TESTING VARIOUS IMAGING METHODS IN ASSESSMENT OF HYOID BONE FRACTURES

Veronika Kováčová, Ivana Šplíchalová and Petra Urbanová

Laboratory of Morphology and Forensic Anthropology, Department of Anthropology, Faculty of Science, Masaryk University, Brno, Czech Republic

Introduction

In the frame of forensic anthropology, gross morphology of hyoid bone fractures may reflect a cause of death (accidental traumas, self-inflicted and assaulted injuries) as well as a mechanism of damage (peri- vs postmortem fractures). The standard approach to examining macromorphology of the fractures in the forensic settings is a visual inspection in conjunction with traditional photography or RTG imaging. Recently, a variety of non-invasive virtual approaches have been made available and have been employed in such assessment [1-2]. Some of the advanced imaging techniques even allow as much as to examine the skeletal trauma on the microscopic level. Still, the amount of literature on microtraumas is scarce. To date, as few as three studies [3-5] aimed at evaluating characteristics of microfractures have been published.

Key words

Bone microstructure; Fracture morphology; Hyoid bone; Micro-CT; Osteons; Perimortem; Postmortem

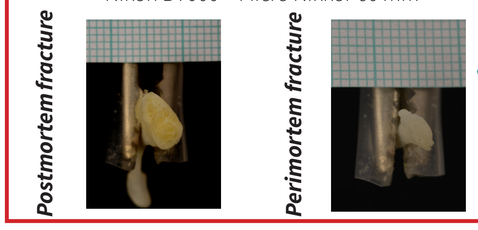
Objectives

The present paper aims at exploring characteristics of peri- and post-mortem fractures in hyoid bone by a variety of available traditional and advanced examination techniques on both macroscopic and microscopic level.

Material & Methods & Results

Photography

Nikon D7000 + Micro Nikkor 60 mm

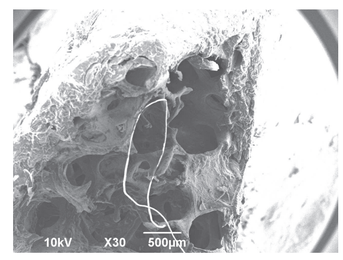


male, 38 ys
fall from height

Right greater horn: **postmortem damage** (at autopsy)
Left greater horn: **perimortem infraction + postmortem damage**

