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Hemiarthroplasty for Femoral Neck Fractures in Elderly Patients: an Epidemiological Study on Mortality and Periprosthetic Fracture Risk

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Introduction

Hip Fracture (HF) is a major public health problem. The incidence of HF rises dramatically in the elderly population with osteoporosis, occurring in 87% to 96% of cases in people aged over 65 years [1, 2, 3]. An estimated number of more than 6 million HF is expected worldwide in 2050 [4].

The mortality rate after HF is very high especially during the first 3 months, with a 5 to 8 fold increase in risk of all-cause mortality [5]. This trend tends to remain higher after many years [6].

Fractures of the femoral neck and trochanteric region represent about 90% of all HF, with a similar incidence [7, 8]. Some authors identify a 50% incidence within HF for femoral neck fractures (FNF) [9, 10].

The optimal treatment of FNF remains controversial, with hemi-arthroplasty (HA) being the mostly used treatment [11], especially in elderly patients. HA is associated with satisfactory functional recovery, early ambulation [11] and a better clinical outcome compared to screw fixation [12, 13, 14].

Nevertheless, an ongoing controversy regarding HA implanting technique (cemented vs uncemented) is still encountered in the literature. Several studies have shown a better clinical result with cemented stems [15-17], anyway the cardiopulmonary risk associated with the use of bone cement is not negligible [15, 18]. Furthermore, although guidelines suggest the use of the cement for HA [19], uncemented implants remain a diffusely adopted solution for HA implant because of surgical time spare and technical ease for several hip surgeons.

Periprosthetic femur fracture (PPF) is a known but uncommon complication of HA, often occurring in elderly patients with several comorbidities and representing a technical challenge for orthopaedic surgeons.

PPF is associated to significant morbidity and mortality in the aged population [20], thus its correct treatment appears to be crucial.

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Although some studies demonstrate a lower risk of PPF in cemented HA [21-25], there is a lack of knowledge regarding the actual epidemiology and clinical features of this event. Aim of the present study is to evaluate a population of femoral neck fracture patients treated with HA, to assess mortality risk and PPF incidence. Possible risk factors for PPF and mortality associated to the event will be secondary aims.

Materials and Methods

All patients admitted to Cattinara Hospital of Trieste (Italy) between January 2010 and December 2015 with diagnosis of FNF treated with HA were considered for the present study.

Data were collected on march 2016 by reviewing the hospital computer storage system and medical records using the ICD-9 (international classification of disease, ninth revision) codes: 820.00, 820.01, 820.02, 820.09, 996.44 for the diagnosis and 81.52 for the procedures.

Two of the authors (A.N. and S.Z.) reviewed the data obtained to identify erroneously included patients. The latter patients and cases with missing data were excluded from the study. For each patient sex, age, ASA (American Society of Anaesthesiologists) score (26), type of anaesthesia, surgical approach, duration of surgery, destination of discharge and number of medications at discharge were recorded.

Patients with an unknown number of medications at discharge and/or unknown ASA score were not excluded from the study but they were not considered in the statistical analysis.

Finally, the use of bone cement was recorded, dividing the population in cemented and uncemented cases.

Follow-up was identified as the time lapse from HA implant and data collection for living patients and as the time lapse from HA implant and death for the others.

Survival curve was calculated and correlated to sex, age and use of cement at different time points (within 7 days, 30 days, 1 year, 5 years).

All PPFs occurred to the population in exam during the study period were recorded. The PPF pattern was classified according to the Vancouver classification system [27]. For all PPF cases the above mentioned demographic and clinical parameters were newly recorded, together with the type of surgical or conservative treatment. Clinical and demographic data were analysed in order to identify possible risk factors for PPF, with particular focus on cement use.

Statistical analysis

Statistical analysis was performed using the IBM SPSS® statistics software.

Mantel–Haenszel odds ratio (MH-OR) with 95% CI was calculated for all the variables present in the study. Subsequently a logistic regression analysis was used for the significant variables. Kaplan-Meier survival curves were obtained from different variables (sex, age, cement use) and compared with the log rank test.

Results

The population in exam counted 1335 patients treated with HA between January 2010 and December 2015 for FNF.

