Hip-fracture type does not affect the functional outcome after acute in-patient rehabilitation: a study of 684 elderly women

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Aim. To investigate differences in the functional outcome between women sustaining cervical or trochanteric fractures of the hip.

Methods. We studied 684 of 736 women admitted consecutively to a rehabilitation hospital in Italy because of their first hip fracture. Functional recovery was assessed by using Barthel index scores. Fractures were classified as either cervical (n=335) or trochanteric (n=349) on the basis of surgical and radiographic findings.

Results. After acute in-patient rehabilitation, women with trochanteric fracture had a significantly lower Barthel index score than women with cervical fracture (median values were 85 and 90 respectively, interquartile ranges were 25 and 30 respectively, P=0.001). Length of stay in the hospital was significantly longer in women with trochanteric fractures (median was 37 days vs 36 days; interquartile range was 10 days vs 8 days, P=0.018). However, the differences between the two groups were no longer significant after adjustment for eight variables that affect functional ability in the same population (i.e., age, pressure ulcers, cognitive impairment, neurologic impairment, infections during the length of stay, bone mineral density, body mass index, and Barthel index scores assessed before rehabilitation). Furthermore, we found no significant differences in the change of Barthel index scores during rehabilitation and in Barthel index efficiency (change in the Barthel index score after rehabilitation divided by the length of stay in hospital) between the two groups of women.

Conclusion. After adjustment for several confounders, we did not show significant differences in the functional outcome between women with cervical or trochanteric fracture of the hip.

Key words: hip fractures, osteoporosis, rehabilitation, treatment, outcome

Many observations support the view that there are significant differences between women who sustain trochanteric fractures and those with cervical fractures of the hip. Trochanteric fractures are associated with a more severe and generalized bone loss, especially of the trabecular component as shown by bone mineral density (BMD) measurement at the proximal femur 1, 2 and spine, 3 and ultrasound determinations at the calcaneus. 1, 4 Consistently, previous vertebral fractures are twice as common in women with trochanteric fractures, 5 and at histomorphometric evaluations the trabecular bone volume, trabecular surface density, and mean wall thickness are all lower in patients with trochanteric fractures. 6 On the other side, cervical fractures are more related to both femoral and pelvic structure (higher values of the neck-shaft angle, increased acetabular bone width, failure of the outer diameter of the femur neck to expand with age). 7, 8 These features are likely related to height (greater in women with cervical fractures) and to the increased risk of inheriting the tendency to suffer a cervical fracture. 5 Further differences regard age and body weight: women with trochanteric fractures are older and thinner than those with cervical fractures. 5 The difference in body
weight depends on fat mass (but not lean mass) as shown by soft tissue body composition analysis performed by dual-energy X-ray absorptiometry (DXA); however, this result should be considered with caution, given the strong cross-correlation between fat and lean components of soft tissue. The presence of substantial differences between the two types of hip fractures is further supported by the observation that in women with bilateral non-contemporary fractures of the hip, the second one is most frequently of the same type as the initial fracture. Altogether, the data shown above indicate that women who sustain cervical or trochanteric fractures belong to two different populations. Besides differences in the pathogenesis, it has been suggested that hip-fracture type may be associated with a different functional outcome. This is a crucial issue, because up to 25% of hip-fracture patients may require long-term nursing home care and only 40% fully regain their pre-injury level of independence. Poor functional recovery contributes to the designation of hip fracture as a major public health problem in western society, which imposes a relevant economic burden on healthcare services and expedites the search for both pharmacological and non-pharmacological strategies for fracture prevention.

A precise definition of the prognostic role of hip-fracture type may help to optimize both preventive interventions and rehabilitation strategies. Unfortunately, studies on the association between hip-fracture type and functional outcome show inconsistent results.

Our aim was to investigate the prognostic role of hip-fracture type in functional recovery, taking into account the potential confounding role of several factors known to affect outcome after injury.

### Materials and Methods

**Patients**

The study was performed in a city with about one million inhabitants and many orthopaedic wards. We focused on women with hip fractures who had been sent to acute in-patient rehabilitation. We evaluated a total of 736 white women who had been consecutively admitted to our Division of Physical Medicine and Rehabilitation for first-time hip fractures. As few nonwhite elderly women live in Italy, this study focused on white women as patients. A total of 52 women were excluded from the study: 32 had hip fractures from either major trauma or cancer affecting bone, 12 could not be assessed because of death or acute diseases, four had arthroplasties at the contralateral hip that made impossible DXA assessment, and four refused to undergo DXA scan. The final study sample included 684 women who gave their informed consent to undergo DXA assessment.