SEM

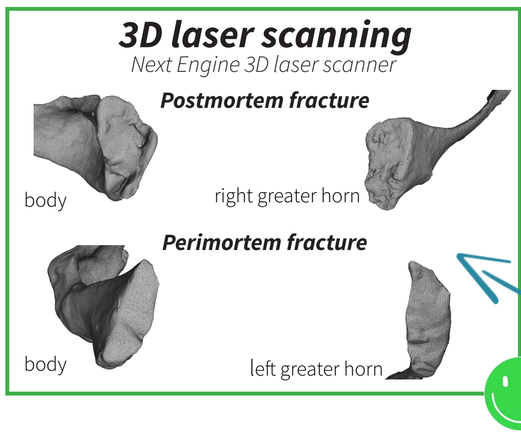
JEOL 6490 LV, secondary electron image



Postmortem fracture

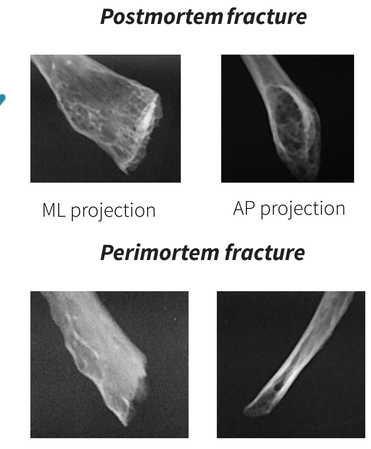
3D laser scanning

Next Engine 3D laser scanner



RTG

Handheld X-ray System Aribex Nomad

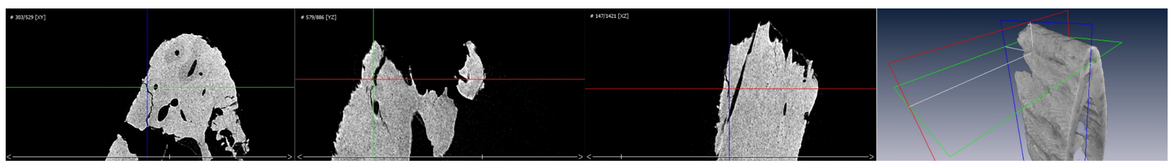


Stereomicroscopy-based photography

Olympus SZH 10 + Canon EOS 1100D

Micro-CT

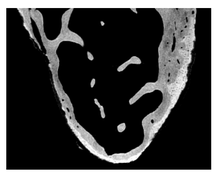
GE v|tome|x L 240



Postmortem fracture

voxel resolution - 0.01 mm
matrix - 796x1483 px
502 slices

Bone tissue characteristic

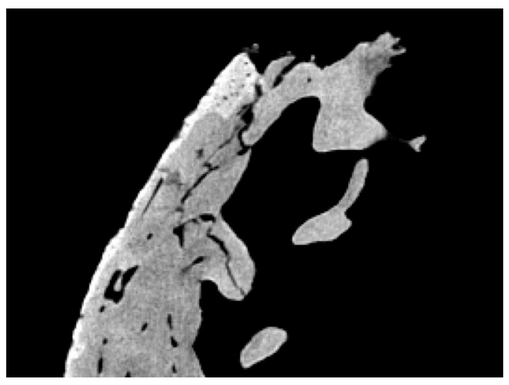


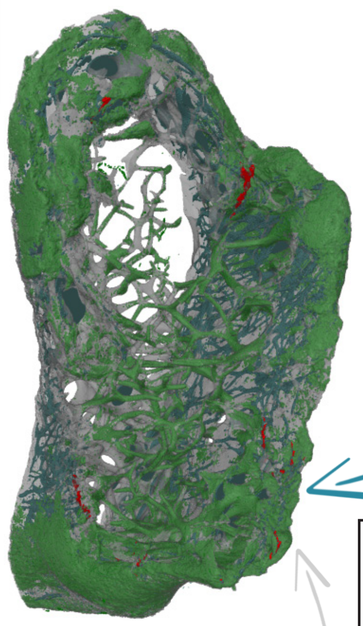
fracture adjacent to the body

- presence of hypermineralized bone tissue
- larger number of osteons
- thin layer of compact bone
- presence of bone trabeculae

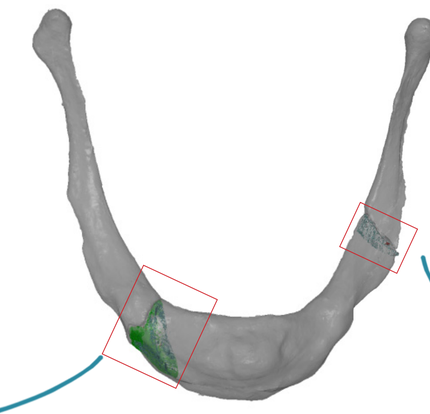
microfractures :

less frequent
branched and irregular progress
mostly presented adjacent to the fracture surface





outer surface
internal structures
area of hypermineralisation
microfractures



Commonalities

- microfractures occasionally intersect the osteons with similar radiodensity (older osteons)
- microfractures exceptionally intersect the osteons with lower radiodensity (younger osteons)

outer surface
internal structures
microfractures

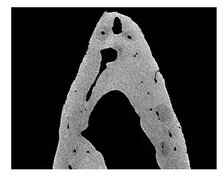
Perimortem fracture

voxel resolution - 0.005 mm
matrix - 886x1421 px
528 slices

Bone tissue characteristic

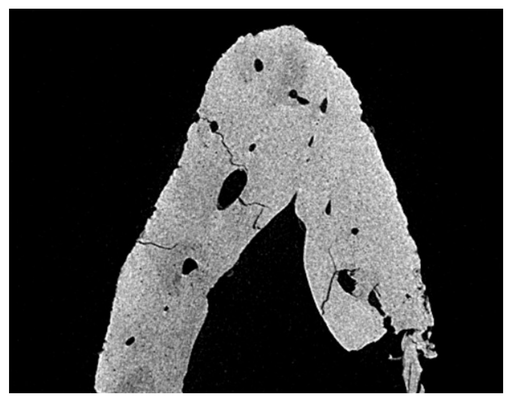
fracture in the middle of the left greater horn

- small number of osteons
- thick layer of compact bone
- more osteons of higher radiodensity



microfractures :

numerous
long and rather uniform progress
occasionally passing through the entire bone layer



Conclusion

Neither radiographs nor standard macrophotography allowed recording and examining the hyoid gross morphology sufficiently. The most appropriate macroscopic analytic approach was shown to be 3D laser scanning, which provided three-dimensional surface models that may serve further as inputs for additional analyses. Of the microscopic techniques, both SEM and stereomicroscopy have the potential for displaying the fractured surface. Due to its inexpensiveness and time efficiency, stereomicroscopy should be viewed as the method of choice for examining trauma in skeletal remains.

Still, it can be concluded that micro-CT was the most beneficial of the tested methods. It allowed us to visualize the bone microstructure in various planes and to reconstruct 3D virtual models of the differentiating skeletal features (i.e., microfractures, Haversian canals). The results based on micro-CT data indicate that there exist characteristics in the course, size and location of the microfractures, which have the potential to facilitate the diagnosis of peri- and post-mortem trauma. The observed characteristics, however, need to be confirmed by future studies.

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CONTACT Laboratory of Morphology and Forensic Anthropology
Department of Anthropology, Faculty of Science, Masaryk University
Kotlářská 2, 611 37 Brno, Czech Republic
www.sci.muni.cz/lamorfa