ARAŞTIRMA / RESEARCH REPORT
İnönü Üniversitesi Tıp Fakültesi Dergisi 2011;18(1):14-19

Metal-on-Metal Total Hip Arthroplasty for Crowe I and II Dysplastic Hips: Short-term Results of 66 Patients

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Objectives: This retrospective study was designed to evaluate outcome of patients with coxarthrosis secondary to low grade hip dysplasia treated with large head Metal-on-Metal (MoM) hip arthroplasty.
Patients and methods: Seventy–six dysplastic hips of sixty-six patients were managed with large head MoM cementless total hip arthroplasty and they had a mean of 51 months (range, 42-62 months) follow-up after surgery. The mean age was 44.5 years and 51 (77.2%) of the patients were female. There were 46 Crowe I hips and 30 Crowe II hips. While ten patients had bilateral dysplastic hips, 2 of them had left sided type I and right sided type II dysplasia. The functional evaluation was done with Harris hip scoring system whereas radiological evaluation was done according to Pagnano, Gruen and DeLee and Charnley.
Results and Conclusion: No dislocation or signs of early aseptic loosening was detected in our patients. Patients whom were operated for bilateral hip dysplasia showed a mean functional score of 89.4±0.4 points beside the unilateral cases which was 96.3±0.7 points ($p<0.005$). No major complication due to surgery was detected. Only in one patient, a periprosthetic fracture was occured and it was satisfactorly treated by internal fixation without implant revision. MoM articulations with large head size have been used to decrease the dislocation rate by increasing the range of motion available prior to impingement and jumping distance before dislocation. Nevertheless, beside such manageable properties, some debate exists about metal ion release in case of these articulations. Our results indicate that large head MoM hip arthroplasty is a good choice for low grade dysplastic hips with good-excellent short-term results without any toxicity according to ion release. Its design can decrease dislocation rate and the propensity for wear debris with a potentially lower rate of failure.
Key Words: Hip Dysplasia; Crowe; Metal-on-Metal; Total Hip Arthroplasty.

Crowe I ve II Displastik Kalçaların Metal-on-Metal Total Kalça Artroplastisi: 66 Hastanın Kısa Dönem Sonuçları

Amaç: Bu retrospektif çalışma, düşük grade kalça displazisine sekonder gelişen kalça artrozunun büyük baş ve metal arkalıklı (MoM) total kalça artroplastisi ile tedavisinin sonuçlarını değerlendirmek için dizayn edilmiştir.
Yöntem: Altmışaltı hastanın 76 kalçası MoM total kalça artroplastisi (TKA) ile tedavi edilmiş ve bu hastalar ameliyat sonrası ortalama 51 ay (ortalama, 42-62 ay) takip edilmiştir. Ortalama yaş 44,5 yıl ve hastaların 51'i (%77.2) si kadındı. Crowe tip I kalçaya sahip olan hastalar 46 iken 30 hasta Crowe tip 2 kalçaya sahipti. Bilateral displazik olguya 10 hastada rastlanmış iken bu hastaların ikisinde sol tip I ve sağ tip 2 displazik kalça mevcuttu. Hastaların fonksiyonel değerlendirmesi Harris kalça skorlaması ile radyolojik değerlendirmesi ise Pagnano, Gruen DeLee ve Charnley'e göre yapıldı.
Sonuçlar ve Yorum: Postoperatif çıkık ya da erken gevşeme tespit edilmedi. Bilateral olgularda ortalama fonksiyonel skorlama 89.4±0.4 iken unilateral olgularda 96.3±0.7 idi ($p<0.005$). cerrahiye bağlı major komplikasyon gelişmedi. Sadece bir hastada periprostetik kırık gelişti ve implant revizyonu gerektirmeden internal fiksasyon ile tedavi edildi. Metal arkalıklı eklemleşmeler sıkışma ve atlama mesafesini arttırarak kalça çıkığı riskini azaltmaktadırlar. Bunun gibi kullanışlı özelliklerinin yanısıra metal iyon salınımı ile ilgili tartışmalar da söz konusudur. Sonuçlarımız, MoM TKA'nin düşük grade displazik kalça çıkığına bağlı koksartrozun tedavisinde iyi-mükemmel sonuçlar ve düşük iyon salınımı ile iyi bir seçenek olduğunu göstermiştir. Dizaynı, düşük aşınma ve çıkık riski ile daha az başarısızlık oranına sahiptir.
Anahtar Kelimeler: Kalça Displazisi; Crowe; Metal-on-Metal; Total Kalça Artroplastisi.

