Cemented hemiarthroplasty after a femoral neck fracture. Survivorship analysis

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Purpose. To analyze the factors that affect the survivorship of subjects treated by hemiarthroplasty after a femoral neck fracture.

Materials and methods. This is a retrospective study of 1196 consecutive subcapital fractures in 1166 patients treated with a Thompson hemiarthroplasty between 1989 and 2001 for a femoral neck fracture. A clinical follow-up was made of a random sample of 220 fractures. Of these, 210 cases were followed up for at least two years or until the patients' death (95.5%). A multivariate analysis was carried out of the effect on survivorship of age, gender, associated conditions, delay of surgery and post-op complications. Implant survivorship was also analyzed.

Results. Median survivorship was 4.5 years. Male gender had a higher mortality rate (RR = 2.47, 95% confidence interval: 1.65-3.70; p < 0.001) as did old age (RR = 1.04, CI: 1.01-1.07; p = 0.005). Although, delay of surgery did not affect long-term survivorship, it did affect survivorship at 6 months: patients operated the same day they were admitted had a higher mortality rate than those operated in the first 10 days after admission (33.3% vs. 10.4%; OR = 4.38; CI: 1.12-16.5; p = 0.03). Only three implants had to be explanted, all of them further to aseptic loosening.

Conclusions. The factors that most significantly contribute to mortality in this group of patients are male gender, age and the presence of a disease. A 24-hour delay of surgery can increase short-term survivorship. Implants rarely fail.

Key words: *hip fracture, hemiarthroplasty, survivorship analysis, Thompson prosthesis.*

Hemiartroplastia cementada tras fractura subcapital de fémur. Análisis de supervivencia

Objetivo. Analizar los factores que afectan a la supervivencia de sujetos tratados con hemiartroplastia tras una fractura subcapital de fémur.

Material y método. Estudio retrospectivo de 1.196 fracturas subcapitales consecutivas en 1.166 pacientes tratados con hemiartroplastia de Thompson tras una fractura subcapital de fémur entre 1989 y 2001. Se realizó seguimiento clínico de una muestra aleatoria de 220 fracturas; de éstas, 210 casos fueron seguidos al menos dos años o hasta el fallecimiento (95,5%). Se realizó un análisis multivariante del efecto de la edad, el sexo, las enfermedades asociadas, la demora de la intervención quirúrgica y las complicaciones postoperatorias en la supervivencia. Se analizó también la supervivencia de los implantes.

Resultados. La mediana de supervivencia fue de 4,5 años. El sexo masculino incrementaba la mortalidad (riesgo relativo [RR]= 2,47; intervalo de confianza para un 95% [IC 95%]: 1,65-3,70; p < 0,001) y también la edad avanzada (RR = 1,04; IC 95%: 1,01-1,07; p = 0,005). La demora de la intervención quirúrgica no afectaba la supervivencia a largo plazo, pero sí a los 6 meses teniendo los operados en el día del ingreso una mortalidad superior a la de los operados en los primeros 10 días tras el ingreso (33,3% frente a 10,4%; *odds ratio* [OR] = 4,38; IC 95%:1,12-16,5; p = 0,03). Sólo tres implantes fueron retirados, todos ellos por aflojamiento aséptico.

Conclusiones. Los factores que más aumentan la mortalidad en este grupo de pacientes son el sexo masculino, la edad y la presencia de enfermedades. Una demora de la intervención de 24 horas puede aumentar la supervivencia a corto plazo. Los implantes rara vez fracasan.

