

# Indices of risk assessment of fracture of the proximal humerus

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## Summary

**Osteoporotic fractures are now a social problem for incidence and costs. Fractures of the proximal humerus events are frequent and constantly increasing. It is estimated that they are 20% of all osteoporotic fractures. Bone densitometry in most cases underestimates the real humeral bone density.**

**There is little information about osteoporotic changes in the proximal humerus and their association with the cortical thickness of the humeral shaft. The ratio between the thickness of the cortical and the total diameter of the humeral diaphysis is the cortical index. Fracture risk limit value is 0.231.**

**Convinced of the need to quantify in a reproducible way the real local humerus bone density, we performed a comparative evaluation of bone density of the humerus and femur in patients admitted to our clinic for fractures of the humerus and femur.**

**We evaluated 28 women treated surgically for a fragility fracture of the proximal humerus or femur neck in 2010. All cortical index obtained were lower than the limit for fracture risk set at 0.231, so the IC was more predictive of neck medial fractures of the femur than had DEXA and the U.S. The information about the cortical index may provide a simple way of determining the bone quality of the proximal humerus and of facilitating decision-making in the surgical treatment of patients with fractures of the humerus. So we want to emphasize the importance of therapy for osteoporosis even in patients with fractures of the proximal humerus, which often have not critical densitometric values of femur or column, but they are at risk of new fractures.**

*KEY WORDS: osteoporosis; cortical humerus index; prediction.*

## Introduction

Osteoporotic fractures are now a social problem for incidence and costs. A reduction of bone mass and osteoporotic bone chan-

ges, especially in the elderly, have been shown to result in a higher risk of fracture of the vertebral bodies, distal radius, proximal femur and proximal humerus (1). Fractures of the proximal humerus events are frequent and constantly increasing. It is estimated that they are 20% of all osteoporotic fractures (2). In addition, they are also an important prognostic factor for the occurrence of additional fracture events. It is estimated that a fracture of the humerus increases of 6 times the risk of fracture neck of femur within one year after the first traumatic event (3). These fractures affect 75% of cases in patients over 65 years of age (Figure 1), and treatment was conservative in 80% of cases (4).

To measure the density (BMD) commonly use the dual-emission X-Ray absorptiometry DEXA performed at the femur or the lumbar spine. Alternatively, use the heel ultrasound (U.S.). Consequently, the assessment of bone quality in the humerus may be incorrect.

For making measurements of the bone mineral density (BMD) in a peripheral part of the body we could utilize also peripheral quantitative computer tomography, commonly abbreviated pQCT, that is a type of quantitative computed tomography (QCT). It is useful for measuring bone strength but it is expensive and not a very reproducible method (5).

Bone densitometry in most cases underestimates the real humeral bone density. In literature studies it emerges that the wrist has densitometry values less than 5 times the patient to other districts. So even the humerus, which has characteristics closer to the wrist will have a lower bone density compared to femur and spine (6).

The proximal humerus bone quality assessment has a key role in choosing the appropriate surgical treatment much more than the other parts of the body (7). In fact, the failures caused by incorrect use of fixation in the humerus has a high percentage. In fact the 3 prognostic factors of success in the surgical treatment of fractures of the proximal humerus are the age, the reduction of anatomic medial calcar and BMD (8).

There is little information about osteoporotic changes in the proximal humerus and their association with the cortical thickness of the



Figure 1 - Displaced fracture of the proximal humerus.

humeral shaft (9). A simple technique which allows determination of the bone quality of the proximal humerus could help in surgical decision-making when selecting a method of repair of a fracture. For example, it may be possible to predict the security of screw fixation in bone. Usually, immediately after a fracture only radiographs are available and therefore it would be ideal to develop a technique which used radiography for the assessment of osteoporosis and the cortical thickness of the proximal humerus (10). Determination of cortical thickness as a predictor of mineralization of the skeleton was first reported in 1960 by Barnett and Nordin. Since then, measurements of the cortical thickness of the femoral shaft and metacarpals have been used extensively to estimate osteoporotic changes in bone (11). The ratio between the thickness of the cortical and the total diameter of the humeral diaphysis is the cortical index. Fracture risk limit value is 0.231. The cortical index is a morphometric index and also an index of involution of the bone (12). Convinced of the need to quantify in a reproducible way the real local humerus bone density, we performed a comparative evaluation of bone density of the humerus and femur in patients admitted to our clinic for fractures of the humerus and femur.

