

Physical Performance Drops after Hip Fracture Surgery: HIPA Study

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Abstract

Disability is one of the least desirable consequences of current population aging. Although the health condition is one of the determinants of disability, the relationship is not linear and the nature of disability cannot be predicted solely from the clinical diagnosis. Therefore, it is necessary to deeply study population with adverse outcomes, as hip fracture is, in order to acquire predictive capacity of frailty that allows delaying disability appearance.

Objectives: Creating and characterizing a cohort of hip fracture patients.

Design: Descriptive study of cohort consisting of 61 individuals study before and after hip fracture surgery.

Setting: People older than 70 years, with Bartle Index higher than 80 and hospitalized with hip fracture and not frail.

Measurements: Functional ability, instrumental activities of daily living, frailty, physical performance and social variables were measured.

Results: Our results showed that, even from independent status, hip fracture is a very important reason for functional impairment in elderly patients. Nearly two thirds of the hip fracture patients developed functional impairment in three months.

Conclusions: Age is essential in recovery, being older-old patients the most affected by disability after hip fracture surgery.

Keywords: Aging; Hip fracture; Disability; frailty

getting more importance in frailty concept [6]. To deepen in frailty concept would allow detecting frail patients that now are not being considered as such, which makes impossible disability detection.

In this regard, several studies have been published showing the utility of the frailty concept in improving the prognostic and predicting the risk in surgical patients [7,8]. Numerous surgical interventions are performed at the end of the life. Among them, hip fracture is one of the most habitual. Different authors have described that the previous functionality status of the patient is a good predictor of disability after clinical fracture [9–11]. However, disability development after surgery observed in elderly with a previous satisfactory status is a reality that has received little research attention. Moreover, taking into account the importance of life style factors in the development of frailty, different populations with diverse background and life-styles should be tested in order to know what stable factors can trigger frailty in these patients

In answer to this necessity, this article displays the HIPA study (Hip fracture in Principality of Asturias) of very elderly patients, with hip fracture. The aim of our study was to characterize a cohort, evaluating tentative factors implied in disability appearance in these independent patients after hip fracture surgery.

Methods

Subjects and Study Setting

Independent patients admitted for acute hip fracture in Orthogeriatrics unit of Hospital Monte Naranco in Oviedo were included in this study. This acute care hospital is associated with the Hospital Universitario Central de Asturias (HUCA) which belongs to sanitary Area IV of Health Asturias System, where more than 300,000 people surveyed are included [12].

Inclusions criteria incorporated the following: elderly patients of 70 years and older with hip fracture (extra- or intra-capsular fractures) that could support the fractured limb during the admission (unstable fractures were excluded); patients that did not suffer clinical complications during hospital admission to carry out precise rehabilitation (cardiorespiratory arrest and upper digestive haemorrhage complications were excluded); and Barthel Index \geq 80.

Exclusion criteria included: high comorbidity (Charlson index $>$ 2), cognitive impairment, meet the fragility criteria (Frail questionnaire \geq 3), obesity (body mass index (BMI) $>$ 30), oncological hip fractures and terminal illness.

This study includes patients older than 70 years who agreed to participate. Of the 100 patients initially included in the study, only 61 completed it. Figure 1 shows the study flowchart.

Study Design

Patients were entered into the orthogeriatrics unit and were evaluated by a geriatrician. A comprehensive geriatric assessment was performed at the income and patients were assessed

Abbreviations: BMI: Body Mass Index; HIPA: Hip Fracture in Principality of Asturias; OR: Odds Ratio; SPPB: Short Physical Performance Battery.

Introduction

Demographic predictions for 21st century build a new scenario characterized by clear mortality decline, leading to increased life expectancy that carries aged population [1]. Moreover, this life span increase does not necessarily imply that the health of those alive at a given age has also improved [2]. Therefore, disability delay or morbidity compression, defined by Fries, et al. in the 1980s [3] is reaching essential importance. Frailty concept was described by Fried and colleagues as the presence in older adults of three or more of the following criteria: unintentional weight loss, exhaustion, low level of physical activity, slow walking and weakness [4]. This description has had a key role in discovering the risk of loss function [5] and in understanding that this biologic syndrome of vulnerability to adverse outcomes is the result of multiple physiological systems deterioration and loss of homeostatic capability [5]. Thanks to frailty description, the prevention of functional impairment and disability is now the main goal of health care.

