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The effect of osteoporotic treatment on the functional outcome, re-fracture rate, quality of life and mortality in patients with hip fractures: A prospective functional and clinical outcome study on 520 patients

Konstantinos G. Makridis [a], Theofilos Karachalios [a,*], Vasilios A. Kontogeorgakos [a], Leonidas S. Badras [b], Konstantinos N. Malizos [a]

[a] Department of Orthopaedic Surgery, School of Health Sciences, Faculty of Medicine, University of Thessalia, CERETETH, University General Hospital of Larissa, Mezourlo Region, 41110 Larissa, Greece
[b] Orhtopaedic Department, General Hospital of Volos, Polimeri 134, Volos, Greece

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ABSTRACT

Numerous high quality studies have shown the positive effects of various osteoporotic medical treatment regimens on bone mass and on the reduction of risk for new spinal, hip and non-spinal fractures in osteoporotic patients. However, the effect of osteoporotic treatment on the functional and clinical outcome of patients who have sustained hip fractures and been treated surgically has not yet been addressed.

Five hundred and twenty patients out of 611 who were admitted (2009–2011), operated on due to a hip fracture and completed their follow-up evaluations were included in this study. Data related to functional outcome scores, re-fracture rate, quality of life and mortality rate were prospectively recorded, analysed and correlated to osteoporotic medical treatment. There were 151 (25%) men and 369 (71%) women with a mean age of 80.7 years (range, 60 to 90 years). At a mean follow-up of 27.5 months (range, 24 to 36 months) a mortality rate of 23.6% at 2 years was recorded. Mean values of functional and quality of life scores were found to have progressively improved within two years after surgery. Seventy-eight (15%) patients were taking osteoporotic treatment before their hip fracture and 89 (17.1%) started afterwards. Osteoporotic treatment proved to be an important predictor of functional recovery (all p values < 0.05), re-fracture rate ($p = 0.028$) and quality of life (EQ-5D, all dimensions, p values < 0.05). Osteoporotic treatment did not affect post-fracture mortality rates.

Osteoporotic treatment taken before or initiated after fracture is a strong predictor of functional and clinical outcome in patients with hip fractures treated surgically.

Introduction

Pertrochanteric and femoral neck fractures (hip fractures) are common in the elderly and are usually associated with osteoporosis and minor trauma (falls). Such fractures should be regarded as a unique entity because several parameters other than high quality surgery such as senility, co-morbidities, metabolic disease, rehabilitation, peri-operative complications and social environment may also influence the outcome [1,2]. During treatment, failure to address these parameters can cause significant morbidity and mortality in this elderly group of patients and exponentially increase the global burden of hip fractures [2,3].

It has recently been suggested that improved treatment and multidisciplinary management of these patients are necessary in order to improve functional outcome, quality of life and mortality rates, and various therapeutic protocols have been described, aiming at comprehensive care of these patients [4–6]. Several predictors of outcome and risk factors of surgical intervention have also been evaluated in patients with hip fractures [7–11]. Amongst them, early surgery followed by prompt rehabilitation, are considered to be positive predictors [1,12], while co-morbidities and peri-operative complications such as infection,

* Corresponding author. Tel.: +0030 2410682722; fax: +0030 2410670107.
E-mail addresses: kmakrid@yahoo.gr (K.G. Makridis), kar@med.uth.gr (T. Karachalios), vaskonto@gmail.com (V.A. Kontogeorgakos), lsbadras@yahoo.gr (L.S. Badras), kmalizos@otenet.gr (K.N. Malizos).

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delirium, pressure sores, deep vein thrombosis and hardware failure are considered negative ones [1]. Numerous high quality studies have addressed issues such as epidemiology and reduction of incidence of new fractures, after medical treatment, in patients with osteoporosis [1]. Despite the fact that these fractures are closely associated with osteoporosis, the role of medical treatment for osteoporosis (taken before or started after hip fracture) as a predictor of clinical and functional outcome is not clearly understood [1].

In this study we evaluate the impact of the medical treatment of osteoporosis on postoperative functional outcome, quality of life, complications, re-fracture rate and mortality in 520 patients treated for hip fractures for whom prospectively recorded and analysed relative data were available.

