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Original article

Beyond mobility assessment: Timed up and go test and its relationship to osteoporosis and fracture risk

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ABSTRACT

Background: Fracture determinants are falls, bone fragility, imbalance, and decreased lower limb strength. The timed up and go (TUG) test assesses most of the fracture determinants.
Aim: To assess the relationship between mobility status using TUG test, bone mineral density (BMD), and different fracture risks predicted by different tools.
Methods: A case (TUG time > 20 seconds)–control (TUG ≤ 20 seconds) study comprised 66 patients and 72 controls. Participants were assessed for falls, fracture history, and BMD using dual energy X-ray absorptiometry; the estimated 10-year fracture risk was also calculated using both the World Health Organization fracture risk assessment tool and Garvan fracture risk calculator.
Results: Patients had a lower femoral BMD ($p = 0.009$), T score ($p = 0.003$), and Z score ($p = 0.001$). Femur neck osteoporosis had a higher number of patients ($p < 0.001$). Patients also had lower lumbar BMD ($p = 0.02$), T-score ($p = 0.02$), and Z-score ($p = 0.005$). The estimated 10-year fracture risk for hip and other osteoporotic fractures were higher among the patients using both fracture risk assessment tool and Garvan calculators.
Conclusion: Poor TUG test results are associated with lower BMD and higher estimated 10 year fracture risk.

1. Introduction

Osteoporosis is a major concern for health providers. The increased healthcare costs, morbidity, and mortality related to osteoporosis and osteoporotic fractures are major health concerns.[1] Therefore, an easy to implement, validated method for the assessment of risk of fractures is needed.[2]

The World Health Organization fracture risk assessment tool (FRAX)[3] and the Garvan fracture risk calculator[4] are both widely available tools in daily practice for individualized fracture risk prediction. These fracture risk prediction tools attempt to integrate many risk factors for osteoporotic fractures in order to produce a single estimation of the fracture risk. The risk factors for osteoporotic fractures include clinical factors such as age and history of fracture and measured parameters such as body mass index (BMI) and bone mineral density (BMD).[5] Currently, in clinical settings, BMD is the primary predictor of osteoporotic fractures.[6]

Unfortunately, less attention has been paid to the role of other risk factors for falling, such as reduced levels of physical activity, poor balance, and low physical performance. These factors have been overlooked as risks for osteoporotic fractures.[6] However, these factors, in addition to bone mass, are important determinants of the occurrence of most appendicular skeletal fractures.[7] Previous studies have suggested that poor mobility is associated with lower BMD[8] and leads to an increased fracture risk.[9] Therefore, fracture prediction models should include assessment of physical performance, along with skeletal structural risk, assessed by BMD.[7]

The timed up and go (TUG) test is a commonly used method of assessing functional mobility among older adults in geriatric clinics. The test measures speed during several functional maneuvers, including standing up, walking, turning, and sitting down. Limited training and equipment are required, so the test is convenient in clinical settings.[10] It is an integral measure of gait speed and balance in widespread clinical settings.[11]

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The aim of this study was to assess the relationship between mobility status using TUG test, BMD, and different fracture risks predicted by different tools.

1.1. Participants

A case–control study was conducted on 138 elderly individuals aged 60 years or older who attended the Osteoporosis Detection Unit in Ain Shams University Hospital, Cairo, Egypt, from August 2012 to March 2013.

Patients were 66 elderly individuals with poor mobility (TUG times >20 seconds) and the controls were 72 elderly individuals with good mobility (TUG results ≤ 20 seconds).

According to Podsiadlo and Richardson,[10] the interpretation of their TUG test results is as follows: TUG ≤ 10 seconds = normal; 10–20 seconds = good mobility, which means they can go out alone and can move without a gait aid; and 20–30 seconds = problems because they cannot go outside alone and require a gait aid.

Shumway Cook et al[12] suggested that the TUG score of ≥ 14 seconds indicated a high risk of falls. According to Hayes and Johnson,[13] there are no normal values available for TUG performance. However, all healthy community-dwelling elderly aged 65–84 years performed the test in ≤ 20 seconds without assistance[14]; meanwhile, frail elderly participants took 10–240 seconds to perform TUG, with 45 out of 57 individuals performing the test in < 40 seconds.[10] The test results of more than 20 seconds indicated the need for assistance, which was considered as a strong indicator of poor BMD compared with fall risk alone.[14] Individuals who could not perform the TUG test were excluded from the study.

