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Effects of Pre-Fracture Depressive Illness and Post-Fracture Depressive Symptoms on Physical Performance Following Hip Fracture

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Abstract

Objectives—To compare the impact of pre-fracture depressive illness and post-fracture depressive symptoms on changes in physical performance after hip fracture.

Design—Longitudinal observational cohort.

Setting—Baltimore metropolitan area.

Participants—Older adults (n=255) with hip fracture who underwent Short Physical Performance Battery (SPPB) assessments at two, six, or twelve months post fracture.

Measurements—Pre-fracture depressive illness (from medical records) at baseline and post-fracture depressive symptoms at two months (using the Center for Epidemiological Studies Depression Scale) were measured. Physical performance was measured using the SPPB, a

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composite metric of functional status with a score ranging from zero to twelve. Weighted estimating equations assessed mean SPPB over time comparing participants with and without pre-fracture depressive illness and subjects with and without post-fracture depressive symptoms.

Results—Participants with pre-fracture depressive illness had an SPPB increase of 0.4 units (95% confidence interval [CI]: −0.5, 1.3) from two to six months, smaller than the increase of 1.0 SPPB unit (95% CI: 0.4, 1.6) in those without pre-fracture depressive illness. Participants with post-fracture depressive symptoms had an SPPB increase of 0.2 units (95% CI: −1.0, 1.5) from two to twelve months, while subjects without post-fracture depressive symptoms had a larger increase of 1.2 units (95% CI: 0.6, 1.8) over the same time period. However, pre-fracture depressive illness and post-fracture depressive symptoms were not significantly associated with SPPB.

Conclusions—Neither pre-fracture depressive illness nor post-fracture depressive symptoms were significantly associated with changes in physical performance after hip fracture, but the magnitude of estimates suggested possible clinically meaningful effects on functional recovery.

Keywords

Hip Fracture; Depression; Physical Performance

INTRODUCTION

Psychiatric comorbidity, particularly depression, is a significant problem among the approximately 260,000 older adult Americans that annually experience a hip fracture.^{1, 2} Estimates of the point prevalence of depression in hip fracture patients range from 9% to 47%, which are considerably higher than the general population.² Depression in hip fracture patients may increase the risk of falls and subsequent fractures and decrease participation in rehabilitation activities, and clinical guidelines recommend for routine mental health screening in hip fracture patients.^{3–5} More importantly, post-fracture depressive symptoms are associated with poorer physical functioning after hip fracture.^{6–10} However, existing research has focused on depression occurring at, or after hip fracture, rather than the consequences of pre-fracture depressive illness.

Depression is dynamic, and prior depressive illness may exacerbate current depressive symptoms.¹¹ Individuals who have a depressive illness onset occurring earlier in time are more likely to experience future depressive symptoms that manifest with a greater frequency and intensity.¹¹ Emerging evidence identifies prior depressive illness, independent of current depressive symptoms, as an important determinant of how people experience the symptoms of musculoskeletal conditions. For example, observational studies indicate that prior depressive illness and not current depressive symptoms are associated with significantly worse prospective pain and functional limitations in rheumatoid arthritis.^{12, 13} The detrimental effects of prior depressive illness on musculoskeletal symptoms also increase in magnitude with the number of prior depressive episodes and an earlier age of onset.^{12, 13} Thus, a history of depressive illness prior to hip fracture may be an independent contributor to physical functioning during the recovery period irrespective of depressive symptoms that occur post fracture.

The aim was to assess the effect of pre-fracture depressive illness and post-fracture depressive symptoms two months after hip fracture on physical performance during the subsequent ten month recovery period. It was hypothesized that pre-fracture depressive illness and post-fracture depressive symptoms would be associated with smaller improvements in physical performance after hip fracture but that the effect of pre-fracture depressive illness would be larger than post-fracture depressive symptoms.

METHODS

Study Sample

Participants hospitalized for hip fracture in the Baltimore Hip Studies (BHS) 7th cohort were recruited from eight participating BHS network hospitals in the Baltimore metropolitan area and were aged 65 years or older at the time of hip fracture and consented to enroll or had a proxy provide informed consent within 15 days of hospital admission. Exclusion criteria included pathologic fracture, not community-dwelling at the time of fracture, non-English speaker, being bedbound for 6 months before fracture, residence of > 70 miles from the hospital, weight of > 300 pounds, not undergoing surgery, and hardware in the contralateral hip. A total of 362 hip fracture patients were enrolled (180 males and 182 females). Five participants did not provide data at the baseline or 2-month follow-up visit and another 18 participants were removed from the analysis sample as a result of an IRB-requested post procedure audit (6 participants were subsequently found to be ineligible because they did not meet study inclusion criteria and 12 participants were determined to be ineligible secondary to failures of the informed consent process), leaving a sample of 339 participants. Study protocols were reviewed and approved by the University of Maryland Institutional Review Board and the review boards of participating hospitals. The analytic sample was drawn from participants (n=255) enrolled in BHS-7 who had Short Physical Performance Battery (SPPB) data at two, six, or twelve months post admission (Figure 1).

