

Uncemented Total Hip Replacements using the Mecron® Acetabular Cup-A Prospective Study

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Abstract

The uncemented threaded cup gained some popularity over the past decade, firstly as a revision and then as a primary procedure. We elected to test the Mecron® acetabular threaded cup system as a routine hip replacement. As there was no matched femoral component, we decided to use an uncemented femoral stem of the Ring system of the hip prosthesis. All patients were logged on to the study at the outset although this is not a controlled comparison with another system. Patients were assessed annually for up to 4 years at the time of reporting.

There were 104 primary total hip replacements in 99 patients between 1987 and 1991. The mean follow-up for this report was 22.5 months (range 12 to 48 months). The mean age was 74.3 years (range 24 to 88 years) and the female to male sex ratio was 3.3:1.

Within the study period, 5 hips required revision, all for acetabular loosening. Patients were assessed by the modified Harris score annually and 60.6% of the cases had an excellent or good short-term result. Poor results were observed in 18.3% of cases. Radiographic studies of the acetabular component were undertaken annually and measured. Migration and tilting of the acetabular cup was observed in all cases. Heterotopic bone formation occurred in 10 patients.

As a result of these poor results, the prosthesis was abandoned in 1991. The cohort of patients continues to be followed. Failure of the Mecron® acetabular cup in our series was mainly due to tilting and migration and not untwisting,

Ann Acad Med Singapore 1997; 26:459-64

Key words: *Loosening, Migration, Revision, Threaded acetabular components, Total hip arthroplasty*

Introduction

Historically, cemented total hip replacement was one of the major breakthrough in the treatment of osteo-, arthritis in this century. However, DeLee and Charnley¹ were soon to observe aseptic loosening of acetabular cup in cemented hip replacement after 20 years. Mulroy and Harris² reported a 20-fold increase in loosening of the cemented acetabular cup between 5 and 11 years despite improved cementing techniques. Cement was thought to cause reduction in bone stock. Furthermore, removal of cement is difficult at revision surgery. To overcome these problems, two different concepts of the uncemented acetabular cup were developed. The first was a press-fit cup and the second was a threaded acetabular cup.

The initial reports of the earliest threaded cups were conflicting. Mittelmeier³ reported less than 1% of loosening in 402 cases of Autophor ceramic threaded acetabular cup. Medreporic threaded acetabular cup also performed well with 90.3% excellent and good results between 5 to 7 years.⁴ Radiologically, the biological an-

choring of the acetabular cups appeared to be permanent after the fourth postoperative year.

However, later reports by Herberts et al⁵ and Kärrholm and Snorrason⁶ showed an unacceptably high rate of aseptic loosening and proximal migration. This was also shown by Engh et al⁷ who recommended that threaded acetabular cups should no longer be used.

The Mecron® threaded acetabular cup (Mecron, Berlin, Germany) is a spherical open ring with a small narrow thread. It is made of titanium-aluminium-vanadium alloy and designed with self-tapping threads which lock onto the rim of the acetabulum. Only minimal acetabular reaming is required to preserve as much of the supporting subchondral bone as possible.

In 1987, we chose to use the Mecron® acetabular prosthesis with 32 mm inside diameter compatible with the cementless Ring femoral prosthesis. This compatibility was confirmed by the manufacturer.

Initial good results with the Mecron® ring lead to a

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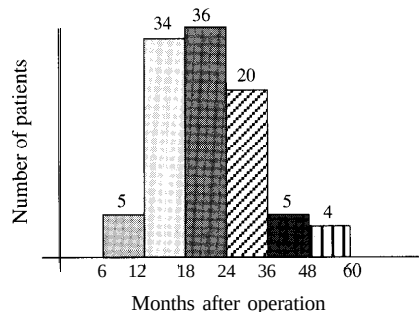
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formal prospective trial of this prosthesis. The aim of this study was primarily to assess the clinical and radiological outcome of total hip replacements with the Mecron® threaded acetabular cup and the cementless Ring femoral component.