During the last few years, there has been a progressive need to expand the concept of frailty from epidemiology to clinical practice. A more biological profile and early detection of subclinical changes or deficits at the molecular, cellular, and or physiologic level are

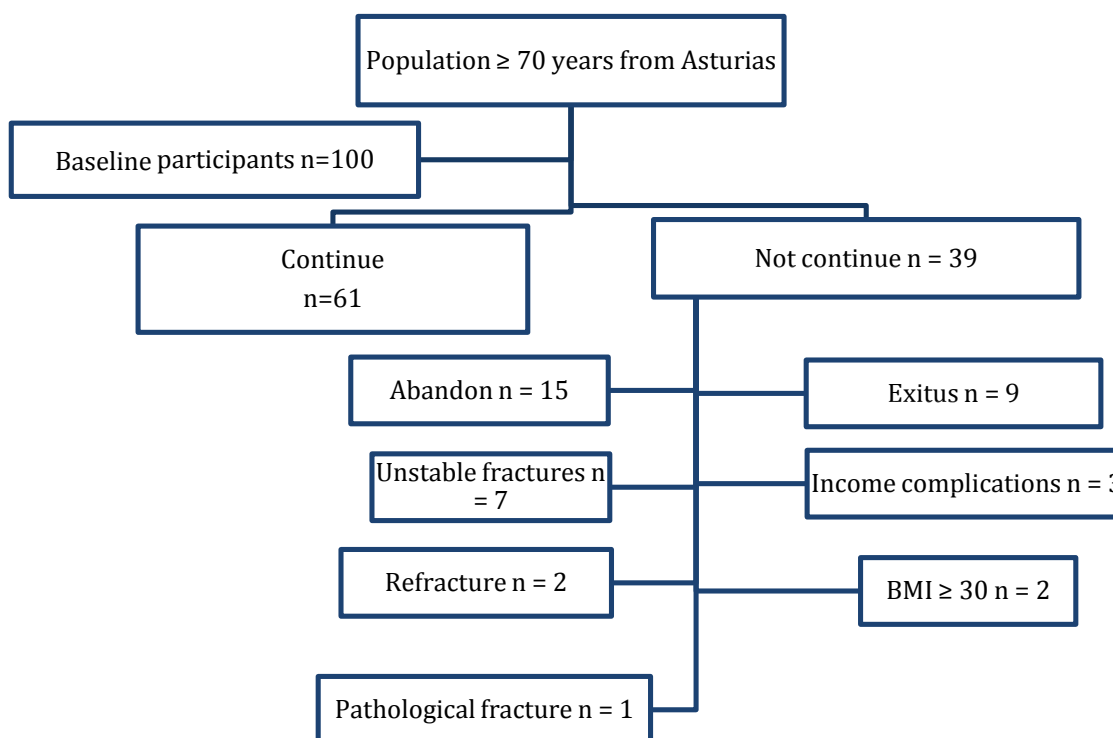


Figure 1: Flowchart indicating patients older than 70 years who participated in the study.

three months after the medical discharge, including a physical performance test that was repeated for the same geriatrician.

Result variables

During the geriatric assessment the functional impairment, the physical performance and the stage of fragility were measured.

The functional ability of the patients were assessed using the Barthel Index, which is a 10-item scale with this basic activities of daily living: feeding, grooming, bathing, toilet use, dressing, walking, transfers, climbing stairs, and continence [13]. The highest score is 100 (independence), and the lowest score is 0 (total dependence). The functional impairment was defined as presenting lower scores on the Barthel Index at hospitalization compared to the three months values.

The instrumental activities of daily living were assessed using the Lawton Index, which is composed of 8-items and assess a person's ability to perform daily task such as using a telephone or handling finances [14]. This parameter was evaluated taking into account the sex of the patient, and the housekeeping items were excluded from the male group for sociocultural reasons, punctuating a maximum of five points.

Frail questionnaire, one of the most validated and used to diagnose fragility [15,16], was used to determine the stage of fragility of the patients at the hospitalization and after three months. This test assesses fatigue, resistance, ambulation, comorbidity and weight loss. Fragile patients have to meet three or more of these criteria, pre-fragile patients meet one or two and non-fragile patients do not meet any of them.

Physical performance was assessed by short physical performance battery (SPPB), which it is usually used to diagnose fragility, but really determines the functional limitation. The SPPB consists of three tests that evaluate a hierarchical test of balance,

a short walk and the ability to standing up from a chair five times consecutively. The total score range from 0–12, where higher score (SPPB > 6) indicates better physical function [17].

