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Total hip resurfacing/replacement with metal-on-metal prosthesis in young patients: studying efficacy

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ABSTRACT

Background: This prospective case series study was carried out to review the literature and compare the efficacy of usage of metal over metal prosthesis in young patients undergoing hip replacement versus conventional metal over polyethylene prosthesis.
Methods: The study was conducted at tertiary care hospital of Indian armed forces with sample size of n=25, to assess early functional outcome of total hip replacement with metal-on-metal prosthesis. Analysis was carried out in terms of improvement in functional status, pain relief, achieving greater range of motion and joint stability.
Results: Mean follow up period was 26 months. The average pre-op Harris hip score was 38.96. The average post-op and last follow up Harris hip score was 84.92 and 86.1. The average pre and post op Harris hip scores of the patients with Idiopathic AVN were 39.7 and 82.5 respectively and the average pre and post op Harris hip scores of the patients with post-traumatic AVN were 37.4 and 86.2. The average pre op and post op Harris hip scores of the patients with non union fracture neck of femur were 36.5 and 86.7 respectively. None of the patient had aseptic loosening, heterotopic ossification or migration of the components, stem failure. There were no cases of dislocation of prosthesis, aseptic loosening, osteolysis, heterotrophic ossification.
Conclusions: This observational study demonstrated better clinical acceptability and profile of metal on metal prosthesis in young patients, having undergone hip replacement.

Keywords: Metal over metal, Harris hip score, Avascular necrosis, Osteolysis

INTRODUCTION

Over the past few decades, many advances in hip replacement have been made and several types of prostheses are available. They may include the traditional total hip replacement, which is a combination of metal and plastic, and the newer metal on metal total hip replacements. A traditional total hip replacement uses a metal head of 28 millimeters in diameter and a plastic socket for motion. While it has an excellent record for long life and durability, the main concern for metal on polyethylene prosthesis is polyethylene debris which creates periprosthetic osteolysis by the release of cytokines and proteolytic enzymes ultimately leading to implant failure.[1] Polyethylene wear debris is cited as the ultimate cause of most total joint arthroplasty failures today leading to an increased frequency of hip revision due to aseptic loosening.[2] This process can take 15 to 25 years and is not a problem for most patients. However, younger patients need new hips, which last substantially longer. These patients are candidates for metal-on-metal replacement. The metal-on-metal total hip simply replaces the plastic material with metal, which is either a cobalt-chrome alloy, or a titanium alloy. These are super metals initially developed for the aerospace industry and now adapted for orthopedics. In laboratory simulator

studies, the metal-on-metal components showed a nine-fold reduction in wear as compared to polyethylene.[3] While metal-on-metal does not have the proven track record of metal on plastic, it is believed that it has the potential to last much longer than traditional hip replacements.

The second major advantage is the very large ball component (large head) that is possible with metal on metal. Removing the thick plastic allows the use of heads that are very close to the size of the natural hip. This reduces the chance of a dislocation and allows much more natural motion. Heads up to 64 mm are possible with metal-on-metal hips, with the average being around 46 mm. The constituent metal ions released through wear of the metal-on-metal total hip arthroplasty are excreted primarily in the urine; serum levels have been 3 to 5 times higher in patients who have had metal-on-metal total hip arthroplasties than in control subjects.[4]

The clinical results of metal-on-metal total hip arthroplasties equal or exceed those of conventional articular couples and rarely are associated with osteolysis compared with conventional couples.[4] Additional advantages of the metal-on-metal combination are the ability to use larger-diameter femoral heads for enhanced stability and the absence of concern over possible fracture of the articular components.[4] The long-term experiences with metal-on-metal total hip arthroplasty make this combination of implant material the ideal choice for younger patients. Second-generation metal-on-metal total hip replacements have experienced short and medium-term success as assessed by Harris hip scores and patient self-assessment. The combined annual linear wear of the metal-on-metal femoral head and acetabular insert is less than 10 mm and osteolysis has only rarely been observed in association with well-fixed metal-on-metal total hip replacements.[5] The most significant advantage to the use of a metal on metal couple in total hip arthroplasty is the clearly documented reduction in wear of the bearing surface.[6] Considering all these various aspects this study was carried out to assess early functional outcome of total hip replacement with metal on metal prosthesis in young patients (25-50 years) in terms of providing improvement in functional status, pain relief, achieving greater range of motion and joint stability and ability to carry out activities of daily living and to assess any early complications which the patients may have to encounter.

