of hip dislocation after primary implantation. For that reason we perform a comprehensive preoperative evaluation of every patient, taking into account their age, body mass index above 30kg/m^2, lumbosacral pathology, neuromuscular disease and sequelae of paediatric hip conditions. We also use a direct anterior approach for most of our primary hip replacements, but what made the biggest difference in luxation rates was the incorporation of dual mobility cups into our daily practice.

The only criterion for inclusion in the analysis was the use of a dual mobility cup in primary THA. Patient specific factors did not play any role in the selection process. This resulted in an extremely heterogeneous group of patients who were operated on for different reasons (fracture, osteoarthritis and avascular necrosis) by various surgeons. These surgeons were using different approaches (classic anterolateral, minimal invasive anterolateral and minimal invasive direct anterior approach), different fixation methods (cemented or cementless) and a variety of different femoral stems (Alta, Aura and Exception - Biomet). There are a lot of studies available in the literature which analyse the difference in hip luxation rates between various approaches [9-11]. These studies however, do not compare luxation rates when using double mobility cups, but rather standard cup designs. In our study, no difference in luxation rates has been found between different approaches when using a dual mobility cup design. We realize our cohort of patients is small and further research on the subject is needed.

The dual mobility concept addresses the risk of dislocation by using a large diameter acetabular shell with a large diameter polyethylene insert. The insert in turn articulates with a metal or ceramic femoral head which is kept within the polyethylene insert. This accomplishes two things; it creates an increased range of motion and a long jump distance which needs to be covered for a luxation to occur. We acknowledge the possibility of early aseptic loosening in dual mobility designs even though we haven't yet encountered this problem in our series. For that reason, we use it as the treatment of choice for patients who are >70 years old and for patients with abovementioned risk factors for hip dislocation.

The diagnosis of deep prosthetic joint infection was made when there was a sinus tract communicating with the prosthesis, or a pathogen was isolated by culture from at least two separate tissue or fluid samples obtained from the affected prosthetic joint, or four of the following six criteria were met: a) abnormal serology (elevated erythrocyte sedimentation rate and serum C-reactive protein), b) elevated synovial leukocyte count, c) elevated synovial neutrophil percentage, d) presence of purulence in the affected joint, e) isolation of a microorganism in one culture of periprosthetic tissue or fluid, or f) there were more than five neutrophils per high-power field in five high-power fields observed from histologic analysis of periprosthetic tissue at ×400 magnification [16]. We recorded 9 cases (approx. 1%) of deep prosthetic joint infection, which is comparable to infection rates reported in the literature with the use of standard cups [17]. The most common organisms identified were Staphylococcus aureus and Staphylococcus epidermidis.

To prevent postoperative thromboembolic events, we normally use a combined therapy of antithrombotic agents (apiksaban or rivaroksaban) until the 35th postoperative day and pre- and postoperative ankle exercises. We also mobilize our patients on the following day after the surgery. We had 1 case of deep vein thrombosis with pulmonary embolism in the first week after surgery which necessitated treatment in the intensive care unit.

So far we had 10 (1,1%) periprostetic fractures, which is lower than normally reported rates of approximately 3 to 4% [18,19]. In these 10 cases, all the fractures occurred on the femoral side either intra- or postoperatively. In our study we focused on the acetabular component and thus we did not analyse the relationship between different stems and fixation options in regards to femoral periprostetic fractures. Avantage Dual Mobility cups (cemented and cementless) used in this series are spherical-cylindrical in shape. Spherical and cylindrical parts of the cup have different functions and only the spherical part is directly involved in fixation of the cup. Therefore the transfer of forces from the cup to the pelvic bone and the risk of periprostetic fracture of the acetabulum are similar to a standard hemispherical cup. There were, however, no fractures involving the acetabular component in our series.

We had 1 case of femoral nerve palsy which occurred with direct anterior approach. This patient regained full function of the affected muscles within 6 months, but some sensory impairment persisted. We believe the damage to the femoral nerve was due to pressure from the anterior muscle retractor. It is important to note that implantation of dual mobility cups does not require any extra exposure or soft tissue dissection in comparison with standard cups.