Other variables were recorder in this study, as age, sex, marital status, educational level, social value, abbreviated Charlson index, BMI, abdominal circumference, pelvic perimeter, type of surgery (osteosynthesis or arthroplasty), polypharmacy (or take five or more drugs) [18], surgical delay from hospital admission, rehabilitation delay from the surgery, and hospital stay during which patients received rehabilitation. Metabolic syndrome was also defined taking into account the abdominal circumference, blood pressure, triglycerides, HDL cholesterol and blood glucose levels [19].

Ethical Aspects

Our investigation complies the standards of the Helsinki declaration concerning investigation with human subjects. All participants received information about the purposes and objectives of the study and signed an informed consent agreement. The local ethics committee approved the study.

Statistical Analysis

Symmetric continuous variables are expressed as mean values \pm standard deviation and mean comparison were analysed using a Welch robust test of independent samples to compare means between groups.

Asymmetric continuous variables were described by their media values (minimum, maximum) and the comparison between groups was performed using Mann-Whitney or Kruskal-Wallis non-parametric tests in the case of two and more than two groups, respectively.

Categorical variables were described by absolute and relative frequencies and compared by the exact Chi-2 test.

To determine which factors influence the SPPB (more or less than six) an analysis of univariate logistic regression was performed. The factors with an odds ratio (OR) less than 0.2 were included in a multivariate logistic regression model with an inclusion criterion stepwise based on the likelihood ratio. The level of significance was set at $p < 0.050$.

Results

This is a descriptive prospective observational cohort study, where start and end variables as functional impairment reflection were measured.

Table 1 showed the characteristics of the sample population at baseline and three months after the medical discharge. Of the 100 patients initially included in the study, 39 did not complete the study for several reasons (Figure 1).

The mean age of the patients was 82.56 and 85.2% of the patients were women. Although the Barthel index, as an indicator of the initial functional status, was 97.13 of average at baseline, indicating an independent cohort without cognitive impairments, 63.9% of the patients worse their functional status three months

Characteristics	n = 61
Age (years)	82.56 ± 6.25 Median 84 years
Females	85.2% (52)
Males	14.8% (9)
Barthel Index (baseline)	97.13 (5.20)
Barthel Index (3 months)	83.44 (17.60)
Lawton Index (baseline)	
Females	7.02 (1.71)
Males	4.55 (1.61)
Lawton Index (3 months)	
Females	5.21 (2.51)
Males	4.44 (2.07)
Charslon Index	0.59 (0.72)
BMI	25.03 (3.78)
Abdominal circumference (cm)	96.18 (10.32)
Pelvic perimeter (cm)	105.57 (9.51)
Surgical delay (days)	5.07 ± 2.14
Delay rehabilitation (days)	2.50 ± 1.61
Hospital stay (days)	14.51 ± 3.02
Polypharmacy	44.26% (27)
Hypertension	63.9% (39)
Diabetes mellitus	21.3% (13)
Dyslipidemia	29.5% (18)
Metabolic syndrome	55.73% (34)
Type of surgery	
Osteosynthesis	60.65% (37)
Arthroplasty	39.35% (24)
Frail Index (baseline)	
Robust	57.40% (35)
Pre-frail	42.60% (26)
Frail	0.00% (0)
Frail Index (3 months)	
Robust	19.7% (12)
Pre-frail	45.9% (28)
Frail	34.4% (21)
SPPB	
Females	5.21 ± 2.48
Males	7.11 ± 3.06

Table 1: Characteristics of the sample population. Data are expressed as the mean ± standard deviation for continuous variables and as frequencies (percentages) for categorical variables. BMI: Body mass index, SPPB: short physical performance battery.

after the hip fracture, reflected in a decrease of 13 points (Table 1). Furthermore, the Lawton index scores decreased two points in the 65.4% of women three months after the hip fracture (Table 1).

Frail questionnaire showed that 57.4% of the patients were robust, 42.6% was pre-frail and none was fragile at baseline (Table 1). However, nearly two thirds of patients changed their stage of frailty three months after hip fracture. Most new frail patients at three months (85.81%) came from the group defined as pre-frail at the admission ($p < 0.001$); 57.14% who were robust at the admission became pre-fragile after three months; only 30.8% of pre-frail patients did not worsen, and none improved their frail condition after the operation (Table 1).

