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# Total Hip Replacement in Developmental Dysplasia of the Hip Using Wagner Cone Prosthesis with Small Diameter Metal-On-Metal Articulation

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## Abstract

### Background

Patients with developmental dysplasia of hip often undergo total hip arthroplasty (THA) at a younger age. THA in such patients are technically demanding because of deficient acetabular bone stock, abnormal femoral anatomy with increased anteversion, leg length discrepancy and soft tissue imbalance. Conical femoral stem with Metal on Metal (MoM) 28 mm bearing have been used to address the anatomical and wear issues in this young patient group. The aim of the study was to review the early midterm clinical results of this prosthesis.

### Material & Methods

Between January 2004 and March 2009 twenty-one consecutive patients (24 hips) with osteoarthritis secondary to developmental dysplasia of the hip underwent metal-on-metal uncemented Allofit Metasul press-fit cups (Zimmer) with 28 mm-heads and tapered uncemented Wagner cone prosthesis stems (Zimmer) using posterior approach.

Functional outcomes were assessed using Oxford hip score (OHS), SF12 physical and mental scores and WOMAC scores. Radiographic outcomes was carried out by two independent observers for leg length discrepancy (LLD), Crowe and Tonnis grading, lateral center -edge (CE) angle, acetabular roof-arc angle and femur neck-shaft angle heterotropic ossification, prosthesis loosening and cup inclination angle.

### Results

There were 5 men and 16 women with mean age of 45 years (SD=9.15, 26-63). The mean follow up was four years (SD=1.7, 2-7). No patients were lost to follow up. Three patients required structural allograft, no patients required intra operative femoral shortening. Classification of DDH was Crowe type I in 14 hips, type II in 8 hips and type III in 2 hips. The mean preoperative CE angle was 10.5°, neck shaft angle was 143° and the acetabular roof arc angle was 25°. 3 hips had Tonnis Grade 2 while 21 had Grade 3 osteoarthritis. The mean cup inclination angle was 42 degrees (range 32-60 degrees). The mean preoperative limb shortening was 19.1 mm (range,-1 to -39) which improved to 2.8 mm postoperatively.

The OHS improved significantly within subjects ($p<0.001$) from a mean of 10.6 (2-28) to 43.9 (30-48). The mean post operative scores were- WOMAC 51 (SD=7.4, 30-56), SF12 physical 51 (SD=8.5, 28-58) and SF12 mental 53 (SD=4.7, 46-59). There were two revisions for aseptic loosening, one stem and one cup; therefore giving an overall survival of 91%. No other hip had radiographic evidence of acetabular or femoral osteolysis. Three patients suffered transient femoral nerve palsy, which recovered completely. We did not observe any dislocation, deep infection or heterotopic ossification.

### Discussion

The medium-term results of the small diameter metal-on-metal hip arthroplasty with a conical uncemented stem have been encouraging in the treatment of this difficult cohort of young patients. The inherent stability and functional outcome provided by the small femoral heads are better than the recent large metal on metal articulations. Further follow up is required to see how small MoM bearing will behave in the long term.

**Keywords:** Developmental dysplasia hip; Wagner hip prosthesis; Metal on metal articulation; Therapeutic Level IV

## Introduction

Patients with developmental dysplasia of hip often undergo total hip arthroplasty (THA) at a younger age. THA in such patients is technically demanding due to deficient acetabular bone stock, abnormal proximal femoral anatomy, leg length discrepancy and muscle contracture. These abnormalities should be taken into consideration while planning total hip arthroplasty in this cohort of patients. Conventional femoral prosthesis (cemented and uncemented) often can fracture the narrow proximal bone. The young age and high activity levels can also result in higher polyethylene wear and early loosening associated with metal on polyethylene articulation. Conical femoral stem with Metal on Metal (MoM) 28 mm bearing have been used to address the anatomical and wear issues in this young patient group.

The Wagner cone prosthesis has a 5 degree taper angle for press fit fixation. It is made from titanium alloy with a rough blasted surface to stimulate osseointegration. The cross section of the stem is circular

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allowing the angle of anteversion to be adjusted to match that of the dysplastic proximal femur. The tapered design provides primary stability while eight longitudinal ribs ensure a high degree of rotational stability [1].

