# Warping in Burned Human Skeletal Remains: assessing the influence of bone collagen through vibrational spectroscopy

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## Introduction

**Analyzing burned human skeletons is difficult due to heat-induced changes (HIC) that interfere negatively with the application and reliability of bioanthropological methods. Therefore, the study of remains burned in controlled experiments has shown to be important in understanding the effects of heat on bones [1]. Warping has been used to determine the pre-burning condition of the remains. These modifications have been associated more often with corpses (with soft tissues), but also arise in unfleshed human burned bones. However, it has been demonstrated that this alone is not enough to make such distinction. So, it has been recently suggested that this could be due to collagen contraction and be thus dependent of the preservation of the collagen-apatite bonds. In brief, bones with well preserved collagen-apatite bonds have a greater elasticity and therefore, are more likely to deform and fracture [2].**

**Aim:**

- **Investigate the association between bone collagen content and the occurrence of heat-induced warping.**

## Material and Methods

✓**Two different samples:**

- ***Archaeological*** **(ARCH) - Modern skeletons of *Hospital de Santo António* (Porto, Portugal); 40 fragments of long bones.**
- ***Forensic*** **(FOR) - CEI/XXI identified Collection (Department of Life Sciences of University of Coimbra); long bones from 14 skeletons; Sex, age at death, *post-mortem* interval is known [3].**

✓**Analyse the presence of collagen in bones before burning through vibrational spectroscopy – FTIR-KBr [4].**

✓**Experimentally burn the two samples: temperature, duration and temperature increment are controlled.**

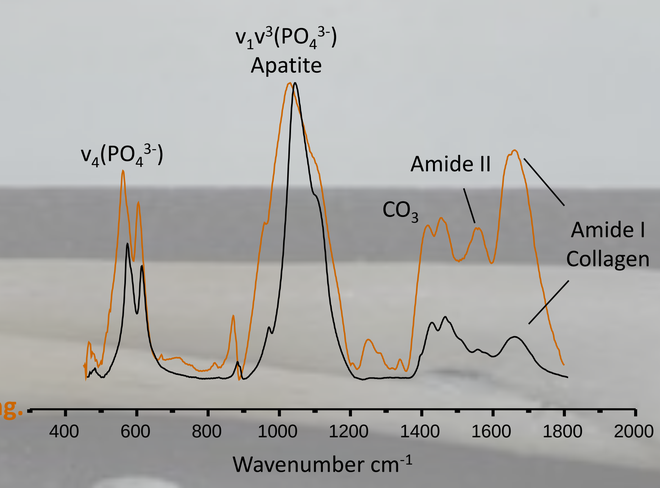
✓**Document the occurrence/absence of heat-induced warping and see if it is correlated with pre-burning collagen content (respective sectra) [5].**

## Preliminary Results

**Figure 1 –** Notice the 1200-1800 $cm^{-1}$ region of the FTIR spectra. Differences in collagen content between the Archaeological and Forensic bones are shown.

**CEI/XXI_65 humerus before burning.**

**Unburnt archaeological bone.**



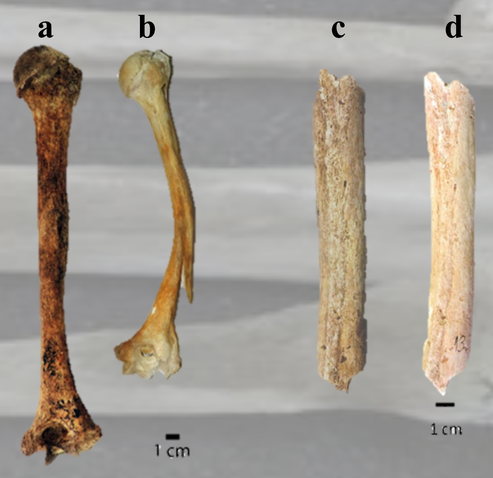




**Figure 2 –** CEI/XXI_65 (a) unburned and (b) burned humerus; archaeological bone (c) before and (d) after burning.

- **FOR samples show more collagen content than ARCH samples.**
- **FOR samples show more heat-induced warping than ARCH samples.**
- **In general, bones with more collagen content are more susceptible to warping.**

## Final Comments

**This research gives important insights about the pre-burning condition of skeletal human remains. Bone collagen was identified as a significant factor but other variables (age, sex, postmortem interval and combustion dynamics) may also have a significant effect on the occurrence of warping. Further investigation may be able to develop a method based on vibrational spectroscopy to estimate if the burning occurred in fleshed or unfleshed (dry/green) remains. This investigation, as part of the HOT project, aims to contribute to Biological and Forensic Anthropology.**

## References

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