Data regarding demographical and clinical parameters for the whole population are shown in table 1.

Sex distribution demonstrated a prevalence of female sex, with 77% (N=1029) of cases occurring in female and 23% (N=306) in male patients. Mean age of the population was 85.02 years (range 48-105). The mean age in the male group was lower than the female one, respectively 83.7 in male sex (range 51-105) and 85.4 (range 48-101) in female sex.

The predominant ASA score was 3 (52% N= 701) followed by 2 (24% N=315), 4 (2% N= 24) and 1 (only 2 patients).

Hemiarthroplasty was performed under spinal anaesthesia in 91% of cases (N=1217) and under general anaesthesia in the remaining 9% (N=117). The average duration of surgical intervention was 70.6 (range 180-38) minutes.

Institutional care was the destination after discharge in 54% of cases (N=721), and the 52% (N= 700) had less than ten medications at the time of discharge.

All the HA were performed with a lateral approach according to Hardinge. The largely most common stem fixation technique was uncemented (87%, N=1157).

When considering stem fixation technique, the cemented group showed a predominant female sex (80%, N= 143), an average age of 87 years (range 103-57), and a prevalent ASA score of 3 (55% N= 98). Spinal anaesthesia was performed in 85% (N=152) of cemented cases with an average time of surgery of 84.7 minutes (range 180-45). Institutional care was the prevalent destination after discharge (56% N=99), and the 56% (N=99) of patients with a cemented HA were discharged with less than ten medications.

		Total n=1335 (1,0)	**Cemented** n=178 (0,13)	**Uncemented** n=1157 (0,87)	**PPF n=15 (1,1)**
Age		85,0 (68-105)	87 (67-103)	84,7 (68,105)	84,6 (78,94)
Sex	*M*	306	35	271	4
	F	1029	143	886	11
ASA score	*Unknown*	293	35	258	3
	1	2	0	2	0
	2	315	42	273	4
	3	701	98	603	8
	4	24	3	21	0
Anesthesia	*Spinal*	1217	152	1065	14
	General	117	26	91	1
Time of surgery (min)		70,6 (38-180)	84,7 (45-180)	68,3 (38-180)	70,13 (50-,105)
Discharge	*Home*	415	57	358	6
	Institutional care	721	99	622	8
	Rehabilitation Institute	137	17	120	1
	Death before discharge	63	5	58	0
N° of medications	*Unknown*	369	56	313	0
	<10	700	99	601	14
	≥ 10	266	23	243	1 7)

Table 1: Data regarding demographical and clinical parameters for the whole population

The uncemented group did not differ significantly in terms of age, sex, prevalent ASA, type of anaesthesia, destination after discharge and number of medications at the time of discharge.

The duration of surgery was shorter, mean 68.3 minutes (range 180-38).

The variable male sex showed a statistically significant positive correlation with 'ASA3' and '<10' [Tables 2, 3]. Moreover, the variable male sex was significantly correlated with 'death' and 'death between 8 and 30 days' [Tables 2, 3]. he Mantel-Haenszel odds ratio test and logistic regression analysis also demonstrated that 'ASA 3' and 'age > 85 years' were risk factors for the outcome 'death' while 'discharged in rehabilitation institute' and '<10 medications' resulted to have a protective role on the same outcome [Table 4].