Patients and methods

Six hundred and eleven consecutive patients who had sustained a hip fracture and were admitted to the hospitals of a country region between 2009 and 2011 were considered eligible for participation in this study (Fig. 1). Inclusion criteria were patients with low energy pertrochanteric and femoral neck fractures, aged 60 to 90 years, and the ability to respond to questionnaires (patients with mild to moderate dementia only were included in the study) and attend follow-up clinics. Exclusion criteria were patients with subtrochanteric hip fractures, high energy hip fractures, pathological hip fractures, patients aged <60 and >90 years, and patients having severe systemic disease (mainly cardiac, respiratory and neurologic)

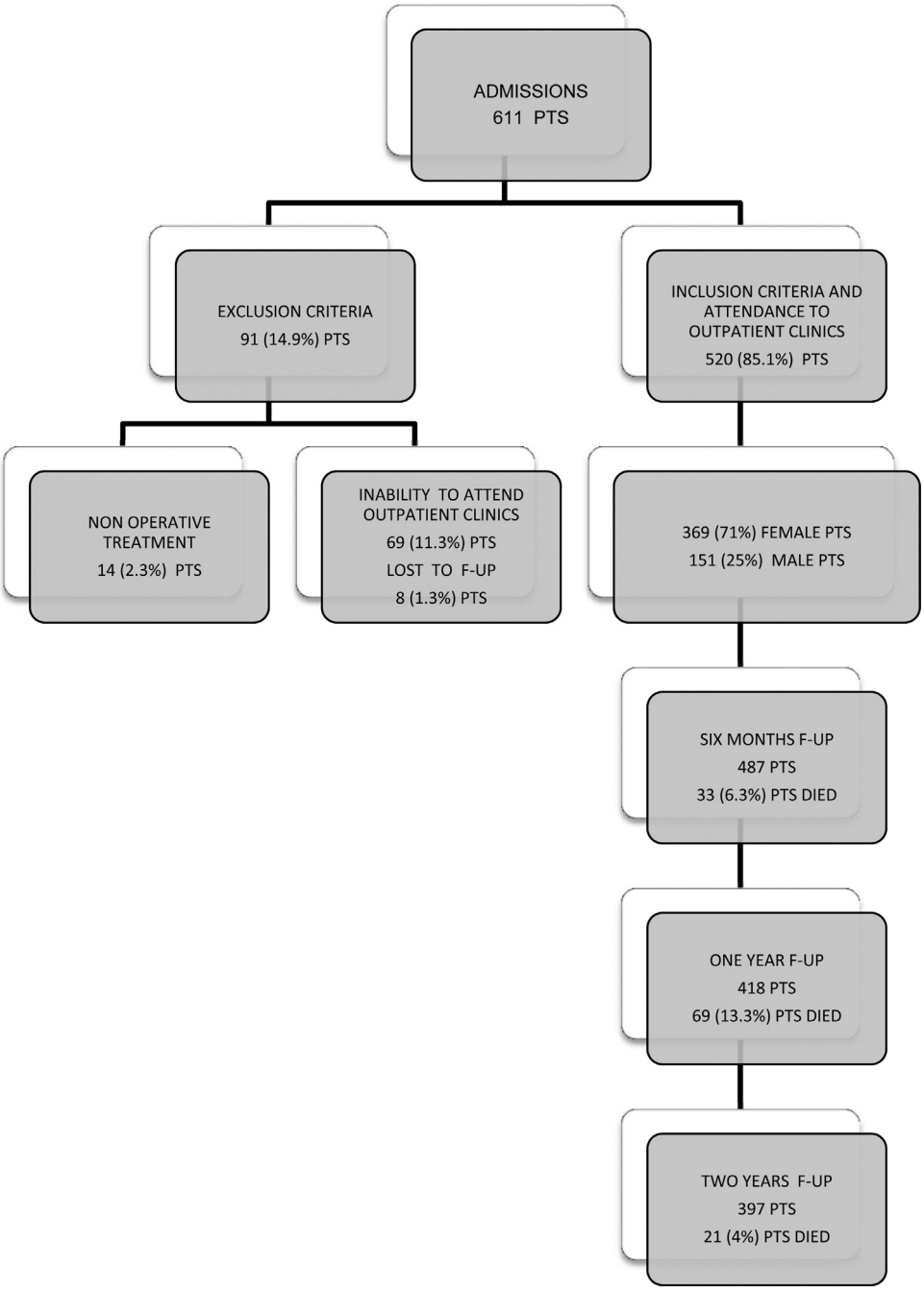

Fig. 1. Study flow chart.

affecting functional recovery. Patients who had undergone non operative treatment were also excluded from the study (Fig. 1). Ethical committee approval was taken according to institutional regulation (3389/10-1-2009, DSc/fm.uth20/7/2011) and all patients signed a consent form in order to participate in the study.

