Dual mobility cups hip arthroplasty as a treatment for displaced fracture of the femoral neck in the elderly. A prospective, systematic, multicenter study with specific focus on postoperative dislocation

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Femoral neck fracture; Total hip arthroplasty; Dual mobility; Elderly

Summary
Introduction: Displaced fractures of the femoral neck in the elderly are best treated with arthroplasty. The type of arthroplasty to be used, either hemi- or total hip arthroplasty, remains controversial as total hip replacements potentially have a higher rate of dislocation.

Hypothesis: Dual mobility cups have a low dislocation rate when used to manage acute fractures of the femoral neck.

Patients and methods: In a multicenter prospective study conducted in France over an inclusion time of 3 months, all displaced fractures of the femoral neck treated with arthroplasty were operated on with insertion of a dual mobility cup. Patients had clinical and radiological assessment at 3, 6, and 9 months postoperative.

Results: Two hundred and fourteen hips in 214 patients with a mean age of 83 years (range, 70–103 years) were included. None of the patients was lost to follow-up. The mortality rate after 9 months was 19%. Two patients (1%) had early postoperative infection successfully treated

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Introduction

Arthroplasty is well accepted as a treatment for displaced fractures of the femoral neck in the elderly. In the case of conservative treatment, local complications occur in 42% of the cases, with only 57% of the survivors being free of complications according to Blomfeldt et al. [1]. There is an increased risk of reoperation after osteosynthesis when compared to hip arthroplasty [2]. Functional results are also better after arthroplasty than after osteosynthesis of the femoral neck [3,4]. However, the best adapted type of arthroplasty to be used in this clinical setting is still under debate. Dislocation is the most frequent complication when a total hip arthroplasty is implanted to treat displaced fracture of the femoral neck [5]. Owing to the large diameter of the head, implantation of a hemiarthroplasty has a lower rate of postoperative dislocation [6]. The best functional results, especially in the case of active elderly patients, are obtained with total hip arthroplasties rather than hemiarthroplasties [7,8]. Dual mobility cups have been reported to have a low rate of postoperative dislocation in elective surgery, not only in primary total hip arthroplasties, but also in revision procedures and most particularly as a treatment for recurrently dislocating hip replacements. Do these implants also perform well in the setting of femoral neck fractures in the elderly and is there an advantage to using such implants to prevent postoperative dislocation? In order to answer these questions, a prospective multicenter study was designed with inclusion of all displaced femoral neck fractures in patients aged 70 and older, from September to December 2008.

Patients and methods

On behalf of the French Orthopaedic and Traumatology Society (SoFCOT), a multicenter prospective study was carried out, including all patients aged 70 or older with a diagnosis of a displaced intracapsular femoral neck fracture, for whom the chosen treatment was an arthroplasty as primary treatment. Inclusion covered a three-month period, from 15 September 2008 to 15 December 2008. In each case, a dual mobility cup was inserted and all surgical approaches were included in the study. Preoperative data were collected including age at operation, gender, side, date of trauma, date of operation, living facilities, need for a walking aid, and preoperative dependence score according to Parker and Palmer [9]. Intraoperative data consisted of surgical approach, denotation of the cup, external diameter of the cup, type of fixation (cemented or cementless), use of a reinforcement ring, material and diameter of the head, denotation of the femoral stem, and any associated procedure such as adductor tendon tenotomy, psoas tenotomy, osteosynthesis of the greater trochanter or osteosynthesis of the acetabulum. Follow-up appointments were scheduled at 3, 6, and 9 months after surgery with clinical and radiological examinations. Every attempt was made to gain information in case of a missed appointment, and in particular the date of death if death occurred and whether any reoperation had been carried out since the last appointment. Clinical data included the ability to walk and the need for technical or personal assistance, residence and in particular whether the patient had returned to the former residence. The need for any walking assistance device was detailed. Data concerning the surgery itself focused on the need for reoperation of any kind, the occurrence of surgical site infection, and periprosthetic fracture of the femur or acetabulum. Dislocations were specifically sought, as well as the number of dislocations since the intervention. The location of the cup was analyzed on plain X-rays looking for cup loosening on successive X-rays. Displacement of the cup was assessed manually and quantified in millimeters using a sharp pencil and ruler as formerly described by Nunn et al. [10]. The condition (union or nonunion) and location (normal or abnormal) of the greater trochanter were also assessed on radiographs. Statistical analysis was performed using the Fisher exact test for categorical data with a significance level of \( P < 0.05 \). For quantitative data, a Wilcoxon test was used with \( P > 0.05 \).