Total hip arthroplasty with polyethylene inserts is largely considered to be the gold standart for treatment of coxarthrosis secondary to developmental dysplasia of hip. However, metal-on-cross-linked polyethylene articulations have been shown to have higher wear induced prosthetic failure.[1-3] Especially higher rates of motion cyclus at the head and polyethylene junction in young and active patients with increased body mass index can trigger osteolysis by increased polyethylene

Başvuru Tarihi: 12.01.2011, Kabul Tarihi: 09.02.2011

wear debris. Complicating matters might lead to early aseptic loosening.[4] This is what, in many respects, has forced the surgeons to revolutionize the implants in use in order to minimize osteolysis and overcome early aseptic loosening.[5]

In 1984, Weber introduced second generation MoM implants with improved sphericity, clearence and metallurgy for adequate surface finish and higher frictional torques.[6] Schmalzried and others have stated that larger head and cementless cup MoM articulations in total hip arthroplasty have reduced wear rate and have lower periprosthetic osteolysis incidence after 21 years of implantation.[4]

The beneficial effect of improved lubrication between the head and cup interface will lead to lower metallic wear debris during motion.[7] This is consistent with previously reported simulator studies in which 5 to 15 million cycles with larger diameter articulations have been shown to reduce wear debris.[8-10]

The purpose of this retrospective study was to investigate short-term results of MoM cementless total hip arthroplasty for consecutive series of patients with coxarthrosis secondary to developmental dysplasia of hip.

Material and Methods

The data of 76 hips of 66 consecutive patients that underwent cementless MoM total hip arthroplasty between May 2005 and February 2007 with a diagnosis of low grade developmental dysplasia of hip, were retrospectively reviewed. All patients undergoing elective primary total hip arthroplasty with participating surgeons were eligible for recruitment. Exclusion criteria were high grade dysplasia, females with childbearing potential, previous hip surgery, renal disease, osteoporosis and suspected malignancy. Overall, the age of the patients ranged from 29 to 60 years (mean, 44.5 years) and 77.2% (n=51) of them were female. Patients were followed-up for a mean of 51 months (range, 42-62 months).

No patients were lost after follow-up. The Crowe classification system was used to determine the grade of dysplasia in patients.[11]

Crowe I was considered as less than 50% of subluxation of the head and Crowe II as 50-74% subluxation. There were 46 Crowe I hips and 30 Crowe II hips. Ten patient had bilateral dysplastic hips and 2 of them had both left sided type I and right sided type II dysplasia.

All patients applied the cementless femoral stem with metal-on-metal porous coated acetabular cup and 38 mm large head (Optimom, metal-on-metal stemmed large diameter total hip replacement, Corin, Gloucestershire, UK). Also all patients received prophylactic antibiotics and tromboprophylaxis in the form of graduated compression stocking. In high risk patients (type 2 diabetes mellitus, history of previous deep venous thrombosis, etc.) pharmacological agents were used for tromboprophylaxis. The press-fit acetabular cup was implanted in an attempt to properly position the acetabular cup in or near to true acetabulum after undersized 2 mm of reaming without screw augmentation in all hips. In 4 hips, patients' excised own femoral heads were reshaped and fixed to superolateral border of the new acetabulum by two screws to make an additional coverage over the acetabular cup. In bilateral cases, operation was sequentially done with a time interval of one week.

At follow-up's, radiological evaluation was done by antero-posterior radiograph of the hip joint to determine graft coverage, radiolucent lines and fixation of the components, as well as functional investigation by Harris hip scoring system. The postoperative localization of the both aproximative rotation center and femoral head rotation center in Pagnanos' four-zone system was determined and compared with functional scores (Figures Ia, Ib).[12]

Figure 1a. 54 years-old female patient with stiff and painful bilateral Crowe type I dysplasia of hip. (before operation)

Figure 1b. According to Pagnano's four-zone system, left side is at zone 2 and right side is at zone 3. Although the localization of the femoral head center is not in true acetabular zone, patient had a satisfactory result (three years after operation).

The Harris[13] and Russotti[14] criteria were used to determine the fixation of the femoral and acetabular components, respectively. For radiolucent lines, femoral components were evaluated by seven zones of Gruen[15] and acetabular components were evaluated by three zones of DeLee and

Charnley[16,17] at each follow-up. The graft coverage of the acetabular cup in 4 patients was examined by the ratio of the cup that is covered by the graft with the medial and lateral edges of the cup on the interteardrop line as mentioned before by Papachristou.[3]

Statistical analysis

For statistical analysis, data was calculated by Statistical Package for the Social Sciences v. 16.0 for Windows (SPSS Inc.). Numerical variables were reported as mean±standard error of the mean (SEM) with range and the nominal variables were reported as observation number and percentage. The stratified subgroups according to the postoper-ative Harris hip scores were compared with four-zone system of Pagnano's acetabular component localization with one-way ANOVA. If there was a significant difference, a post-hoc Tukey test was done.

