Identifying Differences in Funerary Practice from the Distribution of Fracture and Warping Found on Cremated Human Remains at a Bronze Age Cemetery

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Introduction

Purpose: The purpose of this research is to identify differences in funerary practices across the population of the Bronze Age cemetery at the Békés - Jégvermi kert (Békés 103) site in the Körös River region (Fig. 1).

Context: Different types of burial ritual has been discovered, including inhumations and cremations, most of the burials observed were cremations, where the bone fragments were deposited in decorated clay urns and buried in shallow graves (Duffy, et al. 2014). 68 burials have been excavated from the Békés 103 site (of which 58 are urn cremations forming a sample of a cemetery population that may exceed 2,000 individuals (Duffy, et al. 2019).

Based on preliminary analyses, researchers did not find significant differences in the state of cremation. The uniformity can be a large indicator that the society living in this region during the Bronze Age either valued equal treatment of all members in their society, or had an absence of a formal hierarchy.

Figure 1: Location of the Békés 103 site (Körös River region)

(https://en.wikipedia.org/wiki/File:Hungary_physical_map.svg)

Cremation Analysis: In this study, heat induced fractures from cremated human bone are used to determine whether firing conditions were similar or varied within the cemetery.

Background

The number and type of fractures present can provide evidence of the status of the body at the time of cremation (Buikstra and Swegle, 1989). Importantly, different firing conditions can result in the expression of different fracture types.

Figure 2: Documenting fracture types
Photo by Crystina Friese

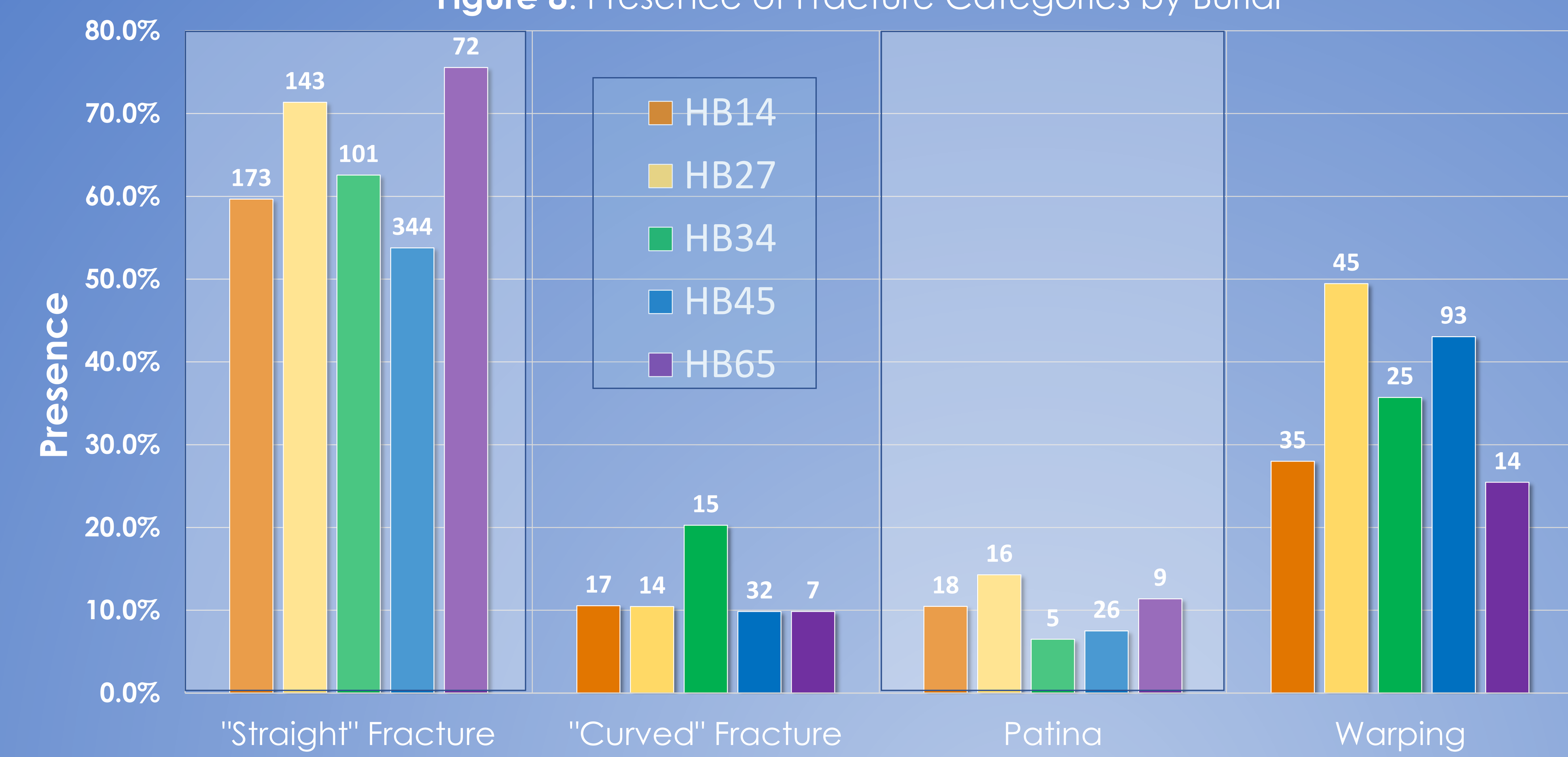
Dry/calcinated bones are prone to **cracking** along the grain of the bone, along the osteon canals as protein denaturalization takes place, causing the structure to collapse in a regular pattern (Symes, et al. 2015). These are the most common fractures for all cremations, but can be less expressed in fleshed remains as the bones are heated unevenly through tissue (Ubelaker, 2008). Similarly, **straight transverse fractures** are found along long bones as heat travels their length—an affect hampered by increasing tissue thickness (Correia, 1990).