Regarding to the disability development or loss of physical performance, a mean score of 5.49 (2.63) points, and therefore, a moderate limitation, was observed at three months (Table 1). Men scored 7.11 (3.06) on average, and women scored 5.21 (2.476) points. The SPPB values were dichotomized including ≤ 6 points scored (moderate or severe limitation) and > 6 (minimal or mild limitation) [17]. It is noteworthy that more than two thirds of patients had scored ≤ 6 points.

Increasingly evidences indicate that older people has distinguishing characteristics to the rest of elderly. Patients older than 84 were more likely to get lower scores in the SPPB ($p < 0.050$). Patients with functional impairment reflected in a decrease in Barthel and Lawton indexes, and those who changed fragile state according to the FRAIL questionnaire also scored significantly lower score in the SPPB ($p < 0.010$) (Table 2). The other studied variables did not influence significantly in the physical activity.

Likewise, patients older than 84 as well as patients with functional impairment (those that scored lower Barthel and Lawton index than in the first record) were more likely to worsen their fragility state three months after the fracture ($p < 0.050$) (Table 3). The other studied variables did not influence significantly in the change in the functional state.

Functional impairment was more likely in patients over 84 years compared to younger subjects ($p < 0.050$), in patients with polypharmacy and in patients who worsened their frailty situation compared to those who had not ($p < 0.050$) (Table 4). The other studied variables did not influence significantly in the functional state.

Multivariate analysis revealed that patients of the same group of age who had lower score on the Lawton index were fifty times more likely to get a SPPB < 6 (OR = 48.916; IC = 7.71 - 310.53; $p < 0.001$). In addition, patients older than 80 were more likely to get a SPPB < 6 (OR = 7.286; IC = 2.17 - 24.41; $p < 0.010$).

Patients who changed their category according to the FRAIL questionnaire have eight times more risk of getting a SPPB ≤ 6, even with the same Lawton index than those who do not change their FRAIL category (OR = 8.153; IC = 1.308 - 50.806; $p < 0.050$).

Discussion

Population aging is a global phenomenon, although the timing and dynamics of aging differ substantially across countries, what makes necessary research these variations by population cohorts. These cohorts allow comparative research for the distinction between effects that are universal and those subject to cultural variation. Our described cohort, HIPA, was designed with the intention to deepen in the role of the previous functionality status, when this was clearly healthy. Our results showed that, independently of this former status, hip fracture proceeded being

Short Physical Performance Battery			
	≤ 6 (42)	> 6 (19)	p - value
Age (years)			
≤ 84 (39)	59.0% (23)	41.0% (16)	0.027
> 84 (22)	86.4% (19)	13.6% (3)	
Sex			
Females (52)	73.1% (38)	26.9% (14)	0.087
Males (9)	44.4% (4)	55.6% (5)	
BMI			
< 20 (6)	66.7% (4)	33.3% (2)	0.410
20-25 (25)	60.0% (15)	40.0% (10)	
25-30 (30)	76.7% (23)	23.3% (7)	
Type of surgery			
Osteosynthesis (37)	75.7% (28)	24.3% (9)	0.153
Arthroplasty (24)	58.3% (14)	41.7% (10)	
Polypharmacy			
Yes (27)	77.8% (21)	22.2% (6)	0.180
No (34)	61.8% (21)	38.2% (13)	
Hypertension			
Yes	64.1% (25)	35.9% (14)	0.286
No	77.3% (17)	22.7% (9)	
Diabetes mellitus			
Yes	69.2% (9)	30.8% (4)	0.974
No	68.8% (33)	31.3% (15)	
Dyslipidemia			
Yes	61.1% (11)	38.9% (7)	0.398
No	72.1% (31)	27.9% (12)	
Metabolic syndrome			
Yes (31)	73.5% (25)	26.5% (9)	0.376
No (27)	63.0% (17)	37.0% (10)	
Functional impairment			
Barthel Index			
Yes (39)	89.7% (35)	10.3% (4)	<0.010
No (22)	31.8% (7)	68.2% (15)	
Lawton Index			
Yes (38)	94.7% (36)	5.3% (2)	<0.010
No (23)	26.1% (6)	73.9% (17)	
Surgical delay (days)	5.02 ± 2.20	5.16 ± 2.06	0.819
Delay rehabilitation (days)	2.46 ± 1.37	2.59 ± 2.23	0.832
Hospital stay (days)	14.88 ± 2.96	13.68 ± 3.14	0.169
Frail Index change			
Yes (48)	72.9% (35)	27.1% (13)	<0.010
No (13)	53.8% (7)	46.2% (6)	

Table 2: Short physical performance battery (SPPB). Data are expressed as the mean ± standard deviation for continuous variables and as frequencies (percentages) for categorical variables. BMI: Body mass index.

one of the main reasons for functional impairment in elderly, as was repeatedly described in disability [10,20,21].

