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Short-term changes in body composition after surgical repair of hip fracture

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Abstract

Background: the deleterious changes in body composition that occur during the year after hip fracture are associated with increased disability, recurrent fracture, and mortality. While the majority of these unfavourable changes have been shown to occur during the first 2 months after fracture, potential changes in body composition occurring earlier than 2 months post-fracture have not been studied. Accordingly, the aim of this study was to rigorously assess short-term changes in body composition after hip fracture.
Methods: total body mass, lean mass, fat mass and total hip and femoral neck bone mineral density (BMD) were assessed via dual energy X-ray absorptiometry at 3 days, 10 days and 2 months post-fracture among 155 hip fracture patients from the Baltimore Hip Studies. Longitudinal regression analysis using mixed models was conducted to model short-term changes in body composition.
Results: no significant changes in body composition were revealed from 3- to 10 days post-fracture. However, significant decreases from 10 days to 2 months post-fracture were noted in the total body mass (−1.95 kg, $P < 0.001$), lean mass (−1.73 kg, $P < 0.001$), total hip BMD (−0.00812 g/cm^2, $P = 0.04$) and femoral neck BMD (−0.015 g/cm^2, $P = 0.03$). No meaningful changes in fat mass were uncovered.

Conclusions: the adverse changes in body composition during the first 2 months after hip fracture appear to have occurred primarily between 10 days and 2 months post-fracture. More research is needed to determine how these findings might help inform the optimal timing of interventions aimed at improving body composition and related outcomes after hip fracture.

Keywords: *hip fracture, body composition, bone mineral density, lean mass, dual energy X-ray absorptiometry, older people*

Background

Hip fracture is a common injury among older adults, which is associated with profound and lasting repercussions. There are over 300,000 new hip fracture patients in the USA per year [1] and the annual incidence of hip fracture is expected to increase to 700,000 in the USA and almost 4 million worldwide by 2050 [2]. Hip fracture is associated with a high degree of mortality as between 16 and 32% of hip fracture patients die in the year following fracture [3–6]. Survivors are burdened with substantial morbidity and recovery is typically prolonged and incomplete. Among the major contributing factors to the morbidity after hip fracture are deleterious changes in body composition.

The total body mass consists of three components: fat mass, lean mass and bone. Fat mass and lean mass demonstrate opposite and unfavourable patterns of change after hip fracture. Fat mass increases by up to 11% [7] and lean mass decreases by up to 6% [8] in older female hip fracture patients during the year after hip fracture. Healthy older women gain only 1.7% of fat mass and lose just 1% of lean mass per year [9]. Lower post-fracture bone mineral density (BMD) has also been associated with recurrent hip fracture, disability and mortality [10–12]. Thus, preventing deleterious changes in body composition could have profound clinical implications in hip fracture recovery. However, therapeutic interventions aimed at improving body composition after hip fracture have produced mixed results [13–16]. This may be due to the fact that the period during which most of the unfavourable changes in body composition occur after fracture is currently unclear.

While most studies have focused on assessing longer term changes in body composition after hip fracture, one analysis revealed that half of the bone and muscle mass that is lost after hip fracture occurs within the first 2 months [8]. However, it is unclear precisely when during the first 2 months the majority of lean mass is lost as no studies to date have assessed short-term changes in body composition after hip fracture. The goal of this analysis was to determine whether short-term changes in body composition occur after hip fracture.

Methods

Subjects

The study sample consisted of participants from the third cohort of the Baltimore Hip Studies (BHS3), described in detail elsewhere [8]. The final sample for this analysis consisted of 155 unique BHS3 participants from whom the body composition measures were obtained from at least one of the 3-, 10-day or 2 month post-fracture study visits. The study sample did not differ from the full BHS3 cohort in any of the key covariates described below (χ^2, $P > 0.05$). The hip fracture of the proximal femur was surgically repaired in all study participants prior to the 3-day study visit. The study was approved by the Institutional Review Boards of the University of Maryland and the individual study hospitals.

Body composition assessment

The body composition outcomes included in this analysis were total hip and femoral neck BMD, total body mass, lean mass and fat mass. All body composition outcomes were assessed with dual energy X-ray absorptiometry (DXA), using either Hologic QDR 1000W® or QDR 1500® (Hologic, Waltham, MA, USA) densitometers. Body composition measurements were obtained at the 3-day visit (mean 4.9 ± 1.1 days from fracture), 10-day visit (mean 11.9 ± 2.7 days from fracture) and 2-month visit (mean 68.9 ± 9.3 days from fracture) on the same densitometer at each visit for each participant. In order to account for the potential influence of post-surgical swelling on lean and fat mass around the site of the hip fracture [17], the lean mass and fat mass in the non-fractured leg were doubled and used in place of corresponding fracture-side values when calculating the total body composition figures. This technique has been used to account for surgical swelling in previous hip fracture studies [18, 19].