METHODS

This study was carried out in tertiary care hospital, sample size calculation was carried out by variables to be considered and SPSS software. The aim was to study early functional results of hip replacement/resurfacing using metal on metal prosthesis in young patients undergoing HIP replacement. The objectives included early functional results of metal-on-metal THR/ASR in young adults, whether MoM THR is an effective procedure for pain relief, improvement in range of motion, correction of deformities and biomechanics and various early complications of metal-on-metal hip prosthesis.

The inclusion and exclusion criteria is shown in (Table 1). A total of 35 patients were enrolled and after exclusion and inclusion analysis 25 patients were included in study. The participant flow is depicted in (Figure 1). The enrolled patients were extensively evaluated, clinically and radiologically. The patient proforma was diligently filled up along with all due consents and follow up at regular intervals was planned. The surgery was carried out after due clearances and anaesthetic pre requisites. Surgeries carried out under spinal anaesthesia+epidural anaesthesia/analgesia and follow up was carried out at regular interval post operatively. Pre operative templating was carried out with consideration of requisite investigations. Harris Hip scoring system was utilised for further evaluation and intervention in the study (Figure 2).

Table 1: Inclusion and exclusion criteria.

S. no.	Inclusion criteria	Exclusion criteria
1.	Age between 25-50 years	Patients less than 25 years or patients above 50 years
2.	Diagnoses: idiopathic AVN, post traumatic, post-partum, chronic steroid intake, non-union neck femur, chronic alcohol induced, legg calve perthes disease, polyarticular RA, primary osteoarthiritis	Females who had not yet completed their family and desirous of further children
3.	Patient having either unilateral or bilateral hip arthritis	Active infection at operative or other site or septic arthritis; tubercular arthritis of hip
4.	Females who had completed their family, no medical contraindication for anaesthesia	Known allergy to metal (e.g. jewellery); the presence of highly communicable disease or diseases that may limit follow-up (e.g. immuno-compromised conditions, hepatitis, active tuberculosis, etc.); significant neurological or musculoskeletal disorders or disease that may adversely affect gait or weight bearing (e.g. muscular dystrophy, multiple sclerosis)
5.		Previous treatment for renal disease