Results

Preoperative assessment

Eleven hospitals took part in this study. Two hundred and fourteen displaced femoral neck fractures met the inclusion
Postoperative assessment

None of the patients was lost to follow-up at 9 months. Twenty-five patients (11%) had died after 3 months and 40 patients (19%) had died within 9 months after surgery. Mortality was significantly increased in the following subgroups when compared to the overall population: patients aged 87 years or older at surgery ($P<0.05$), men ($P<0.05$), patients with a dependence score according to Parker less than 7 ($P<0.005$), patients needing a walking aid before surgery ($P<0.001$), and patients living in institutions before surgery ($P<0.001$). Regarding function, 151 out of 214 (70%) patients returned home with no increase in dependency. After 9 months, 18% of the survivors needed more personal care than before the fracture. As for the ability to walk, 50% did not need any walking assistance at home and 31% of the patients were free of walking assistance both at home and outside the home. Complications other than dislocations led to eight additional procedures (3.7%): two debridements for postoperative infection, five femur osteosynthesis procedures for postoperative periprosthetic fracture of the femur, and one exchange procedure for infection and mobilization of the cup after unrecognized intraoperative fracture of the acetabular wall. There was only one complication that led to reoperation after 3 months: one periprosthetic femoral fracture treated with osteosynthesis. Dislocation occurred in three cases out of 214 (1.4%). All three cases dislocated within the first 3 months following surgery and none of these cases had any recurrent dislocation. None of the dislocations were intraprosthetic dislocations between the retentive polyethylene liner and the prosthetic head. All three dislocations were of the large articulation of dual mobility between the polyethylene liner and the metallic shell. The three dislocations were treated with close reduction under general anesthesia. The three dislocations occurred in three patients who had been operated on using a posterior approach. In all these cases, the cup had been inserted without anteverision as observed on postoperative X-rays (Fig. 2). No patient operated on using an anterior, anterolateral, or direct lateral approach sustained postoperative dislocation. The dislocation rate when comparing the posterior approach to all the other approaches, however, was not statistically different. Due to the small number of dislocations, no difference could be detected concerning the age at operation or the external diameter of the shell. Nine patients were noted as having a greater trochanter outside its anatomical location. None of these nine patients had sustained a dislocation. At follow-up, there was no modification of the position of the cup on standard anteroposterior X-ray in any of the 173 patients still living after 9 months who had retained their cup (Fig. 1B).

Figure 1 Case of displaced fracture of the left femoral neck treated with total hip arthroplasty using a dual mobility cup. A. Preoperative planning was done on the healthy right side. B. Anteroposterior view in standing position at 9 months postoperative. Intermedia (Zimmer, Étupes, France) cemented stem and Saturn (Amplitude, Neyron, France) cementless cup inserted through a Hardinge-Müller approach. Limited heterotopic ossifications were observed.

criteria during the time of the study and all were operated on using a dual mobility cup as the acetabular component (Fig. 1). There were 156 females and 58 males. The mean age at operation was 83 years, ranging from 70 to 103 years. The left side was involved in 58% of cases. Before the fracture, 152 patients (71%) were living at home and 81 (38%) did not have any further assistance. Thirty-nine patients (18%) were living in institutions including healthcare facilities and 23 (11%) in nonmedical senior homes. The median independence score according to Parker was 6 out of 9 (range, 0–9). Before occurrence of the fracture, 86 (40%) of the patients could walk with no technical assistance and 36 (17%) only needed one cane outside of the home. Forty-three patients (20%) needed either two crutches or a walker, and seven patients (3%) had no walking ability at all. The mean time from fracture until operation was 3 days. One hundred and twenty-two patients (57%) were operated on the same day or the day after they had sustained their fracture. A posterior approach was used in 172 (80%) cases and a lateral or anterolateral approach in the remaining 42 (20%) cases. Cement was used for fixation of the cup in seven cases (3%); the other 207 cups were impacted without cement. The mean external diameter of the cup was 51 mm, ranging from 44 to 59 mm. A 28 mm femoral head was used in 182 cases (85%), and a 22.2 mm femoral head for the remaining 32 cases. A metal-lic femoral head was used in 203 cases (95%). Additional surgery was performed in 19 (9%) patients: osteosynthe-sis of the greater trochanter (15 cases), psoas tenotomy (three cases), and osteosynthesis of the acetabulum (one case).
Discussion

The systematic use of total hip arthroplasties to treat displaced intracapsular fractures of the proximal femur in elderly patients is not common practice. It was only performed in the setting of this study, limited in time, to avoid the bias of selecting the better cases (no co-morbidity, lower age, no mental impairment) for total hip replacement, leaving the more problematic cases for hemiarthroplasties.

