Obliteration of Sharp Force Trauma Artefact by High Particulate Water Wash

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Introduction

Forensic examination of bone is not always a straightforward enterprise. A complex interplay of factors contribute to the information able to be obtained from a set of skeletonized remains that is largely influenced by the environment in which the remains were found. Weathering effects on bone have been well-studied and documented with respect to skeletonized remains in terrestrial settings (Behrensmeyer 1978, Hockett 1996). However, little work has been published to expand upon the process of degradation that occurs in bones that are submerged in tidal water for extended periods of time.

Coastal areas attract a significant amount of death, whether it be homicides, suicidal drownings, boating accidents, burials at sea, transport from rivers, or disposal sites from land homicides (Pokines and Symes 2013). Natural disasters such as Hurricane Katrina in the United States or the Boxing Day 2004 Tsunami account for a significant number of deaths as well. Recent events such as the sinking of the Italian cruise ship *Concordia*, as well as other maritime disasters warrant further understanding of marine taphonomy. Especially in situations where criminal charges are being brought, an accurate body count is necessary to determine the severity of the charges and knowing when a set of remains entered the water can help determine whether or not this time frame is appropriate for the event being investigated. Studying the physical changes that occur over time to bones that may have been injured in a traumatic event may provide useful information to investigators, including estimation of time since deposition, trauma site identification, and associating remains with a particular event.

Results

Statistical tests (ANOVA and linear regression) were performed using a VSN International GenStat® Versions 16 and the following results were obtained.

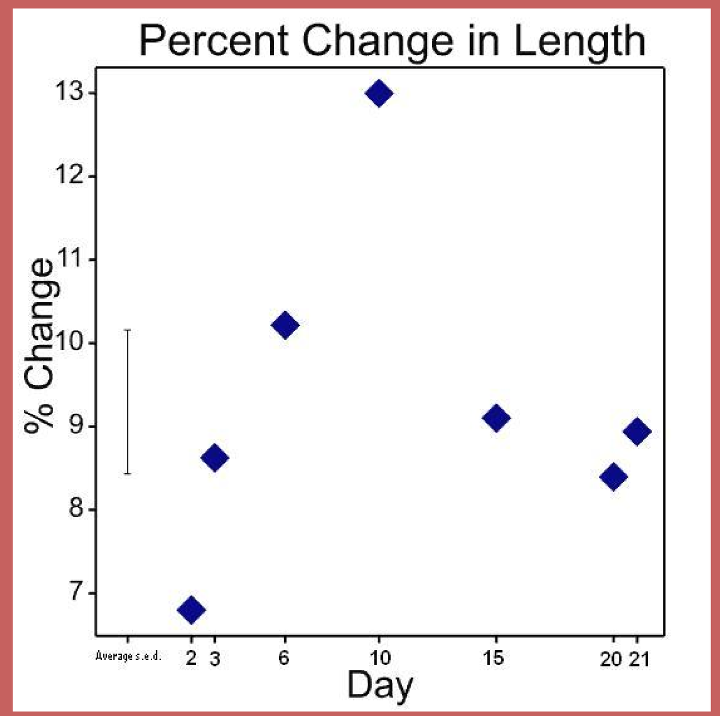


Figure 1 – ANOVA for the percent change in length of cut by day.

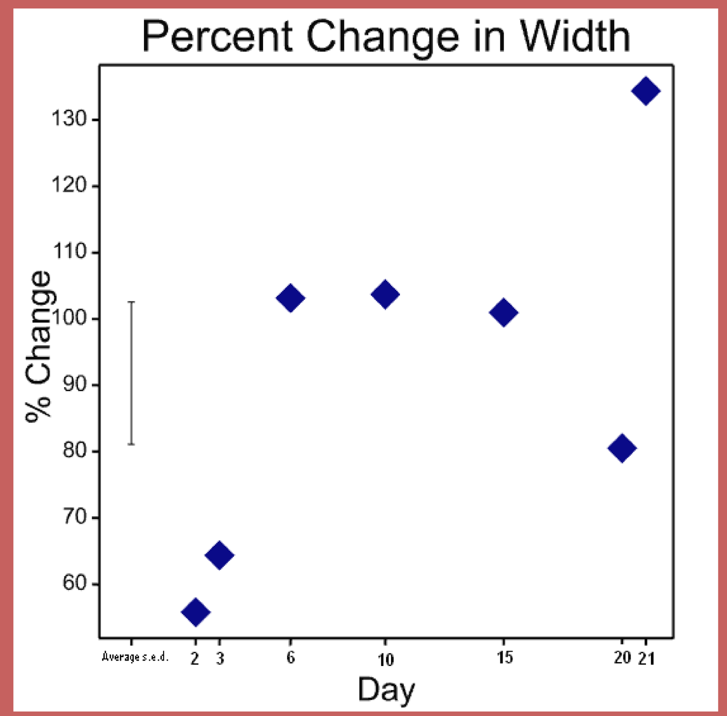


Figure 2 – ANOVA for the percent change in width of cut by day.