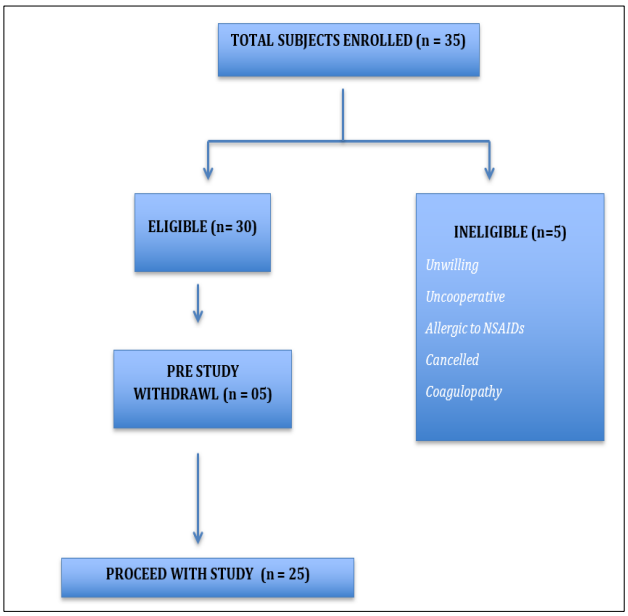
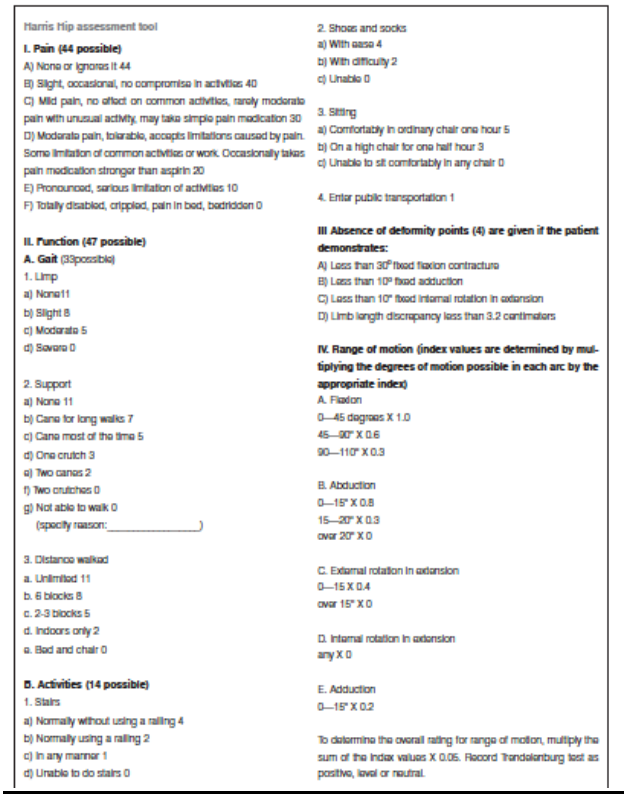


Figure 1: Participants flow.


Harris Hip assessment tool

I. Pain (44 possible)
A) None or ignores it 44
B) Slight, occasional, no compromise in activities 40
C) Mild pain, no effect on common activities, rarely moderate pain with unusual activity, may take simple pain medication 30
D) Moderate pain, tolerable, accepts limitations caused by pain. Some limitation of common activities or work. Occasionally takes pain medication stronger than aspirin 20
E) Pronounced, serious limitation of activities 10
F) Totally disabled, crippled, pain in bed, bedridden 0

II. Function (47 possible)
A. Gait (33possible)
1. Limp
a) None11
b) Slight 8
c) Moderate 5
d) Severe 0

2. Support
a) None 11
b) Cane for long walks 7
c) Cane most of the time 5
d) One crutch 3
e) Two canes 2
f) Two crutches 0
g) Not able to walk 0
(specify reason:_____)

3. Distance walked
a. Unlimited 11
b. 6 blocks 8
c. 2-3 blocks 5
d. Indoors only 2
e. Bed and chair 0

B. Activities (14 possible)
1. Stairs
a) Normally without using a railing 4
b) Normally using a railing 2
c) In any manner 1
d) Unable to do stairs 0

2. Shoes and socks
a) With ease 4
b) With difficulty 2
c) Unable 0

3. Sitting
a) Comfortably in ordinary chair one hour 5
b) On a high chair for one half hour 3
c) Unable to sit comfortably in any chair 0

4. Enter public transportation 1

III Absence of deformity points (4) are given if the patient demonstrates:
A) Less than 30° fixed flexion contracture
B) Less than 10° fixed adduction
C) Less than 10° fixed internal rotation in extension
D) Limb length discrepancy less than 3.2 centimeters

IV. Range of motion (index values are determined by multiplying the degrees of motion possible in each arc by the appropriate index)
A. Flexion
0—45 degrees X 1.0
45—90° X 0.6
90—110° X 0.3

B. Abduction
0—15° X 0.8
15—20° X 0.3
over 20° X 0

C. External rotation in extension
0—15 X 0.4
over 15° X 0

D. Internal rotation in extension
any X 0

E. Adduction
0—15° X 0.2

To determine the overall rating for range of motion, multiply the sum of the index values X 0.05. Record Trendelenburg test as positive, level or neutral.