Prospective data was recorded for all patients as follows: patient demographics, mental status, history of preceding fall and fracture, medication and co-morbidities were documented. Fracture type, surgery related parameters, living conditions, rehabilitation and complications were also recorded. Previous history of diagnosis and treatment of osteoporosis (at least six months prior to hip fracture), bone mass studies, osteoporotic treatment initiated following hip fracture, and a family history of osteoporosis, treatment and fractures in parents were also recorded.

Postoperative functional recovery was assessed using three different groups of scales. The overall walking scores included the Parker mobility score [13], walking speed test [14], and time up and go test [15]. Hip functional scores included the LEFS (lower extremity function score) [16], and HOOS (hip dysfunction and osteoarthritis outcome score) [17]. Hip joint reconstruction scores included the objective Harris hip score [18] and the subjective Oxford-12 and WOMAC scores [19]. The SF-12 [20] and EuroQol-5D [21] questionnaires were used to evaluate quality of life after surgery, while the clinical dementia rating was used to evaluate mental status and dementia level [22]. The Charlson comorbidity index (age-adjusted) was used as a co-morbidity assessment tool and predictor of clinical outcome [23]. When possible preoperative values of all the above scales were taken, and postoperative recordings were taken at six months, one year and two years. For those patients unable to attend outpatient clinics, home or nursing home visits and evaluations were arranged by one (KGM) of the study team. Any postoperative (either medical or surgical) complications, hip re-fracture rate and mortality rate at 6 months, 12 months and two years were also recorded.

Statistical analysis

Quantitative data were recorded and statistically analysed using the Student *t*-test for unpaired and paired samples. Qualitative data were analysed using the Pearson chi-square and Fisher's exact tests. Non-parametric parameters were analysed using the Mann–Whitney–Wilcoxon test. A logistic regression analysis model was used in order to evaluate the influence of possible risk factors and predictors of outcome. Significance levels were set at $p < 0.05$ with confidence intervals at 95%. All tests were calculated using the SPSS Inc. Data Access Pack for Windows, version 17.0.1.

Results

Of the 611 patients admitted, 520 (85.1%) met the inclusion criteria and were able to attend follow up outpatient clinics (Fig. 1). There were 369 females (71%) and 151 males (29%) patients, with a mean age of 80.7 years (range 60 to 90 years) and a mean BMI of 25.5 (range 19.5 to 33.5). The mean observation period was 27.5 months (range 20 to 36). Another eight (1.3%) patients were initially included, but later removed from the study due to inadequate data. All patients were available for time interval evaluations and for those who died: 0–6 months: 33 (6.3%), 6–12 months: 69 (13.3%) and 1–2 yrs: 21 (4%) the last follow up recordings were used for analysis (Fig. 1). The mean time delay to surgery was 3 days (range 0 to 16 days) mainly due to the widespread use of modern anti-platelet medication and the mean duration of hospitalisation was 7.05 days (range 5 to 30 days). The hip joint involved, type of fracture, type of surgery and mental status are all shown in Table 1. While many patients had had a previous screening for osteoporosis (DEXA studies), only 167 (32.1%) patients had started (at least six months prior to hip fracture) or started osteoporotic treatment after fracture treatment (Table 1). Ninety-two patients experienced both medical and surgical complications with an overall complication rate of 17.7%. The overall mortality rate at 2 years was 23.6%.

Mean values of walking, hip functional, hip reconstruction and quality of life scores were progressively improved within two years after surgery. However, patients did not fully reach their preoperative functional status (Table 2).

Osteoporosis treatment statistically significantly (s.s.) improved several hip functional scores (Table 3), decreased hip re-fracture rate ($p = 0.028$) (Table 3) and improved all quality of life parameters (Table 4). The overall and mortality rates at different time intervals were not affected by osteoporotic treatment (Table 3). The subgroup of patients who had started osteoporotic treatment before hip fracture showed a trend (though not statistically significant) towards stronger statistical correlations related to postoperative functional recovery and lower hip re-fracture rates (Table 3). There was no relationship between length of medical treatment intake and outcome. When patients of the osteoporosis treatment group were compared to those of the non-treatment group no differences were shown in terms of demographics, mental status, living conditions or rehabilitation. Statistical analysis was repeated separately for patients who sustained femoral neck and for those who sustained pertrochanteric fractures (Table 1). No differences were found concerning functional and clinical outcome, re-fracture rate and mortality rate. Surgery related parameters, type of fracture, mental status,

Table 1
Descriptive study data.