Palabras clave: *fractura de cadera, hemiartroplastia, análisis de supervivencia, prótesis de Thompson.*

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Subcapital hip fractures are a usual heath problem in the elderly. They have an annual incidence of between 30 and 100 per 100,000 inhabitants[1-3], and of around 500 per 100,000 inhabitants over 70 years of age[4]. These fractures are a significant cause for the loss of functional capacity and the reduction of life expectancy. Displaced subcapital fractures (Garden types III and IV) tend to benefit from surgical treatment with reduction and osteosynthesis or hip replacement[5-8]. Although there is no agreement as to whether modular or bipolar models are better than classical Austin-Moore or Thompson-type implants[9-12], for the group of older and more infirm patients, hence those with a shorter life expectancy, it would seem appropriate to initially select a partial hip replacement[13,14], which permits an speedy gait recovery.

In 1990 a review was carried out of the results of Thompson-type hemiarthroplasties implanted in our Hospital following an osteoporotic fracture[15]. But sixteen years later socioeconomic and epidemiological circumstances have changed in our country, which makes it necessary to conduct a new review of the characteristics and prognosis of this group of patients.

The purpose of this study is as follows: to describe the different epidemiological parameters of subjects that sustain a hip fracture and are treated with hip hemiarthroplasty; to analyze the factors that affect patient survival following hip hemiarthroplasty; and to review the complications that occur and their effect on patient survival.

MATERIALS AND METHODS

Se presenta un retrospective study of the patients operated on for a femoral subcapital fracture in our Department between January 1989 and December 2001. We reviewed the records of all patients and selected those where the osteoporotic subcapital femoral fracture was initially treated with a Thompson-type hip hemiarthroplasty. We excluded those subjects that presented with neoplastic disease at the fracture site, or who had received some different treatment (conservative or surgical) prior to implant placement.

A total of 1,166 subjects (group A: 939 females and 227 males) with 1,196 subcapital femur fractures (637 left, 499 right and 30 bilateral) treated with a Thompson-type hip hemiarthroplasty met the inclusion criteria. Of all these subjects different epidemiological, medical and admission-related data were obtained. (table 1).

As it is difficult to make a thorough review of a large group, a smaller group (Group B) consisting of 220 fractures in 217 subjects was selected at random. The same data were obtained for group B as for the larger group, and a clinical follow-up session was conducted either in person or by telephone. The inclusion criteria were that patients had to either have been evaluated at least two years after surgery, or have died.

Table 1. Data concerning both groups of patients

Epidemiological data	Age
	Gender
	Size of the fracture
Previous medical events	Presence of:
	High blood pressure, diabetes mellitus, dementia, Parkinson's disease, chronic obstructive pulmonary disease, heart disease, previous cerebrovascular events, psychiatric diseases, osteoporosis, other fractures and other
Data on hospitalization	Time in hospital before surgery
	Time in hospital following surgery
	Intraoperative complications
	Approach
	Size of prosthesis
Data on evolution	Complications requiring readmission

The epidemiological and admission parameters were compared between the 2 groups and with the data available from González Herranz et al's historical series[15]. A Kaplan-Meier analysis was carried out to estimate the survival curve for subjects in group B and an individual survival analysis was performed of the effect that gender, age, the presence and amount of concomitant diseases, time to surgery (as a magnitude per se and stratified into three groups: patients operated the first day, patients operated between the first and the eleventh day and patients operated beyond the eleventh day), length of hospitalization and the appearance of intra- or post-operative complications had on survival. A further analysis was made to determine the effect of these factors on survival at 6 months. A multivariate Cox model analysis was conducted with those factors whose effect on survival was individually significant. A Kaplan-Meier survival analysis was also made for implant survivorship. The statistical analysis was carried out with the S.P.S.S. 12.0 software.

RESULTS

Of the 220 randomly selected cases making up group B, it was possible to carry out a clinical follow up over at least 2 years or until the patient's death in 210 cases (95.5%); it is this group that was used as a basis to perform the result analyses. Of these 210 cases, 117 were followed up until death, which occurred at a mean 2.4 years (standard deviation: 2.45 years) after surgery. The 93 individuals that remained alive at the end of follow-up were followed up for a median of 4.6 years (from 2 to 9.9 years; inter-quartile range: 3.4 years).