Figure 2: Harris hip scoring.

RESULTS

Age and sex distribution

The study covered 25 cases of hip replacement in young in which 23 were males and 2 females (Table 2). 23 cases of total hip replacement and 02 cases of hip resurfacing. The oldest patient was of age 49 years and the youngest 26 yrs, with the average age being 36.8 years (Figure 3). Pre-operative indications of the study population is depicted in (Table 3).

Table 2: Sex wise distribution of the patients.

Sex	N	%
Male	23	88
Female	02	12

Table 3: Indications for surgery.

Indication	N	%
Idiopathic AVN	9	36
Post Traumatic AVN	5	20
Chronic steroid intake AVN	1	4
Post partum AVN	1	4
Chronic alcohol induced	2	8
Non-union neck femur	4	16
Legg clave perthes disease	1	4
Polyarticular RA	1	4
Primary osteoarthiritis	1	4

Intra-operative observations

The average operative time was 2 hr 11 min (1 hr 45 min to 3 hr 15 min). The mean approximate blood loss was 340 ml (250-500 ml). We used Durom cup, Metasul head and FMT stem in 23 cases and 2 cases underwent ASR with Durom cup and femoral component. The median head size was 50 mm and the range were between 48 mm-54 mm. One patient had an intraoperative periprosthetic fracture shaft of femur (type B2), one had limb length discrepancy in the form of shortening >1 cm, one had limb length discrepancy in the form of lengthening >1 cm which was compensated by a shoe raise on the opposite side. 1 patient had a limp and used a cane for ambulation. 4 patients had mild to moderate thigh pain, which subsided by the end of 6 months of follow-up. The complication rates as encountered were noted and managed accordingly (Table 4).

Table 4: Complications as encountered.

Complications	N
Peri prosthetic fracture(intraoperative)	01
Shortening >1 cm	01
Lengthening >1 cm	01
Limp	01
Anterior thigh pain	04

Pre and post operatively Harris score were obtained and analysed (Table 5) (Figure 5). The average pre-op Harris hip score was 38.96, the average post-operative Harris hip score was 84.92, The average Harris hip score at the last follow-up was 86.1 The average pre op and post op Harris hip scores of the patients with idiopathic AVN were 39.7 and 82.5 respectively. The average pre-op and

post op Harris hip scores of the patients with post-traumatic AVN were 37.4 and 86.2 respectively.

Table 5: Pre-OP and post-OP Harris hip scores.

Causes	Pre-OP HHS	Post-OP HHS	Difference
Idiopathic AVN	39.8	82.5	42.7
Post Traumatic AVN	37.4	86.2	48.8
Chronic steroid intake AVN	42	84	42
Post partum AVN	41	92	51
Alcohol induced AVN	42.5	86	43.5
Non-union NOF	36.5	86.7	50.2
LCPD	39	90	51
Rheumatoid arthiritis	31	74	43
Primary OA	45	90	45

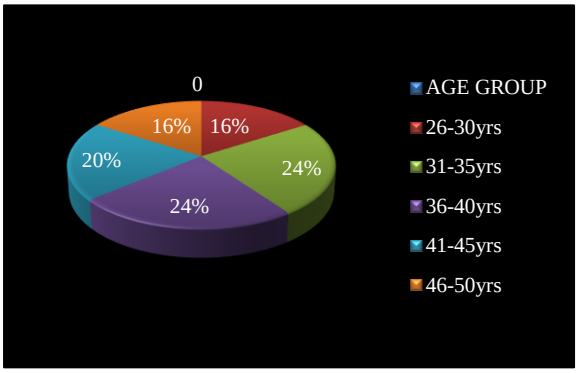


Figure 3: Age distribution of study population.

