LOWER LIMB STRUCTURE AND FUNCTION PREDICT BONE DENSITY OF THE PROXIMAL TIBIA

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INTRODUCTION

Hardening of subchondral bone is a hallmark of advanced osteoarthritis (OA) and is suspected to play a role in the pathogenesis of the disease[1]. Frontal plane knee alignment and moments have been linked to both subchondral bone mineral density (BMD) of the proximal tibia and knee OA[2, 3, 5]. The severity of knee OA has also been linked with medial tibial torsion and limited hip mobility; however, their association with tibial BMD has not been studied[6, 7]. This experiment determined if measures of lower limb structure and function could be used to predict BMD of the proximal tibia.

METHODS

Fifty healthy limbs from 17 females and 8 males; average age: 34 (21-56); average BMI: 24.7 (21.2-28.0) were studied. Eight cameras operating at 120 Hz (Eagle; Motion Analysis Corporation, CA) and 2 force plates operating at 480 Hz (AMTI; MA) were used to collect gait data using a standard Helen Hayes marker set. Orthotrac software calculated the varus/valgus knee angles and moments.

Ultrasound (Sonosite 180plus; MA) was used to image the planes of the posterior tibial plateau and the distal anterior capsular margin. A digital inclinometer (AeroAngle PRO 160, Macklanburg-Duncan, OK) was mounted on the transducer to measure the angular difference between the proximal and distal landmarks. Subjects sat with the foot secured in a custom frame mounted on the wall with the knee flexed and the tibia parallel to the floor (Figure 1).

Hip internal and external rotations were measured using the inclinometer with subjects prone and the knees flexed. A hip rotation index was calculated as the difference between internal and external rotation.

Figure 1. Distal tibial measurement. The arrow points to ultrasound image of the anterior capsular margin; the inclinometer measures the tilt of the transducer when the image is horizontal on the screen.

BMD within the medial and lateral compartments of the proximal tibia was measured using dual energy x-ray absorptiometry (Hologic Delphi W; MA). Compartment widths were ½ the proximal tibia width, and the height was from the cortical line to the superior margin of the fibular head.

Simple and forward stepwise regression was used to determine if maximal knee varus, maximal abduction moments, the hip rotation index and tibial torsion could predict the ratio of the medial to lateral compartment BMD in the proximal tibia.

RESULTS AND DISCUSSION

The hip rotation index, tibial torsion, knee alignment and abduction moments were able to predict a significant portion of the variance associated with BMD distribution ($r^2 = 0.68$; $p = 0.004$). Individual relationships determined from simple regression are listed below (Table 1).

Table 1. Results of simple regression analyses.

Variable	r	sig.
hip rotation index	-0.58	0.001
tibial torsion	-0.40	0.004
abduction moment	0.40	0.005
knee alignment	-0.16	0.318

These results indicate that limb structure and function contribute significantly to BMD of the proximal tibia. Hip rotation and tibial torsion had not previously been investigated and appear to play an important role in this relationship. Knee alignment was less important in this experiment than previously reported[4]

CONCLUSIONS

Limited internal rotation of the hip and medial tibial torsion were related to increased subchondral BMD in the medial compartment of the proximal tibia, and may play a role in the pathogenesis of knee OA.

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