Dependent variables	Discharged at home		Discharged at istitutional care		Discharged at rehabilitation institute		ASA2		ASA3		ASA4		N of medications <10		Death before discharged		Death Within 7 days		Death between 8-30 days		Death between 1 month- 1 year		Death after 1 year		PPF	
Independent variables	Odds ratio	P <0.05	Odds ratio	Odds ratio	Odds ratio	P <0.05	P <0.05	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05	Odds ratio	P <0.05
Sex (male)	0,90 (0,68-1,19)	X	0,77 (0,60-0,99)	✓	1,22 (0,82-1,83)	X	0,50 (0,35-0,70)	✓	1,75 (1,35-2,28)	✓	2,05 (0,89-4,73)	X	0,65 (0,50-0,84)	✓	3,39 (2,02-5,67)	✓	4,26 (1,13-15,95)	✓	2,45 (1,38-4,35)	✓	1,77 (1,33-2,35)	✓	1,16 (0,86-1,57)	X	0,80 (0,54-1,18)	X
Age >85	0,71 (0,56-0,90)	✓	0,91 (0,53-1,55)	X	3,33 (2,27-4,88)	✓	1,45 (1,113-1,87)	✓	0,85 (0,68-1,05)	X	0,93 (0,41-2,11)	X	0,98 (0,79-1,21)	X			2,62 (0,65-10,55)	X	0,23 (0,10-0,49)	✓	0,70 (0,54-0,91)	✓	0,76 (0,58-0,99)	✓	Not calculable	
Cemented stem	1,07 (0,78-1,48)	X	0,91 (0,53-1,55)	X	0,55 (0,22-1,41)	X											3,28 (0,81-13,26)	X	1,41 (0,67-2,95)	X	1,00 (0,68-1,45)	X	1,13 (0,78-1,64)	X	1,00 (0,22-4,46)	X

Table 2: Odds-ratio (Mantel-Haenszel method) count with a confidence range of 95% for the variables **sex** (female sex = 0 male sex = 1), **age** (< 85yrs =0, >85 yrs = 1), **cemented stem** (uncemented stem = 0 cemented stem = 1).

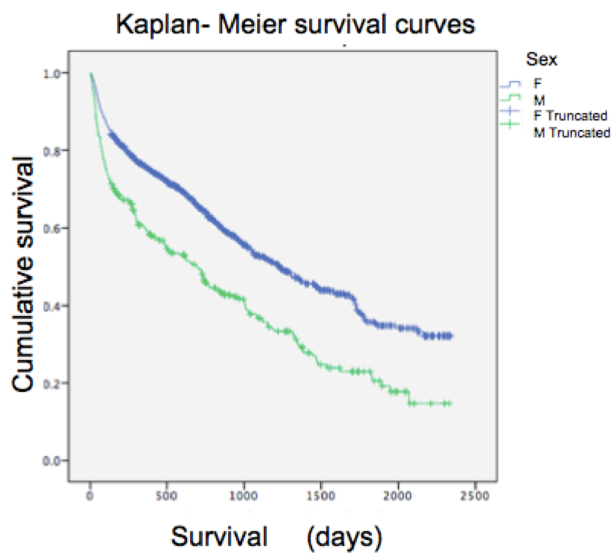
Dependent variables	Discharged at home		Discharged at istitutional care		Discharged at rehabilitation institute		ASA2		ASA3		N of medications <10		Death before discharged		Death Within 7 days		Death between 8-30 days		Death between 1 month- 1 year		Death after 1 year	
Indipendent variables	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05	MLR	P < 0.05
Sex (male)			0,90 (0,68-1,18)	X			0,62 (0,41-0,95)	✓	1,41(1,02-1,95)	✓	0,75 (0,57-0,98)	✓	2,68 (1,52-4,71)	✓	3,73 (0,97-14,26)	X	2,09 (1,13-3,86)	✓	1,35 (0,95-1,93)	X		
Age > 85 yrs	0,84 (0,65-1,08)	X			2,58 (1,72-3,86)	✓											0,11 (0.03-0,38)	✓	0,42 (0,16-1,09)	X	0,44 (0,17-1,14)	X

Table 3: Multinomial logistic regression (MLR) for the variables resulted to be significant at the odds-ratio count (Mantel-Haenszel method – see Table 2)

Dependent variable	Independent variables	Sex (male)	Age >85	Cemented stem	Discharged at home	Discharged at istitutional care	Discharged at rehabilitation institute	ASA2	ASA3	ASA4	N of medications <10	PPF
Death	Odds ratio	2,16 (1,66-2,81)	1,75 (1,40-2,17)	1,22 (0,88-1,67)	1,31 (1,04-1,66)	0,81 (0,65-1,01)	0,30 (0,20-0,45)	0,68 (0,52-0,87)	1,35 (1,09-1,68)	5,08 (1,72-14,95)	0,54 (0,43-0,67)	0,86 (0,13-2,40)
	P <0.05	✓	✓	X	✓	X	✓	✓	✓	✓	✓	X
	MLR	0,72 (1,23-2,40)	1,59 (1,26-2,00)	///	1,17 (0,92-1,51)	///	0,33 (0,24-0,55)	0,92 (0,65-1,28)	1,34 (1,01-1,78)	5,41 (1,74-16,80)	0,73 (0,54-0,98)	///
	P <0.05	✓	✓	///	X	///	✓	X	✓	✓	✓	///

