H10 Long Bone Healing Following Trauma

Lenore Barbian, PhD*, *Department of History & Anthropology, Edinboro University of Pennsylvania, Edinboro, PA 16444*

The goal of this presentation is to offer information on the timing of macroscopically observable osseous changes related to long bone healing for an historic skeletal sample and compare these observations to those previously reported for cranial fractures.

This presentation will impact the forensic community by contributing to the available research on fracture healing rates by providing a non-destructive method to assess fracture healing. The data presented here can be used to aid investigators in more accurately predicting time since injury in forensic settings.

The analysis of fractures in dry bone is of considerable medicolegal importance and can contribute significant information on the cause and timing of death. However, much remains to be learned about the timing of specific bony responses during the healing process. A previous study has already explored the timing of initial bony response to injury in regard to cranial fractures (Barbian and Sledzik 2008)[1]. Using the same historic sample, this study further investigates the macroscopic timing and appearance of fracture healing in long bone specimens.

The Civil War skeletal collection at the National Museum of Health and Medicine, Washington, DC represents a collection with detailed case history reports that make it possible to compute the time elapsed from insult to recovery, amputation, or death. From this collection, a sample of humeri and femora specimens with gunshot wound fractures were selected for observation (n=262). Each specimen was macroscopically examined and scored for the presence or absence of any bony response. This presentation will report on the rates of four bony responses around the fracture area: osteoblastic response, osteoclastic response, line of demarcation, and sequestration. Osteoblastic response was defined as any bone building response including the deposition of subperiosteal new bone, rounding of the fracture margins, or the presence of areas of woven bone. Osteoclastic response was defined as areas of pitting, exposure of the diploë, or other bone resorptive response. A line of demarcation was seen as an "etched" line running adjacent to the fracture margins and appearing as a shallow depression. Sequestration was noted when a segment of bone was becoming necrosed.

A comparison of the findings from this study with the previous one reveals that the osteoclastic, osteoblastic, and line of demarcation responses show a similar pattern to that recorded for cranial fractures. Specifically for the clastic and blastic responses, there is a clear trend of increasing frequency in the weeks post-fracture with over 80% of the sample demonstrating a response by the sixth week post-fracture. For the line of demarcation, there is an increasing prevalence of this response through the fifth week post-fracture followed by a decrease in frequency in the sixth and subsequent weeks.

Different from the cranial fracture study is the onset and prevalence rates of the bony responses. The cranial fracture healing study found that the osteoclastic response can occur earlier than the osteoblastic response. While this finding is not supported by the long bone data, the frequency of osteoclastic response in long bones is slightly higher than that of the osteoblastic response through the second week post-fracture. The most notable finding from this study is the prevalence of all the bony responses during the first week post-fracture. In fact all four bony responses were scored as present during the first week post-fracture and over 41% of the first week post-fracture specimens displayed at least one osseous response. In comparison, the cranial fracture study found an initial latency period of approximately one to two weeks for each of the four osseous responses scored. Although it has been long recognized that cranial bone responds differently to fracture (Sevitt 1981)[2], the long bone rates of osseous response during the first week post-fracture still seem remarkable. The cranial healing study found that the earliest bony response occurred five days post-fracture. However, the long bone data suggest that some individuals are manifesting a bony response in less than five days. This occurs most frequently for the osteoclastic (n=33) and osteoblastic (n=32) responses although line of demarcation (n=3) and sequestration (n=3) are also represented. This appears to be in direct contradiction to our current understanding of the bone healing process.

While these results may seem surprising, it should be noted that at least some of the bony responses scored during the first five days post-fracture do not appear to be consistent with the initial osseous response to trauma, but rather appear to be more consistent with longer term bony changes. This would appear to be the case with the observations of sequestration as well as the some of the osteoblastic responses which were associated with rounded fracture margins (n = 8) or the deposition of areas of woven bone (n=8). It, therefore, seems likely that some of the bony lesions scored represent pre-existing conditions unrelated to the bony fracture per se. It is known that the health of Civil War soldiers was compromised due to a number of factors including nutrition, sanitation, and infectious disease vectors (Bollet 2002)[3], and these factors may help to explain the observations reported here. In forensic contexts determining the timing of multiple fractures is often important, and the initial results of this study suggests that macroscopic bony responses on fractured long bones may reflect more than simply fracture healing.

References:

1. Barbian L, Sledzik P. Healing following cranial trauma. J Forensic Sci 2008; 53: 263-268.

2. Sevitt S. Bone repair and fracture healing in man. Edinburgh: Churchill Livingstone, 1981.

3. Bollet AJ. Civil War medicine: challenges and triumphs. Tucson, Arizona: Galen Press, Ltd., 2002.

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