

# Large diameter metal on metal total hip replacement for femoral neck fractures with neurological conditions

## A retrospective assessment

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### ABSTRACT

**Background:** Patients with Parkinson's disease and poliomyelitis can have a femoral neck fracture; yet, the optimal methods of treatment for these hips remains controversial. Many constrained or semi-constrained prostheses, using constrained liners (CLs) with a locking mechanism to capture the femoral head, were used to treat femoral neck fractures in patients with neurological disorders. We retrospectively studied a group of patients with Parkinson's disease and poliomyelitis who sustained femoral neck fractures and were treated by total hip arthroplasty using an L-MoM prosthesis.

**Materials and Methods:** We retrospectively reviewed 12 hips in 12 patients who underwent large-diameter metal-on-metal (L-MoM) total hip replacement between May 2007 and October 2009. Eight of the 12 patients (8 hips; 66.7%) had Parkinson's disease and 4 patients (4 hips; 33.3%) were affected with poliomyelitis.

**Results:** The followup time was 5.2 years (range 3.6-6.0 years). At the latest followup, all the patients showed satisfactory clinical and radiographic results, with pain relief. No complications, such as dislocation or aseptic loosening occurred.

**Conclusion:** We believe the use of L-MoM can diminish the rate of instability or dislocation, after operation. The L-MoM is an option for patients with Parkinson's disease and poliomyelitis with femoral neck fracture.

**Key words:** Femoral neck fracture, Parkinson's disease, poliomyelitis, total hip arthroplasty, metal on metal prosthesis

**MeSH terms:** Femoral neck, Parkinson's disease, poliomyelitis, hip replacement

### INTRODUCTION

Total hip replacement (THR) has been successfully used to treat femoral neck fractures with displacement, especially in elderly patients.<sup>1</sup> This procedure has proved to be superior to hemiarthroplasty and internal fixation for functional rehabilitation and health-related quality of life,<sup>2,3</sup> but the main concern of instability or dislocation with this treatment is yet to be solved.<sup>4</sup> Patients with neurological conditions affecting the hip pose a particular challenge for the replacement surgeon with associated paresis, spasticity, contractures and tremors potentially leading to poor muscle

tone across the hip. Compared to the patients with normal muscle strength, abnormal muscle tone predisposes patients who undergo THR to early failure because of dislocation and aseptic loosening.<sup>5-7</sup>

Many constrained or semi-constrained prostheses, using constrained liners (CLs) with a locking mechanism to capture the femoral head, were used to treat femoral neck fractures in patients with neurological disorders. This combination maintains the junction between femoral head and acetabulum cup, but increases the stress force on the hips and decreases the range of motion (ROM),<sup>8</sup> resulting in loosened acetabular components and disassociation of hip prosthesis, rendering surgery a failure.

As the relationship between the diameter of the femoral head and dislocation rate clarified, large-diameter femoral head prostheses have been increasingly used for their unique stability in THRs.<sup>9</sup> The maximization of the diameter of femoral head achieved by large-diameter metal-on-metal (L-MoM) total hip prosthesis was considered beneficial to elderly patients, especially for those with weak muscle strength and poor mobilization status for its better stability and low incidence of early dislocations and revisions, while allowing early functional rehabilitation.

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We retrospectively studied a group of patients with Parkinson's disease and poliomyelitis who sustained femoral neck fractures and were treated by total hip arthroplasty using an L-MoM prosthesis. Is this technique suitable for these special patients? Currently no relevant report has been published concerning the use of L-MoM THR for femoral neck fracture in patients with Parkinson's disease or poliomyelitis. Thus, we compared the clinical and radiographic results after L-MoM THR in these patients with other surgical options.

## MATERIALS AND METHODS

12 hips in 12 patients who underwent large MoM THRs for femoral neck fractures with either Parkinsons disease or poliomyelitis, between May 2007 and October 2009, constituted this retrospective study. Patients' demographic data were collected before surgery, including age, sex, weight, height, body mass index, diagnosis necessitating surgery and muscle strength of the affected limbs before fracture [Table 1]. There were 8 patients with Parkinsons disease and 4 patients with poliomyelitis. Patients' muscle strength could be found from their most recent clinical record. All patients were monitored, with the average followup period being 5.0 years (range, 3.6-6.0 years). Preoperative evaluation included obtaining a plain radiograph of the pelvis as well as anteroposterior views of the involved hip.