Depression Measures

Study visits were conducted at baseline (within 22 days of admission) and at two, six, and twelve months after admission which included questionnaires and measures of body composition and functional performance. Medical charts were also abstracted at study enrollment by research staff to obtain subjects' comorbidity history. Two different measures were used to assess depression: (1) pre-fracture depressive illness at study baseline (n=255) and (2) post-fracture depressive symptoms at two months follow-up (n=209). Pre-fracture depressive illness was assessed at study enrollment during medical record chart reviews. Post-fracture depressive symptoms at two months, the time of the first physical performance assessment, were measured using the 20-item patient-reported CES-D and recommended screening threshold of 16.¹⁴ Depressive symptoms at study enrollment were also assessed to evaluate the relationship between pre-fracture depressive illness and depressive symptoms at study baseline.

Physical Performance

The SPPB was used to assess physical performance following hip fracture. The SPPB evaluates lower limb function and comprises three separate tasks: standing balance, chair

rise repeated five times, and three meter gait speed. Each task is rated on a scoring scale that ranges from zero to four, and higher scores are indicative of better physical performance. The individual scores from each task are added together to calculate a summary metric of physical performance, with zero and twelve being the lowest and highest possible scores, respectively.¹⁵

Covariates

For the analysis of pre-fracture depressive illness, all covariate data were obtained at study baseline because depression history was assessed at enrollment. For the analysis of post-fracture depressive symptoms, covariate data were obtained from measures at study baseline or the two-month follow-up visit. Specifically, medical record data were only collected at study baseline, while two month patient-reported survey data were used. Variables obtained from medical records included age (years), sex, body mass index (BMI), and comorbidity. Number of comorbid conditions was assessed using a modified Charlson Comorbidity Index that omitted mild liver disease.¹⁶ Patient-reported surveys were used to assess race (white or nonwhite), education (years), marital status (never, married, widowed, divorced, or separated), social interaction, physical activity (hours per week), cognitive status, hip pain (yes or no), and antidepressant use (never, past, or current). Social interaction was evaluated as number of social activities adapted from a social activity measure developed by House and colleagues.¹⁷ Physical activity was measured using the Yale Physical Activity Scale (YPAS).¹⁸ Cognitive status was evaluated with the Modified Mini-Mental State (3MS) examination.¹⁹ Hip pain was reported as “pain in or around either hip joint, including the buttocks, groin, or either side of the upper thigh.” Medications used to treat depression were assessed using a single-item asking about the use of antidepressants (fluoxetine, sertraline, paroxetine, or bupropion).

Statistical Analysis

Participants’ demographic and clinical characteristics were compared separately between those with and without (1) pre-fracture depressive illness and (2) post-fracture depressive symptoms at two months. For continuous variables, means and standard deviations were calculated, and percentages were estimated for categorical measures. T-tests and chi-square tests were used to assess differences in the distributions of continuous and categorical variables by participants’ depression status: pre-fracture depressive illness versus no pre-fracture depressive illness; and post-fracture depressive symptoms at two months follow-up versus no post-fracture depressive symptoms at two months.

Weighted estimating equations (WEE) were used to assess the relationship between depression (pre-fracture illness or post-fracture symptoms) and physical performance during the recovery period. WEE accounted for missing data and selective survival using weighting, where the weights are the inverse probability of observation conditional on predictors of missing data. SPPB scores from two to twelve months were modeled as a continuous variable in all outcome models. Multivariable WEE adjusted for covariates tested the depression (pre-fracture illness or post-fracture symptoms) by time interaction to determine whether changes in physical performance in the year following fracture differed between depressed and non-depressed participants. Differences in change of 0.4 – 1.5 SPPB units

were considered to be clinically meaningful.²⁰ Statistical significance was set at an alpha level of 0.05 for primary outcome models. All statistical analyses were conducted using Stata (Version 13, Stata Corp, College Station, Texas, USA).

RESULTS

Descriptive Characteristics

The distributions of covariate values by pre-fracture depressive illness and post-fracture depressive symptoms were generally similar between the groups (Table 1). There was no significant difference in baseline depressive symptoms among subjects with and without pre-fracture depressive illness (54.7% and 47.3%, respectively). Pre-fracture depressive illness was associated with significantly greater comorbidity and likelihood of reporting past and present antidepressant medication use. Post-fracture depressive symptoms two months after hip fracture were associated with a higher likelihood of baseline depressive symptoms, but otherwise there were no significant differences.