These tests showed a significant difference in the length and width of the cuts between the different exposure days, particularly in the middle days of the trial* ($F_{(1,451)} = 4.36$, $p<0.001$; $F_{(1,451)} = 3.25$, $p = 0.004$).

Overall there was a significant negative relationship between the initial width of each cut and the percent change in that width after experimental treatment ($R2=0.085$, $F(3,448)=15.04$, $p <0.001$). There was also a significant difference in how each substrate affected this relationship ($t(448)=-2.73$, $s.e.=17.2$, $p = 0.007$). The cuts abraded by diatomaceous earth experienced a greater mean percent change in width after exposure ($F_{(1,451)} = 9.75$, $p = 0.002$).

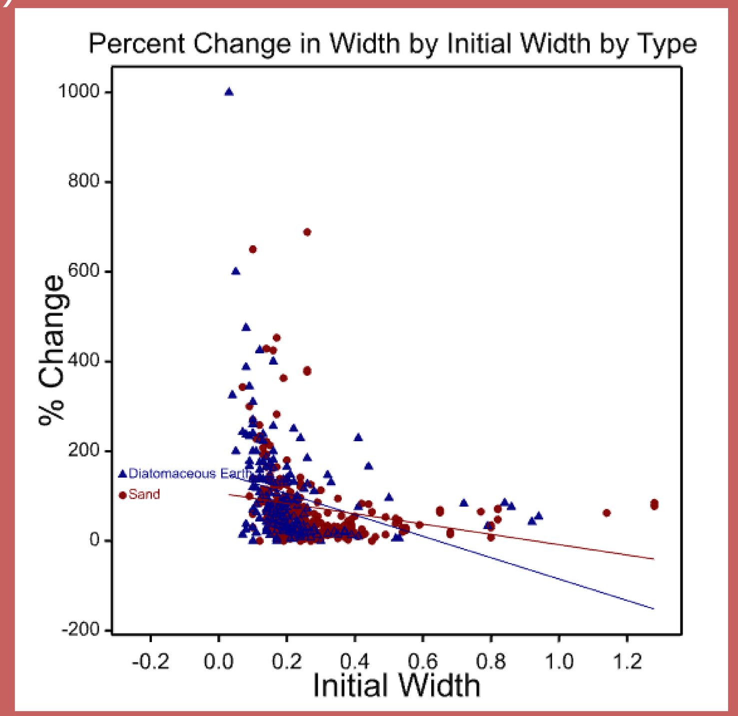


Figure 3 – Linear regression model for the percent change in width of cut by initial width, separated by type of particulate.

