A45 The Impact of Bone Density and Bone Thickness on Gunshot Trauma to the Skull

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Learning Overview: After attending this presentation, attendees will gain awareness of: (1) how bone mineral density and bone mineral content affect the propagation of radiating fractures and the overall fragmentation of the skull following a gunshot wound; and (2) how bone thickness affects the size and mozphology of entrance and exit wounds.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating and discussing how bone density and bone thickness affect the formation of radiating fractures and the size/shape of entrance and exit wounds.

A greater understanding of the tissue density in the region of the gunshot may allow researchers greater estimation powers when estimating bullet caliber.[1] Bone mineral density and mineral content represent an understudied and potentially fruitful avenue of gunshot research. Here, measurements of bone mineral density are utilized to assess the density of tissue at the point of gunshot impact and the effect that differing densities have on the morphology of entrance and exit wounds, as well as on radiating fractures.

Forty-five adult human heads from individuals donated to an anatomical tissue supply company were obtained for traumatic analysis. A specially designed shooting stand was constructed to hold each head at a height matching that of an average adult male. Individuals were shot once in either the frontal bone (superior to glabella), temporal, or parietal bone (in the approximate region of euryon) with a Smith and Wesson revolver with a $1^{7}/_{8}$-inch barrel loaded with .38 Special bullets. Bullets used were full metal jacket and jacketed hollow points, and these were chosen at random and equally distributed.

The heads were processed using standard maceration techniques prior to being scanned for bone mineral density and bone mineral content using Dual Energy X-ray Absorptiometry (DEXA). Bone thickness was measured within 5mm of the entrance and exit wounds using spreading calipers. The radiating fractures were measured using a Scale Master digital plan measure. Fragmentation of the skull was assessed by sorting individuals into categories based on degree of fragmentation: 1=no fragmentation; 2=partial fragmentation, but wound shape still evident; 3=partial fragmentation, wound shape obscured; and 4=complete fragmentation. Shape of the entrance and exit wounds was assessed using the circularity function in the image processing program ImageJ.

A Pearson product-moment correlation analysis was performed to assess the relationship between bone mineral density, bone mineral content, and bone thickness (entrance and exit) and the size/morphology of entrance and exit wounds, the extent of radiating fracture formation, and the degree of fragmentation of the skull (significance set at p=.05). Preliminary results indicate there is no significant correlation between bone mineral density and bone mineral content and the size of entrance and exit wounds. There are moderate negative correlations between bone mineral density and bone mineral content and the total length of the exit wound radiating fractures (r=-.492, p=.013; r=-.505,p=.010), the maximum length of the exit wound radiating fractures (r=-.562, p=.003; r=-.543, p=.005), and the degree of fragmentation (r=-.427, p=.010; r=-.421, p=.021). Entrance wound thickness had a slight positive correlation with entrance wound perimeter (r=.336, p=.028) and a slight negative correlation with entrance wound circularity (r=-.325, p=.033). Exit wound thickness had no significant correlations, nor did exit wound size or shape.

These results have implications for future gunshot wound analysis, as they suggest that bone mineral density and bone mineral content have more of an effect on the propagation of radiating fractures and the degree of fragmentation of the skull than they do on entrance and exit wound size and shape. These data also suggest that bone thickness near the entrance wound affects entrance wound size and shape. Future research will focus on how this knowledge of the effects of bone density and bone thickness can help distinguish between bullet types and perhaps also bullet calibers.

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Reference(s):

1. Anna Paschall and Ann H. Ross. Bone Mineral Density and Wounding Capacity of Handguns: Implications for Estimation of Caliber. *International Journal of Legal Medicine*. 131, no. 1 (2017): 161-166.

Gunshot Analysis, Bone Mineral Density, Radiating Fracture Analysis