Materials and Methods

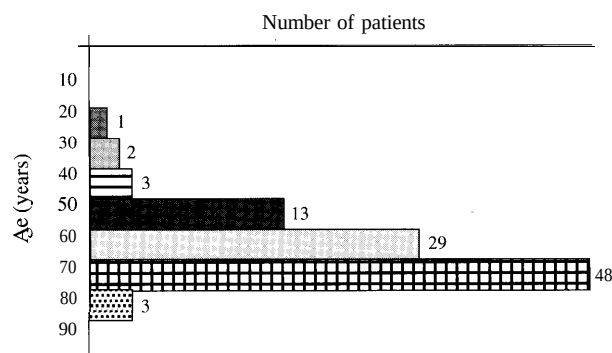
One hundred and sixteen consecutive primary total hip replacements were performed over 5 years between 1987 and 1991. Ninety-nine patients with 104 total hip replacements were available for review. Five patients had both hip replaced but none of these were replaced simultaneously. The mean follow-up period of the group was 22.5 months with a range of one year to four years (Fig. 1).

The mean age of the patients was 76.3 years with a range of 24 to 88 years. Seventy-eight per cent of our patients were in the 60 to 80 years age group (Fig. 2). There were 76 males and 23 females. Seventeen patients were lost to follow-up. These included 2 deaths unrelated to the surgery and 12 patients who had moved elsewhere. In addition, 2 patients had dislocation during the early postoperative period and were revised to an-



Mean follow-up = 22.5 months (range 12 to 60 months)

Fig. 1. Duration of follow-up of the patients



Female:Male = 3.3:1

Mean age = 76.3 years (range 24 to 88 years)

Fig. 2. Age distribution of patients.

other type of prosthesis. These occurred during the learning curve and were excluded from the study. One patient, who had post infarct dementia 6 months after surgery was not able to participate in the review, was excluded.

Eighty-three per cent of our patients had primary osteoarthritis. Eleven per cent had rheumatoid arthritis (Table I). All operations were performed by experienced surgeons utilising an approach familiar to them. Sixty-three cases were performed by a posterior approach and 41 cases by an anterior approach.

The acetabulum was reamed until the subchondral bone was exposed at the rim of the acetabulum. A Mecron® ring prosthesis 2 mm larger than the reamer was used. It was inserted with a specially designed torque wrench. A maximum of 70 Newtons of torque was applied. The Ring uncemented femoral stem was used in all cases.

Two patients required trochanteric wiring following accidental fractures of the trochanter. Femoral allograft augmentation of a postero-superior segmental defect was also done for one patient with acetabular dysplasia.

A uniform method of postoperative management was followed. Antibiotics and antithrombotic prophylaxis were given. The patients were mobilised at 48 hours postoperatively, partially weight-bearing on crutches for 2 months. The patients were reviewed independently by a research registrar. Each patient was seen at 3 months, 6 months and 6 monthly for two years, then annually after 2 years.

Clinical outcome was measured by Shaw et al's⁸ modification of the Harris Hip Scores⁹ which included an assessment of activities of daily living, range of hip movements, hip deformity and pain, and the results are graded as excellent (90 to 100), good (80 to 89), fair (70 to 79) or poor (0 to 69).

The radiological assessment was based on the criteria recommended by Sutherland¹⁰ as well as that recommended by Gruen.¹¹ Antero-posterior, lateral, oblique/Judet radiographic views of the pelvis were taken preoperatively, immediate postoperatively and annually. In addition, a special Mecron® view which allows the lug of the prosthesis to be visualised was used. This lug is located along the rim of the cup. This special view features the threaded cup in a true right angle profile by compensating for the anteversion of the acetabulum by tilting the X-ray beam in a cephalo-caudal direction. Changes in the position of the lugs in this standardised view allow any untwisting of the implant to be detected (Fig. 3).

Results

The mean Harris Hip Score improved from 44 preoperatively to 79 postoperatively. It improved by a

further 10 points at one year. However, during the latest review, only 60% of the patients had an excellent or good result and the majority of the cases in the fourth year showed a deterioration in Harris Hip Scores (Table II).