Table 4: Odds-ratio (Mantel-Haenszel method) count with a confidence range of 95% for the variable **death** (not death = 0, death = 1) and multinomial logistic regression (MLR) for the variables resulted to be significant at the odds-ratio count.

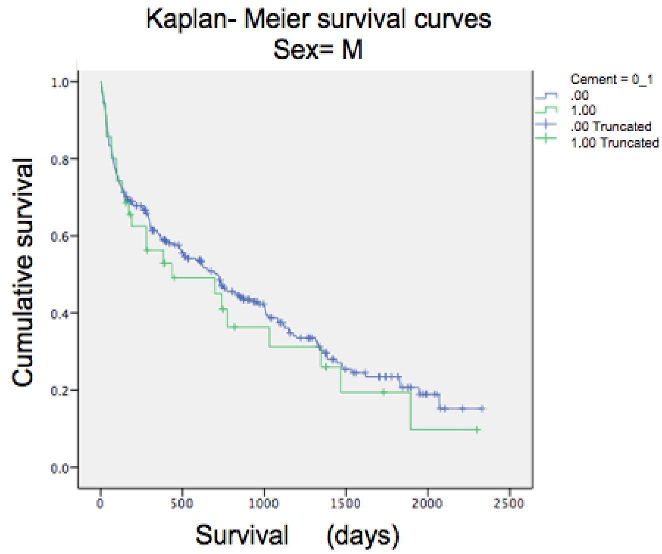
Kaplan-Meier survival curves [Figure 1] obtained for the whole population showed a significant correlation with the variable 'sex' (p-value <0.001), with female patients having a lower mortality rate. When Kaplan-Meier curves were analysed separately for male and female sex there was no significant correlation with the variables 'cemented stem' and 'age > 85 years' (p-values 0.407 and 0.523) [Figures 2-5].



	Chi-square	Df	p- value
Log Rank (Mantel-Cox)	38.915	1	P<0.001

Variable		mort.7days	mort.30days	mort.1year	mort.5years
Sex					
	Females	0,4%	3,4%	24,5%	64,6%
	Males	1,6%	8.2%	40,6%	78,2%

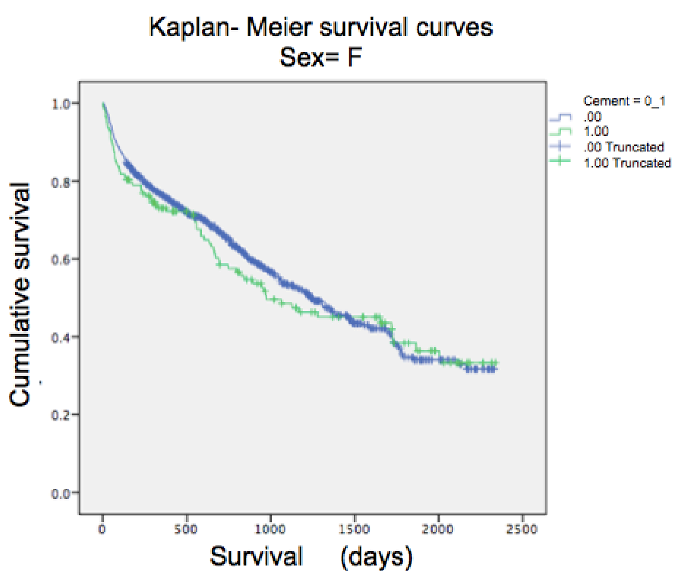
Figure 1: Kaplan meier survival curve of male and female patients populations



	Chi-square	df	p-value
Log Rank (Mantel-Cox)	0.689	1	0.407

Variable	**Cemented**	**mort.7days**	**mort.30days**	**mort.1year**	**mort.5years**
Males					
	No	1,5%	8,1%	40%	78%
	Yes	3,6%	8,6%	46,5%	90%