**Outcome measures**

Functional evaluation, both at rehabilitation admission and at discharge from the rehabilitation hospital, was assessed by skilled physiatrists using the Barthel index (original version unchanged). The change in the Barthel index score after rehabilitation was calculated as follows: Barthel index score after rehabilitation – Barthel index score before rehabilitation. Eight factors that were significantly associated with the functional outcome after hip fracture in our rehabilitation hospital were recorded for each woman: age,
pressure ulcers (stage 2 or higher according to the classification from the National Pressure Ulcer Advisory Panel),\textsuperscript{30} cognitive impairment (Mini Mental State Examination < 24/30), neurologic impairment (impairment found at clinical examination due to neurologic diseases, \textit{i.e.} Parkinson’s disease, stroke with hemiplegia, paraparesis, monoparesis, tetraparesis or cerebellar syndrome, as previously defined),\textsuperscript{26} infections (all infections requiring antibiotic treatment during the length of stay), BMD assessed at the unfractured femur (region of interest = total proximal femur), body mass index (BMI) = weight/(height$^2$), and the Barthel index score assessed before rehabilitation. To calculate BMI, height was assessed by a standard method (with the patients standing) in the majority of the patients; 21 women, who could not keep the standing position, were measured supine. BMD was assessed at the unfractured femur by DXA (QDR 4500W, Hologic), and it was expressed as a T-score (BMD values were compared with the reference range of the young sex-matched population by using standard deviation units). The reference population T-score calculation was derived from the Third National Health and Nutrition Examination Survey (NHANES III). The percent coefficient of variation for repeated measures for total femur BMD in hip-fracture patients over three days was 1.8%. Hip fractures were classified as either cervical (n=335) or trochanteric (n=349) on the basis of surgical and radiographic findings.

The rehabilitation protocol was similar for patients with cervical or trochanteric fractures.

\textbf{Statistical analysis}

Descriptive statistics for the women with cervical and trochanteric fractures are shown in Table I. Comparisons between the two groups were made by an unpaired T-test for normal variables and by a Mann-Whitney test for non-normal variables. To adjust the data for potential confounding variables, we performed a linear multiple regression analysis: the eight prognostic factors listed above were included together with hip-fracture type as independent variables in a linear multiple regression model (dependent variable = Barthel index after rehabilitation). As the Barthel index score was non-normally distributed, area transformation was performed, using the formula $(r=1/2)/w$, where $w$ is the number of observations and $r$ is the rank, as previously described.\textsuperscript{27, 31} Linear multiple regression was also performed by substituting the change in the Barthel index score after rehabilitation or the Barthel index efficiency (normalized by area transformation) for the Barthel index score. Following area transformation of the dependent variables, the residuals were normally distributed in all regression models. Colinearity diagnostics showed that the percent of variance in each predictor that could not be accounted for by the other predictors was always greater than 75\% (no redundant predictors were found).

The statistical package used was SPSS, version 13.

\textbf{Results}

Barthel index scores assessed after rehabilitation were significantly lower in the 349 women with trochanteric fractures than in the 335 women with cervical fractures (median values were 85 and 90 respectively, interquartile ranges were 25 and 30 respectively, P=0.001), as shown in Figure 1. However, after adjustment for the eight confounding variables (\textit{i.e.}, age, pressure ulcers, cognitive impairment, neurologic impairment, infections, BMD, BMI, and Barthel index scores before rehabilitation), multiple regression analysis showed no significant associations between hip-fracture type and Barthel index scores assessed after rehabilitation. Results of multiple regression are shown in Table II. The results did not change when height and weight were substituted for BMI (data not
Changes in Barthel index scores during rehabilitation in the women with trochanteric fractures were not significantly different from those found in the women with cervical fractures: both median values (=35) and interquartile ranges (=15) were the same in the two groups (P=0.742). At linear multiple regression, no significant associations were found between hip-fracture type and change in the Barthel index scores during rehabilitation after correction for the eight prognostic factors (Table III). Length of stay in hospital was slightly longer in the women with trochanteric fractures: the median value was 37 days versus 36 days in the women with cervical fractures (interquartile range 10 days and eight days, respectively, P=0.018). However, hip-fracture type was not significantly associated with the length of stay in hospital at multiple regression, after correction for the eight prognostic factors (data not shown). Furthermore, we found no significant differences in the Barthel index efficiency between the two groups: median values was 1.094 in the women with cervical fractures and 1.0 in those with trochanteric fractures (interquartile range: 0.619 and 0.583, respectively; P=0.545).