Table 2 shows the mean values of the different epidemiological variables and concomitant diseases obtained for the 2 groups. The mean values for the data related to admission and post-operative complications for the two

Table 2. Epidemiological data and previous medical events in the 3 groups

Variable	Group A	Group B	1994 series
Number of fractures	1,196	210	528
Epidemiological data			
Age	82,1 (± 7,54)	82,3 (± 8,0)	78 (NA)
Gender (M/F)	227/939 (19.5%/80.5%)	44/167 (21%/79%)	98/430 (19%/81%)
Side of fracture (right/left/ bilateral)	499/637/30	89/115/3	232/296/NA
Previous medical events			
Number of events	1.3	1.5	0.7
High blood pressure	288/1,166 (24.7%)	64/210 (30.1%)	NA
Diabetes mellitus	154/1166 (13.2%)	27/210 (12.9%)	8%
Dementia	183/1,166 (15.7%)	38/210 (18.1%)	NA
Parkinson's disease	52/1,166 (4.5%)	7/210 (3.3%)	NA
Chronic obstructive pulmonary disease	75/1,166 (6.4%)	18/210 (8.6%)	5%
Psychiatric diseases	64/1,166 (5.4%)	12/210 (5.7%)	NA
Previous cerebrovascular events	120/1,166 (10.3%)	23/210 (11%)	NA
Heart disease	223/1,166 (19.1%)	45/210 (21.4%)	NA
Other osteoporotic fractures	101/1,166 (8.7%)	23/210 (11%)	NA
Other events	242/1,166 (20.8%)	48/210 (22.8%)	NA

Mean values are reflected. The figures between brackets are percentages or standard deviations. M: male; F: female; NA: data not available;

Table 3. Data related to hospitalization and complications in the 3 groups

Variable	Group A	Group B	1994 series
Number	1,166	210	528
Data on hospitalization			
Time in hospital before surgery (days)	9 (± 7.3)	10 (± 7.5)	4.8
Time in hospital after surgery (days)	16 (± 13.1)	16 (± 14.1)	NA
Approach (anterolateral/lateral/ posterior)	1,152/5/9	204/1/5	528/0/0
Diameter of prosthesis (mm)	45.1 (±3,0)	45 (± 3.1)	NA
Dead while hospitalized	43 (3.69%)	7 (3.33%)	NA
Intra-operative complications	49 (4.2%)	10 (4.2%)	
Instability	12 (1.0%)	2 (1.0%)	NA
Greater trochanter fracture	20 (1.7%)	4 (1.9%)	2 (0.4%)
Inappropriate prosthetic diameter	11 (0.9%)	1 (1.0%)	NA
Other	6 (0.5%)	3 (1.4%)	NA
Postoperative complications:	74 (6.3%)	12 (5.7%)	
Dislocation	16 (1.4%)	3 (1.4%)	(0.4%)
Infection	26 (2.2%)	4 (1.9%)	7 (1.3%)
Infection requiring reoperation	14 (1.2%)	2 (1.0%)	3 (0.6%)
Cup wear requiring reoperation	12 (1.0%)	0 (0%)	NA
Other complications requiring reoperation	6 (0.5%)	2 (1.0%)	NA

Mean values are reflected. The figures between brackets are percentages or standard deviations. Differences between groups A and B were not significant. NA: data not available;

groups are shown in table 3. When available, we also included the data of the study by González Herranz et al[15]. No significant differences between groups A and B were seen with respect to epidemiological variables, personal history or the variables related to admission or complications, which suggests that they are homogeneous groups.