Covariates

A wide variety of potential confounders of short-term changes in body composition after hip fracture were assessed. These included age at the time of fracture, history of osteoporosis, education and a host of medical complications that were assessed after hip fracture. Please see Supplementary data, available at *Age and Ageing* online, Appendix SI for more information on the specific complications and their prevalence in this sample.

Statistical analyses

Descriptive analyses were performed to characterise the study population and assess the short-term changes in the mean body composition after hip fracture. The time from fracture was estimated by using day of hospitalisation as the

Table 1. Participant characteristics

Variable (units)	Mean (SD) (*n*)		
	Day 3	Day 10	2 Months
Age at fracture (years)	80.7 (7.5) (155)	–	–
Education (years)	11.6 (3.3) (142)	–	–
History of osteoporosis (% Yes)	11.1% (155]	–	–
Confusion (% Yes)	18.1% (154)	–	–
Urinary tract infection (% Yes)	7.8% [154)	–	–
Pneumonia (% Yes)	3.9% (154)	–	–
Pressure sores (% Yes)	3.9% (154)	–	–
Acute delirium (% Yes)	3.2% (155)	–	–
Body composition outcomes			
Total body mass (kg)	56.0 (10.4) (91)	56.2 (11.1) (126)	54.9 (10.6) (103)
Lean mass (kg)	38.0 (5.1) (91)	38.8 (6.2) (126)	36.7 (5.2) (103)
Fat mass (kg)	16.5 (6.4) (91)	15.7 (6.5) (126)	16.5 (6.2) (103)
Total hip bone mineral density (g/cm^2)	0.59 (0.11) (96)	0.58 (0.12) (120)	0.58 (0.11) (93)
Femoral neck bone mineral density (g/cm^2)	0.55 (0.09) (96)	0.54 (0.09) (121)	0.53 (0.08) (93)