Age at surgery and postoperative mortality at 3 months did not differ significantly from other prospective studies of femoral neck fractures in the elderly [1–4, 7, 8], in particular the SoFCOT multicentric study conducted in France in 2007 [11]. Therefore, no obvious bias in patient selection was observed between these two studies. Performing a total hip replacement in this elderly population did not imply an increased mortality rate after 3 months [11]. Skinner et al. [12] showed that there is no increase in mortality rate when a total hip replacement is performed instead of a hemiarthroplasty as treatment for a displaced fracture of the femoral neck among otherwise healthy elderly patients. Postoperative dislocation is a key issue when treating displaced fractures of the femoral neck. One of the potential drawbacks of performing a total hip arthroplasty in such a situation is that the dislocation rate may be higher than what is observed when performing a hemiarthroplasty. The rate of dislocation after hemiarthroplasty was 3.8% whatever surgical approach was used and 6.9% in the posterior approach, as reported in 2007 [11]. The relative risk of dislocation was 2.9 times less, although not statistically significant, when using a dual mobility cup whatever surgical approach was used, and the relative risk of dislocation was 3.9 times less when using a dual mobility cup and a posterior approach, reaching statistical significance ($P < 0.05$) [11]. Comparing the present series of dual mobility cups in the treatment of displaced fractures of the femoral neck to recent series of bipolar hemiarthroplasties, the relative risk of dislocation appears 4–4.7 times higher for hemiarthroplasties [3, 6–8, 12]. The use of dual mobility cups in the treatment of displaced fractures of the femoral neck also appears safer in terms of the criteria of postoperative dislocation when compared to conventional cups [11–13]. The difference is clear, especially when there is no further patient selection than a displaced fracture of the femoral neck in the elderly. Johanson et al. [13] reported a 22% rate of dislocation after total hip replacement for fracture of the femoral neck in a population of nonselected elderly people of similar age (84 years) to the current series. The relative risk of dislocation reported by these authors with conventional total hip replacements was 15.5 times higher than what was observed in this study using dual mobility cups ($P < 10^{-3}$) [13]. The rate of dislocation reported by Lu-Yao et al. [14] in a meta-analysis comprising 746 total hip replacements as a primary treatment for a displaced fracture of the femoral neck was 10.7%. Mean age at surgery was 72 years, potentially due to the selection of younger patients when compared to the present series of dual mobility cups. Nevertheless, the relative risk of dislocation was 7.6 times higher for the conventional cups used in that meta-analysis when compared to the present series of dual mobility cups ($P < 10^{-4}$) [14]. The good short-term results after implantation of a dual mobility cup as a part of a total hip arthroplasty following a displaced fracture of the femoral neck need to be followed for a longer time. Good long-term results with these implants have already been reported in the setting of primary hip replacement for osteoarthritis or avascular necrosis of the femoral head, the complication rate being particularly low for patients older than 70 years at the time of surgery [15]. Concerns about potential wear had also already been ruled out, with a mean annual volumetric polyethylene wear of 54.3 mm$^3$ [16]. The use of cemented dual mobility cups, either directly in the host bone or in a reinforcement ring, has only recently been introduced, although good early results have been reported [17]. This might be an option in cases of severe osteoporosis, but questions remain regarding the quality of fixation over a longer period of time. Using dual mobility cups makes total hip replacement a safe option in terms of postoperative dislocation. Improvements in postoperative pain and function are described as early as 1–2 years after surgery with the use of a total hip replacement instead of a hemiarthroplasty [18]. In addition, the use of dual mobility cups provides a significant decrease in postoperative dislocation compared to hemiarthroplasties when a posterior approach is chosen, with a relative risk of dislocation 3.9 times lower ($P < 0.05$). When using a posterior approach, care should be taken not to retrovert the cup. Indeed, dislocation was found only when there was retroversion of the cup (Fig. 2). Nevertheless, a dislocation rate of 1.7% with a posterior approach, despite the unfavorable clinical setting of an intracapsular fracture of the proximal femur, is far less than previously reported after primary total hip arthroplasty, even with the use of 32 mm heads [19].

Further study is needed before extending the indications for total hip arthroplasty following a fracture of the femoral neck, to assess the potential cost and complications of a longer procedure with its potential acetabular complications and weigh them against the potential benefits of a low dislocation rate and improved bearing in comparison with hemiarthroplasties.
Conclusion

The systematic use of dual mobility cups in the treatment of displaced fractures of the femoral neck in the current prospective study had a low dislocation rate of 1.4%, even though a posterior approach had mainly been performed by operators with variable experience. Owing to this low dislocation rate, the use of such dual mobility cups should be taken into account when treating a displaced intracapsular fracture of the proximal femur in an elderly patient, as soon as the indication for a total hip replacement has been retained.

Disclosure of interest

Dr. Adam, Dr. Philippe, Dr. Ehlinger, Dr. Roche, Profs. Molé and Prof. Bonnotet declare that they have no conflicts of interest concerning this article.

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