Parameter	Number of patients (percentage)
Right hip	283 (54.4%)
Left hip	237 (45.6%)
Femoral neck fractures	196 (37.7%)
Unipolar prosthesis	122 (62.2%)
Bipolar prosthesis	74 (37.8%)
Cemented	93 (47.5%)
Cementless	103 (52.5%)
Intertrochanteric fractures	324 (62.3%
Intramedullary nail	190 (58.6%)
Sliding screw-plate	134 (41.4%)
Dementia	91 (17.5%)
Living conditions	
Family	403 (77.5%)
Nursing home—alone	117 (22.5%)
Rehabilitation	
Yes	184 (35.4%)
No	336 (64.6%)
History of falls	89 (17%)
Previous osteoporotic fracture	68 (13%)
Previous bone mass recording	303 (58.3%)
Osteoporotic treatment	167 (32.1%)
Started before fracture	78 (15%)
Biphosphonates	46
SERMs	5
1–34 PTH	7
Calcitonin	11
Strodiumranelate	9
Started after fracture	89 (17.1%)
Biphosphonates	59
SERMs	3
1–34 PTH	4
Denosumab	8
Strodiumranelate	7
Calcitonin	8

Table 2
Mean values of walking, hip functional, hip reconstruction and quality of life scores at different time intervals.

Parameter	Preop	6 m Post-op	1 Year post-op	2 Years post-op
Overall walking scores (mean)				
Parker Mobility score	7.26	8	6.61	6.79
Walking Speed test	–	0.25	0.33	0.38
TUG test	–	22.46	16.29	15.14
Hip functional scores (mean)				
LEFS	56	34	46.5	47.5
HOOS-symptoms	100	80	80	85
HOOS-pain	100	72.5	82.5	85
HOOS-daily life activities	77.95	64.7	85.3	85.3
HOOS-recreational activities	56.25	25	25	25
HOOS-quality of life	100	43.75	75	80
Hip reconstruction scores (mean)				
Harris Hip score	–	81	92.5	94
Oxford-12	44	34.5	43	43
WOMAC	17	39	22	20
Quality of life scores (mean)				
SF-12 physical component	54.8	35.4	45.3	47.6
SF-12 mental component	58.1	57.2	56.4	57.5

rehabilitation and living conditions were shown (logistic regression analysis model) not to be independent predictors of functional recovery, re-fracture rate, quality of life and mortality rate.

Discussion

Hip fractures in the elderly are associated with significant morbidity and mortality and Health Care providers are concerned at the consequences for both the individual and the community. Surgical treatment remains the gold standard and the goal is stable fixation after reduction or replacement in order to allow immediate mobilisation [10]. For several decades orthopaedic surgeons focused on the quality of surgery and early mobilisation of hip fracture patients without taking into account their total care and management requirements. Even following satisfactory surgery, many patients still experience long-term disability or death with the total one-year mortality rate ranging from 14 to 36% [1,24]. Recently, it has been suggested that post-fracture management is at least equally important and that several factors other than surgery also influence outcome [1]. General guidelines have appeared regarding optimal treatment [25,26] and recent algorithms have been proposed that could reduce the need for reoperation in routine clinical practice [27]. However, complex challenges still exist concerning hip fracture epidemiology, prevention, postoperative management, quality of life and predictors of clinical and functional outcome.

In this study we analysed prospectively collected data in an attempt to determine whether osteoporotic treatment is a predictor of functional recovery, re-fracture rate, quality of life and mortality rate in patients with hip fractures. It is suggested that osteoporotic treatment is an important predictor of functional recovery, re-fracture rate and quality of life in this group of the population.