Results

At the time of latest follow-up, the over-all mean preoperative Harris hip score was improved from 36.7±0.4 (range, 35-39) to 91.7±1.1 (range, 88-95) points ($p<0.005$). Patients whom were operated for bilateral hip dysplasia showed a mean functional score of 89.4±0.4 points beside the unilateral cases which was 96.3±0.7 points ($p<0.005$). Harris hip scores of unilateral cases were excellent in 25 (44.6%), good in 24 (42.8%) and fair in 7 (12.6%) hips. Bilateral cases showed excellent scores in 6 (30%), good scores in 8 (40%) and fair scores in 6 (30%) hips. There were no poor results. Satisfaction was reported as excellent in 56 cases and they pointed out a pain-free hip at mobilization or daily living activities.

A comparative assessment was done between acetabular component position and Harris hip scores. Based on Harris scores, the relation between subgroups of final scores and four-zone of true acetabular region according to post-hoc Tukey test indicated the significance of localization of postoperative femoral head center in four-zone system on Harris hip scores ($p<0.001$) (Table 1).

Table 1. The subgroups of post-operative Harris hip scores compared with Pagnano's four-zone system.

	PFZS	Fair	Good	Excellent	P value
Bilateral dysplasia (n=10)	1 (n=12)	2	5	5	<0.001
	2 (n=5)	2	2	1	<0.001
	3 (n=2)	1	1		<0.005
	4 (n=1)	1			<0.001
Unilateral dysplasia (n=56)	1 (n=37)	1	11	25	<0.001
	2 (n=12)	0	12		=0.004
	3 (n=6)	5	1		<0.005
	4 (n=1)	1			<0.001

Abbreviations; PFZS: Pagnano's four-zone system

Preoperative physical examination showed limited cumulative flexion-extension range as 75° (range, 52°-76°) and cumulative internal-external rotation as 13° (range, 11°-16°). The mean cumulative postoperative flexion-extension was improved from 75.7° (range, 52°-76°) to 114.3° (range, 102°-123°); abduction-adduction, from 30.2° (range, 19°-38°) to 51.2° (range, 48°-58°) and internal-external rotation, from 18.6° (range, 15°-24°) to 56.2° (range, 45°-65°) (all $p<0.001$). The mean preoperative limb-length discrepancy was 1.1 cm and all was improved at unilateral ceases. Only at one case, who had operated for bilateral hip dysplasia, the limb-length discrapancy was found to be lesser than 1 cm.

On radiologic examination, the femoral stem was found to be implanted in varus at two cases. At three hips, 20% of the superior-lateral part of the acetabular cup was found to be uncovered by the acetabular rim. The mean inclination of the acetabular cups was 43° (range, 38°-50°) and foremost used size was 54 mm.

According to Harris and Russotti, Gruen and DeLee and Charnley criteria, there were not any radiolucent line detected at the implant-ossous interval. There was no radiolucent line between the bone-implant interface of the seven delineated sections of femur. Also any demarcation was detected at the cup-bone interface at the last visit The mean superior displacement of the femoral head-neck junction was 1.4 cm (range, 1.1-1.7 cm).

No major complications such as dislocation, deep wound infection or deep venous thrombosis were observed. In one of the patients for whom graft was used for cup coverage, resorption was detected. Grade 1 heterotrophic ossification One patient was reoperated for type 2 periprosthetetic fracture at postoperative second month. At this patient, treatment was accomplished by internal fixation of the femur with Dall-miles cable sytem and allograft use without any prosthesis revision due to stability of the implants.

Discussion

We found that cementless MoM cup arthroplasty with a cementless stem has an excellent short-term results with functional improvement. To date, most published studies have agreed on the acetabular dysplasia of the hip to be an important risk factor on developing secondary osteaoarthritis.[18,19] Pain with or without limping are the main complaints in hip dysplasia. The accomplishment of improving these symptoms at what ever age can best be achieved with total hip arthroplasty.[20]

There is overwhelming evidence that conventional THA with a combination of 28 mm heads and polyethylene inserts demonstrate inherent bias on range of motion, muscle weakness and lower hip extensor and abductor moments.[21,22] Studies in which conventional friction pairings used showed long-term higher rates of osteolysis and aseptic loosening secondary to excessive polyethylene wear. In contrast, these studies demonstrate excellent short-term results as were noted in our study. Although polyethylene inserts fabrication is being revolutionized and the wear rate is theoretically decreased by processing of high-cross links, we offer the use of MoM articulation with large heads for the positive effect to muscle balance arround the hip joint.