Pre-Fracture Depressive Illness and Change in Physical Performance

Participants with pre-fracture depressive illness had a slower recovery of physical performance from two to six months compared to those with no pre-fracture depressive illness (Figure 2A), although the difference was not statistically significant ($P=0.14$). Adjusted estimates of SPPB change in participants with pre-fracture depressive illness were 0.41 units (95% confidence interval [CI]: $-0.48, 1.30$) from two to six months and 1.66 units (95% CI: $0.72, 2.60$) from two to twelve months. Estimated SPPB changes in participants without pre-fracture depressive illness were 0.98 units (95% CI: $0.40, 1.57$) from two to six months and 1.08 units (95% CI: $0.48, 1.68$) from two to twelve months.

Post-Fracture Depressive Symptoms and Change in Physical Performance

Findings indicated similar physical performance changes from two to six months in participants with and without post-fracture depressive symptoms (Figure 2B) but a non-significant divergence in twelve-month recovery ($P=0.17$). Adjusted SPPB changes from two to six months were estimated to be 0.99 units (95% CI: $-0.01, 1.99$) and 0.98 units (95% CI: $0.42, 1.54$) in participants with and without post-fracture depressive symptoms, respectively. However, participants with post-fracture depressive symptoms had an SPPB change of 0.17 units (95% CI: $-1.03, 1.38$) from two to twelve months, smaller than the estimated SPPB change of 1.20 units (95% CI: $0.57, 1.83$) for those without post-fracture depressive symptoms.

DISCUSSION

This study compared the impact of pre-fracture depressive illness and post-fracture depressive symptoms on changes in physical performance following hip fracture and showed different patterns of functional recovery that did not reach statistical significance. Pre-fracture depressive illness negatively influenced physical performance from two months to six months, while the effect of post-fracture depressive symptoms manifested at one year follow-up. Participants without pre-fracture depressive illness or post-fracture depressive

symptoms achieved similar levels of physical performance at six and twelve months follow-up. Although the associations were not statistically significant, the magnitude of the differences in change suggest the observed relationships may be clinically meaningful.

The results are consistent with previous studies showing that depressive symptoms after hip fracture are associated with poorer prospective physical functioning.^{6–10} The findings also demonstrated that participants with pre-fracture depressive illness had a slower improvement in physical performance by a magnitude of approximately 0.6 SPPB units from two to six months post fracture. Depressive symptoms can affect physical behavior in older adults and are associated with decreased movement and less engagement in the activities of daily living.²¹ Among older adults with a history of depressive illness, behavioral patterns may be established during periods of depressed mood, resulting in decreased physical activity and a deconditioning of the body.^{22, 23} Pre-fracture depressive illness could slow the proximal recovery of physical performance by reducing patients' participation in rehabilitation activities or being associated with greater frailty immediately following hip fracture.^{3, 23} However, pre-fracture depressive illness had no long-term impact on physical performance. By contrast, post-fracture depressive symptoms at two months were associated with a much smaller SPPB change from two to twelve months than their comparators, a clinically meaningful difference of more than one SPPB unit. For an acute musculoskeletal condition that has a long symptomatic period occurring on a recovery trajectory, pre-fracture depressive illness and post-fracture depressive symptoms may differentially affect functional limitations and changes in physical performance.

Differences in mental healthcare and treatment may account for the different effects on the recovery of physical performance after hip fracture regarding pre-fracture depressive illness compared to post-fracture depressive symptoms. More specifically, there were few participants with post-fracture depressive symptoms at two months who had experienced pre-fracture depressive illness (34%) and the majority reported never taking antidepressants (63%). Conversely, many participants with pre-fracture depressive illness reported current antidepressant use (67%) and few had unresolved depressive symptoms two months after fracture (30%). A history of depressive illness increases the likelihood of psychiatric evaluation among older adults and the use of antidepressant medications prior to and after hip fracture.^{24, 25} In addition to alleviating psychosocial symptoms, antidepressant treatment is intended to achieve functional remission in the context of depression's impact on physical behavior.²⁶ Thus, persons with hip fracture who have a history of depressive illness may not experience long-term deficits to physical performance due to better depression management. However, those who fracture a hip but have no history of depressive illness may develop depressive symptoms due to the experience of such an acute, stressful, and disabling medical event.²⁷ These individuals likely comprise the many persons who have no resolution in their depressive symptoms, which go un-recognized and un-treated during the recovery period, ultimately leading to long-term decrements to physical performance after hip fracture.^{25, 28, 29}