Osteoporotic medication reduces fracture risk, possibly increases muscle strength and coordination, and may also improve fracture healing—such effects may help to explain the findings of this study [1,28–30]. An in-depth search of the literature shows that the positive effect of various osteoporotic treatment modalities on bone mass and on reduction of fracture risk (vertebral, hip and non-vertebral fractures) is well proven [31–36]. It has also been suggested that osteoporotic medical treatment may improve the architecture and integrity of the bone-implant interface of both cortical and cancelous bone, leading to a reduction of implant related failures [1,31–33]. However, only two studies have shown that zolandronic acid and calcitonin administration, respectively, can alter the outcome following surgery for pertrochanteric fractures by reducing re-fracture rate [30,37]. Surprisingly, only 32.1% of our patients had had or had started treatment after surgery. No differences between patients taking and not taking treatment were found regarding demographics, mental status, living conditions and rehabilitation. Thus, we were not able to identify a specific patient profile which would lead to better compliance with medical treatment and a better outcome. It seems that a large number of patients, despite our efforts for optimal treatment, are still missing out on the chance of starting such treatment. This is due, in our opinion, to a health system failure when it comes to multidisciplinary treatment management. When the two subgroups of patients under osteoporotic medication were analysed separately, patients who had started treatment before hip fracture showed a trend towards an improvement in functional recovery and lower re-fracture rate. Based on our findings, patients admitted to our departments with a hip fracture are now thoroughly investigated for metabolic bone diseases and start treatment with a high affinity bisphosphonate (zolendronic acid),

Table 3
Osteoporosis treatment as a predictor of outcome (mean and *p* values, statistically significant differences are in bold).

	Osteoporosis treatment (in total)	Osteoporosis treatment (before fracture)	Osteoporosis treatment (started after fracture)
Parker mobility score	**8.8 vs 5, p = 0.013**	**8.83 vs 5, p = 0.0001**	**8.3 vs 5, p = 0.0001**
Walking speed test	**0.64 vs 0.29, p = 0.007**	**0.69 vs 0.29, p = 0.002**	**0.57 vs 0.29, p = 0.042**
Time up and go test	**6.36 vs 19, p = 0.005**	**6.63 vs 19, p = 0.005**	**6.26 vs 19, p = 0.004**
LEFS	**59.33 vs 29.25, p = 0.0001**	**62.1 vs 29.25, p = 0.0001**	**58.5 vs 29.25, p = 0.0001**
HOOS-symptoms	85.6 vs 75, $p = 0.103$	86.16 vs 75, $p = 0.05$	82.5 vs 75, $p = 0.052$
HOOS-pain	**84.16 vs 57.5, p = 0.001**	**85.4 vs 57.5, p = 0.001**	**81.6 vs 57.5, p = 0.001**
HOOS-daily life activities	**85.2 vs 55.9, p = 0.001**	**86.7 vs 55.9, p = 0.001**	**83.5 vs 55.9, p = 0.001**
HOOS-recreational activities	**20.55 vs 9.37, p = 0.007**	**19.8 vs 9.37, p = 0.048**	**21.6 vs 9.37, p = 0.013**
HOOS-quality of life	**70.33 vs 49.5, p = 0.007**	**68.33 vs 49.5, p = 0.044**	**71.83 vs 49.5, p = 0.03**
Harris hip score	**97.6 vs 81.25, p = 0.046**	**98.1 vs 81.25, p = 0.001**	**96.5 vs 81.25, p = 0.001**
Oxford-12	**46.6 vs 35.6, p = 0.0001**	**47.3 vs 35.6, p = 0.0001**	**44.3 vs 35.6, p = 0.008**
WOMAC	**14.66 vs 39.2, p = 0.0006**	**14.3 vs 39.2, p = 0.0001**	**15.16 vs 39.2, p = 0.0001**
SF-12 physical component	**55.9 vs 22.8, p = 0.001**	**56.6 vs 22.8, p = 0.001**	**54.9 vs 22.8, p = 0.001**
SF-12 mental component	57.83 vs 47.9, $p = 0.055$	56.4 vs 47.9, $p = 0.092$	57.87 vs 47.9, $p = 0.055$
Charlson comorbidity index (age-adjusted)	3.88 vs 3.77, $p = 0.925$	4.11 vs 3.77, $p = 0.759$	3.66 vs 3.77, $p = 0.917$
Re-fracture rate	**4.2% vs 13%, p = 0.002**	**3.84% vs 13%, p = 0.018**	**4.49% vs 13%, p = 0.024**
Mortality rate	18.5% vs 26%, $p = 0.061$	17.9% vs 26%, $p = 0.148$	19.1% vs 26%, $p = 0.215$

Table 4
Correlation of osteoporosis treatment and quality of life elements (statistically significant mean and *p* values are in bold).