### Operative procedure

All patients were given broad-spectrum antibiotics on the day of surgery which were continued for 24 h after surgery. One 100-mg indomethacin suppository was given each night for three nights and then an oral dose of 100 mg a day was given with mucoprotection, up to the 14<sup>th</sup> day after surgery. All patients received prophylactic anticoagulants via once-daily administration of low-molecular-weight heparin.

**Table 1: Clinical details of patients**

Primary diagnosis	Gender	Age (years)	Weight (kg)	Height (cm)	Muscle strength (affected limb)	Duration of followup (year)
PD*	M	62	74	169	5	5.1
PD	M	65	68	175	4	5.8
PD	M	70	76	173	4	6.0
PD	F	63	62	158	5	5.4
PD	F	74	57	162	4	4.8
PD	M	72	63	167	5	3.9
PD	M	68	77	173	5	5.2
PD	M	76	69	166	4	4.7
Poliomyelitis	M	64	67	163	3	3.6
Poliomyelitis	F	56	59	164	3	5.3
Poliomyelitis	M	61	62	176	2	5.9
Poliomyelitis	M	58	65	172	3	4.6

\*PD = Parkinson's disease

One surgeon (WX) performed all operations using the posterolateral approach with the patient in the lateral position. Durom acetabular components (Zimmer, Warsaw, IN, USA), Metasul large-diameter femoral heads (Zimmer GmbH, Winterthur, Switzerland), and VerSys Fiber Metal Taper stems (Zimmer) were implanted. All prosthesis were cementless.

For patients with Parkinson's disease, we used general anesthesia to control the muscular rigidity and tremor. After hip exposure, the operation could be finished successfully with the routine surgical steps. In patients with poliomyelitis, the situation was complicated. First, general anesthesia and muscle relaxant were used for muscle relaxation. Secondly, the main problem was dysplastic acetabulum and femur. Preoperatively, we carefully measured the diameter of femoral medullary cavity in order to help us make preparation for the minimum sized femoral prosthesis. The false and true acetabulum should also be identified during operation. The true acetabulum was reamed to accommodate the acetabular component and the cup was implanted in a press-fit manner. If possible, bulk autograft was also considered to increase the fixation of the acetabular component. Third, leg length discrepancy was no more important than stability in these patients. Due to the acetabulum moving down and the muscle contracture, the recovery of leg length discrepancy becomes difficult. In our poliomyelitis patients, we just made it stable enough to avoid dislocation, though leg-length discrepancy was found at followup period (although this did not affect their activities of daily living).

Patients were guided to do stepwise exercises, such as quadriceps femoris isometric contraction, after the operation and try to get out of bed with the help of a crutch or walker from the second day to 1 week postoperatively. Weight bearing was restricted to 20% (with the aid of a walker) for 1 week and then advanced to 50% (with cane or crutch in ipsilateral hand) for another week. After 2 weeks of walking exercise, all patients were advanced to full bearing as tolerated. Most patients were discharged home within 1 week postoperatively and the average hospital stay was 6 days. Clinical and radiologic assessment was done before surgery; at 3 months, 6 months, and 1 year after surgery and then once a year. Clinical assessment of pain, function, deformities and ROM was based on the evaluation system developed by Harris.<sup>10</sup> A Harris hip score of  $\leq 70$  points was considered as a poor outcome, 70-79 points as fair outcome, 80-89 points as good and  $\geq 90$  points is considered as an excellent outcome. Activity ability was graded using the University of California at Los Angeles (UCLA) activity score,<sup>11</sup> which ranges from 1 point (inactive) to 10 points (regular participation in an impact sport).

Serum cobalt was assayed using inductively coupled plasma mass spectrometry and serum chromium every year after

surgery using atomic absorption spectrometry. Results were given in microgram per liter. Normal values were less than 0.53 µg/L for cobalt and less than 0.26 µg/L for chromium.

