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Examining Asymmetries in Microfractures

Abstract:

This research is examining asymmetries in a human skull with sharp force trauma in order to estimate directionality of impact force. The skull was microCT scanned at the University of Texas CT Lab. Amira 5.6.0 imaging software was used to measure cortical thickness and microfractures were enumerated and described for each fragment. This study is one of five other human bone trauma projects examining asymmetries in skeletal elements. The idealistic outcome of this project is to produce a more refined data set that can aide medicolegal communities in producing a more accurate prognosis or cause of trauma.

Introduction:

In forensic anthropology the study of bone trauma has historically focused on gross anatomical patterns in fractures. More information may be available using CT technology to examine trauma at a microscopic scale. Looking at the inside and outside of bones can help identify the weapon used and the trajectory of the impact. Most of the time, when studying trauma morphology, it is done on a macroscopic level. This particular study looked at the microfractures of the cortical bone on a microscopic level to gain more insight on the way trauma effects bones on a much smaller scale. A chi-squared and one way t-test were used to determine differences in cortical thickness and number of microfractures found in each fragment. This study is one of five other human bone trauma projects examining asymmetries in skeletal elements. The idealistic outcome of this project is to produce a more refined data set that can aide medicolegal communities in producing a more accurate prognosis or cause of trauma.

Materials and Methods

A skull with sharp force trauma was borrowed from the Southeast Texas Applied Forensic Science Facility (STAFS) in Huntsville, TX (Figures 1 – 2). MicroCT technology from The University of Texas CT lab was used to scan the specimen. A computer program, Amira 5.6.0, was then used to render, examine, and then measure the different fragments of the bones and the microfractures.

Discussion:

Bones have anisotropic properties that allow them to react differently to loads with different applied forces (6). Bone can only absorb impacting energy to a certain limit, and once the limit is exceeded the fibers in the cortical bone show radiating fractures in an attempt to disperse the impacting force. The force applied to a skull is a combination of intrinsic factors including cortical bone density, fracture morphology, and the position of the body when struck. Extrinsic factors such as trajectory of the impact and velocity at which the machete travels are also accounted for (6). Through the use of Amira, a microCT scan software, bone can more closely be scrutinized by analyzing fracture morphology to gain a better understanding of impact trajectories from which a strike was made (2-5). After segmenting the different fragments of the skull, they were examined to determine how many microfractures each fragment had. The fragments were also measured multiple times and an average cortical thickness of each fragment is listed in the poster. Microfractures were counted on each fragment and those numbers

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were used to run a chi-squared and a t-test. The results indicate that not having the same amount of microfractures in teach fragment of the skull was statistically significant.

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Abstract

In forensic anthropology the study of bone trauma has historically focused on gross anatomical patterns in fractures. More information may be available using CT technology to examine trauma at a microscopic scale. This research examines asymmetries in a human skull with sharp force trauma in order to estimate directionality of impact force. A skull with sharp force trauma from the Southeast Texas Applied Forensic Science Facility (STAFS) was microCT scanned at the University of Texas CT Lab in Austin, Texas. Amira 5.6.0 imaging software was used to measure cortical thickness and microfractures were enumerated and described for each fragment. A chi-squared and one way t-test were used to determine differences in cortical thickness and number of microfractures found in each fragment. This study is one of five other human bone trauma projects examining asymmetries in skeletal elements. The idealistic outcome of this project is to produce a more refined data set that can aide medicolegal communities in producing a more accurate prognosis or cause of trauma.

Introduction

In the field of anthropology, fracture morphology is used to determine peri- and post mortem trauma. Internal and external bone morphology provides detailed information that can be used to discern the type of weapon and the trajectory of impact used to inflict the damage (1). Since traditional methods of observation are limited and focus mainly on macroscopic trauma morphology; the use of microCT technology was utilized so that the skull was able to be analyzed on a much smaller scale. This study focused on bone fragmentation and the microscopic trauma inflicted by a machete.

Materials and Methods

A skull with sharp force trauma was borrowed from the Southeast Texas Applied Forensic Science Facility (STAFS) in Huntsville, TX (Figures 1 – 2). The skull specimen was scanned using microCT technology at The University of Texas CT lab. Amira 5.6.0 was used to render, visualize and measure the skull trauma (Figures 3 – 4). The number of microfractures per fragment were counted by observing the internal and external surfaces of the bone (Figure 5). The distribution of microfractures found in each fragment relative to the impact trauma were used to determine asymmetry.