2. Materials and methods

Data regarding the history of previous fractures and falls occurring within the last year were collected.

2.1. Anthropometric measures

Weight and height were measured at the time of bone densitometry measurements and the BMI was calculated.

Functional mobility was assessed using the TUG test, which was performed using an ordinary armchair and a stopwatch. Participants were seated with their back against the chair. They were instructed to stand up, walk for 3 m (to a mark on the floor), turn around, walk back to the chair, and then sit down. The task was done at the ordinary walking speed with participants wearing their usual footwear. Timed calculation in seconds started on the word "go" and stopped as the participant sat down. One untimed trial was allowed before testing. The test was conducted three times, and a mean value was calculated for study.[10]

2.2. BMD measurement

Bone densitometry was performed on all participants using dual energy X-ray absorptiometry (DXA; Lunar DpX+_MD Pencil scanner with software version 1.3 g; Lunar Radiation, Madison, WI, USA). The scanning was done in the supine position; the examined areas were lumbar vertebrae and left femoral neck. The graph showed a total BMD in g/cm, in relation to age, its age-matched percentage (Z-score), its peak reference percentage (T-score) with consideration of patient sex, weight, and height. World Health Organization definitions were used to define osteoporosis, which is the T-score of −2.5 or less.[15]

2.3. Estimated fracture risk calculation

The baseline data were used to calculate the estimated 10-year risk of fracture using the FRAX–Palestine and Garvan calculator. FRAX–Palestine was selected because Palestine has an osteoporosis epidemiology that is close to the osteoporosis epidemiology of Egypt, which is not represented in the FRAX assessment. The age, sex, BMI, history of personal fracture, history of parental hip fracture, smoking status, glucocorticoid use, alcohol intake, presence of rheumatoid arthritis or secondary osteoporosis, and femoral neck BMD T-score were entered into the online FRAX–Palestine assessment tool.[3]

Age, sex, femoral neck BMD T-score, number of falls within the past year, and the number of fractures since the age of 50 years were also entered into the online Garvan calculator assessment tool.[4] The estimated 10-year probability of hip and osteoporotic fragility fractures were obtained for each of the individuals using both calculators.

2.4. Ethical considerations

The study methodology was reviewed and approved by the ethical committee of the Faculty of Medicine, Ain Shams University. Informed consent was obtained from all participants in this study.

2.5. Statistical methods

The collected data were coded, tabulated, revised, and statistically analyzed using SPSS version 16 (SPSS, Chicago, IL, USA). Quantitative variables were presented in the form of means and standard deviation. Qualitative variables were presented in the form of frequency tables (number and percent). Comparison of two quantitative variables was performed using the Student *t* test, while multiple variables and multiple comparisons were done by both one-way analysis of variance and *posthoc* (least significant difference) tests. The qualitative variables were compared using the χ^2 test. Linear regression analysis was performed in order to identify the variables that were independently associated with FRAX T-score estimated hip fracture. A p-value < 0.05 was considered statistically significant.

3. Results

A comparison of demographic characteristics between patients and controls is shown in Table 1. There was matched demography for age and sex in patient and control groups. The most common comorbidities amongst our population were hypertension (37.7%), diabetes mellitus (26.8%), osteoarthritis (21.7%), ischemic heart disease (20.3%), and cerebrovascular stroke (2.89%) (See Supplementary Table). Patients showed a higher BMI (31.20 ± 8.56 kg/m^2), higher number of falls in the last year (1.79 ± 2.03), and a higher number of previous fractures (0.36 ± 0.65) compared with the controls (28.34 ± 7.12 kg/m^2, 1 ± 1.79, and 0.22 ± 0.45; $p = 0.03$, 0.017, and 0.004, respectively). BMD (0.78 ± 0.16 g/cm^2), femoral T-scores (−1.89 ± 1.15), and femoral Z-scores (−0.67 ± 0.098) of patients were significantly worse compared with those of controls (0.85 ± 0.13 g/cm^2, −1.33 ± 1.03, and −0.06 ± 1.05; $p = 0.009$, 0.003, and 0.001, respectively). Osteoporosis prevalence at the femoral neck was highly significant in these patients compared with the controls ($p \leq 0.001$). DXA results of the lumbar vertebrae showed significantly worse results for BMD ($p = 0.02$), T-score ($p = 0.02$), and Z-score ($p = 0.005$) for patients who had a higher prevalence of osteoporosis ($p = 0.014$; Table 1).