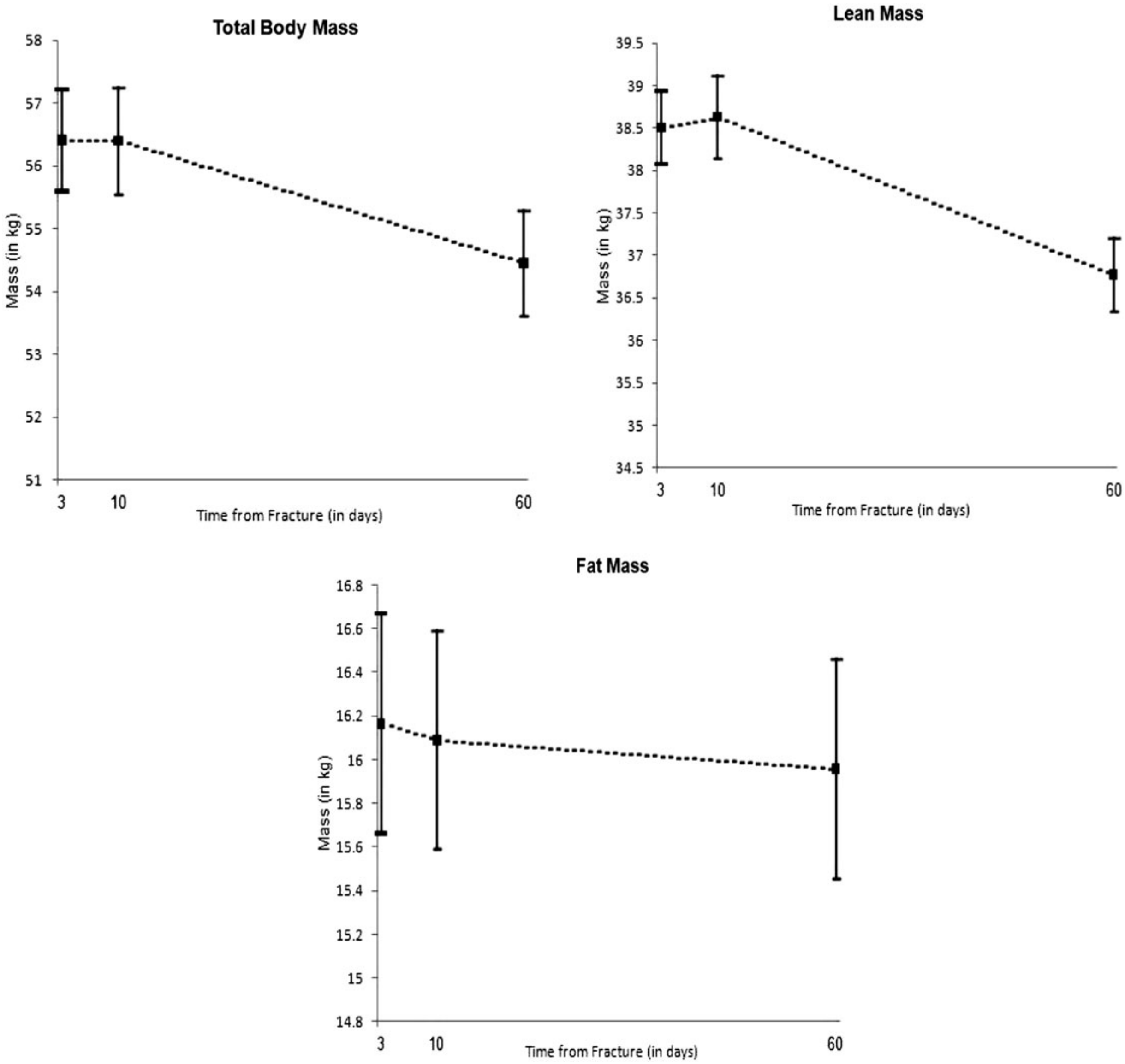

Figure 1. Body mass outcomes after hip fracture. Square represents point estimate, upper bar represents point estimate + standard error and lower bar represents point estimate − standard error.

starting point was treated as a categorical variable (Day 3, Day 10 or 2 months) in all analyses. The treating time from fracture as a continuous variable did not alter the analyses and these results are not reported. Longitudinal regression analysis of post-fracture body composition was conducted using mixed models with an exchangeable covariance matrix and robust standard errors. Random effects were assumed to have a normal distribution. The following variables were considered as potential covariates in the models to adjust for baseline characteristics: age, education, history of osteoporosis and medical complications (confusion, urinary tract infection, pressure sores, pneumonia and acute delirium). The inclusion of these covariates did not reduce the standard error of the estimates and only the unadjusted regression model results are reported. A sensitivity analysis was also conducted to compare findings among the subgroup of participants with data from all three time points ($n = 33$) to participants with data from at least one time point ($n = 155$). No meaningful differences were uncovered and the subgroup analyses are not reported. Associations with $P \leq 0.05$ were considered statistically significant. All analyses were conducted using SAS version 9.1 (SAS Institute, Cary, NC, USA).

Results

Table 1 presents the descriptive characteristics of the study population at each visit. One hundred and fifty-five female hip fracture patients with a mean age of 80.7 [standard deviation (SD) = 7.4] years and mean education of 11.6 (SD = 3.3) years were studied. Eleven per cent of the sample reported a history of osteoporosis. Post-fracture medical complications that affected a meaningful number (>3%) of participants are reported.

Figures 1 and 2 illustrate the mean trajectories of the body composition outcomes during the 2 months after hip fracture as predicted by the regression models. More detail on the regression results is provided in Supplementary data are available in *Age and Ageing* online, Appendix SII.

Discussion

This was the first study to rigorously assess the potential changes in body composition as soon as 10 days after hip fracture. The deleterious short-term changes in body composition previously noted to occur by 2 months post-fracture were confirmed in this analysis. The findings of this study also suggest that the bulk of these changes occur between 10 days and 2 months after the injury.

There were a number of strengths of this study that contribute to the potential clinical implications offered by these novel data. Corrective hip fracture surgery was performed on all study participants and all of the body composition measurements were assessed after surgery. The fact that all participants underwent corrective surgery is an important feature of the study as major surgical procedures induce weight loss and unfavourable body composition changes, which are often confounded by oedema around the surgical site. Several measures were taken to minimise the effect of post-surgical oedema on body composition estimates. Lean mass and fat mass on the non-operative leg were doubled and substituted for lean mass and fat mass on the fractured leg when calculating the total body mass. This substitution has been employed in previous studies and is believed to reduce the effect of regional oedema occurring around the site of surgery on lean mass estimates [18, 19].

There were also several notable limitations to this study. While a sensitivity analysis revealed no statistically significant differences in changes in body composition among the full sample ($n = 155$) and participants with data at all three time points ($n = 33$), future studies should be mindful of the challenges of acquiring body composition data from functionally