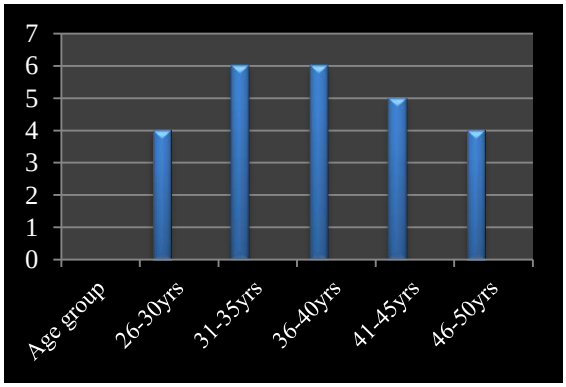


Figure 4: Sex distribution of study population.

The average pre-op and post-op Harris hip scores of the patients with non-union fracture neck of femur were 36.5 and 86.7 respectively. None of the patient had aseptic loosening, heterotopic ossification or migration of the components, stem failure, till the last follow-up. There were no cases of dislocation of prosthesis, aseptic loosening, osteolysis, heterotrophic ossification. None required revision surgery during the period of the study.

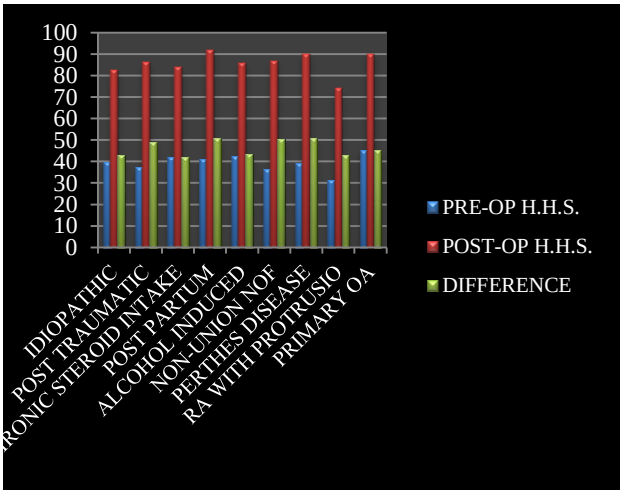


Figure 5: Pre and post-op Harris score.

DISCUSSION

Severe afflictions of the hip especially in young, active and productive individuals between ages of 25 and 50 yrs, with many active years ahead of him provides a serious challenge to the treating surgeon. In advanced cases hip replacement provides excellent pain relief and movement. In our study we performed hip replacement on 25 cases with various diagnosis ranging from AVN, non union neck of femur, sequelae of leg calve perthes disease, poly articular rheumatoid arthritis and primary osteoarthritis. All patients received metal on metal prosthesis and had almost similarly satisfactory outcomes. Metal on metal bearings have been shown to have more survival in terms of wear. Tharani et al[7] stated that metal on metal bearings which have a much longer life (25-30 years) compared to the more traditional metal on polyethelyene bearing. In their retrospective review of 83 un cemented metal on metal THR using 28 mm Metasul articulation in 73 patients younger than 50 years, Delaunay et al found that 80% patients had an activity level graded 4 or 5 as measured with the system of Devane et al.[8] There was no radiographic evidence of component loosening at average 7.3 years of follow up. The 10-year survivorship with the end point of revision was 100%. They found that Metasul bearings with cementless acetabular components were promising in younger patient population. Keeping these in view and considering the young age and higher functional requirement of the patients in our study and we selected uncemented metal on metal prosthesis as the choice of implant for our patients. The functional outcome and improvement in HSS in our study were comparable to other published series on metal-on-metal hip replacement. In our study we used the Durom acetabular cup.[9] In our study, the average pre-op HSS was 38.96, the average HSS post-op at 6 months improved to 84.92. The average HSS at the last follow-up was 86.1. Similar