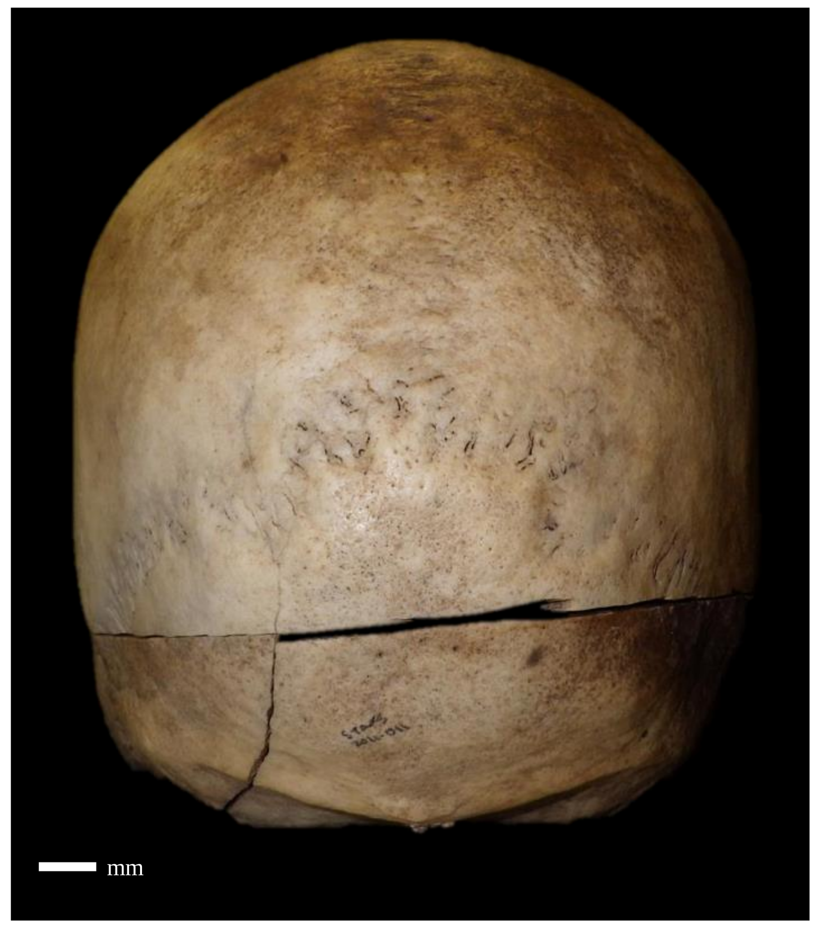


Figure 1: Posterior view of sharp force trauma to the occipital

Figure 1: Inferior view of sharp force trauma to the

Results

Fragment	Fragment Location	Number of Microfractures	Average Cortical Thickness (mm)
1	Posterior / Superior	7	7.04
2	Posterior / Inferior	2	6.30
3	Anterior / Superior	2	7.10
4	Anterior / Inferior	0	6.10