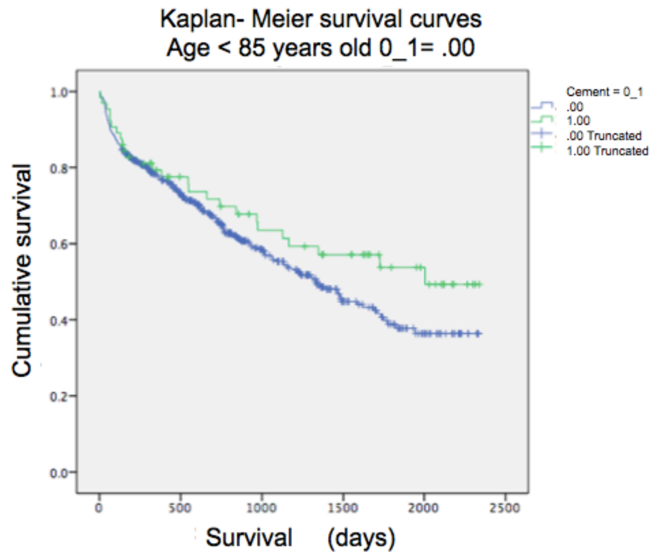
Image 2: Kaplan meier survival curve of the cemented and uncements stem populations – male sex subgroup



	Chi-square	df	p-value
Log Rank (Mantel-Cox)	0.689	1	0.407

Variable	**Cemented stem**	**mort.7days**	**mort.30days**	**mort.1year**	**mort.5years**
Female					
	No	0,3%	2,9%	24%	66%
	Yes	1,7%	6,5%	27,4%	63,5%

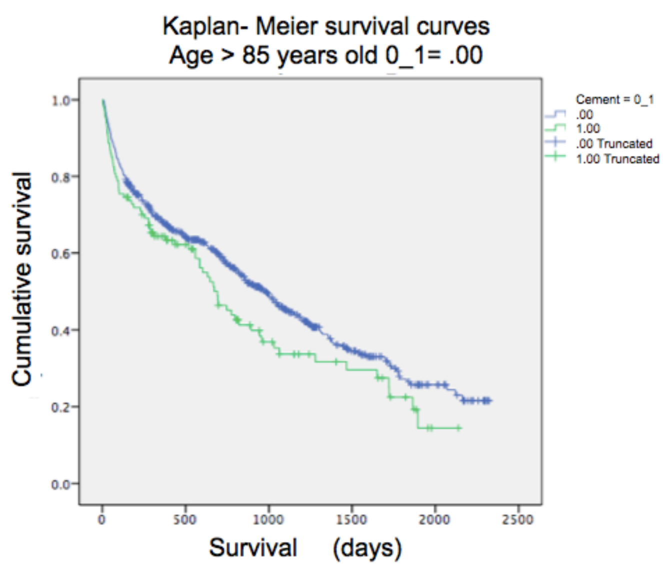
Figure 3: Kaplan meier survival curve of the cemented and uncements stem populations – female sex subgroup



	Chi-square	df	p-value
Log Rank (Mantel-Cox)	0.391	1	0.523

Variable	Cemented stem	mort.7days	mort.30days	mort.1year	mort.5years
< 85 years					
	No	1%	2,5%	22,4%	62,2%
	Yes	2%	3,9%	21,7%	47,76%

Figure 4: Kaplan meier survival curve of the cemented and uncements stem populations – age < 85 years subgroup



	Chi-square	df	p-value
Log Rank (Mantel-Cox)	0.391	1	0.523

Variable	Cemented stem	mort.7days	mort.3days	mort.1year	mort.5years
> 85 years					
	No	0,3%	5,5%	32,5%	74%
	Yes	2%	8,8%	36%	75%

Figure 5: Kaplan meier survival curve of the cemented and uncements stem populations – age > 85 years subgroup

Periprosthetic femoral fracture occurred in 1.1% (N=15) of patients, with the 100% of cases occurring around an uncemented stem [Table 5].

