POST-TRAUMATIC BONE LOSS IN CIVIL WAR SOLDIERS

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INTRODUCTION

This research explores the relationship between bone mineral density, physical activity, and lifestyle in Civil War soldiers, 19th-century civilians, and contemporary white males. To better understand factors leading to low bone density in young adults, this investigation first quantifies bone mineral density in 19th-century civilians, Civil War soldiers who died soon after receiving mortal injuries (less than 15 days), Civil War soldiers who lived longer than 15 days after injury, and modern individuals. This study then tracks the rate at which incapacitated soldiers lose bone density after traumatic injury. By examining the rate of bone loss after a crippling injury, we can appreciate the effects of severe trauma and immobility on bone mineral density. Broadly, this study explores how the lifestyles of modern white males compare with their active 19th-century counterparts, and, more specifically, it illustrates the effects of physical activity on bone mineral density.

MATERIALS AND METHODS

This study examined four samples of white males between the ages of 18 and 40 years. Femora from modern individuals (n=58) were obtained from the William Bass Donated Body collection at the University of Tennessee, Texas State University at San Marcos, and the Smithsonian Institution. The three 19th-century samples: civilians (n=11), Civil War soldiers who lived less than 15 days after injury (n=30), and Civil War soldiers who lived longer than 15 days after injury (n=54) were obtained from the National Museum of Health and Medicine, the Bureau of Reclamation, and other donors.

Fig. 1. Right femur of Second Lieutenant G.A.C. This femur shows evidence of a gunshot fracture. The patient lived 340 days after injury and died from exhaustion. Photo by Chip Clark.

Fig. 2. Femur in the process of being scanned by a Dual-Energy X-Ray Absorptiometry Instrument. Photo by Alexis Goots.

The femora were scanned at the Washington Hospital Center by a GE Lunar Prodigy Dual-Energy X-Ray Absorptiometry instrument, an accepted method for measuring bone density in living patients. This type of equipment has also been used in studies of archaeological remains to assess the occurrence of osteoporosis in older adults (Lees *et al.* 1993; Mays 1998; Mays 2006). The scans were performed with the aid of a radiographic technician and measured density in the femoral neck. Neck densities of modern and 19th-century men were compared using analysis of variance. Linear regression was then used to evaluate the relationship between length of life after sustaining mortal pelvic or femoral injuries and femur bone density in severely wounded soldiers. Statistical analyses were performed using SAS Enterprise Guide 4.2.

RESULTS

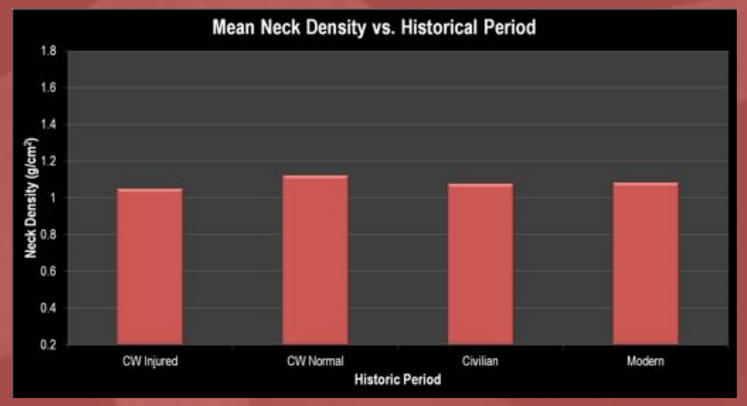

Fig. 3. Bone mineral density values among 19th-century civilians, Civil War soldiers who died of perimortem injuries, and modern young adult males are not statistically different.