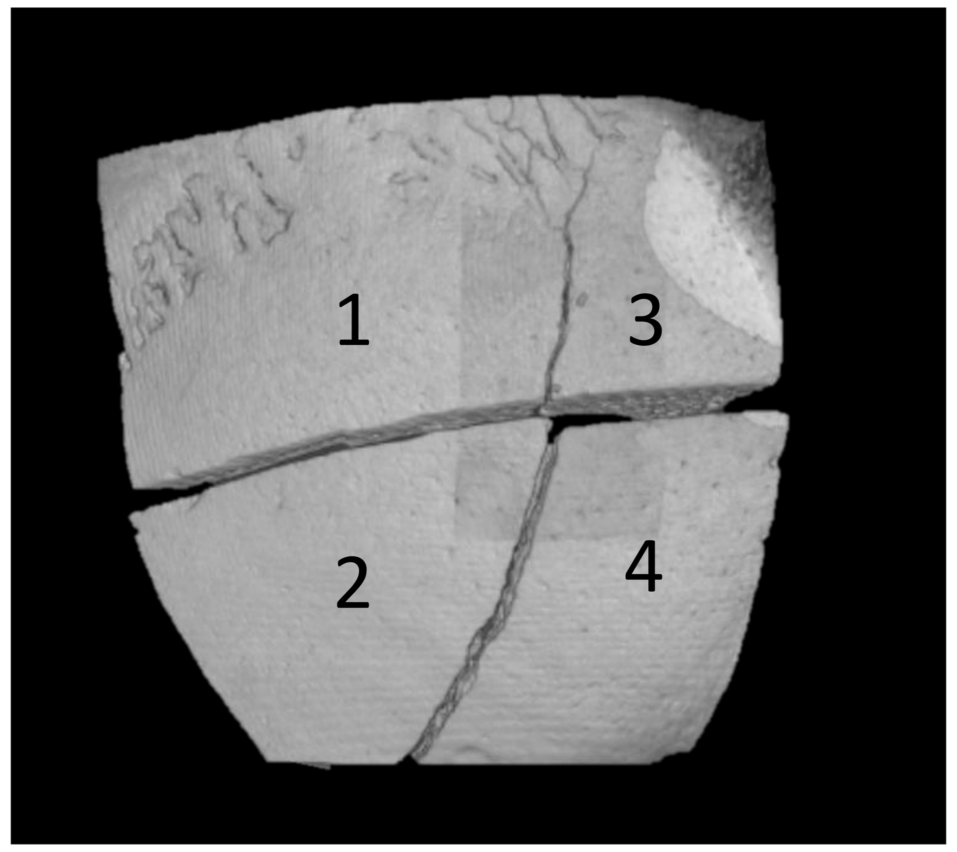


Figure 3: External view of fragments 1-4

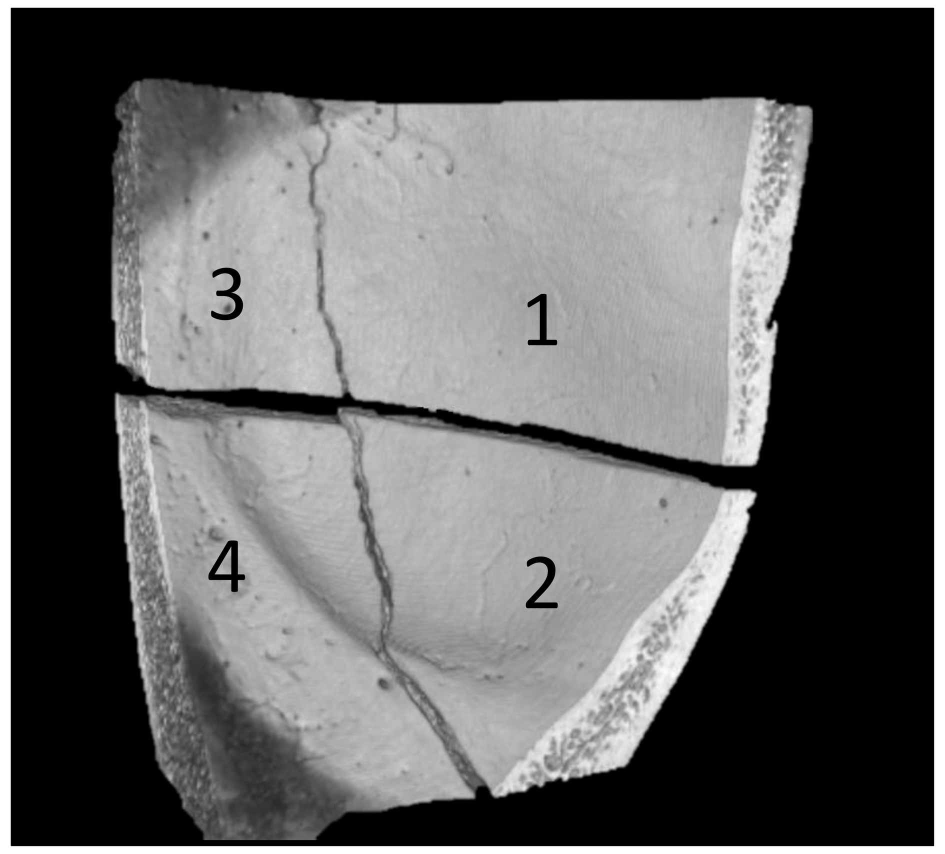
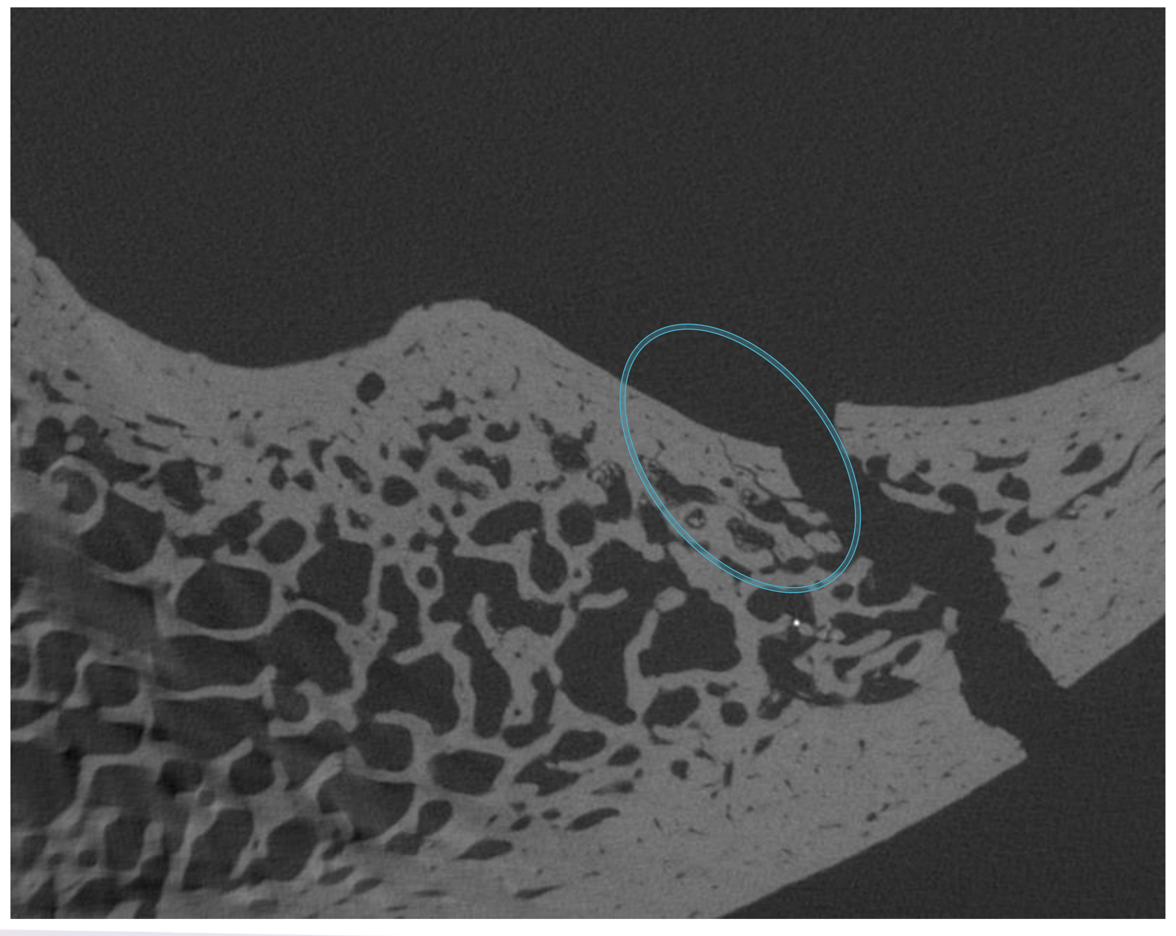


Figure 4: Internal view of fragments 1-4



Discussion

Bones have anisotropic properties that allow them to react differently to loads with different applied forces (6). Bone can only absorb impacting energy to a certain limit, and once the limit is exceeded the fibers in the cortical bone show radiating fractures in an attempt to disperse the impacting force. The force applied to a skull is a combination of intrinsic factors including cortical bone density, fracture morphology, and the position of the body when struck. Extrinsic factors such as trajectory of the impact and velocity at which the machete travels are also accounted for (6). Through the use of Amira, a microCT scan software, bone can more closely be scrutinized by analyzing fracture morphology to gain a better understanding of impact trajectories from which a strike was made (2-5). The results were indicative of reliable methodology. The results indicate that not having the same amount of microfractures in each fragment of the skull was statistically significant (Chi-Squared results are 0.0213<0.05). Future studies will examine additional specimens with varying types of trauma to expand the scope of this project.

Acknowledgements

We would like to thank the STAFS facility for their assistance with this project, the CT Lab in Austin, Texas and our research advisor. We would also like to thank the individuals who have donated their bodies to science, for without them this project would not be possible.

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