Patient	Age	Sex	Days after HA	Trauma	Fracture type	Surgical treatment	Implant type	Cemented
1	89	F	626	Low energy	B1	Conservative	PPF Biomet	NO
2	92	F	2063	Low energy	B2	Stem revision and cerclage wires	PPF Biomet	NO
3	91	F	1190	Low energy	B1	Conservative	PPF Biomet	NO
4	92	F	1116	Low energy	C	Plate and screw fixation	PPF Biomet	NO
5	87	F	24	Low energy	Ag	Conservative	Avenir Zimmer	NO
6	82	M	52	Low energy	B1	Cerclage wires	Hip Star	NO
7	83	F	40	Low energy	B1	Plate and screws fixation with cerclage wires	Avenir Zimmer	NO
8a	94	F	43	Low energy	B1	Plate and screws fixation and cerclage wires	Avenir Zimmer	NO
8b	94	F	1208	Low energy	B1	Cerclage wires	Avenir Zimmer	NO
9	83	M	81	Low energy	B1	Stem revision	Taperloc Biomet	NO
10	78	F	1076	Low energy	B2	Stem revision	Avenir Zimmer	NO
11	86	F	380	Low energy	B1	Conservative	Avenir Zimmer	NO
12	89	F	23	Low energy	B2	Stem revision	Avenir Zimmer	NO
13	94	M	16	Low energy	B2	Stem revision	Taperloc Biomet	NO
14	93	M	624	Low energy	B2	Cerclage wires	Taperloc Biomet	NO
15	86	F	245	Low energy	B1	Conservative	Avenir Zimmer	NO

Table 5: Data regarding demographical and clinical parameters for the PPF population

One patient sustained two PPFs, thus 16 cases of PPF were noted. All PPF cases were caused by a minor, low energy trauma.

PPF population counted 73.3% (N= 11) of females and 26.7% (N= 4) of males with a mean age of 84.6 years (range 78-94). The predominant ASA score was 3 (53.3% N= 8) and the 93.3% (N= 14) of the interventions were made under spinal anaesthesia with an average surgical time of 70.13 minutes.

Institutional care was the destination after discharge in 53.3% of cases (N=8), and the 93.3% (N= 14) had less than ten medications at the time of discharge.

All the data regarding PPF population are shown in table 1.

In 20% of cases PPF occurred within thirty days after HA, in 26% of cases between 30 days and 1 year and in the remaining 54% after 1 year.

According to the Vancouver classification, 6.6% (N=1) were Ag fractures, 53.3% (N=9) B1, 23.3% (N=4) B2, 6.6% (N=1) C [Figure 5, 6].

Mortality rate of the PPF population reached 46% at follow-up (7 patients), with death occurring between 31 days and 1 year in 2 cases and after 1 year in the remaining 5 cases.

Mantel-Haenszel odds ratio test for the variables cemented stem, age >85 years and sex did not show a significant correlation with PPF [Table 2].

Kaplan-Meier survival curve was not obtainable for the PPF subgroup because of the small sample size.

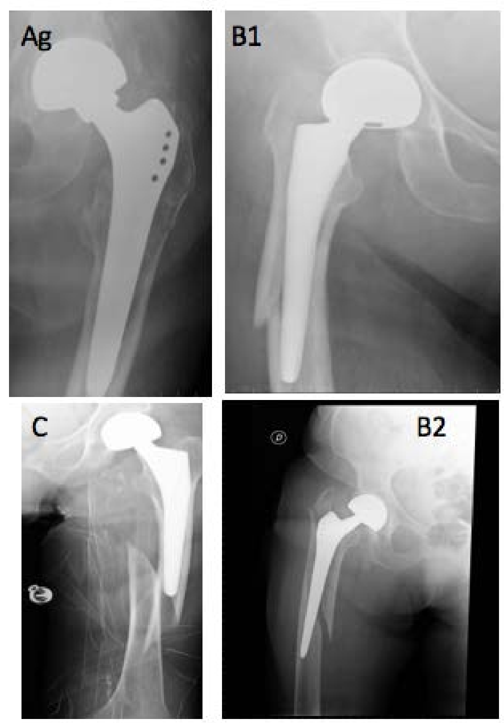


Figure 6: Radiographic images of different periprosthetic fractures occurred in the study population classified according to Vancouver classification.