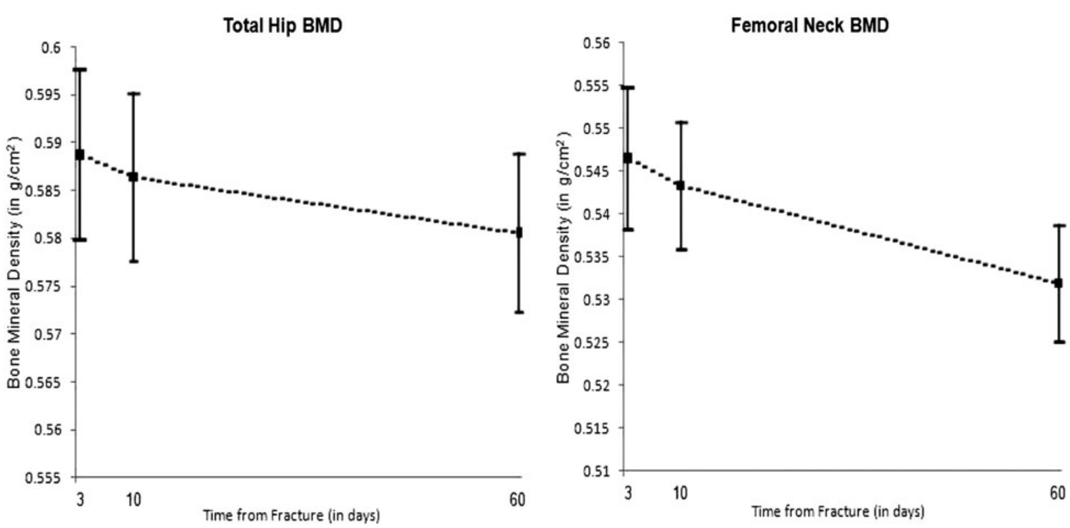

Figure 2. Bone mineral density outcomes after hip fracture. Square represents point estimate, upper bar represents point estimate + standard error and lower bar represents point estimate − standard error.

compromised hip fracture patients. Despite the efforts to account for surgical swelling described previously, there was likely some residual impact on the changes in lean mass from 3- to 10 days post-fracture. However, a review of the influence of water content on body composition as measured by DXA suggests that these results are unlikely to be explained by fluid shifts alone. It is believed that changes in the water content of 5% are likely to affect DXA estimates of body fat by only 1–2.5% [20].

While further study is warranted, the detrimental changes in body composition known to occur by 2 months after hip fracture do not appear to meaningfully occur within the first 10 days after the injury. These novel findings might ultimately help inform both the optimal timing of initiation as well as the specific therapeutic approach of future pharmacological, dietary and physical activity interventions and ultimately contribute to enhanced study compliance and improved outcomes after hip fracture.

Key points

- Deleterious changes in body composition have been noted during the year after hip fracture and associated with adverse outcomes, but potential changes in body composition occurring shortly after hip fracture have not been rigorously studied to date.
- While this study confirmed the detrimental changes in body composition by 2 months after hip fracture that had been noted previously in smaller studies, there were no significant changes in body composition revealed from 3- to 10 days post-fracture.
- These findings may help inform the optimal timing of interventions aimed at improving body composition and related outcomes after hip fracture.

Conflicts of interest

Dr Magaziner reports consulting agreements with Novartis, Ammonett and OrgaNext, and grant funding from Eli Lilly. Dr Miller is a full-time employee of GlaxoSmithKline.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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The relationship between health-related quality of life, obesity and testosterone levels in older men

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Abstract

Background: quality of life evaluated by Short-Form 36 (SF-36) is decreased in obesity and hypogonadism, but the importance of regional fat mass is unknown. In the present study, we evaluated associations between SF-36, regional fat deposits and bioavailable testosterone (BioT) in ageing men.
Methods: a population-based cross-sectional study in older men. Data included SF-36 questionnaires with the dimensions such as physical function, role limitations physical, bodily pain, general health, vitality, social function, role limitations emotional and mental health. Furthermore, waist, lean body mass (measured by dual X-ray absorptiometry), visceral adipose tissue and subcutaneous adipose tissue (SAT) (measured by magnetic resonance imaging) and BioT were established.
Results: five hundred and ninety-eight men aged 60–74 years were included. The SF-36 dimensions such as physical function, general health, vitality and role limitations functional were inversely associated with waist and SAT and positively associated with BioT. In multiple regression analysis, waist was the body composition measure with the strongest association with SF-36 dimension scores.
Conclusion: SF-36 dimension scores were more closely associated with central obesity than with BioT.
Clinical trial registration number: www.clinicaltrials.gov, NCT00155961.

Keywords: *testosterone, quality of life, body composition, MRI, DXA, men, older people, SF-36, population-based*

Introduction

Adiposity is a major component of the metabolic syndrome and an independent risk factor for the development of type 2 diabetes mellitus and cardiovascular disease [1]. Total fat mass is inversely associated with testosterone levels [2, 3] and regional fat distribution is important for testosterone activity. In healthy young men, visceral adipose tissue (VAT) correlated independently with bioavailable testosterone (BioT) levels [4]. Subcutaneous adipose tissue (SAT) comprises 80% of adipose tissue, and high SAT is strongly predictive of insulin resistance, inflammation and decreased adiponectin levels [5–7]. SAT was not, however, associated with BioT

†D. G. and T. L. N. contributed equally to the manuscript.