The survival analysis for the group of 210 patients showed a median survival rate of 4,5 years (95% confidence interval: 3.7 to 5.4 years), with a peri-operative mortality rate of 9.5% at 30 days, 21.0% at one year and 31.4% at 2 years (fig. 1). The univariate Kaplan-Meier analysis demonstrated that age (fig. 2), gender (fig. 3), the side of the fracture, medical history and the presence of dementia and chronic obstructive pulmonary disease had a significant effect on survival. An analysis was made of the effect that the time at which surgery was performed had on survival. Initially, a Cox regression analysis was carried out, which did not find differences in survival that were related to time to surgery (hazard ratio: 1.02; 95% CI: 0.99-1.04; p = 0.25). When the sample was divided into 3 groups (patients operated the first day, patients operated between the first and the eleventh day and patients operated after the tenth day), it was seen that the Kaplan-Meier survival analysis did not show any significant differences between the 3 groups (p =

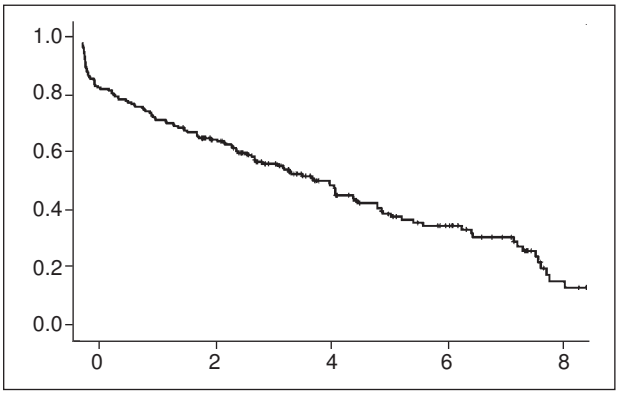

Figure 1. *Kaplan-Meier survival analysis of the 210 subjects with a minimum follow-up of 2 years. The survival rate is shown on the horizontal axis and years on the vertical axis.*

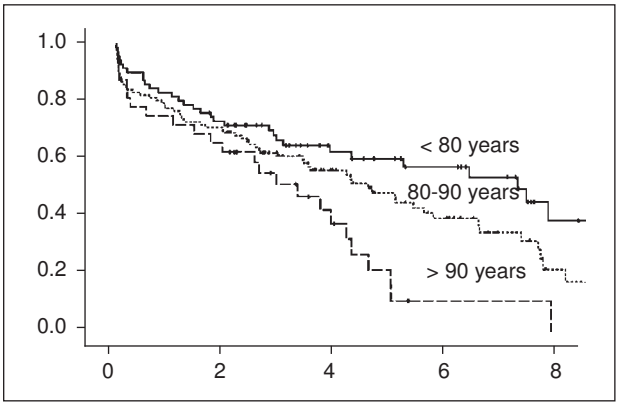

Figure 2. *Kaplan-Meier survival analysis according to age. In order to make the effect apparent, subjects were distributed into 3 groups: < 80 years (solid line), entre 80 y 90 years (dotted line) and > 90 years (discontinuous line).*

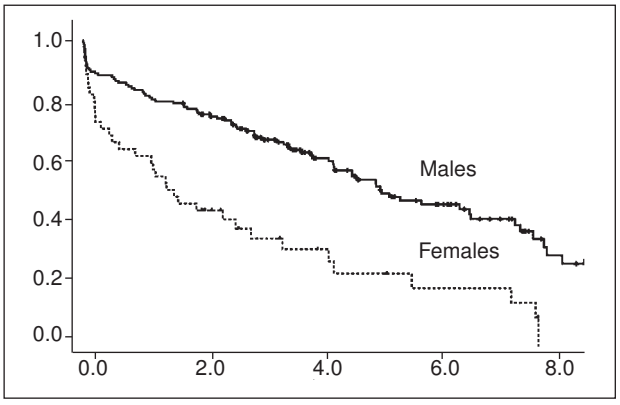

Figure 3. *Kaplan-Meier survival analysis according to gender. The solid line represents the females and the dotted line the males.*