At the latest review, only 78% showed improvement in pain. Twelve per cent of the patients had persisting thigh pain. Thigh pain in our patients displayed a decreasing trend occurring in 62% of the cases in the first year, 24% in the second year and only 12% in the third and fourth years (Fig. 4). Groin pain displayed an increasing trend from 5% in the first year to 10% in the second year, 24% in the third year and 42% in the fourth year (Fig. 4).

Eighty per cent of the patients confirmed that their gait has improved but only 25% of the patients were walking without any aid. The combined range of hip movements in 80 hips improved (but only 32 of these patients had near normal hip movements), 15 hips remained the same and 9 hips worsened.

The X-rays were assessed for initial implant position, evidence of loosening or migration and untwisting of the acetabular cup. An optimal initial prosthesis position was established when:

- 1) the opening angle of the prosthesis was between 20° and 60° , and
- 2) the tear-drop to the centre of the hip distance did not differ by more than 5 mm between contralateral hips.

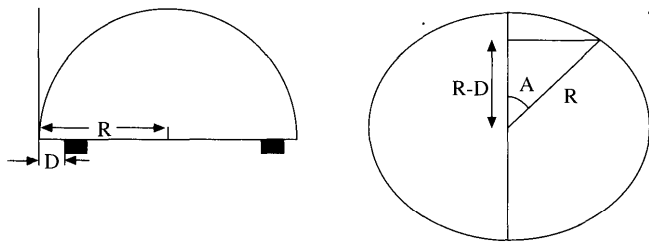


Fig. 3. Assessment of acetabular cup untwisting (described by J D Gray).

*Special Mecron Views (compensating for cup version).

*Stubs identified and distances "D" and "R" measured.

*Change of angle A in follow-up Mecron View by 20° is significant.

TABLE I: DISEASE PROFILE OF THE PATIENTS

Disease profile	No. of patients
1. Primary osteoarthritis	82
2. Rheumatoid arthritis	11
3. Ankylosing spondylitis	1
4. Perthes Disease	1
5. Avascular necrosis	
6. Congenital hip dysplasia	2
7. Paget's Disease	1

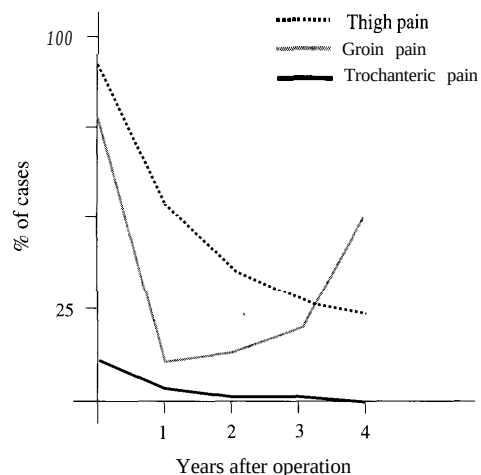
Seventy-nine of the 104 hip prostheses were thought to be inserted satisfactorily.

Acetabular migration was considered to have occurred when there was greater than 5 mm difference in the position of the centre of the hip joint between the postoperative and the latest X-rays. Eighty per cent of the acetabular cups showed migration at 2 years and 100% showed migration at 4 years. Ten per cent of the cups showed valgus tilting by more than 10° and 70% showed varus tilting by more than 10° (Table III).

Acetabular radiolucency was classified using the method of DeLee and Charnley into three zones. This was further considered to be stable, probable loose and definitely loose. Not all acetabular cups which showed tilting and migration were accompanied by significant radiolucency. Only 5 cases were thought to be definitely loose with global and progressive radiolucency and 7 acetabular cups were thought to be probably loose.

Untwisting of the acetabular cup was assessed by a special mecron view. By measuring distances of D and R which represent the distance of the lug to the edge of the cup and radius of the cup respectively. Angle A can be calculated and untwisting of the cup can be identified (Fig. 3). Only one acetabular cup showed evidence of untwisting by more than 20° . The patient was, however, asymptomatic.