EQ-5D Dimension	Osteoporotic medication	No Osteoporotic medication	Total	*p*
Mobility	Patients	Patients	Patients	
No problems	129	229	358	**0.004**
Problems	38	124	162	
Self-care				
No problems	118	217	335	**0.041**
Problems	49	136	185	
Usual activity				
No problems	131	239	370	**0.021**
Problems	36	114	150	
Pain/discomfort				
No problems	108	191	299	**0.023**
Problems	59	162	221	
Anxiety/depression				
No problems	117	216	333	**0.049**
Problems	50	137	187	

as well as calcium and vitamin D supplementation before discharge. We consider that the investigation and subsequent treatment of osteoporosis is cost effective compared to the treatment of new hip fractures (with the inevitable complications) in such patients. A once-a-year bisphosphonate dose regimen also facilitates patient compliance which is usually low in this type of fracture population. Further investigation is needed to help us understand more clearly the role of osteoporosis treatment, the concept of medical intervention beginning at admission, with diagnosis, early recognition of high risk patients and initiation of a treatment protocol which could prove critical for the postoperative management of these patients.

A further subgroup analysis taking into consideration surgery related factors, fracture type (either neck or trochanteric fractures), mental status and dementia, living conditions and rehabilitation, failed to show that any of the above factors act as predictors of outcome. Despite the fact that neck and trochanteric fractures present with a rather different epidemiology and require different surgical management, they show similar outcome in terms of function, re-fracture rate, quality of life and mortality rates. Co-morbidities are common in elderly hip fracture patients including cardiovascular and pulmonary disease, malnutrition and dementia [1]. They synergistically affect the postoperative functional ability of patients and can significantly increase the risk of death [38,39,11,40–43]. Dementia has been reported as an important predictor of poor prognosis regarding walking ability and a return to independent activities of daily life [44]. Another study has supported the claim that pre-fracture motor level rather than cognitive status is the most critical factor for motor gain after surgery [45], while in a recent paper it is suggested that cognitive impairment does not significantly affect functional recovery if patients are referred to rehabilitation postoperatively [46]. In the present study, the clinical dementia rating was used to assess the cognitive ability of patients, including parameters such as memory, orientation and judgment. Although functional scores and quality of life parameters were obviously better in patients without dementia, there was no statistically significant difference as compared to those patients with impairment of their cognitive status. Despite this, dementia should be carefully evaluated preoperatively and specific care should be taken in order to improve functional ability after surgery.

Delayed surgery of more than 48 h has been associated with increased morbidity, mortality and functional disability [47,48], with a recent meta-analysis showing that delayed surgery increased the risk of pressure sores and death [49]. Unfortunately, early surgery is not always feasible due to medical instability in older patients and the need to undertake a meticulous clinical and laboratory investigation prior to surgery.

Rehabilitation after hip fracture surgery should start as soon as possible with progression to ambulation as tolerated, helping patients to achieve their independence. A randomised controlled trial showed that multidisciplinary postoperative intervention programs enhance functional performance and mobility [8]; however, there is no conclusive evidence of their effectiveness. Moreover, it is not always feasible for all patients to receive increased rehabilitation care due to socioeconomic factors. On the other hand, support provided by family or an institutional care unit cannot always greatly improve the functional outcome of patients. Indeed, analysis in the present study showed no significant improvement in patients living within a familial environment or receiving a scheduled rehabilitation program, although functional scores and quality of life parameters were better than those of patients living alone or in an institutional nursing home or not following a specific rehabilitation plan. Further studies may be needed, with longer follow-up to examine the exact role of rehabilitation and postoperative living conditions on outcome in hip fracture patients.

Consistent with other studies [50,51], a high mortality rate was observed in our patients. Despite our efforts at improving the postoperative care of our patients, there was a mortality rate at the level of 23.6% at two years, which seemed not to be influenced by osteoporotic treatment, in contrast with a previous report [30].

The limitations of this study are a relatively short follow-up and the lack of a non-operative control group. However, a variety of hip joint function and quality of life evaluation scales were used and other possible predictors of outcome found in the literature were assessed. Despite the relatively small number of patients, the low patient drop-out rate of this study improves its strength.

In conclusion, osteoporotic treatment proved to be a critical factor that can positively affect functional recovery, re-fracture rate, quality of life, and hardware-related complications. In an orthopaedic ward, early diagnosis and treatment for osteoporosis after hip fracture surgery gives patients a better chance of a favourable clinical outcome.

Conflict of interest statement

There is no conflict of interest with the performance of this study.

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