Discussion

The present study population is characterized by prevalence of female sex (77%) and advanced mean age (85.02 years), with male patients being meanly younger (85.4 vs 83.7 years). These data are comparable to other literature reports, delineating the most common characteristics of FNF patients [1-6, 28]. Moreover, several comorbidities, high ASA score and elevate number of medications are often reported in these patients and recognized as risk factors for perioperative morbidity [29, 30]. Indeed, Yeoh and Colleagues [31] found an increment in 30-day mortality rate in patients with ASA score 3-4. Other authors [32-34] reported mortality after 1 year from intervention to be influenced by ASA score. The present study data seem to confirm these findings, with a higher mortality rate at 30 days for ASA 3 and 4 patients. Moreover, statistical analysis demonstrated a significant association for ASA 4 with the outcome death.

The present study results also demonstrate a higher mortality rate at different time points and significant association with the outcome death for age >85 years and male sex. The Kaplan-Meier survival curves for the variable sex reached a statistical significance, especially for the mortality rate between 8-30 days from surgery. These findings are comparable to the literature, which reports an association of increased mortality and poorer functional recovery with advanced age [1-4, 35, 36] and a higher mortality rate for male sex [37-39]. A possible explanation for these findings may reside in the worst medical conditions of male patients presenting with FNF. Indeed, male sex demonstrated a significant association with ASA 3 score and negative association with < than 10 medications at discharge in the present study.

As far as stem fixation technique is concerned, the literature generally reports better results for cemented stems in terms of clinical outcome, pain and reoperation rate [15, 21-25]. On the other hand, in the present study surgery duration was significantly longer in cemented cases, which confirms previous literature reports [32, 33]. Moreover, bone cement implant syndrome needs to be taken in account. In the present study, due to its retrospective design, no data regarding bone cement implant syndrome was disposable. Nonetheless, a slightly higher mortality rate in the perioperative period (1 vs 3% within 7 days) was found for cemented case, as other authors previously reported [16, 40]. However, mortality rate for cemented and uncemented implants seems not to differ at mid and long term [16, 39]. Indeed, the present study demonstrates a similar mortality rate in the two groups at 1 year follow up (42% and 46%) and after 1 year (45%). Finally, stem fixation technique did not demonstrate a significant association with the outcome death. In elderly patients treated with HA for FNF periprosthetic femoral fractures can be a serious complication [15-17]. This event is poorly studied in the literature, with a reported incidence which ranges from 0.4% to 4% [16, 17, 21-24]. Thus, the 1.1% incidence of PPF noted in the present study seems to align with previous literature findings. At radiographic analysis, Vancouver B1 and B2 fractures were prevalent (76.6%) in the present study, comparably with what already reported in literature [23, 24].

The low incidence of PPF in FNF patients treated with HA may be due to the low functional demand together with high mortality rate of these patients. However, as in total hip arthroplasty implants, PPF seem to occur in HA patients more often in uncemented implants [16, 17, 21-24]. In fact, all PPF cases reported in the present study population occurred in uncemented implants. However, probably due to the low number of events, the statistical analysis failed to recognize uncemented stem fixation as a risk factor for PPF. Likely, the present study did not demonstrate a significant correlation of PPF with the variable 'age >85 years'. Other authors previously failed to demonstrate a significant correlation [17, 43], although advanced age is generally considered a possible risk factor for PPF [41, 42]. On the other hand, previous studies reported a higher mortality rate in PPF patients [17, 22] which was not registered in the present study. In fact, mortality rate did not result to be statistically higher in PPF patients compared to all HA (0.46 vs 0.50), probably because of the low number of events [17, 22].

Conclusion

Elderly patients treated with HA for FNF confirm to be a population with a relevant mortality rate, which demonstrates to be significantly associated with age, male sex and ASA score. PPF represent an infrequent but potentially serious complication of HA implanted for FNF. There is a lack of evidence regarding the effect of PPF on mortality rate. However, advanced age and the use of uncemented stems seem to be risk factors for this event.

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