**Materials and methods**

In our study, we evaluated 28 women treated surgically for a fragility fracture of the proximal humerus or femur neck in 2010. None case of secondary osteoporosis. The patients were divided into three groups. The first group consists of 9 patients with fractures of the proximal epiphysis of the humerus, the second 10 patients with medial femoral neck fracture and the third group consists of 7 patients with lateral femur neck fracture. The average age of the first group is 74.8 years, 83.05 years for the second group and 85 years for the third. All the patients during hospitalization were being examined with densitometry (DEXA spine and femur) and U.S. (heel). We calculated the humeral cortical index (IC) of all assessable patients with a Rx humeral AP with a simple formula:

$$(X-Z) / Z$$

Where Z is the diameter of the humeral shaft and X is the diameter of the medullary (Figure 2).

**Results**

The average densitometric values relative to the first group (humerus fracture) were respectively -2 (U.S. to heel), -2.7 (DEXA at the spine) and -2.63 (DEXA at the femoral neck); in the second group instead we found a mean value of -1.8 (DEXA at the spine) and -1.9 (DEXA femoral neck) and -1.9 (U.S. to heel); in the third group, finally, the average value was -3.9 (U.S. to heel), -2, 6 (DEXA at the spine) and -2.5 (DEXA at the femoral neck) (Table 1). The average cortical index in the first group was found to be 0.201, that of group 2 was 0.223 and that of group 3 was 0.218 (Table 2).

Table 1 - Average densitometric values.

	DEXA SPINE	DEXA FEMUR	US HEEL
GROUP 1 (HUMERUS AVERAGE AGE 74.8 YEARS OLD)	-2.7	-2.63	-2.0
GROUP 2 (MEDIAL FEMORAL NECK AVERAGE AGE 83.05 YEARS OLD)	-1.8	-1.9	-1.9
GROUP 3 ( LATERAL FEMORAL NECK AVERAGE AGE 85 YEARS OLD)	-2.6	-2.5	-3.9

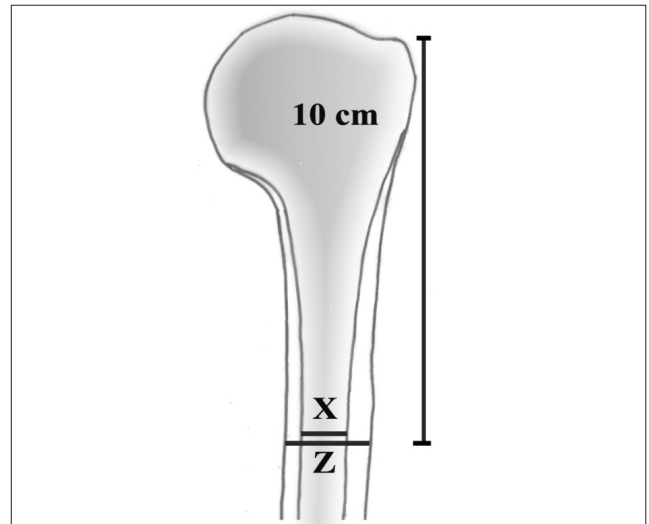


Figure 2 - It shows how to calculate the Cortical Index in humerus.

Table 2 - Average cortical index values.

	CORTICAL INDEX
Group 1	0.201
Group 2	0.223
Group 3	0.218

**Discussion**

All cortical index were lower than the limit for fracture risk set at 0.231. Even the IC was more predictive of neck medial fractures of the femur than had DEXA and the U.S. that indicated only a state of osteopenia. From the obtained results we can observe that fractures of the proximal humerus have affected relatively younger subjects than those with femoral neck fracture (Figure 3). However, the densitometric values of these patients are worse than those found in the group of older women who have a fracture of the medial femoral neck. In addition, the proximal epiphysis of the humerus is anatomically and biomechanically comparable to the medial femoral. We must remember that the lateral fractures of the femur neck (group 3) occur for trauma with higher kinetic energy than the medial fractures and our control group was the one with the highest average age. The results obtained by densitometry in patients with osteoporotic wrist is 5 times lower than those shown to occur in other districts. The upper limb is an anatomical region whose loads are lower than in other parts of the body and has a greater and earlier bone resorption than in femur and spine. Furthermore, we believe that any injury to the rotator cuff contributes to reduction of bone density in the humeral head due to a reduction of the function.



Figure 3 - Proximal humerus fracture in a young woman.

The extreme lack of bone mass in the humerus makes the surgical synthesis very difficult. This is the reason why many international studies questioning the choice of appropriate means of synthesis.

The information about the cortical index may provide a simple way of determining the bone quality of the proximal humerus and of facilitating decision-making in the surgical treatment of patients with fractures of the humerus.

So we want to emphasize the importance of therapy for osteoporosis even in patients with fractures of the proximal humerus, which often have not critical densitometric values of femur or column, but they are at risk of new fractures. When we decide the treatment of postmenopausal patients is necessary to perform a

careful risk assessment of fracture of the humerus, which may use, as well clinical-anamnestic data and densitometric, even the estimate of the cortical index.

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