The purpose of this study was to analyse the functional and the radiographic results of consecutive uncemented, total hip arthroplasty using Wagner uncemented cone prosthesis hip stem (Zimmer) and uncemented Allofit Metasul press-fit cups (Zimmer) with small diameter metal on metal articulation for the treatment of patients with Crowe grade I, II and III developmental dysplasia of the hip.

## Material and Methods

Between January 2004 and March 2009 twenty-one consecutive patients (24 hips) with osteoarthritis secondary to developmental dysplasia of the hip underwent metal-on-metal uncemented Allofit Metasul press-fit cups (Zimmer) with 28 mm-heads and tapered uncemented Wagner cone prosthesis stems (Zimmer) using posterior approach. No patients were lost to follow up.

All patients had developmental dysplasia of the hip which was not associated with any other known syndromes or neuromuscular disorder. The hips were classified according to Crowe's grading [2]. The patients were informed about the risks of metal on metal implants prior to the operation.

The average age of the patient at the time of surgery was 45 years. There were 16 women and 5 men; three female patients underwent bilateral sequential total hip arthroplasty surgery. Eleven procedures were performed on the left hip, and thirteen procedures were performed on the right hip.

Surgery was performed using a posterior approach with the patient under general or regional anaesthesia in the lateral position. Antibiotic cover (Intravenous Cefuroxime 1.5 gm) and thromboembolic prophylaxis (low molecular weight heparin) was used in all patients. After resection of the femoral head and total capsulectomy, the position of the true acetabulum was identified before reaming. The acetabulum was reamed sequentially using hemispherical reamers to obtain interference fit between the anterior and the posterior columns. The acetabular cup was implanted in the position of the anatomic hip center with 45 degrees of inclination and 15 degrees of anteversion. If there was a defect superiorly of more than 1 cm then a femoral head autograft or allograft was used to augment the acetabular roof. The graft was fixed with 4.5 mm AO screws. Femoral preparation and implantation of the stem was done as described by Wagner and Wagner [1]. With the circular cross section of the stem of the cone prosthesis, the angle of anteversion can be adjusted according to the desired proximal femoral anatomy, as compared to the flat or transverse oval profile of the conventional femoral stems where fixation of the stem can be difficult. All patients received 28 mm femoral head, thus providing small diameter metal on metal articulation. No patient required femoral shortening at the time of primary hip arthroplasty. Post operatively patients walked with the help of walker or two crutches for 6 weeks.

All patients were followed up at 6 weeks, 6 months and then yearly basis with radiographs and clinic visit. Radiographic evaluation was performed by two authors who were blinded to the clinical results and were not involved in surgery. The preoperative radiographs were reviewed for leg length discrepancy (LLD), Crowe and Tonnis grading, lateral center -edge (CE) angle, acetabular roof-arc angle and femur neck-shaft angle. Postoperative radiographs were reviewed for heterotropic ossification, LLD, stem loosening and subsidence, acetabular loosening and cup inclination angle. A computer system-Picture Archiving and Communication System (PACS) was used for the analysis of radiographs. The dysplastic hips were classified according to Crowe's grading; Type I, less than 50% subluxation: Type II, 50-75% of subluxation: Type III, 75-100% subluxation: and Type IV, more than 100% subluxation. Osteoarthritis in the hips was graded 0-3 according to Tonnis [3]. Heterotropic ossification was graded according to Brooker et al. [4]. Osteolysis was defined as an appearance of a focal area of bone resorption evidenced by a cystic lesion [5]. Cup inclination was determined on anteroposterior radiograph of the pelvis with a horizontal reference line through the base of the teardrops. Definite acetabular loosening was defined as a change in the cup angle of greater than 5 degrees on the anteroposterior pelvic radiograph or a change in the vertical or horizontal position of the cup of greater than 2 mm [6]. Subsidence was determined by measuring the vertical distance from the superior margin of the greater trochanter to the collar of the stem and the vertical distance from the collar of the stem to the midpoint of the lesser trochenter. A difference of 4 mm or more in the measured distance between the immediate post operative radiograph and the radiograph taken at the last follow up was considered to indicate stem migration [7,8].

The patients were prospectively evaluated pre and post operatively by one experienced nurse (HM) using the Oxford hip scores (OHS). We also calculated the post operative Short Form 12 (SF12) physical and mental scores and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores.