Femoral migration was assessed according to the method recommended by Sutherland et al.¹⁰ Femoral sinking was seen in approximately 70% of the cases but



Pain		Site of persisting pain	
No pain	= 55 (53%)	Thigh	= 40
Improved	= 26 (25%)	Buttocks	= 0
Same intensity	= 18 (17%)	Groin	= 26
Worse	= 5 (5%)	Trochanter	= 8

Fig. 4. Analysis of pain source.

TABLE II: CLINICAL OUTCOME

I. Harris Hip Scores	
Mean preoperative scores	44.43
Mean postoperative scores	79.59
Mean 1st year score	87.89
Mean 2nd year score	84.50
Mean 3rd year score	63.70
II. Harris Hip Scores (Latest review)	
Excellent (90 to 100)	36 (35%)
Good (80 to 89)	26 (25%)
Fair (70 to 79)	18 (21%)
Poor (0 to 69)	19 (19%)

TABLE III: IMPLANT MIGRATION AND TILTING

A. Acetabular migration (>5 mm)	
Medial	35
Superior	45
B. Acetabular cup tilting (>10°)	
Varus	73
Valgus	11
C. Femoral prosthesis migration	
Sinking <2 mm	68
Sinking >2 mm	0
No sinking	36

none were more than 2 mm which is non-conclusive of femoral component loosening. This was noted in eighty-four per cent of the hips seen in the first year and 16% in the second year. None of the prostheses showed progressive sinking after the second year. Femoral radiolucency was assessed by the method of Gruen et al.¹¹ Femoral radiolucency of less than 2 mm was seen in 36 cases after the second year. All occurred in Gruen zone one but none worsened (Table III).

Nineteen patients had one or more complications. Ten patients developed heterotrophic ossification. In 2 of these patients, it was severe enough to lead to total stiffness of the hip. Interestingly, both patients were asymptomatic and contented with the clinical results. Five of the 104 cases were revised at the time of review to another type of prostheses due to acetabular loosening. One patient sustained a femoral nerve neuropraxia intraoperatively but completely recovered within 6 months.

Discussion

One of the principal long-term problem of total hip replacements is the aseptic loosening of the cemented acetabular cup. Cementless threaded acetabular cup was introduced as a solution to this problem. Although Mittelmeier³ and Lord and Bancel⁴ reported good results with their prostheses, other centres were unable to re-

produce such excellent results. This led to various modifications to the design of the implants. The Mecron[®] ring was one of the later designs with a hemispherical cup to allow the retention of as much subchondral bone as possible. In addition, an open ring allowed bone graft augmentation of the supero-medial acetabular roof.

Engh et al⁷ and Capello et al¹² reported unfavourable results with this implant when used in younger patients (mean age 54 and 61 years respectively). It was suggested that the threads had not worked into the hard bone without a tap and were not embedded well enough. In this study, the mean age was older and tapping was not part of the procedure. Standardisation of insertion was attempted by using a special torque wrench. This enabled the surgeons to ensure that all acetabular cups were inserted to a consistent torque inspite of varying age of the patients and bone quality. Very often, the fixation of the cup feels quite secure. Kody et al¹³ conducted laboratory tests of seven different types of threaded acetabular cup, with regards to initial fixation and durability, concluded that tightness of insertion (high torsional torque) corresponds to good initial fixation (high tilting moment) but it does not necessarily give long-term stability. Perhaps, high insertional torque causes increased local stress and increased pressure necrosis. Thus, a tight insertion may not necessarily provide a long-term solution to the problem of cup migration.