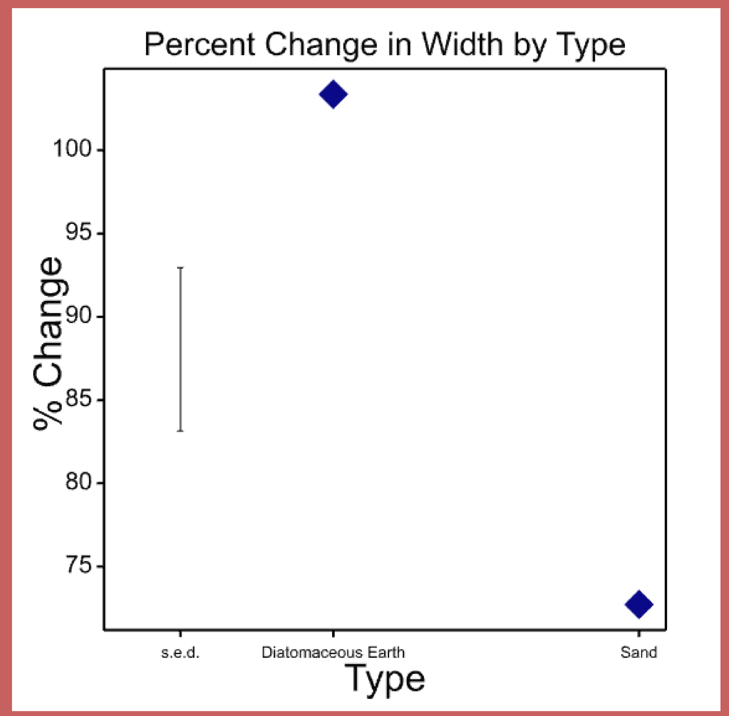


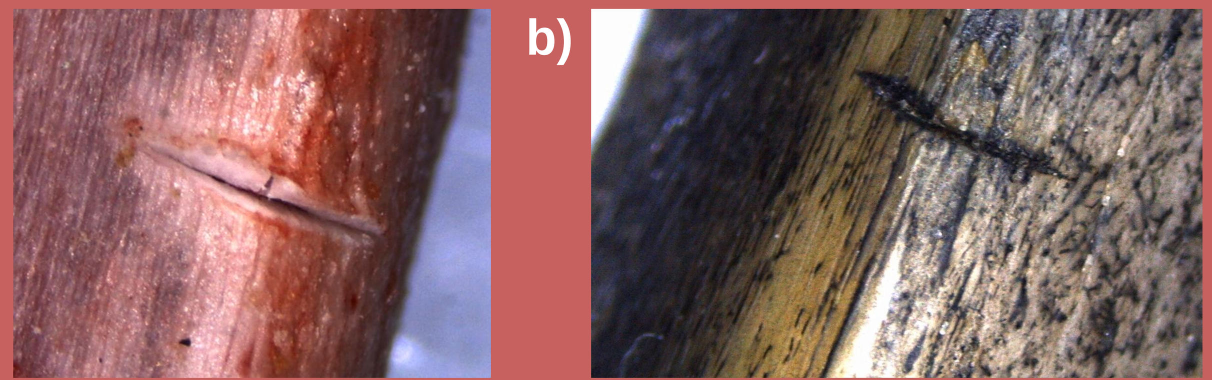
Figure 4 – ANOVA for the percent change in width of cut by type of particulate.

Methods

For each trial, whole racks of *S. scrofa* rib bones were acquired and imaged using a Nikon D5100® camera and Leica S6D® stereomicroscope with a mounted camera. The samples were manually defleshed and sectioned using a rotary tool into inch-long sections. Chop wounds were inflicted manually using a cleaver on the superior and inferior aspects of each rib section except for eight segments that were reserved for uninjured controls.

Three replicate sets of measurements were taken with a digital caliper of segment width, segment thickness, and cortical thickness at both ends of the segment, as well as length, width, and depth of each cut.

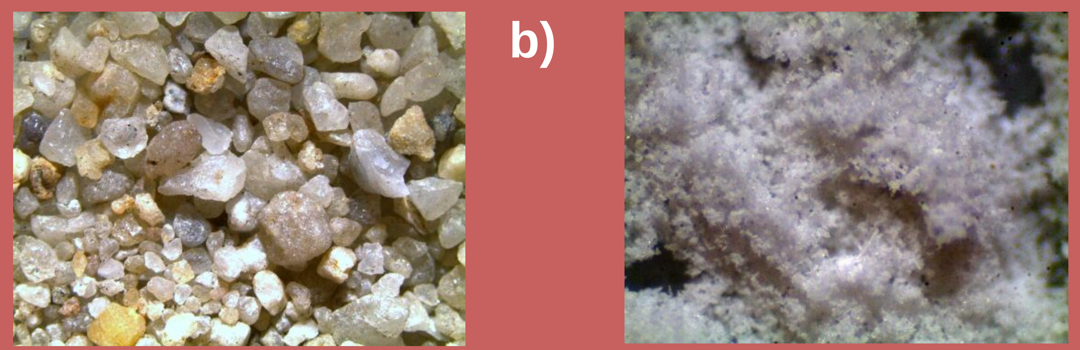
a) b)



Sharp force trauma injury before (a) and after (b) exposure to experimental conditions. Taken with Leica S6D® stereomicroscope and mounted camera.

Sand and diatomaceous earth were chosen as the abrasive particulate because of the presence of both materials in marine environments.

a) b)



Sand at 6.5X magnification (a) and Diatomaceous earh at 40X magnification. Taken with Leica S6D® stereomicroscope and mounted camera.

