REGIONAL OSTEOOPENIA FOLLOWING REPETITIVE OVERLOADING INJURIES OF THE TIBIA

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INTRODUCTION: Post fracture osteopenia of the extremities after a frank or traumatic fracture has been well documented. Localized bone mineral density (BMD) losses of up to 25 to 50% 3 to 6 months into the healing process are observed in the lower extremity. The mechanism of such rapid bone loss is thought to be related to disuse and/or local hyperemia stimulated resorption. Tibial stress fractures (TSF) and medial tibial stress syndrome (MTSS, "shin splints"), caused by repetitive overloading, also cause injury to bone the lower extremity and can be as debilitating as a frank fracture. However, the regional changes in BMD following TSF or MTSS and other repetitive use injuries are as yet unknown. We report an initial cross-sectional study of bone density changes in the tibia following documented TSF or MTSS in a group of running athletes. We hypothesized that these injuries should also result in persistent, localized bone loss near the site of injury as in frank fracture.

METHODS: Eight athletes from local collegiate lacrosse and track teams with a unilateral TSF or MTSS were recruited under institutional IRB approval. The subjects, 4 males and 4 females, were between the ages of 18 - 22 years, with a mean time since initial injury of 4.5 months (range, 2 - 8 months). Five suffered MTSS, confirmed by physician or physical therapist, and 3 subjects had a TSF, confirmed by bone scan. The BMD of the tibial shaft was determined by DXA in a region over the injury site (point of maximal pain), in sub-regions immediately proximal and distal to the site and for the "global" region (Fig 1). The GE-Lunar DPX-iQ DXA scanner was used with adaptation of the standard forearm software. The corresponding sub-regions in each subject's non-injured tibia were also measured and used as internal control. The standard proximal femur (hip) BMD in the non-involved side was used as an indicator of general skeletal density status. The percent difference in BMD between corresponding regions in the injured and non-injured tibia was the key output variables and the paired t-test was used for statistical comparisons to uninjured side.

RESULTS: Individually and on average, each subject lost bone density in the injured area relative to the contralateral limb in all sub-regions (mean 9.4 % – 12.6 %, p < 0.003) (Fig 2). All 3 sub-regions showed almost identical reduction in BMD. Every subject showed a reduced bone loss in the injured tibia (range 2 – 16 %, global) despite expected subject variations in absolute density. No significant differences in BMD loss were observed between TSF and MTSS subjects (global region mean loss: 9.8 ± 4.1 %; and 11.0 ± 5.8 %, respectively), permitting pooling of data at this early stage. Men and women had similar losses and all subjects had average or above global hip T-scores. The density loss on the injured side showed no substantial trend with time since initial injury (Fig 3).

DISCUSSION: These findings suggest that there is a significant decrease (global average 10.3 %) in regional BMD surrounding a TSF or MTSS that persists at least for 2 to 8 months after initial injury. Similarly, Magnusson, et.al,1 found athletes with MTSS to have lower BMD at the tibial site of pain than both asymptomatic non-athletic and athletic controls (15 ± 9%, 23 ± 8% respectively). Those authors did not find significantly decreased BMD in the affected vs. unaffected legs of athletes with unilateral symptoms, but did identify significantly lower BMD at the region of pain in the unaffected leg of athletes with unilateral symptoms compared to controls. Their findings suggest that athletes with MTSS may be predisposed to this injury by virtue of relatively lower BMD. This is in contrast to our findings, where BMD was significantly lower in the affected than in the unaffected leg for subjects with both MTSS and TSF. Our findings suggest that a substantial portion of the regional density loss is likely due to post-injury disuse, including repair-induced hyperemia and remodeling. However, in the present study, it was not possible to determine how much, if any, of the bone loss was present before the injury was manifest. Because our study did not include an asymptomatic athletic control group, it is possible that generalized BMD may be lower in these affected athletes than in such a control population. The apparent similarity between bone loss in MTSS and TSF may reflect the theorized close relationship of these two types of injury. Longitudinal studies will be required to examine these questions, the relationship of other factors, and the long-term consequences of this bone loss.

Acknowledgement: Special thanks to Timothy Neal, M.S, ATC, and Jennifer Ratcliff, M.D. for their assistance.