There are limitations to this research. The small sample may have resulted in limited statistical power. Depression is often under-recognized in routine clinical practice by treating physicians and using medical records to assess prior depressive illness may underestimate

prevalence.³⁰ Depressive symptoms assessed using patient-reported questionnaires are not representative of depression as defined using diagnostic criteria and may overestimate prevalence.¹⁴ The cohort was mainly white older adults from the Baltimore metropolitan area, and the findings may lack generalizability to more diverse hip fracture samples. There is also the potential for confounding by unmeasured factors. These potential sources of bias are mitigated through the various strengths. Although the sample is small, it is one of the largest cohorts of both male and female hip fracture patients assessed over the year after hip fracture. The study used modern methods to handle missing covariate and outcome data and selective survival. Additionally, extensive clinical and patient-reported measures were available to control for a wide variety of potential confounders.

CONCLUSION

Pre-fracture depressive illness and post-fracture depressive symptoms both may have a clinically meaningful effect on the recovery of physical functioning following hip fracture. However, our findings indicate that depressive symptoms after hip fracture, rather than depressive illness occurring earlier in time, are more detrimental during the recovery period because of the long-term effect on physical performance. Our results underscore the need for better depression screening and management throughout the entirety of the year following hip fracture, particularly among individuals with no history of depressive illness and depressive symptoms that occur beyond initial hospitalization during the recovery period.

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Figure 1.
Flow diagram for analytic samples.

Figure 2.
Predicted SPPB by (A) baseline history of depressive illness and (B) current depressive symptoms two months post fracture

Table 1

Baseline characteristics among participants in those with and without a history of depressive illness and with and without current depressive symptoms two months post fracture.

Variables	History of Depressive Illness			Current Depressive Symptoms		
	Yes (n=57)	No (n=198)	P	Yes (n=40)	No (n=168)	P
Female	35 (61.4%)	95 (48.0%)	0.07	22 (55.0%)	88 (52.4%)	0.76
White	51 (91.1%)	178 (91.3%)	0.96	35 (89.7%)	154 (92.2%)	0.61
Age	81.1 (6.9)	81.1 (7.6)	0.97	90.0 (8.3)	80.7 (7.2)	0.85
Years of Education	13.3 (3.4)	13.3 (3.4)	0.85	13.2 (3.0)	13.4 (3.4)	0.68
Marital Status			0.83			0.19
	<i>Never</i>	4 (7.1%)	10 (5.1%)	2 (5.1%)	8 (4.8%)	
	<i>Married</i>	22 (39.3%)	79 (40.3%)	15 (38.5%)	74 (44.3%)	
	<i>Widowed</i>	25 (44.6%)	90 (45.9%)	19 (48.7%)	72 (43.1%)	
	<i>Divorced</i>	3 (5.4%)	14 (7.1%)	1 (2.6%)	12 (7.2%)	
	<i>Separated</i>	2 (3.6%)	3 (1.5%)	2 (5.1%)	1 (0.6%)	
Social Interaction	11.1 (8.9)	10.8 (9.3)	0.81	7.2 (9.3)	7.9 (7.2)	0.59
YPAS	14.0 (11.7)	17.2 (13.2)	0.11	7.4 (8.4)	10.2 (10.6)	0.12
BMI	26.1 (5.4)	25.2 (5.2)	0.25	25.3 (4.7)	25.7 (5.3)	0.71
Comorbidity	2.4 (1.9)	1.9 (1.7)	0.03	2.5 (2.0)	1.8 (1.7)	0.05
MMSE	85.7 (14.8)	85.9 (15.4)	0.94	85.4 (15.2)	87.5 (11.2)	0.30
Pain	7 (13.7%)	31 (17.5%)	0.52	29 (74.4%)	106 (67.1%)	0.38
Antidepressants			<0.001			0.66
	<i>Never</i>	14 (25.0%)	159 (82.0%)	25 (62.5%)	119 (71.7%)	
	<i>Past</i>	5 (8.9%)	10 (5.2%)	4 (10.0%)	12 (7.2%)	
	<i>Current</i>	37 (66.1%)	25 (12.9%)	11 (27.5%)	35 (21.1%)	
Baseline Depressive Symptoms	29 (54.7%)	89 (47.3%)	0.34	32 (84.2%)	64 (39.5%)	<0.001
2 Month Depressive Symptoms	13 (29.6%)	27 (16.5%)	0.05	-	-	-
Prior Depressive Illness	-	-	-	13 (32.5%)	31 (18.5%)	0.05

YPAS: Yale Physical Activity Scale; BMI: Body Mass Index; Modified Mini Mental State test