## A31 Butterfly Fractures in Medicolegal Investigations

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After attending this presentation, attendees will have acquired knowledge regarding bending bone fracture patterns in adult long bones. Broken bones have been studied for more than 100 years, yet little research has applied and validated fracture patterns in medicolegal investigations.

This presentation will impact the forensic science community by contributing to the knowledge of fracture biomechanics and the utility of evaluating the direction of bending bone failure in a medicolegal environment as well as aiding attendees in the interpretation of long bone fractures. Blunt trauma is addressed as a whole, with an emphasis on: (1) the application of bone trauma interpretation in practice; (2) the significance of the identification of a blunt butterfly fracture pattern; and, (3) the recognition of biomechanical modes of failure. A Pedestrian Vehicle Accident (PVA), a common medicolegal occurrence in which the expertise of a forensic pathologist and anthropologist is needed, will be used as an exemplar for the discussion.

More than 30 years ago, anthropologists began to work hand-in-hand with forensic pathologists, which marked the beginning of a new relationship in forensic science that emphasized bone trauma diagnoses based in biomechanics. Autopsy became the ideal environment to apply and validate bone trauma research.[1] The identification of the modes of bone failure and the features of tension and compression of tubular bone fractures were shown to be accurate in determining bending direction of reconstructed bone and became standard practice in forensic anthropology.[2-4]

Recently, experimental research in three-point bending has exhibited considerable variation in butterfly fracture patterns and has urged caution in using these fractures in establishing bending direction:

"If practitioners consider only the presence and orientation of complete butterfly fractures, they may be unable to accurately interpret impact direction and all trauma cases."[5]

This introduces confusion in bone trauma analysis, whether blunt or ballistic, as all are based on biomechanical principles of bone failure. The recognition of these features in bone is usually based on visual patterns, such as blunt butterfly fractures, with the intent of immediately establishing bending direction. So where does the confusion lie in explaining and interpreting blunt butterfly fractures? And, how does this affect our current application and interpretation of long bone fractures in medicolegal investigations?

Obviously, interpretation of processed bone has limitations, as demonstrated by an exemplar of a broken leg from a PVA. In this case, it will be demonstrated how soft tissue and context makes the determination of bending and Point Of Impact (POI) possible. POI requires prior knowledge, despite claims in the historic literature. With prior knowledge and context, an analyst can reconstruct a bone fracture for pattern analysis and can further separate these bones for macroscopic examination of tensile and compressive failure. The above-mentioned experimental research on three-point impacts also concluded that surfaces of broken bone accurately indicated areas of tension and compression.[5]

This presentation contextualizes bending bone fractures within the framework of current knowledge and discusses the application of this knowledge to a medicolegal environment. This study contends that the variable morphology observed in a butterfly pattern is attributed to the continuous adjustments and failures of bone bending. With enough energy, tension failure forms in a bone shaft, with shear and compressive forces guiding or diverting fractures. Bone's ability to resist compression energy directs initial fractures longitudinally along the shaft. Eventually, complete fractures are formed as fractures approach the side of compression.

Therefore, the blunt butterfly fracture pattern indicates initial failure, which eventually progresses into or toward maximum compression failure. The overall morphology of the fracture pattern reveals general direction of bending, while discerning the actual contour of the bone in cross section assists in establishing bending direction of that bone at that location.[6]

An anthropologist must remain forensically conservative in his/her analytical approach to trauma analysis, particularly when prior knowledge or context is not available. A blunt butterfly fracture pattern can assist in establishing bending direction of the bone; however, an analyst must be cognizant of variation in fracture morphology and must not purely rely on these features for interpretation of an injury. Anthropologists need to be cognizant of the intrinsic features of bone, the biomechanical principles of bone failure, and the application of this body of knowledge to a medicolegal investigation.

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**Blunt Butterfly Fractures, Biomechanics, Fracture Direction**



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