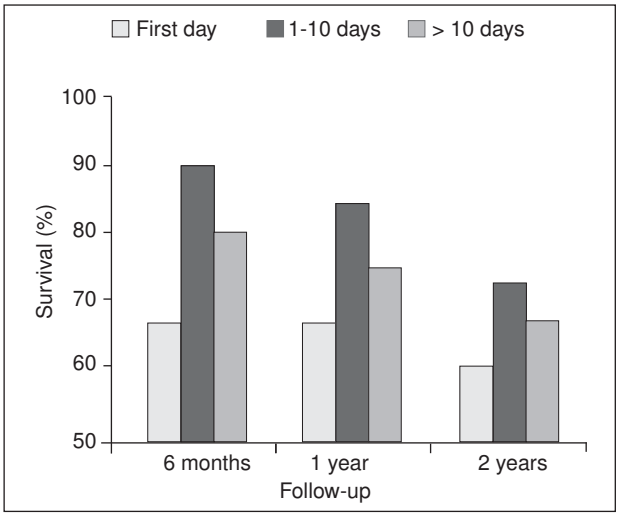

Figure 4. *Survival of the subjects at 6 months, one year and 2 years, depending on whether they were operated within the first 24 hours, between days 1 and 10 or after the tenth day.*

0.55) (fig. 4). The dislocation of the prosthesis was seen to exert a significant influence on survival (p = 0.002) with the 3 patients who sustained dislocations of their arthroplasty dying within 6 months. The other intra- or post-operative complications, separately or as a whole, was not seen to have a significant effect. The presence of high blood pressure, diabetes mellitus, Parkinson's disease, heart disease, prior cerebrovascular accidents, another osteoporotic fracture or psychiatric diseases, excluding dementia, did not seem to affect survival.

A multivariate Cox regression analysis was performed, where we included all variables that proved significant in the univariate analysis. It was seen that the only factors that influenced survival were age, gender and personal history. An increase in age of one year curtailed life expectancy by 4% (relative risk [RR] 1.04; CI 95%: 1.01-1.07 p = 0.005). Males had a mean mortality rate 2.2 times higher that of females (RR 2.47; CI 95%: 1.65- 3.70; p < 0.001). A higher overall amount of previous medical events significantly increased mortality (RR: 1.16; confidence interval 1.07-1.45; p = 0.004), so that each previous medical event led to a 19% mortality increase.

An analysis was carried out of early survival (6 months) in the series, which gave a result of 81.9%. We also calculated the effect of age, gender, number of previous medical events, surgical delay and intra- and post-operative complications on the survival rate at 6 months. We found that the Lumber of previous medical events, gender and surgical delay had a highly significant effect. Males showed a lower mean survival rate at 6 months than females (66% vs. 86%; hazard ratio: 0.32; 95% CI: 0.15-0.69; p = 0.003). A greater overall amount of previous medical events significantly increased mortality (RR: 1.36; CI 95%: 1.03-1.80; p = 0.03), so that each previous medical event led to a 36% increase in mortality. Patients operated in the first 24 hours had a far higher mortality than those operated between the first and the eleventh day (33,3% vs. 10.4%; odds ratio: 4.38; CI

95%: 1.12-16.5; p = 0.03) (fig. 4). The mortality rate of patients operated after the tenth day was higher than that of those operated between the first and the eleventh day (20% vs.10.4%; not significant, p = 0,132).

A Kaplan-Meier analysis was carried out to study implant survivorship. Of the 210 implants with at least 2 years' follow-up, only 3 were revised. All of these were exchanged due to painful aseptic loosening of the stem 10 months (in 2 patients) and 3.2 years after being implanted an uncemented total prosthesis.

DISCUSSION

We present the results of a very large series of patients (1,166) with a displaced proximal femur fracture subjected to a cemented hemiarthroplasty. We carried out a retrospective survival analysis of a sizeable random sample (220) from this group. Minimum follow-up required in our series was 2 years with very few patients lost to follow-up (5%). The comparison with the data of the 1994 study shows that the male/female ratio and the marginal prevalence of the left side are maintained. Mean age seems to have increased by almost 5 years (82.1 vs. 78 years), as has the number of previous medical events (1.3 vs. 0.7 per patient). Mean survival in the 1990 group after 3.5 years' mean survival was 69.8%, while in the present study mean follow-up was 3.4 years and survival 44.3%. This difference is difficult to assess since samples are not homogeneous, but the increased number of associated problems, added to a more advanced age, could explain this difference.