**Discussion**

We found significant differences in Barthel index scores assessed before rehabilitation between women with trochanteric or cervical fracture of the hip. This significant difference persisted after acute in-patient rehabilitation. The length of stay in the hospital was significantly different between the two groups of women. However, the differences between the women with trochanteric or cervical fractures were small and were no longer significant after adjustment for the eight variables that affect functional outcome in the same population. Furthermore, we found no significant differences in the change of Barthel index scores during rehabilitation and in Barthel index efficiency between the two groups of women. Previous studies on the prognostic role of hip-fracture type in functional outcome showed conflicting results, though the majority of the previous reports showed a significantly worse function in the patients with trochanteric fractures. A large study evaluated the functional outcome in The Netherlands and Sweden. Patients with cervical fractures were more likely to be discharged to independent living. The same authors showed that in a sample of 837 patients rehabilitated in primary health care, fracture type was significantly associated with some activities of daily living (ADL), i.e., dressing and personal hygiene, assessed four months after fracture. Trochanteric fracture was associated with higher risk of not continuing to live at home one year postoperatively in a group of 643 home-dwelling patients from the United Kingdom. A prospective study of 336 patients in the United States showed that
fracture type was associated with reduced ambulatory ability at a one-year follow-up.\textsuperscript{15} Our study differs from those quoted above because of three features. First, we focused on acute in-patient rehabilitation. Second, we assessed function by using the Barthel index. Third, we took into account the confounding role of several variables which affect function in our population of elderly women with hip fracture, as previously shown.\textsuperscript{25-29} Given multiple differences between our study and previous ones, we cannot point out a single factor underlying discrepancies in the results. However, we hypothesise that a pivotal role may be attributed to the confounders, because we actually showed a significant worse function in women with trochanteric fractures, but this result disappeared after adjustment by using a multivariate analysis. Our hypothesis is based on the known differences between women who sustain cervical or trochanteric fractures of the hip;\textsuperscript{5} the factors associated to hip-fracture type may be the actual determinants of the prognostic differences between women who sustain trochanteric or cervical fracture. Interestingly, one previous report analysed the prognostic role of hip-fracture type by using a multivariate analysis approach: the authors assessed several parameters of functional outcome, showing that fracture type was not an independent prognostic factor, in agreement with our data.\textsuperscript{32}

In our sample, several factors including Barthel index score assessed before rehabilitation, cognitive impairment, age, neurologic impairment, BMI, infections, and BMD were significantly associated with the functional outcome. The role of all these variables has already been described.\textsuperscript{25-29}

Limitations of the study

This study has several limitations. Our sample included white women admitted to a single rehabilitation hospital in Italy, who agreed to be studied and who could be evaluated by DXA. As a consequence, our data is not generalizable to the overall population of patients who sustain hip fractures. We assessed the functional recovery after hip fracture by using only one functional scale (\textit{i.e.}, the Barthel index). However, the Barthel Index has been widely employed to evaluate the functional outcome after hip fracture, the role played by several prognostic factors in affecting the functional outcome, and the functional progress due to either rehabilitation or other treatments.\textsuperscript{23} We adjusted our results for several variables, but could not include among the potential confounders some factors that were associated with function either in our population (\textit{i.e.}, circulating levels of 25-hydroxyvitamin D and parathyroid hormone)\textsuperscript{31,33} or in other samples (\textit{i.e.}, pre-fracture level of functional ability, social support, depression, pain, some comorbidities, nutritional status, and postoperative delirium).\textsuperscript{23,34-44} Furthermore, we could not distinguish the prognostic effects exerted by fracture type and type of surgical procedure, because of the strong association between these two variables. We excluded from the study women who suffered from their second hip-fracture, because they could not undergo BMD assessment on the contralateral hip. The role of a previous hip fracture as a factor affecting ability to function has been poorly studied and results on this issue are controversial.\textsuperscript{45-47} Regardless, women suffering from a second non-contemporary hip fracture are less than 10\% of the total population of hip-fracture women.\textsuperscript{11,45,46} Finally, we did not collect data at a long term follow-up.

Conclusions

We studied a large sample of hip-fracture women admitted to acute in-patient rehabilitation. After adjustment for several confounders, we did not show significant differences in the functional outcome assessed by using the Barthel index score between women with cervical or trochanteric fracture.

References