Radiologic assessment included a standing anteroposterior radiograph of the pelvis with the radiograph centered at the pubic symphysis and a lateral radiograph of the operated hip joint. Regions of possible aseptic loosening were defined according to Gruen (zones 1-7)<sup>12</sup> for the periprosthetic femur and according to De Lee and Charnley (zones 1-3)<sup>13</sup> for the per prosthetic acetabulum. We assessed the acetabular component migration by determining the vertical and horizontal positions of the component. The vertical position was determined by measuring the distance between the inter teardrop line and a parallel line tangential to the superiormost aspect of the acetabular component. The horizontal position was determined by measuring the distance between a vertical line drawn through the medial aspect of the teardrop and a parallel line drawn tangential to the most medial aspect of the acetabular component.<sup>14</sup> Subsidence resulting from loosening was defined as any change in the acetabular component position >4 mm in either the vertical or horizontal position in relation to the teardrop.<sup>15</sup> Ectopic ossification was classified according to the system described by Brooker *et al.*<sup>16</sup>

## RESULTS

All the patients were male with an average age of 65.7 years (range 56-74 years). Eight of the 12 patients (8 hips; 66.7%) had Parkinson's disease and 4 patients (4 hips; 33.3%) had been affected with poliomyelitis. At the most recent followup visit, all patients were ambulatory and there were no complications such as dislocation, infection, femoral neck fracture, nerve injury, or symptomatic deep vein thrombosis, indicating that it is better than other reported surgical options selected [Table 2]. Before fracture, the muscle strength of the affected limbs was grade 4-5 in Parkinson's disease patients and grade 2-3 in poliomyelitis patients. Both groups of patients retained the same grade at the last followup examination. The average preoperative Harris hip score was 10.1 ± 6.5, compared to 76.4 ± 5.6 at the last followup examination. The average preoperative UCLA score was 2.3 ± 0.6 compared to 6.7 ± 0.8 at the last followup examination [Table 3]. Outcomes were considered as fair in seven cases and poor in five which were related to the inevitable progression of the neurological disease. All patients experienced significant pain relief.

The mean duration of surgery after injury was 3 days (range 1-4 days). The mean diameter of femoral head was 40 mm (range 38-42 mm) and the mean diameter of acetabular cup used was 46 mm (range 44-48 mm). All patients had restored their hip function in flexion extension, abduction adduction, rotation and total ROM, compared with before surgery.

**Table 2: Results following THR for femoral neck fracture as reported in different series**

Author	Diagnosis	THR (number)	Component	Result
Weber <i>et al.</i> <sup>7</sup>	PD*	107	Uncemented and cemented components	93% pain relief and 6 (6%) dislocations (all revisions) 3 (3%) aseptic loosening
Meek <i>et al.</i> <sup>5</sup>	PD	2394	N/A*	0.0 to 0.46 annual dislocation rate
Spinnickie <i>et al.</i> <sup>28</sup>	Poliomyelitis	1	Cementless components Constrained liner	Dislocation
Cameron <sup>6</sup>	Poliomyelitis	1	Uncemented constrained components	N/A
Laguna <i>et al.</i> <sup>17</sup>	Poliomyelitis	1	Uncemented components	Painfree and well fixed