We performed Kaplan-Meier survival analysis (Medcalc Software, Mriakerke, Belgium) to April 2011 with revision for any reason as end point. The t-test was used to detect statistically significant difference in the mean OHS between the preoperative score and the score obtained at the final assessment.

## Results

There were 5 men and 16 women with mean age of 45 years (SD=9.15,26-63). The mean follow up was for four years (SD=1.7,2-7). No patients were lost to follow up. Two patients had both previous acetabular and femoral osteotomy; five patients had only previous femoral osteotomy while three had acetabular osteotomy prior to hip arthroplasty. Classification of DDH was Crowe type I in 14 hips, type II in 8 hips and type III in 2 hips. The mean preoperative CE angle was 10.5°, neck shaft angle was 143° and the acetabular roof arc angle was 25°. 3 hips had Tonnis Grade 2 while 21 had Grade 3 osteoarthritis. The mean cup inclination angle was 42 degrees (range 32-60 degrees). The mean preoperative limb shortening was 19.1 mm (range, -1 to -39) which improved to 2.8 mm (range, 0 to -26) postoperatively.

Three patients underwent supero lateral acetabular coverage with structural allograft while in four patients femoral head autograft was used to cover the defect. No patients required intra operative femoral shortening. The median acetabular cup size was 50 (median, 48: range48-58) mm while the median conical femoral prosthesis size was 17 (median, 17: range15-21) mm.

The OHS improved significantly within subjects ($p<0.001$) from a mean of 10.6 (2-28) to 43.9 (30-48). The mean post op scores were-WOMAC 51 (SD=7.4,30-56), SF12 physical 51(SD=8.5,28-58) and SF12 mental 53 (SD=4.7,46-59). There were two revisions for aseptic loosening, one stem and one cup. One 56 year old female patient with Crowe type II dysplasia underwent revision of the acetabular component after 3 years for aseptic loosening. She required structural allograft at the time of index surgery which underwent partial osteonecrosis

and cup migration prior to her revision (Figure 1). One other female patient with Crowe type I dysplasia had progressive, slow subsidence of 15 mm stem and had revision surgery 7 years postoperatively after pain and increased leg length discrepancy developed. One patient had radiographic evidence of acetabular radiolucent lines in all 3 delee charnley zones and one had femoral stem radiolucent lines (zone 1&7). Both these patients remain asymptomatic and did not warrant any further surgery. Two patients suffered transient femoral nerve palsy, which recovered completely. None of the two patients had any previous hip or pelvic surgery performed in their childhood. We did not observe any dislocation, deep infection, metal hypersensitivity, thrombo embolic events, thigh pain or heterotopic ossification in any of our patients.

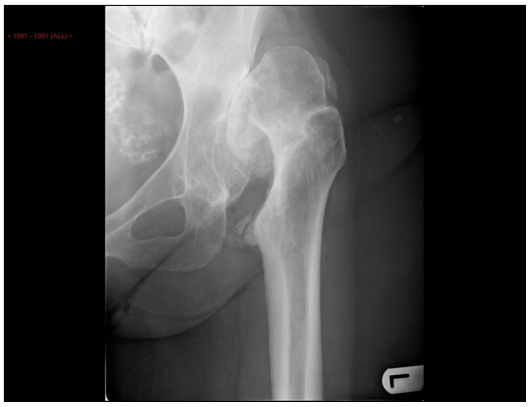

**Figure 1a:** AP X ray of left hip of 56 year old female patient showing Crowe grade II dysplasia and advanced secondary osteoarthritis

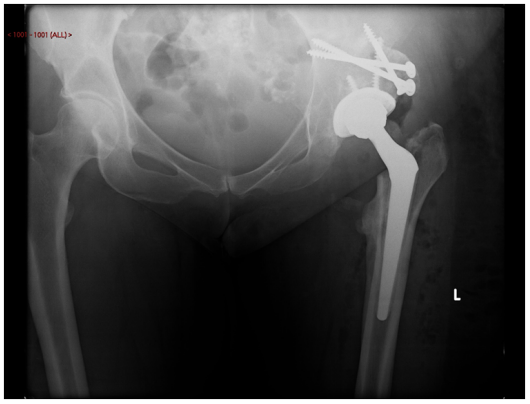

**Figure 1b:** One week after total hip replacement with Allofit cup, Wagner Cone prosthesis and structural allograft


**Figure 1c:** Two year post op showing migration of the acetabular cup because of osteonecrosis of the graft

## Survivorship analysis

Kaplan-Meier survivorship with an end point of revision was 91.7% (Figure 2).