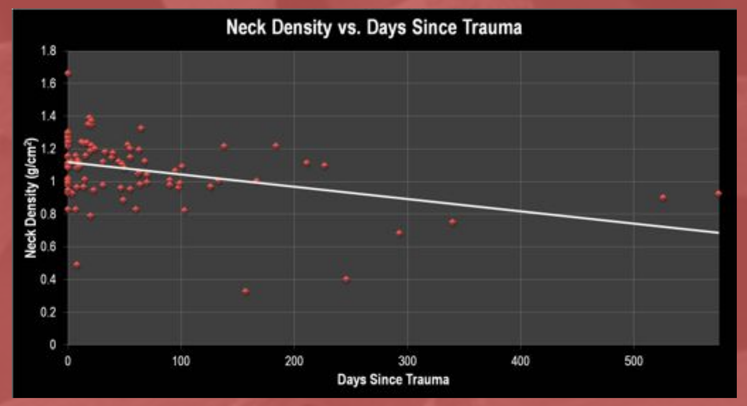

Fig. 4. The results show a significant correlation between immobilizing injury and decreasing bone density measured over a span of 575 days. The correlation between neck density and number of days since trauma has an r-value of -0.37292. This negative correlation implies that the longer a soldier lives with an immobilizing injury, the lower the density of his injured leg at death due to declining health and a reduction in weight-bearing post-trauma.

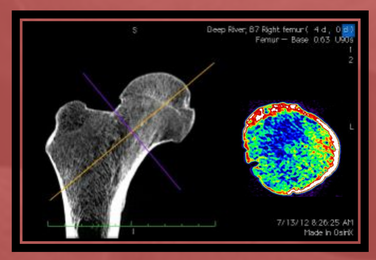

Fig. 5. CT scan of a femoral neck with high bone density. The white, red, yellow, and green regions are more dense than the blue region. CT imagery by Dr. Bruno Frohlich.

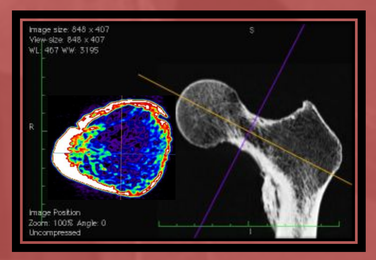

Fig. 6. CT scan of a femoral neck with normal bone density. Note the lack of green relative to Fig.5. The blue region is less dense than the green region. CT imagery by Dr. Bruno Frohlich.

DISCUSSION

The lack of a statistically significant difference in bone mineral density across time is interesting given the perception of greater physical activity and a more strenuous lifestyle of 19th-century Americans. However, modern white males are larger than their Civil War counterparts (Kolata 2006). Research has shown that carrying more weight leads to an increase in bone density of weight-bearing bones like the femur (Felson *et al.* 1993). Perhaps the larger size of modern individuals counteracts the less strenuous lifestyle that is perceived to be characteristic of contemporary American society. Gage (2005) posits that, despite modern changes in nutrition, smoking, exercise, and stress, humans are no less healthy, in terms of degenerative diseases like osteoporosis, in their contemporary environment than they were 200 years ago. The results of this study also quantify the effect of immobility on bone density. Upon admission to hospitals, wounded Civil War soldiers were laid on straw mats until their injuries could be treated, which sometimes involved amputation. Bone infections and septicemia were common, and, in the wounded series, ultimately contributed to the deaths of many of these soldiers. Wounded men were confined to their beds and treated with what was known as “absolute rest” (Adams 1985). Injury and a consequent period of restricted mobility, as these wounded soldiers experienced, can produce enlarged cortical bone Haversian canals, decreased cancellous bone, and cortical bone thinning, indicating the onset of osteopenia from a loss in bone density (Schultz 2003). The correlation coefficient between neck density and days since trauma indicates a moderately negative relationship between the two variables. Incapacitation, loss of weight-bearing capability, and declining health led to a perceptible decrease in femoral neck density within two to three months.

CONCLUSION

This study is the first to quantify the difference in bone mineral density in young American adults across time and also breaks ground in its quantification of bone loss after traumatic injury. This project has clinical implications, as it emphasizes the importance of keeping patients active after surgery to avoid bone loss.

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