Conclusion

We acknowledge that we use dual mobility cups mostly for older patients (mean age of 76.8 years), who are generally less physically active. Thus our results are not directly applicable to a younger, more demanding group of patients.

Bibliography

1. Garellick, G., Kärrholm, J., Rogmark, C., Rolfson, O. & Herberts, P. (2011). *Swedish Hip Arthroplasty Register.* Annual Report 2011.

2. Annual Report June 2010. *The Norwegian Arthroplasty Register 2013*.

3. Australien Orthopaedic Association National Joint Replacement Registry. Annual Report. Adelaid: AOA.

4. Devane, P. A., Wraighte, P. J., Ong, D. C. & Horne, J. G. (2012). Do joint registries report true rates of hip dislocation? *Clin Orthop Relat Res., 470*(11), 3003-3006.

5. *National Joint Registry for England and Wales*. 8th Annual Report, 2011.

6. Alberton, G. M., High, W. A. & Morrey, B. F. (2002). Dislocation after revision total hip arthroplasty: an analysis of risk factors and treatment options. *J Bone Joint Surg Am., 84-A*(10), 1788-1792.

7. Woo, R. Y. & Morrey, B. F. (1982). Dislocations after total hip arthroplasty. *J Bone Joint Surg Am., 64*(9), 1295-1306.

8. Berry, D. J., von Knoch, M., Schleck, C. D. & Harmsen, W. S. (2004). The cumulative long-term risk of dislocation after primary Charnley total hip arthroplasty. *J Bone Joint Surg Am., 86-A*(1), 9-14.

9. Barton, C. & Kim, P. R. (2009). Complications of the direct anterior approach for total hip arthroplasty. *Orthop Clin North Am., 40*(3), 371-375.

10. Sheth, D., Cafri, G., Inacio, M. C., Paxton, E. W. & Namba, R. S. (2015). Anterior and Anterolateral Approaches for THA Are Associated With Lower Dislocation Risk Without Higher Revision Risk. *Clin Orthop Relat Res., 473*(11), 3401-3408.

11. Masonis, J. L. & Bourne, R. B. (2002). Surgical approach, abductor function, and total hip arthroplasty dislocation. *Clin Orthop Relat Res.,* (405), 46-53.

12. Ivan De Martino, Georgios Konstantinos Triantafyllopoulos, Peter Keyes Sculco & Thomas Peter Sculco (2014). Dual mobility cups in total hip arthroplasty. *World J Orthop., 5*(3), 180-187.

13. Harris, W. H. (1969). Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end result study using a new method of result evaluation. *J Bone Joint Surg Am., 51*(4), 737-755.

14. DeLee, J. G. & Charnley, J. (1976). Radiological demarcation of cemented sockets in total hip replacement. *Clin Orthop Relat Res.,* (121), 20-32.

15. Kaplan, E. L. & Meier, P. (1958). Nonparametric estimation from incomplete observations. *J Am Stat Assoc., 53*(282), 457-481.

16. Javad Parvizi, Benjamin Zmistowski, Elie Berbari, F., Thomas Bauer, W., Bryan Springer, D., *et al.* (2011). New Definition for Periprosthetic Joint Infection: From the Workgroup of the Musculoskeletal Infection Society. *Clin Orthop Relat Res., 469*(11), 2992-2994.

17. Luis Pulido, Elie Ghanem, Ashish Joshi, James Purtill, J. & Javad Parvizi (2008). Periprosthetic Joint Infection: The Incidence, Timing, and Predisposing Factors. *Clin Orthop Relat Res., 466*(7), 1710-1715.

18. Abdel, M. P., Watts, C. D., Houdek, M. T., Lewallen, D. G. & Berry, D. J. (2016). Epidemiology of periprosthetic fracture of the femur in 32 644 primary total hip arthroplasties: a 40-year experience. *Bone Joint J., 98-B*(4), 461-467.

19. Berry, D. J. (1999). Epidemiology: hip and knee. *Orthop Clin North Am., 30*(2), 183-190.