results have been found by other authors, Boughebribe et al reported on a continuous series of 106 uncemented acetabular cups (Durom™) implanted in 102 patients (mean age, 66 years).[10,11] In their study, the mean HHS improved from 49.3 preoperatively to 91.6 at 30 months follow-up. Our results were comparable to the study of Holloway et al who examined the results of a metal-on-metal total hip replacement with a Metasul-lined cup. They performed 29 THAs in 27 young patients (mean age 49 years). Mean preoperative HSS of 60 improved to 93 at most recent follow-up. Sharma et al had also reviewed 215 primary hip arthroplasties performed using Metasul (Sulzer, Winterthur, Switzerland) metal-on-metal articulation with an average follow up of 7.33 years (range 5-11.4 years). The mean preoperative HHS was 39.8 and mean postoperative hip scores rose to 89.5, 87.3, 88.4 and 85.8 at 1-year, 3-year, 5-year and final follow-up respectively. Saito et al also reviewed 106 total hip arthroplasties performed with a metal-on-metal hip system. The average HHS of 39.5 points before surgery improved to 87.8 points at 05 years follow up.

In our small series there were no dislocation of the prosthesis during follow up period. Absence of dislocation following hip arthroplasty can be directly attributed to using large diameter heads. In our study we used a large head for all our patients where in the median head size was 50 mm and we had no dislocations in our follow up period. Cuckler et al compared the rates of dislocation of large diameter heads to the 28 mm metal femoral head and found a 2.5% dislocation rate in first 3 months following surgery in the small head as compared to nil in the large head.[12] Smith et al also reviewed 327 patients (377 hips) retrospectively with varying diagnoses and indications but all of whom received large-diameter metal-on-metal prostheses.[13] During the short follow up period, there were no dislocations. They concluded that the use of large-diameter femoral heads and metal-on-metal articulations decreases the risk of dislocations, making their use a viable choice for primary and revision procedures. Proper placement of cup is very important for the success of metal on metal prosthesis.

De Haan et al had found that that steeply-inclined acetabular components angle more than 50 degrees give rise to higher concentrations of metal ions due to increased edge loading.[14] In all our cases the inclination of the acetabular cup ranged from 36 to 44 degrees with a median of 40 degrees. This may be directly related to the fact that senior surgeon performed surgeries and had vast experience in joint replacement surgeries. Osteolysis after traditional bearing is attributed to generation of polyethylene wear debris particles. Metal on metal eliminates the use of polyethylene in bearings and hence osteolysis of bone can be eliminated. We observed that there was no evidence of osteolysis on follow up radiographs. Long et al followed 181 patients (207 hips) over a period of 1 to 2 years following implantation of a large-diameter articulation (Durom Metasul).[15] No osteolysis was observed on radiographs in any zone of any hip. Radiographic cup inclination had a range of 28-52. The results of our study were comparable to or in some cases even better than some of the studies because the cases were done by a single experienced joint replacement surgeon and the size of the study was small 25 cases. Due to small follow up period, only short term outcome was studied. In our study only one patient had major complication. It was an intraoperative periprosthetic fracture shaft of femur (type B2), which occurred during implantation of uncemented stem and was managed with SS wire fixation. We had a fracture rate of 4% which was slightly more than the study of Schwartz et al who had a 3% (thirty-nine of 1318) rate of intraoperative periprosthetic fracture when a uncemented femoral component was used.[16] Our rate was also higher than that of the study conducted by Long et al.[15] In their study, there were three femoral fractures with one intraoperative and two seen on postoperative radiographs in a total of 181 cases (1.6%). We recommend that for prevention of this type of complication due diligence must be exercised during femoral canal preparation and sizing. Two patients (8%) had limb length discrepancy following surgery. One patient had shortening >1 cm and it was compensated by foot wear modification. This was significantly less than the series by Jasty et al who reported an incidence of 16% limb length inequality in a series of 85 total hip replacements, their criteria was a shortening of 1 cm or more and were corrected by foot wear modification.[17] Our results were also better compared to the study conducted by Weng W in which in a series of 80 cases 23 legs had a lengthening of >1 cm and 13 operated legs were shorter by a mean of (6.4+/-2.1) mm (3 to 19 mm).[18]

