Blunt Force Trauma of the Skeleton: Fractures at 50km/h

Angela Martens
Emily Stach
Don Crawford
University of Victoria

ABSTRACT

Blunt force trauma (BFT) is defined as trauma inflicted by a wide focus and a slow loading force (Byers, 2016 & Kranioti, 2015). This makes BFT, when inflicted by motor vehicles, unique because the applied force is fast loading. Motor vehicles are an increasingly common cause of BFT (Heider et al., 2009 & Weninger and Hertz, 2007). Due to the continuing increase in incidence rates of motor vehicle related BFT it is becoming imperative for forensic anthropologists to identify and interpret skeletal trauma associated with motor vehicles. This experiment is designed to analyze bone fracture patterns resulting from motor vehicle collisions. A motor vehicle travelling at 50km/h was used to run over three specimens; a *Bos Taurus* (cow) femur; a *Sus scrofa* (pig) leg and head. Our research into the effects of motor vehicle BFT revealed common skeletal fracture patterns across two of three specimens.

INTRODUCTION

The forensic anthropologist must be skilled in the analysis and description of skeletal trauma; they must be able to distinguish between types of trauma and determine if skeletal trauma and manner of death are associated (Kranioti, 2015).

Blunt force trauma (BFT) is defined as trauma with a wide focus, inflicted by a slow loading force (Byers, 2016 & Kranioti, 2015). Hard surfaces such as the ground when fallen on, or a piece of furniture that is stumbled into, as well as objects such as bats or clubs, and motor vehicles can cause BFT (Byers, 216). This broad definition makes BFT the most common type of trauma experienced by forensic anthropologists. However, BFT inflicted by motor vehicles is unique, the focus is wide but the force is fast loading.

Motor vehicles are becoming an increasingly common cause of BFT (Haider et al., 2009 & Weninger and Hertz, 2007). Due to the increasing incidence rates of BFT being caused by motor vehicles it is more important than ever for the forensic anthropologist to be able to determine and identify the features of skeletal trauma caused by motor vehicles.

This experiment investigates the bone fracture patterns of BFT caused by motor vehicles with the goal of identifying specific trends in skeletal trauma resulting from motor vehicle collisions.

MATERIALS & METHODS

Three specimens were tested in this experiment:
(1) A partially de-fleshed front right pig leg
(2) A section of a left cow femur
(3) A fully fleshed, complete pig head
These specimens were chosen based on their structural differences; the bones of each specimen should display fractures pattern unique to their morphology.


Figure 1. Front right *Sus scrofa* (pig) leg.


Figure 2. Left *Bos taurus* (cow) femur.

The vehicle used to run over the specimens was a 1996 Dodge Ram; weight is estimated at 2268kg (approx. 5000lbs).


Figure 3. *Sus scrofa* (pig) head.


Figure 4. 1996 Dodge Ram.

After the specimens had been successfully tested, they were processed for data collection and analysis. Processing the specimens involved the removal of all soft tissues and the collecting and drying of the bones and bone fragments.

Data collection recorded the number and location of fractures sustained by each specimen. The fractures were analyzed and classified according to fracture typology.

RESULTS: Pig Leg

Processing this specimen revealed that no epiphyseal fusion had occurred on the humerus, ulna, or radius, and 49 individual bones and bone fragments were collected.

Analysis of the bones and bone fragments documented two complete fractures:
(1) an oblique fracture of the lateral ridge of the olecranon fossa.
(2) a transverse fracture of the capitulum.


Figure 5. Processed collection of bones and bone fragments of the pig leg specimen.


Figure 6. Oblique fracture to the lateral ridge of the olecranon fossa.


Figure 7. Transverse fracture of the capitulum.

RESULTS: Cow Femur

Processing of the specimen collected 12 bone fragments.

Analysis of the bone fragments revealed evidence for multiple complete fractures.

The proximal end of the femur sustained a severe comminuted fracture.

The distal portion of the femur displays evidence of a spiral fracture on its diaphysis.


Figure 8. Processed collection of bone fragments of the cow femur specimen.


Figure 9. Replacing bone fragments along the path of the spiral fracture.


Figure 10. Comminuted fracture of the proximal end of the cow femur specimen.

RESULTS: Pig Head

84 bone fragments were recovered from processing the specimen.

For analysis each bone fragment was numbered and reconstructed.

The pig skull sustained severe comminution. The left and right sides of the skull and mandible present the majority of fractures. Both zygomatic bones sustained complete fractures that separated them from the skull. The left and right rami were separated from the body of the mandible as a result of sustained fractures; an oblique fracture on the left ramus; a comminuted fracture on the right ramus.


Figure 11. Processed collection of the pig head specimen; 84 total fragments.

The left maxilla sustained multiple complete fractures that separated a section of it from the skull.


Figure 12. The reconstructed comminuted fracture to the right ramus of the mandible.


Figure 13. The reconstructed left maxilla; section labeled #3 was separated by multiple fractures.


Figure 14. Reconstructed pig skull and mandible; more than 30 fragments were unsuccessfully reconstructed.

CONCLUSIONS

The minimal fractures sustained by the bones of the pig leg were unexpected because they are inconsistent with the application of a fast loading force. This could be explained by poor contact made between the specimen and the vehicle. Only the distal humerus sustained fractures, it is possible that the articulation of the distal humerus and the proximal ulna was the only point of contact with the vehicle.

The cow femur's comminuted proximal end but largely intact distal end is likely due to the vehicle only making contact with the proximal end. The spiral fracture present on the femur's diaphysis is likely the result of simultaneous forces being applied; the rotation of the vehicle's tires creating a torsional force while the weight of the vehicle applies a compression force.

The severe comminution of the pig skull, and the majority of the fractures presenting along it's left and right sides were indicative of a fast loading, wide focus, force applied laterally compressing the head left to right.

Common fracture patterns resulting from BFT inflicted by a motor vehicle were documented in 2 of 3 specimens. High energy, fast loading, forces are commonly associated with comminuted fractures (Byers, 2016).

For future research high speed cameras to record the vehicle making contact with the specimens in slow motion are strongly recommended. This would provide much greater information on the points of contact between vehicle and specimen, and the forces applied to the specimen from contact with the vehicle. Also, driving over a specimen is different from colliding with a specimen. To test BFT fractures of a motor vehicle collision an apparatus to suspends the specimens should be used.

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