EFFECTS OF AREA SELECTION CHOICE ON QUANTIFYING PROXIMAL TIBIA BONE DENSITY

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INTRODUCTION

Previous research on osteoarthritic gait has demonstrated an important link between abnormal joint loading and bone mineral density (BMD). Patients with medial compartment knee osteoarthritis (OA) have large knee abduction moments and elevated proximal tibia BMD (Wada et al., 2001). There is an associated link between increased BMD and osteoarthritis, however the causative relationship is not clear (Hurwitz et al., 2001). Osteoarthritis is a degradation of articular cartilage, nonetheless, Radin and Rose (1986) have suggested that OA is initiated by or prompted to progress by increased density of subchondral bone. Therefore, quantifying bone mineral density may be important to understanding the progression of OA.

Hurwitz and colleagues (1998) reported a strong link between medial/lateral distribution of proximal tibia BMD and internal knee abduction moment, where larger abduction moments (representing larger medial joint forces) are associated with larger medial/lateral BMD ratios. Hurwitz et al (1998) used the midline of the proximal tibia to separate the medial and lateral compartments. However, it is conceivable that using the midline as a medial/lateral divider may result in the bone density quantification to over or underestimate the distribution of knee joint load. Therefore, the purpose of this study was to assess choice of proximal tibia bone mineral density quantification (three medial/lateral width and two height techniques) and subsequent correlations with internal knee abduction moment during walking.

METHODS

Fourteen males and 18 females (M_{age} = 39.1 ± 15.3 yrs; M_{height} = 172.9 ± 10.6 cm; M_{mass} = 76.0 ± 15.1 kg) with asymptomatic knees served as subjects. Gait and BMD data were obtained from both legs (n=64) for analysis.

To obtain data used in calculating gait mechanics, lightweight reflective markers were placed bilaterally on the legs and feet of the subject using the Helen Hayes marker set. Motion analysis cameras captured three-dimensional position data (60Hz) of these markers and a force platform captured ground reaction force data (480Hz) as the subject walked at their freely chosen speed overground along a 20-meter walkway. Peak net internal abduction moments for the knee (MK_{abd}) of both legs were determined using an inverse dynamics approach and normalized to body mass (Orthotrak software, Motion Analysis Corporation).

BMD of the knee was measured bilaterally via dual energy x-ray absorptiometry (Hologic Delphi W). Medial and lateral compartments of the proximal tibia were divided using three methods: 1) 50% medial, 50% lateral, 2) 40% medial, 20% middle, 40% lateral, and 3) 33% medial, 33% middle, 33% lateral. The middle region's BMD was not quantified. Height of the compartment area was quantified using two methods: 1) full height – from tibial plateau to the superior surface of the fibular head, and 2) half height – the proximal half of the full height. BMD ratio was calculated as medial BMD/lateral BMD for a total of six areas (3 medial/lateral methods by 2 height methods).

Pearson product moment correlations were calculated between MK_{abd} and each of the six BMD ratios.

RESULTS AND DISCUSSION

The mean MK_{abd} was 0.43 (sd=0.15) Nm/kg. Med/lat BMD ratios ranged from 1.16 (sd=0.08) for the 40% med/lat full height method to 1.26 (sd=0.14) for the 33% med/lat half height method. This range of BMD ratios is consistent with published data of asymptomatic knees, measured with the 50% width technique (Hurwitz et al., 1998).

The strongest correlation between knee abduction moment and proximal tibia medial/lateral BMD was 0.357, associated with the 40% med/lat full height method (Table 1). This method disregards the middle 20% of the proximal tibia, which may be susceptible to "cross-over" effects, where medial joint forces could potentially affect the lateral aspect of the tibia near the midline, and vice versa. Our correlation of 0.357 was smaller than the 0.556 correlation reported by Hurwitz et al. (1998).

The differences in correlations among the different medial/lateral quantification methods were smaller than the correlation differences between height techniques. Furthermore, our data suggest the full height area technique yields greater correlations.

SUMMARY/CONCLUSIONS

Our study demonstrated minor sensitivities in the selection of the proximal tibia medial/lateral compartment area when calculating the BMD ratio. Disregarding a small 20% middle portion of the proximal tibia when quantifying BMD may prove beneficial when conducting follow-up testing, where identifying the exact midline for the 50% med/lat method may be more prone to error.

REFERENCES

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Table 1: Pearson product moment correlations (p value) between MK_{abd} and each proximal tibia medial/lateral BMD ratio method (n=64 legs).

medial/lateral method	**50% med/lat**	**40% med/lat**	**33% med/lat**
height method			
full	0.326 (p=0.008)	0.357 (p=0.003)	0.317 (p=0.010)
half	0.231 (p=0.065)	0.238 (p=0.057)	0.213 (p=0.089)