In our study, nearly two thirds of the hip fracture patients developed functional impairment in three months. The Barthel index fell an average of 15 points at three months after surgery, and Lawton index score dropped two points in women.

Other studies describe greater functional loss after hip fracture reflected in a greater decline in Barthel and Lawton indexes [9,20]. This might be due to that those patients started from a worse initial functional situation in a case [9], or that the post-fracture reassessment was conducted at six months in the other [20].

Age is a key factor in the prevalence of hip fracture. More than 85% of hip fractures occur in patients older than 65 years and particularly the oldest-old, after 80 years, shows an exponential increase of its incidence [10,22]. As we expected taking into account

the literature [10,20], we also observed an association between older patients and greater functional impairment.

The use of medicines in elderly is an important factor causing adverse effects and complications [23]. Polypharmacy is currently a public health problem with a high prevalence which is independently associated with increased mortality. It brings many adverse consequences [24], including the functional impairment that was also observed in our study and the change in the FRAIL category. This result also fits with Vergara's study, where nearly half of patients which exhibited functional impairment took four or more drugs [20].

As in the studies of the Vergara and González-Zabaleta groups [9,20], type of surgery (osteosynthesis or arthroplasty) did not significantly influence the development of functional impairment. On the other hand, other studies define the type of surgery as

Frail index change			
	Non-change (20)	Change (41)	p - value
Age (years)			
>84 (22)	13.6% (3)	86.4% (19)	0.017
≤84 (39)	43.6% (17)	56.4% (22)	
Sex			
Females (52)	30.8% (16)	69.2% (36)	0.420
Males (9)	44.4% (4)	55.6% (5)	
Functional impairment			
Barthel Index			
Yes (39)	12.8% (5)	87.2% (34)	<0.001
No (22)	68.2% (15)	31.8% (7)	
Lawton Index			
Yes (38)	15.8% (6)	84.2% (32)	<0.001
No (23)	60.9% (14)	39.1% (9)	
BMI			
< 20 (6)	0.0%	100.0% (6)	0.318
20–25 (25)	32.0% (8)	68.0% (17)	
25–30 (40)	40.0% (12)	60.0% (28)	
Type of surgery			
Osteosynthesis (37)	27.0% (10)	73.0% (27)	0.234
Arthroplasty (24)	41.7% (10)	58.3% (14)	
Polypharmacy			
Yes (27)	22.2% (6)	77.8% (21)	0.117
No (34)	41.2% (14)	58.8% (20)	
Hypertension			
Yes	30.8% (12)	69.2% (27)	0.655
No	36.4% (8)	63.6% (14)	
Diabetes			
Yes	15.4% /2)	84.6% (11)	0.132
No	37.5% (18)	62.5% (30)	
Dyslipidemia			
Yes	22.2% (4)	77.8% (14)	0.255
No	37.2% (16)	62.8% (27)	
Metabolic syndrome			
Yes (34)	35.3% (12)	64.7% (22)	0.640
No (27)	29.6% (8)	70.4% (19)	
Surgical delay (days)	5.40 ± 2.06	4.90 ± 2.18	0.390
Delay rehabilitation (days)	2.235 ± 1.89	2.61 ± 1.50	0.473
Hospital stay (days)	14.30 ± 3.36	14.50 ± 2.86	0.725

Table 3: Frail index change. Data are expressed as the mean ± standard deviation for continuous variables and as frequencies (percentages) for categorical variables. BMI: Body mass index.

a predictor of functional disability for activities of daily living [10]. They showed that patients of 81.2 years on average with hip fracture underwent osteosynthesis scored nearly one point less in Katz index six months after the surgery [10]. In our study most patients undergoing osteosynthesis (70.3%) had functional impairment, (73%) changed their category according to the FRAIL questionnaire and (75.7%) and were more frequently with SPPB ≤ 6, worse results than patients undergoing arthroplasty. It seems that arthroplasty is a better surgical treatment for patients with hip fracture, but more studies in this direction are necessary.