## Discussion

Total hip arthroplasty remains the best solution for the management of secondary osteoarthritis in dysplasia patients however the implant choice is still controversial. The Wagner Cone prosthesis hip stem was designed by Prof H Wagner in 1990, with slight modification (enlarged proximal shoulder, slim neck and additional offset version 125) of the stem in year 2006. The tapered anchorage of the stem promotes primary stability while the extensive rotational stability is provided by the eight longitudinal ribs design. As far as we know, very few studies have looked at the results of using this stem with small diameter MoM bearings for dysplastic hips. Recently Claramunt et al. [9] presented a series of 30 hips treated with this kind of stem with very good clinical and radiological results at 43 months of follow up. The bearing surfaces used in the study were not described.

Metal on metal bearings have a lower volumetric wear, high fracture toughness and easy fabricability as compared to metal on polyethylene bearings [10]. Parmaksizoglu et al. [11] have shown good functional and radiographic results with large diameter metal on metal total hip arthroplasty, incorporating subtrochenteric femoral shortening in fifteen hips with Crowe IV dysplasia; however Cobb et al. [12] have recently published their concern regarding the unexplained post operative pain with these implants, which may be related with the iliopsoas impingement independent of the acetabular component. National Joint Registry for England and Wales 8th Annual report [13] has shown lower revision rate with small diameter (<36 mm) metal on metal prosthesis following primary total hip replacement as compared to large head (> 36 mm) with resurfacing cup after 6 years .In our study, all hips were implanted with 28 mm prosthetic metal head with a mean cup inclination angle of 42 (range, 32-60). We did not encounter any problems with unexplained groin pain or dislocation in any of our patient.

Acetabular cup fixation in dysplastic hips poses technical challenges; a high acetabular cup fixation perpetuates abductor insufficiency, limping, and limb-length discrepancy while high rates of loosening have been reported in some studies. This may be related with the poor bone quality leading to inadequate fixation and stability. The techniques used to achieve primary stability include; use of multi hole cups, press fit implantation, bone grafting of the acetabular roof and