PD = Parkinson disease, \*N/A = Not available

**Table 3: Preoperative and postoperative clinical scores**

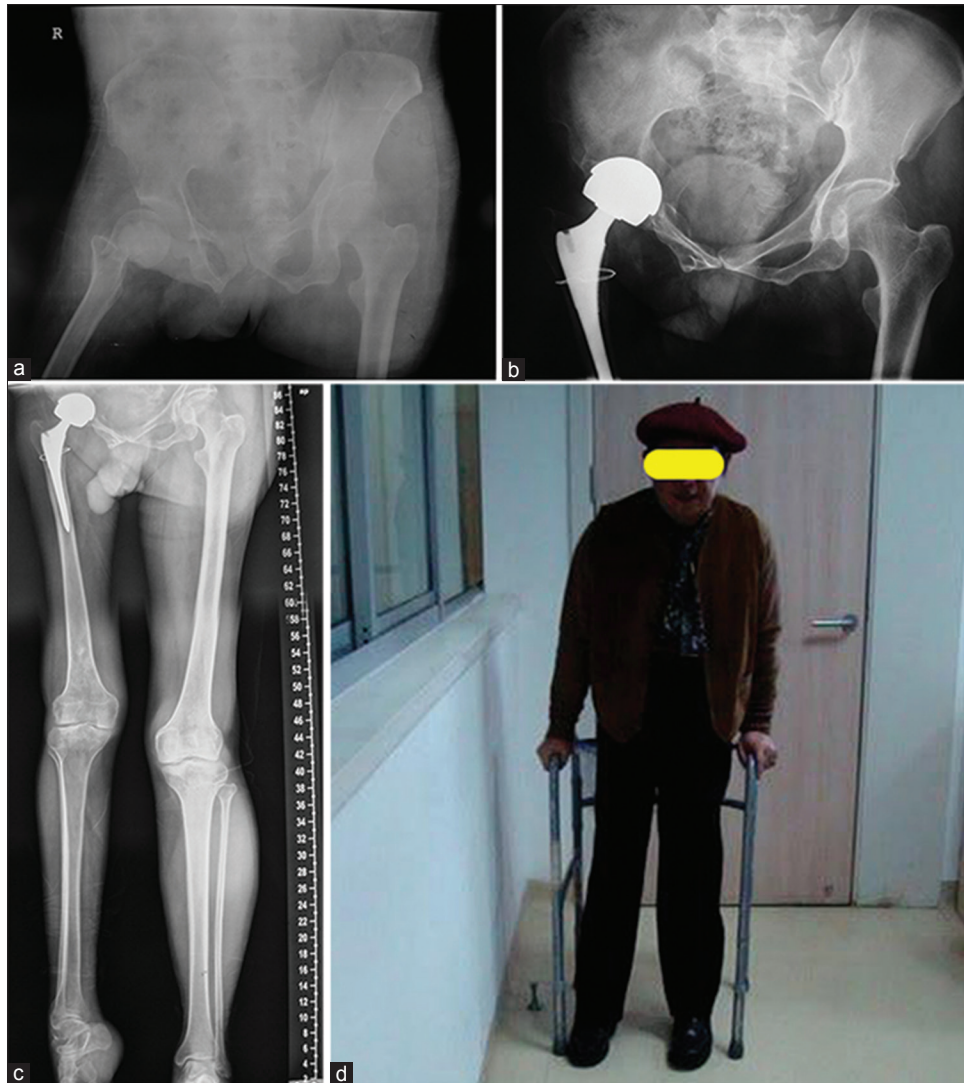
Score	n	Average clinical scores		
		Preoperative	Postoperative	Improvement
Harris	12	10.1±6.5	76.4±5.6*	66.3±5.5
UCLA	12	2.3±0.6	6.7±0.8*	4.4±0.3

UCLA indicates University of California as Los Angeles. \*P=0.000, the comparison between preoperation and postoperation value of the same group.

At the final followup evaluation, 1 of the 12 hips (8.3%) had Brooker I heterotopic ossification. All prostheses were fixed in place and no instances of frank loosening were noted. No patients were found to have continuous radiolucent lines, although in some patients with stable hips, there were 1 to 2 mm peripheral radiolucent lines, usually at the superolateral portion of the acetabular component bone interface. There was no evidence of migration of any acetabular or femoral component [Figures 1 and 2].

## DISCUSSION

Evidence has suggested that Parkinson's disease patients are at increased risk of falls, which is more related to intrinsic (disease related) factors than extrinsic (environmental) factors.<sup>17</sup> Patients with poliomyelitis are prone to leg fractures after mild trauma because of osteoporosis.<sup>18</sup> The common effects of Parkinson's disease and poliomyelitis are poor or imbalanced muscle tone across the hip and osteoporosis. These neurological conditions predispose patients who undergo THR to early failure because of dislocation and aseptic loosening.<sup>5,19</sup> Wicart *et al.*<sup>20</sup> had reviewed 14 consecutive patients with neuromuscular disease, who had 18 total arthroplasties of paralytic hips. The mean followup was 5.6 years and one acetabular loosening, three femoral loosening, and four prosthetic dislocations occurred.