Different guidelines recommend intervene to elderly patients with hip fracture within the first 48 hours [25], as many studies have shown the association between surgical delay and increased one year mortality [21]. However, our work and other studies have seen no relationship between functional impairment and surgical and rehabilitation delay [26].

Functional decline during hospitalization is very common in

older patients. Between 35 and 50% of elderly patients admitted for acute illness loses its ability to independently perform activities of daily life [27]. We found no significant differences between functional impairment and hospital stay, although we noted that patients with functional decline were more than one day of hospitalization on average than those who did not change their functional status.

Metabolic syndrome is a clustering of several medical conditions associated with the risk of developing cardiovascular disease and diabetes [28]. The prevalence of metabolic syndrome is increasing in people over 70 years [29], so several works suggest an association between metabolic syndrome and functional status [28,30,31]. However, although two out of three patients with metabolic syndrome exhibited functional impairment, the relationship between them was not supported by statistical analysis. This is consistent with a recent study with more than 1500 participants were metabolic syndrome did not affect the functional status of sedentary older adults at high-risk for mobility disability [32].

Functional impairment (Barthel Index)			
	Without Impairment (22)	With Impairment (39)	p - value
Edad			
> 84 (39)	43.6% (17)	56.4% (22)	0.050
≤ 84 (22)	22.7% (5)	77.3% (17)	
Sex			
Females (52)	36.5% (19)	63.5% (33)	0.853
Males (9)	33.3% (3)	66.7% (6)	
BMI			
< 20 (6)	16.7% (1)	83.3% (5)	0.415
20-25 (25)	44.0% (11)	56.0% (14)	
25-30 (40)	33.3% (10)	66.7% (30)	
Type of surgery			
Osteosynthesis (37)	29.7% (11)	70.3% (26)	0.291
Arthroplasty (24)	45.9% (11)	54.1% (13)	
Polypharmacy			
Yes (27)	18.5% (5)	81.5% (22)	0.011
No (34)	50.0% (17)	50.0% (17)	
HTA			
Yes	35.9% (14)	64.1% (25)	0.971
No	36.4% (8)	63.6% (14)	
Diabetes			
Yes	23.1% (3)	76.9% (10)	0.272
No	39.6% (19)	60.4% (29)	
Dyslipidemia			
Yes	33.3% (6)	66.7% (12)	0.744
No	37.2% (16)	62.8% (27)	
Metabolic syndrome			
Yes (34)	32.4% (11)	67.6% (23)	0.498
No 27)	40.7% (11)	59.3% (16)	
Surgical delay (days)	5 ± 2.05	5.10 ± 2.21	0.856
Delay rehabilitation (days)	2.05 ± 2.06	2.72 ± 1.32	0.212
Hospital stay (days)	13.91 ± 2.65	14.85 ± 3.18	0.224
Frail index change			
Yes	31.8% (7)	87.2% (34)	0.000
No	68.2% (15)	12.8% (5)	

Table 4: Functional impairment (Barthel Index). Data expressed as the mean ± standard deviation for continuous variables and as frequencies (percentages) for categorical variables. BMI: Body mass index.

Abizanda, et al. described that the fragility criteria of Fried are associated with increased mortality, incidence of disability and functional impairment [33]. In our study we found a relationship between age and functional impairment, so older patients were more likely to worsen in the state of fragility.

Different studies of patients with hip fracture describe fragility as a predictor of a poor prognosis, longer hospital stays and even mortality [34,35].

A recent study of Prestmo and colleagues described that elderly patients with hip fracture scored 5.12 points of average on SPPB, four months after the surgery [36]. This is consistent with our patients since they scored 5.49, and therefore they exhibited a severe functional limitation. Those patients included in the ≤ 6 SPPB group were statistically associated with a FRAIL questionnaire group change and functional impairment three months after the surgery. Although polypharmacy, high BMI or metabolic syndromes were more frequently in patients with SPPB ≤ 6, and they were staid more than one day of average at the hospital, this was no supported in a statistical way.

In conclusion, patients that displayed good functional status (IB ≥ 80) before the surgery will have better physical performance

with mild to moderate functional limitation three months after the hip fracture. But, age has demonstrated essential in hip fracture recovery, showing older-old patients' worse recovery capacity.

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Disclosures

The authors declare that they have no conflict of interest.

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