There was no prosthetic joint infection in our study. One patient had a limp due to adductor weakness following surgery. Four patients (16%) had mild to moderate thigh pain, which subsided by the end of 6 month follow up period. Thigh pain is a significant complication after cementless total hip arthroplasty. In most cases, reported symptoms are mild to moderate and resolve spontaneously. In their study Brown said that the incidence of recalcitrant thigh pain with uncemented THA ranges from 0.5% to 40%.however only a small percentage (<4%) experience severe debilitating pain.[19] They suggested that possible causes include bone-prosthesis micromotion, excessive stress transfer to the femur, periosteal irritation, or a mismatch in Young's modulus of elasticity that increases the structural rigidity of the prosthetic stem relative to the femur. Initial treatment remains conservative, such as use of oral nonsteroidal anti-inflammatory drugs and activity modification which we followed in our cases. If symptoms do not resolve 1 to 2 years after THA and activity remains severely limited because of thigh pain, surgery should be considered. Cortical onlay strut grafting of the femur at the prosthetic stem tip can be effective for refractory thigh pain. During our study there was no none of the patient had heterotopic ossification. In their study Rosendahl et al The reported incidence after

total hip arthroplasty (THA) ranges from 0.6% to 90% and in most instances it is clinically asymptomatic with about 2% to 7% of patients experiencing some symptoms.[18] During our follow up period, none of the patient had aseptic loosening, migration of the components or stem failure till the last follow-up. However, a long term follow up is required to assess these complications. None required revision surgery during our follow up period. None of the complications in our study were related to the bearing surface used. None of the patients had any features suggesting hypersensitivity to metal ions.

Tissue reaction to metal debris is a possibility following metal on metal articulations. Metal ions release can be accelerated due to improper component positioning leading to edge loading or from the modular head and neck taper junction of the femoral component. During our study none of the patient reported with features suggestive of irritation of local soft tissues due to metal debris. Mahendra et al analyzed changes in the periprosthetic soft tissues and the femoral heads in 52 MoM arthroplasties which they revised.[20]

Substantial necrosis was observed in the periprosthetic connective tissue in 28 of the cases, including all pseudotumors, and 5 cases of component loosening. Langton et al in their series have described a failure rate as a consequence of adverse reaction to metal debris (ARMD) of 3.2% in ASR resurfacing group, and 6.0% in the ASR THR group.[21] Due to short duration of our study, assessing complications related to generation of metal debris in MoM articulations was beyond the scope of our study. Due to short duration of follow up in our study, we cannot comment whether MoM bearing would provide better survival in terms of need for revision in young active population. However long-term studies have shown that MoM hip articulations have better survival than traditional bearing.

Limitations

Limitations of current study were that study was a prospective case series only assessing functional outcome in small number of patients who underwent large diameter metal on metal hip replacements. There were no control groups. Our study did not compare the outcome between traditional bearings and metal and metal bearings. Neither had it compared results of THR using small heads and the large head. This study had a sample size of 25 and the mean duration of follow up was 26 months. The small sample size and follow up signifies about not being able to comment upon long term complications as, aseptic loosening, migration of components, dislocation and pain.

CONCLUSION

From current short case series and short follow up period its concluded that use of large diameter metal on metal hip replacements can provide good functional outcome in young and active patients in short term. In addition, variety of hip diseases leading to advanced arthritis can be treated with similar outcomes using MoM bearings. The usage of MoM components is associated with lesser difficulties during intra operative implantation with minimal major complications. However, long term follow up is needed to assess whether metal debris particles generated in MoM bearings would cause any adverse soft tissue reaction and to assess survivability of MoM implant, loosening, revision rates. We encourage the use of this technique for all young and active patients who require a total hip replacement.

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Ethical approval: The study was approved by the institutional ethics committee

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