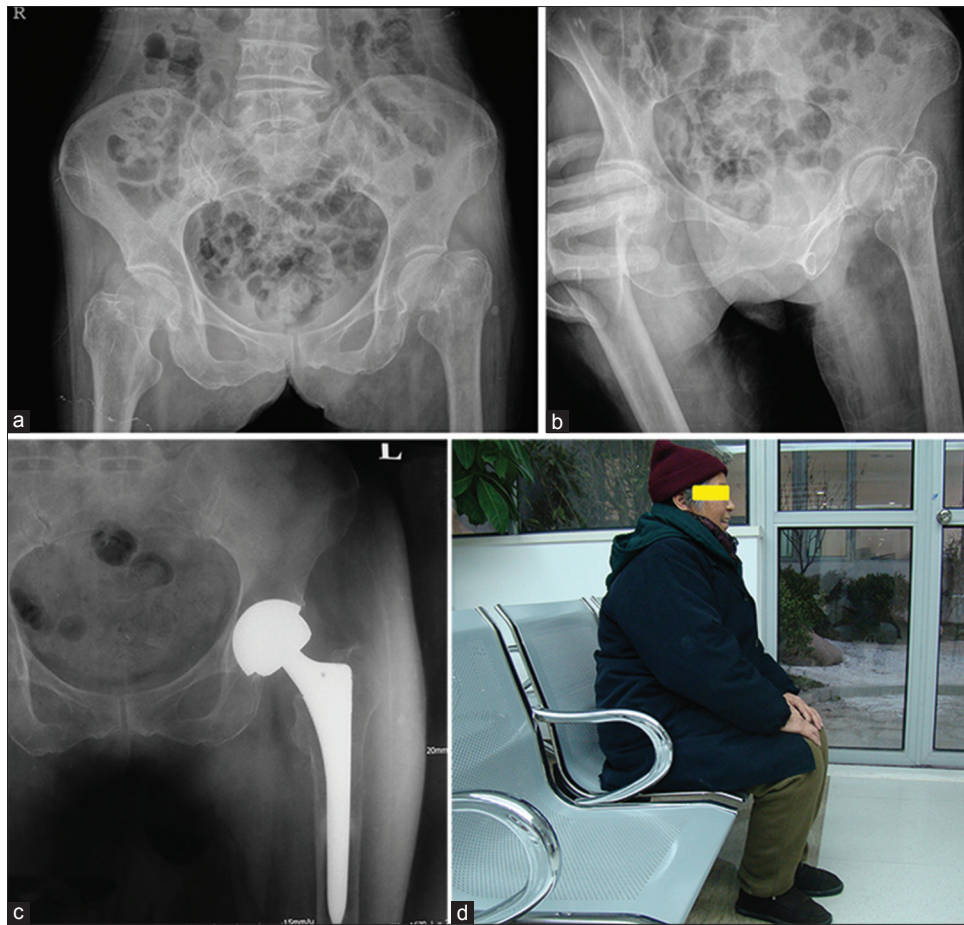


**Figure 1:** (a) Preoperative radiograph of pelvis with both hip joints anteroposterior view showing dysplasia of the right pelvis, fracture of the right femoral neck (Garden grade IV). (b) Radiograph obtained 5 years after surgery showing that the prosthetic head and acetabular cup were settled in position and were articulating well. (c) The lower limbs full length radiographs showing right limb shortening. (d) Clinical photograph showing the gait with walker

Large femoral heads is available to keep hip stability. The design of prosthesis provides increased ROM with avoidance of neck-shell impingement caused by the increased head: Neck ratio. Meanwhile, larger femoral heads provide a greater resistance to dislocation because of the increased jump distance required to dislocate. Fricka *et al.*<sup>4</sup> suggested using the combination of highly cross-linked polyethylene and large femoral head to restore joint stability. In their study group, large femoral heads (>32 mm) were used in 47 cases. At the mean followup of 2.2 years (range 2-3.2 years), there were 2 (4.3%) reoperations caused by redislocation and both redislocations occurred with 36-mm heads. No reoperations in the setting of revision THA with intraoperative instability were reported. Spinnickie *et al.*<sup>21</sup> reported a 71-year-old patient with nonunion of an intertrochanteric fracture and poliomyelitis with flail extremities. The patient underwent conversion THA using a 58-mm cementless shell and screws

and a CL. The trunion and femoral head were disassociated 5 months later and the hip was revised with a 40-mm femoral head and an unconstrained polyethylene liner with a lip elevated by 15°. The authors believed that large femoral head increased the stability of the hip and decreased the risk of dislocation.