Median survival in our group was 4,5 years with 55.7% mortality after a mean 3.4 years' follow-up; time elapsed from surgery to the patients' death was 2.4 years on average. These survival results are similar to those obtained in other series: Haidukewych et al[16] reviewed the survival of a group de 212 patients with a mean age of 78.8 years, treated with a bipolar prosthesis. They observed a 56% survival rate at 5 years. Healy et al[17], in a sample of 66 patients (80.4 years old on average), found a 33% mortality rate, with a period of 2.3 years between surgery and the patients' death. Hudson et al[18], in a group of 264 patients treated with hemiarthroplasty observed a mortality rate at 8 years of 61%, as compared with a rate of 77% in our own series at 8 years.

Age proved to be a determining factor for general survival so that, excluding other confounding factors, being one year older meant a 4% increase in mortality risk. These findings are in line with those obtained by Aharonoff et al[19], whose prospective analysis of 612 patients treated with hemiarthroplasty found that the relative risk of dying when over 85 years of age as compared with younger patients was 2.7%. Likewise, Roche et al[20], in 2,448 subjects with a hip fracture observed a significant effect of age on survival. Nonetheless, Eiskjaer et al[21] did not find this effect in 203 subjects with fractures treated with a bipolar arthroplasty. In our study, this age-related effect is not apparent in terms of short-term survival (6 months) (p = 0,13), which could be attributed to the fact that it is other factors (chiefly previous pathologies and gender) that affect short-term survival. A similar result was obtained by Sikand et al[22], who found that age did not seem to exert any effect on the survival at 30 days of a group of 130 patients with an undisplaced subcapital fracture. However, Parvizi et al[23] observed higher mortality at 30 days in patients older than 70 years in a group of 7,774 patients of similar characteristics to those in the present series.

The subject's gender decisively affected short and long term survival, so that males had a much higher mortality rate than females of the same age. This finding is significant even if it is in line with the analysis, taking into account associated factors like comorbidity and age. Authors have found contradictory evidence in this regard: some[23] do not find survival-related differences between the sexes and attribute the findings of other researchers to an inadequate assessment of comorbidities. However, Roche et al[20] in a prospective study of 2,448 patients found that gender was a determining factor, in spite of considering other factors (hazard ratio: 1.5-2.1 for survival at one year). Nevertheless, the effect of gender on survival did not seem to affect functional recovery in a group of 398 patients reviewed by Koval et al[24]. In sum, the effect of gender on survival following these types of fractures is still a moot point.

Intra- or post-operative complications appeared in 10% of patients (4.2% and 5.7% respectively). The statistical analysis found no significant effect of complications (either individually or as a whole) on the subjects' survival, except in the case of implant dislocation. This lack of significance is probably due to the low number of complications (which reduces the power of the analysis) rather than with a truly nonexistent effect. In this study we have not taken into account systemic complications, which have been shown by other authors to increase mortality[19]. The only statistically significant data was increased mortality following implant dislocation: the 3 patients that sustained a dislocation died at 22 days, 5 months and 6 months after surgery. This finding is in line with the research of other authors. Blewitt and Mortimore[25] found a 65% mortality rate at 6 months in 20 patients (2% of total) who sustained a dislocation as compared with the 10% rate observed in those who did not sustain a dislocation.