Initial clinical results showed an unimpressive improvement in Harris Hip Score from 44 to 79 points. However, the Hip Score in the majority of patients showed a deteriorating trend after the third year. The majority of the patients complained of thigh pain in the first year probably due to the uncemented femoral prosthesis used. Ring¹⁴ also reported a similar problem with his patients. The thigh pain disappeared subsequently and was replaced by groin pain on weight-bearing which was thought to be painful acetabular instability.⁷

Radiological analysis of the initial threaded acetabular cup position showed that insertion technique of the acetabular component was difficult. Only 79% of the prostheses were being seated in satisfactory position. Shaw et al⁸ had also reported difficulty in seating the acetabular component. Not uncommonly, the acetabular component was left sitting proud of the acetabular bed. Removal of the acetabular cup was often impossible and one was forced to leave the poorly inserted component in place. Shaw et al⁸ also suggested that overreaming seems to be a solution to the problem and this appears to be unreasonable putting the component at risk of migration. In our institution, reaming to the subchondral bone is only done along the rim of the acetabular cup in the hope of obtaining a secure fixation but this did not seem to prevent migration or enhance the fixation. All cases with four years of follow up had

shown evidence of migration by the criteria laid down by Massin et al.¹⁵ This migration was principally in a supero-medial direction. Not all the patients were symptomatic. We observed that a new shell of bone forms over the acetabular cup in an attempt to stabilise the implant. Engh et al.¹⁷ suggested that the groin pain was indicative of acetabular instability. This was a major symptom in 26.9% of the cases at the latest review though 100% of the acetabular cup showed either tilting or migration. There was a significant worsening of the problem of thigh pain with time ($P = 0.006$).

The reason for the high incidence of acetabular cup tilting and migration was not obvious. No correlation was found between age, sex, surgeons, bone quality, disease profile, cup size and migration or tilting. Krugluger and Eyb¹⁶ suggested polyethylene debris from the acetabular cup liner as the cause of the progressive osteolytic reaction in the infero-medial acetabular wall in their series of threaded acetabular cups. Unfortunately, they did not mention the type of prostheses used and our observations did not concur with theirs. Migration or tilting without osteolysis was the predominate radiographic appearance in our series. Only very few cases showed osteolytic changes in the infero-medial acetabular wall and no significant osteolysis was seen in the proximal femur. We feel that local stress due to weight-bearing and subsequent bone remodelling was a more likely cause of migration in our series as the migration in the majority of cases was in the line of weight transmission, that is, superomedially.

Despite some concerns about untwisting of the threaded cup from repetitive hip movements, this was only seen in one patient. The patient was asymptomatic. Even in cases where there was tilting, migration and gross loosening, untwisting of the cup was not an accompanying problem.

None of the revised cases was due to untwisting. Of the 5 revised cases, 4 had acetabular cups implanted in a satisfactory position. The fifth patient had a very high cup position. All the cases were revised for acetabular loosening and all had migrated supero-medially. None had evidence of untwisting and femoral loosening. In these cases, revision to a cemented cup was straightforward and the femoral stem was left in-situ.

Radiolucency of the femoral component was observed in 70% of the cases, all in the Gruen zone 1. None of the lucencies was progressive and none was greater than 2 mm in thickness. It was obvious that thigh pain was a major problem initially with an uncemented femoral stem. The thigh pain subsequently disappeared in many cases. This would account for the improved one-year mean Harris score from 79 to 88 points. After a few years, thigh pain was only a minor problem with only 8% of patients complaining of thigh pain. Our findings are

similar to those of Ring.¹⁴ None of the femoral components showed any progressive radiolucency after two years and were considered to be stable.

Heterotrophic bone formation was another major problem and causes a serious reduction in hip movement. This is similar to the finding of other investigators.⁹ Four of the 10 cases of heterotrophic ossification were of Brooker's class 3 and 6 cases were of Brooker's class 4. The cause of this problem is unknown. One possible reason is the poor removal or clearance of the bone dust from reaming. Perhaps, careful removal of these osteogenic material is vital to prevent this problem. This is not unique to threaded acetabular cups and is not greatly different from that of cemented or press fit femoral cup.

By 1991, there was a decision to abandon the use of Mecron® threaded acetabular cups due to the obviously poor clinical results during an average follow-up of 22.5 months with a high incidence of cup migration and tilting. These were similar to other published unsatisfactory clinical^{5,9,17} and biomechanical reports.^{18,19} Although we used a hybrid system, we feel that the main deficiency lies with the smooth threaded cup and not in the femoral component.

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