Recently, L-MoM prostheses have been extensively used and have shown satisfactory clinical and radiographic results.<sup>22-24</sup> Sikes *et al.*<sup>22</sup> compared the safety and efficacy of L-MoM (range, 38-53 mm) THR with standard head size (range, 28-32 mm) metal-on-polyethylene THR. No failures or revisions occurred in the large-diameter head group, while two dislocations were found in the small-head group. The use of large-diameter femoral heads is a viable option for high-risk patients to avoid dislocation in primary THR. In order to obtain large-diameter femoral head to



**Figure 2:** (a) Radiograph of the pelvis with both hip joints anteroposterior view showing left femoral neck fracture (Garden grade IV). (b) The attempted lateral radiograph of the left hip showing fracture of the femoral neck. (c) Radiograph five years after surgery, the acetabular and femoral prosthesis were fixed in place and no lucencies were detected. (d) Clinical photograph showing that she could sit down on common seat

maintain stability, we chose L-MoM prostheses for patients with neurological conditions.

Because of low incidence of dislocation, L-MoM prostheses allow patients to do rehabilitation exercise as early as possible, which is particularly important for patients with neurological conditions. Literature reports have shown potential complications such as urinary and respiratory track infections, sepsis, decubitus ulceration, deep vein thrombosis, and pulmonary embolism occurring after a hip fracture reconstruction in these patients. All these complications were related to being bedridden for a long term.<sup>25-29</sup> In our study cohort, we encouraged patients to do quadriceps femoris isometric contraction after the operation and try to get out of bed with the help of a crutch or walker from the second day to 1 week postoperatively. At the last followup, no such complications were reported.

Recent studies have recommended the discontinuation of L-MoM THR because of its adverse effects. Indeed, the major concerns are soft tissue reactions which include aseptic lymphocyte-dominated vasculitis-associated

lesions (ALVAL), pseudotumors, squeaking, and adverse reactions to metal debris and metal ion release into the circulation. Migaud *et al.*<sup>30</sup> have debated that the implant design, component position, metallurgy, and the tribological properties of MoM bearings are the major issues in the reduction of adverse effects. Metallurgy is a key factor in the success of MoM bearings. Likewise, the MoM coupling design is critical and may promote early failure when not appropriate. The use of large-diameter heads can't avoid unsuitable orientation which leads to edge loading and excessive secondary metallic debris production. In fact, MoM bearings are very sensitive to malpositioning (edge loading in L-MoM THR). The dislocation rate with large-diameter heads is very low and is a common reason to use these components, but the main concern is the occurrence of pseudotumors secondary to wear resulting from vertical cup placement. In our study series, no such complications occurred; this might have been the benefit from correct component position and low level of activity.

Till date, the use of L-MoM THR for femoral neck fracture in neurological conditions has not been reported. And THR

is rarely used to treat degenerative joint in poliomyelitis patients with the evidence in literature being limited to case reports. In our patients with neurological conditions, we used L-MoM THR to reconstruct the function of the hip and obtained satisfactory followup results. There was no dislocation or occurrence of other complications. Therefore, we set out to determine whether this device was suitable for femoral neck fracture with distinct displacement in patients with Parkinson's disease and poliomyelitis. Our aim was to recover the hip function, decrease the dislocation rate and maintain long term prosthesis survival. At the latest followup, pelvic radiographs demonstrated well positioned prosthesis, with no symptom of loosening. The articulation was stable enough to allow the patient to return to his prefracture level of function. Though the Harris hip score was not higher than that in the normal patient, they regained the ability of daily life. We believe that if the bone stock is enough, the use of L-MoM devices can result in a much better stability for the patients with neurological conditions.

In conclusion, patients with Parkinson's disease and poliomyelitis are associated with an increased risk of falls, osteoporosis and fractures, most notably at the femoral neck. Neurological conditions in these patients affecting the hip pose a particular challenge for the replacement surgeon, with associated paresis, spasticity, contractures, and tremors potentially leading to poor or imbalanced muscle tone across the hip. Dislocation and aseptic loosening are the main complications. L-MoM THR improved stability and reduced the incidence of dislocation. It also decreased the stress force on the hips and avoided loosening of the acetabular components, which is suitable for these special patients. At the last followup, no dislocation and aseptic loosening occurred in the group of L-MoM THRs. Outcome with regard to pain relief and ROM recovery was excellent. Although Durom L-MoM THR has been recalled by the company, with adequate design and appropriate tribological properties, MoM bearings constitute highly resistant articulations. The stability and low incidence of dislocation are, in the authors' opinion, the major reason for continuing with MoM articulations as long as they are well designed, manufactured, and inserted correctly. L-MoM is an option for Parkinson's disease and poliomyelitis patients.

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