Surgical delay in the group of 210 patients who were followed up was of 10 days on average. This type of delay is infrequent and probably unacceptable. It is associated to the patients' significant level of associated comorbidities, to the logistical difficulties inherent in performing these types of procedures in an emergency, the distribution of OR time in the department and the scarcity of beds in the resuscitation room. The initial quantitative statistical analysis did not

show a significant effect of surgical delay on general survival or survival at 6 months. Since some authors have suggested that surgery on the first day the patient is admitted could increase morbidity[26] use of the variable "number of days to surgery" seemed inappropriate, for which reason we decided to stratify groups into three subgroups: the first included subjects operated on the day of admission; the other 2 distinguished between subjects operated before and after the mean surgical delay, i.e. ten days. The statistical long term survival analysis did not provide significant results. This may be attributed to the fact that in this group of elderly subjects with significant comorbidities survival beyond 3 years (mean follow-up in that series) does not depend so much on personal or procedure-related factors but rather on the morbidity caused by the fracture itself, with the possible effect of the surgical delay being masked by other factors. In fact, the statistical analysis of survival 6 months after surgery did show significant differences between the group operated the first day (67% survival) and the group operated between the first and the tenth day (90% survival).

The fact that surgical delay has an effect on the survival of these patients is controversial and has implications for healthcare policy. Although common sense suggests that surgery must be performed as soon as possible, there is anecdotal evidence that indicates that if carried out in the first few hours surgery might lead to a higher morbimortality rate since the subject is decompensated and could benefit from a slight deferral. Kenzora et al[26], in a retrospective review of 406 patients operated on for a subcapital fracture, found results similar to those in this series with a lower survival rate at one year in the group of patients operated on the day of admission (72%), as compared to those operated between the first and the sixth day (96%), for which reason they recommended a 24 hour deferral of the procedure to stabilize the patient. On the other hand, other authors[21] have not seen surgical delay to have a significant effect on the survival of these patients. Lastly, there is growing evidence that delay negatively affects survival: some authors[27-29] found an increased association (surgical delay and mortality) and 2 recent studies have confirmed that finding: In an observational prospective study that included 2,660 patients, Moran et al[30] observed that a delay of more than 4 days led to a significant increase in mortality at 30, 90 and 365 days; they did not see any effect in shorter delays. Lastly, in a powerful study that reviewed survival in over 100,000 patients admitted into different hospitals in the UK between 2001 and 2004, Bottle y Aylin[31] observed that even a delay of just one day significantly increased mortality at 30 days.

Implant survivorship analysis suggests that implant failure is not a significant problem for this type of patients. Estimated implant survivorship at 10 years was 97.8%. These results compare favorably with those of Eiskjaer and Ostgard[32], who found a survivorship rate of 85% at 10 years, and with those of Haidukewych et al[16], who had a survivorship rate of 93.6% at 10 years. In the present study all revisions were carried out because of the stem's aseptic loosening, there being no revisions caused by cup wear; this could be due to the fact that the symptoms produced by the wear of the acetabular fossa is slight by comparison to the risks of revision arthroplasty in an elderly population, and also to the fact that in this group de patients there is a significant age-related functional limitation that reduces wear[33]. Other authors also observed that cup wear is a rare cause for revision in these patients: Tellisi and Wahab[34] found no cases and in Haidukewych et al's series[16] 10% of revisions (0.4% of prostheses implanted) were carried our for this reason. These results seem to warrant the decision not to use bipolar or interchangeable head implants, which are more expensive and lead to other types of complications[9,12,18]. There were no revisions of stem explantations due to deep infections or severe instability, which account for up to 40% of revisions in other series[16,34].

To conclude, Thompson-type hip hemiarthroplasty is an efficient remedy to address subcapital hip fractures in the elderly population. The median survival in our group was 4.5 years, with male gender, age and the presence of comorbidities as the factors that most significantly increase mortality. The effect of surgical delay on the survival of these patients remains controversial, although our study seems to suggest that a delay of 24 hours could be beneficial in increasing short term survival. Dislocation is a potentially lethal complication and must be avoided. Implants seldom fail as a result of loosening and cup wear is rare.

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Conflict of interests

The authors have declared that they have no conflict of interests.