**Figure 1d:** Four year post revision of the acetabular cup

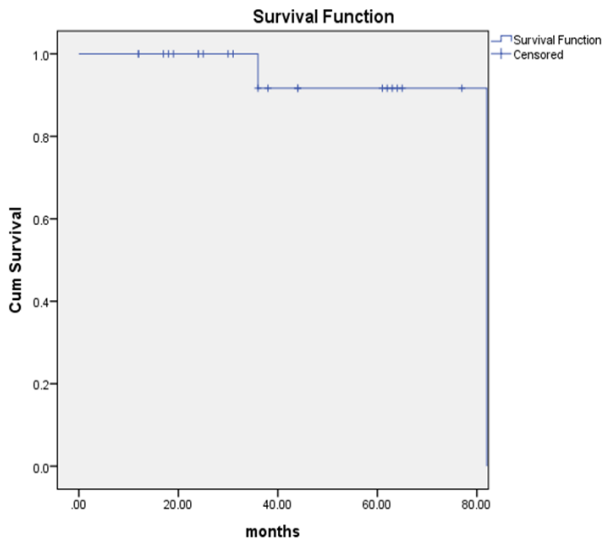


**Figure 2:** Kaplan-Meier curve of the prosthetic survival in the 24 hips.

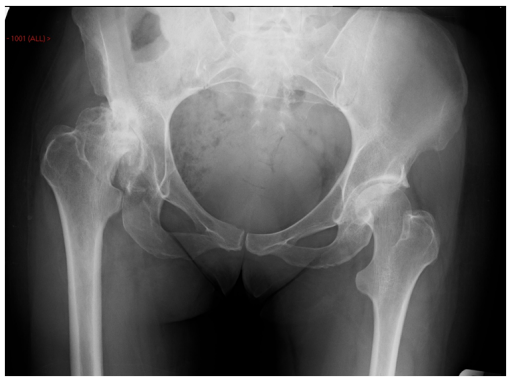

**Figure 3 a:** AP Pelvis X ray of 45 year old female with Right hip dysplasia

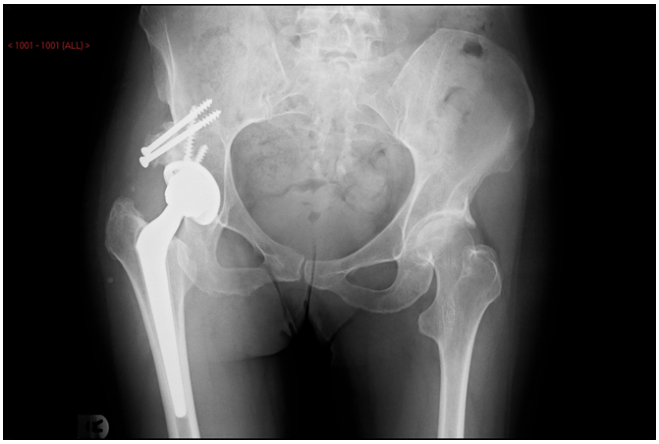

**Figure 3b:** Post operative radiograph showing implantation of the Allofit cup and Wagner cone prosthesis with bulk femoral head autograft for acetabular reconstruction

medialisation of the cup (cotylopasty). Recently, Kim and Kadowaki [14] have reported 10 year survival of 94% with cementless THA and autologous femoral bone graft in 70 patients with developmental dysplasia. In our study we did not encounter any problem with cup incorporation other than one patient underwent revision surgery for cup loosening secondary to osteonecrosis of the supporting femoral head graft. The stem failure demonstrated the technical failure of an undersized stem not achieving initial stability for bony integration.

Biant et al. [15] have reported excellent ten year clinical and radiographic results (no revisions or loosening) in 28 patients with Crowe III or IV dysplasia using the cement less modular S-ROM stem prosthesis. Perka et al. [16] have shown survival rate 100% for the femoral stem at 9.3 years using uncemented Zweymuller hip system for patients with osteoarthritis secondary to Crowe I, II, III, IV DDH. However, the Zweymuller stem has limited ability to correct abnormal femoral version. In terms of loosening, subsidence or thigh pain no significant difference was noted by Kumar et al. [17] in using the cemented and uncemented stems for low grade dysplasia. Schuh et al. [18] have published long term clinical and radiographic results of the Wagner cone prosthesis in 94 patients with mean follow up 11.5 years. The survival rate of the prosthesis was 91% in their series.

Our study has certain limitations. We prospectively collected all data, but we do not have any control group for which we used a different component to compare and contrast outcomes. The short follow up (average four years) and the small number of patients also limit our ability to generate definitive conclusions.

Our experience with the Wagner cone prosthesis has shown no incidence of thigh pain and satisfactory clinical scores. Good functional and radiological outcome can be expected with small diameter metal on metal articulation in patients with DDH (Figure 3). It is known that the incidence of femoral osteolysis after cementless hip arthroplasty increases with time and may progress rapidly, therefore continued follow up will be required to determine whether small diameter metal-on-metal bearings in these patients will result in less osteolysis and loosening. Compared to large metal on metal articulations they appear to be working better.

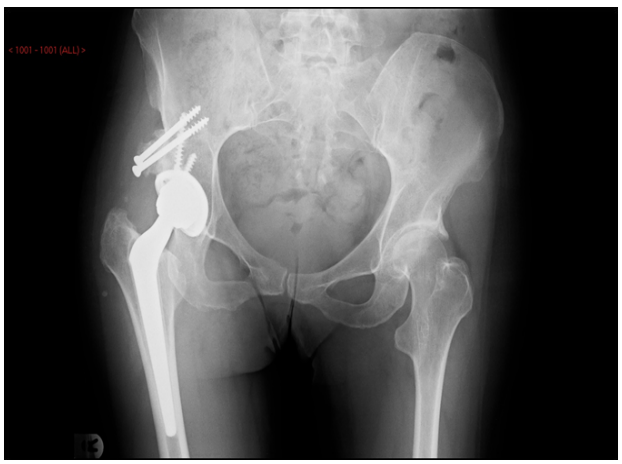

**Figure 3 c**: After 5 years the cup and the stem are stable and osseointegrated

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