Shaker Apparatus

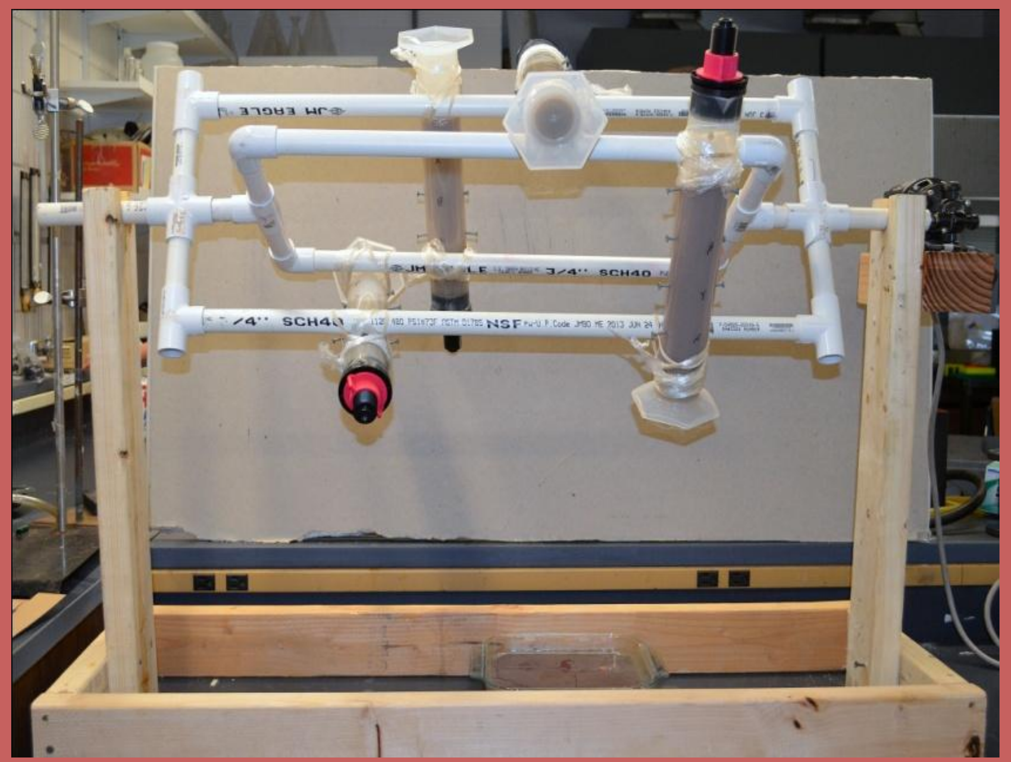
Shaker Model

The shaker model consisted of a heavy-duty plastic tube 3" in diameter affixed to a Plexiglass platform. The bones, particulate, and water were placed inside the tube via holes cut into the top and the whole platform was placed on an orbital shaker, which induced unidirectional wave motion at 75 rpm.

Tumbler Model

The tumbler consisted of a rectangular PVC frame supported by a wooden base, to which four 500-mL plastic graduated cylinders with bones segments inside were affixed. This frame was then rotated at a steady speed of approximately 9.5rpm by a fractional horsepower gearmotor. These rotations simulated bidirectional wave action.

*There was a significant difference in the mean percent change in the length of the cuts between all days except between Days 3, 5, 20, and 21. Also, There was a significant difference in the mean percent change in the width of the cuts between all days except between Day 2 and Day 3, and between Day 6 and Day 10 and Day 15.



Tumbler Apparatus

Discussion

The deterioration of sharp force trauma artefact in bone is an important facet of interpreting the circumstances surrounding the death of a set of remains. This study has shown the time-dependency of such deterioration as seen in the significant differences between the number of days of experimental exposure and the magnitude of morphological change induced in the sample cuts (Figure 1 & 2). Also, the initial size of the trauma appears to have an effect on the percent change after exposure, with narrower initial cuts experiencing a greater magnitude of morphological change than samples with wider initial cuts (Figure 3). Changes in the size of each cut can likely be attributed to tissue loss due to abrasion by either sand or diatomaceous earth. These two particulates appear to have different abrasive strengths, as there was greater tissue loss in the samples exposed to diatomaceous earth than in those abraded by sand (Figure 4). This information serves as a platform from which further research on pinpointing the time of deposition of a set of remains in a marine environment can be initiated and expand the knowledge base of the forensic field.

References

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