H107 Effect of Loading Environment on the Healing of Long Bone Fractures

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The educational goal of this presentation will examines the timing of the healing sequence in long bones, without the aid of modern medicine, and investigates the effects of loading on the appearance of healing stages.

This presentation will impact the forensic science community by examining the effects of various factors on the appearance of healing stages, practitioners will be better able to determine the timing of a particular traumatic event in cases of abuse and in the identification of postmortem remains.

There have been several studies done to create a timeline for the healing of fractures using a variety of technologies. With the exception of a study on crania, these have focused primarily on long bones. Though these studies roughly agree on the timing of important stages in the healing process, none has addressed the observed difference between weight-bearing and non- weight-bearing bones, especially during the critical callus formation stage. Previous work used a variety of long bones to increase the available sample size from clinical settings. By using a historical population and focusing on two analogous bones, this study uses an increased level of variable control to determine if this difference exists without the benefit of modern medicine and if it is significant.

The Civil War Collection at the National Museum of Health and Medicine was used for both its size and documentation. Only femora and humeri were utilized from this collection as they were analogous but in different loading environments and only those caused by shot fractures, treated by the removal of the affected bone, and with the necessary docu- mentation were included. This limited the sample size to 130 humeri and 62 femora. All the included fractures were comminuted. The healing stage of each specimen was noted and separate timelines created for the femur and the humerus. Those were then compared to find any differences between them.

Initial callus formation was seen at approximately 44 days (6 weeks) for the femur and 62 days (9 weeks) for the humerus. Callus formation was complete by 145 days (~5 months) for the humerus, with an outlier at 219 days still forming a callus. Femora did not complete callus formation for 328 days (~11 months), with a severe case not completing formation in 525 days. It should be noted that the fractures included in this study were severe with little attempt at resetting the bone. This callus initially appears lumpy and disorganized in appearance but will remodel to a smooth callus in about 9-10 months for a humerus, however a femur requires more than a year to reach this stage. The length of the callus formation stage between these two bones is significant with $\rho = 0.028$ while the timing of these stages overall is not statistically significant, though there is a trend for the humerus to start later. With the use of modern medicine, callus formation begins at 7-10 days and ends in 6-8 weeks on average.

The differences seen in healing time and the length of stages between femora and humeri is likely due to differences in mechanical environment, a femur bears weight while a humerus does not. Though these timelines are rough, they illustrate that mechanical environment has a large affect on healing behavior. The large discrepancy between these timelines and those seen in modern medicine are likely due to a variety of causes including the severity of these injuries and lack of treatment, the prevalence of disease, and the unlikely survival of evidence for the early stages of callus formation. The use of historic populations to control for confounding variables, such as type of injury and treatment, can offer greater resolution of the factors affecting healing rates than clinical studies alone.

Biomechanics, Fracture, Healing

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