A28 Forensic Fractography of Bone: A New Approach to Skeletal Trauma Analysis

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After attending this presentation, attendees will be familiar with how fractography can be used to assess skeletal fractures in forensic anthropological trauma analysis, increasing the accuracy of trauma interpretations.

This presentation will impact the forensic science community by enhancing the analysis of skeletal trauma using a new method of fracture examination that is reliable, easy, and inexpensive.

Fractography is the study of fracture surface characteristics and their relationship to crack propagation. This science is routinely used in forensic examinations of materials such as glass, ceramics, metals, and plastics to identify the initiation point and nature of the material's failure. Fracture surfaces of brittle materials typically display features reflecting the speed and stability of the propagating crack front. Generally, crack initiation sites are relatively featureless, becoming more featured with increasing crack speed and instability. These changes can be seen as arrangements of ridges and lines with specific orientations with respect to the moving crack front.

The fracture surfaces of bone also reveal information about fracture initiation and propagation, yet the science of fractography has rarely been applied to bone in forensic anthropological contexts. It is hypothesized that the science of fractography can be applied to forensic skeletal analysis to provide additional information about the bone's failure and the trauma event. Here, the application of fractographic principles to the analysis of fractured femoral cortical bone is tested to determine the utility of fractography in the forensic analysis of skeletal trauma. The bone samples consisted of 12 biomechanically fresh human femora that underwent controlled three-point bending as part of a previous study.

Several methods for enhancing visualization of the fracture surface were assessed, including magnification, oblique lighting, various contrast media (including powders, inks, and sputtered gold films), casting/molding, and Computed Tomography (CT) scanning. Such coatings and treatments are often used in other forensic fractography analyses to decrease reflection and increase contrast; in particular, bone's light color can result in reflections and low contrast that interfere with visualizing surface details. Dual-contrast fingerprint powder applied to the bone fracture surface combined with oblique lighting and low-magnification microscopy (1-4x) was determined to result in optimal visualization of the features. Moreover, this approach is relatively easy, inexpensive, and reversible.

The fractured femur specimens were then examined by seven assessors (three forensic anthropologists with no previous experience with fractography and four forensic fractographers with no previous experience examining bone). For each specimen, assessors documented the presence or absence of fractographic features, including bone mirror, arrest ridges, bone hackle, wake features, and cantilever curl. In addition, the assessors recorded their conclusions regarding the direction of crack propagation based on the presence, location, and orientation of these features.

The results strongly indicate that fractographic features observed in bone can be used to determine the location of fracture initiation and the direction of crack propagation. Interobserver error in identifying the presence of features was insignificant (p=0.244), and there was 100% agreement between all assessors for all specimens regarding crack propagation direction. Multiple correspondence analysis also revealed good agreement between the fractographic features and the fracture initiation site. Experience may play a role in identifying fractographic features, and greater precision is found in the identification of more features when the cortical area is greater.

Fractographic analysis of bone can be used to reliably determine the point of fracture initiation and the direction of fracture propagation by assessing the bone for the presence, location, and orientation of surface features. These features can generally be observed with the unaided eye, although they are further enhanced using oblique lighting, contrast medium application, and low-power microscopy. This approach is reliable and can be easily and inexpensively applied in forensic anthropological examinations. Fractographic analysis should be used in conjunction with the examination of other fracture characteristics to provide a more thorough and accurate analysis of the bone's failure and the trauma event.

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