This study revealed any complication according to screw placement. We think that the redundancy of screw placement in MoM arthroplasty can prevent complications according to screw fixation. The implant design we used necessiated stable implant fixation without screws. We didn't detect any component malposition and short-term follow-up is sufficient for evaluating biologic fixation of the implants.

Also, due to inefficient acetabular bone stock and shallow acetabulum, there are some technical difficulties at these operations. Angular and structural abnormalities of the proximal femur and neuromuscular abnormalities around the hip joint have led the operation to be more challenging compared to the primary hip arthroplasties.[1,16,23,24] The most encountered problem in our cases were medial wall insufficiency and excessive femoral antetorsion. Contolled reamization after exploring the cotyle by osteotomies have led us to maximize the avaible space for a cementless and screwless large cup.

We also did not observe any dislocation in our patients during follow-up. Also there are well documented papers concerning dislocation after THA. As mentioned previously by Amstutz et al.[25] cementless metal-on-metal implant usage for hip dysplasia has many advantages such as lower dislocation rate, well-fixation of the cup and higher effective radius despite shallow acetabulum. Several authors emphasised the importance of using low wearing implants to gain excellent results.[26-28] A hypothetical advantage of large MoM head is that large heads, especially bigger than 32 mm will help to reduce wear by increasing the entrainment velocity and improving lubrication.[9] McKellop et al.[2] reported that subsequent lower incidence of periprosthetic osteolysis in MoM arthroplasty is due to lower than 20-100 times polyethylen wear rather than conventional total hip arthroplasty. Also the difference between the radius of the head and the shell, named as clearance, effects directly the wear rate.[9]

This study does have some limitations. First, although these implants do not have long-term randomized comparative studies, this study has a relatively short follow-up period. Secondly, we did not randomized patients. Obesity, female gender, age can have adverse effects on MoM articulations.[29,30]

Moreover, there may be accumulation of metal ions because of excessive use or eccentic loading. Until recently, the hip surgeon's concern about metal ion release from MoM articulations and their potentially adverse effects on renal function, hypersensivity and even malignant potential led them accept this type of articulation as methodically flawed.[31-34] But outcome studies furhter objectify these undesirable adverse effects as metal debris accumulations.[35,36] Its exact consequence, if any, about metal ion intoxication is a subject of debate with biomechanic and clinical studies that support several differing view points. We did not detect any adverse reaction in our series although the majority of the patients were female.

In our study, majority of excellent results were obtained from the patients whose postoperative femoral head center was located in the first zone of Pagnano. Regarding this center, the clinical and radiological outcomes of many studies indicate lesser osteolysis compared with conventional couples. As in our study, similar reults were obtained on all clinical outcome measures from the study by Garbuz et al. But, with a minimum of 9.6 months of follow-up they concluded the large head metal articulation to release much more metal ions than resurfacing cups. We evaluated the radiographs postoperatively to localize the position of the cups and femoral head center. We agreed with the previous reports in that we did not detect either superior placement or early implant loosening. In all studies available, including this study, the MoM hip arthroplasty itself improves the clinical outcome, the documented clinical improvement should be may be related in part to the localization of the femoral head center into the no 1 zone of Pagnano.

From the study design we are not able to forecast long term consequences of MoM arthroplasty. Besides we didn't document the metal ion concentrations in our patients. Merely, we didn't discover any early complication pointing out metal ion intoxication. With these limitations our data indicate that cementless MoM cup arthroplasty with a cementless stem is a good choice of treatment for improving painful hip and limping in Crowe type 1 and 2 dysplastic hips as primary coxarthrosis. During the relatively short duration of follow-up, we did not detect any signs of loosening or dislocation in our patients. In addition, we think that, the myriad uses and advantages of MoM hip arthroplasty includes higher satisfaction rates and long term survivor-ship with regard to conventional arthroplasty for surgical treatment of hip osteoarthritis secondary to acetabular dysplasia.

Conflict of interest statement: None of the authors of this manuscript had any assistance in writing this article or any source of payment for the writing of this article. We have no disclosures to make regarding any financial and personal relationships with other people or organizations that could inappropriately influence this work. 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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