Curved transverse fractures (Fig. 3) occur on fleshed bones when the soft tissue is destroyed causing the bone to bend and break during incineration (Symes, et al., 2015).

Patina (Fig. 4) is a superficial cracking that occurs on the flat bone over long periods of heating, as collagen breaks down and makes the bone brittle (Bontrager, et al., 2015). **Warping** (Fig. 5)is the structural collapse of bone as a result of the shrinkage process; it is exhibited at much higher frequency in fleshed bone (Ubelaker, 2008).

Results

Figure 8: Presence of Fracture Categories by Burial



For the five burials analyzed (Fig. 6-9), the distribution of fracture type group is fairly uniform.

A chi-square analysis of each group found a statistically significant relationship exists between the burials for three of the fracture types: Straight Fractures (x^2=.001, df=4, p=1.73E-07), Curved Fractures (x^2 = 0.00, df=4, p=4.42E-09), and warping (x^2 = 0.14, df = 4, p=2.38E-03).

However, the test found the presence of patina across the sample to be independent (x^2 = 1.671 df = 4, p=0.204).

	Grouped with Cranial and Postcranial							
	"Straight" Fracture		"Curved" Fracture		Patina		Warping	
	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence
HB14	**213**	144	**17**	144	**18**	154	**35**	90
HB27	**157**	63	**14**	120	**16**	96	**45**	46
HB34	**117**	70	**15**	59	**5**	72	**25**	45
HB45	**370**	318	**32**	293	**26**	320	**93**	123
HB65	**102**	33	**7**	64	**9**	70	**14**	41

Figure 9: The relative presence and absence of scores for the four groups by burial. The amount of material recovered from the excavation of burial urns can vary, creating samples of variable size.

Fracture types explained

Figure 3 : Curved transverse fracture (HB 45): This type is characterized by curved cracks in long bone that can resemble thumbnails when they disarticulate. Thumbnail fractures are the most valuable indicators of the fleshed state.

Figure 4: Patina (HB 45): Named for their resemblance to cracks of old oil paintings, these fractures are characterized by an even distribution across areas of bone and superficial depth. Patina can be an evidence of long exposure to lower levels of heat.

Figure 5: Warping (HB 8): This type of modification is most apparent in larger fragments of bone where the regular structure has been altered. Being associated with soft tissue, fat, and moisture, warping is strong evidence of flesh on the bones.

Raw Data

Scoring Bone Fragments

Presence and absence of a fracture type were recorded for each fragment. The total scorable fragments was calculated by type as the sum of all fractures with scorable presence and all with scorable absence. The percentage is then calculated with this number as the total.

Figure 6: Cranial scores raw data and percentage present

	Cranial									
	Delamination		Linear Fractures		Curved Tissue R.		CB Warping		CB Patina	
	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence
HB14	20	32	40	9	8	41	11	34	8	47
%	**38.5%**		**81.6%**		**16.3%**		**24.4%**		**14.5%**	
HB27	7	8	14	4	4	7	10	6	1	24
%	**47%**		**78%**		**36%**		**63%**		**4%**	
HB34	11	11	16	5	4	16	8	8	1	21
%	**50%**		**76%**		**20%**		**50%**		**5%**	
HB45	15	25	26	7	10	15	18	7	5	46
%	**38%**		**79%**		**40%**		**72%**		**10%**	
HB65	28	8	30	6	5	24	8	16	6	31
%	**78%**		**83%**		**17%**		**33%**		**16%**	

	Postcranial													
	Longitudinal		Non Directional		Straight Transverse		Curved Transverse		PB Patina		PB Warping		Delamination	
	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence	Presence	Absence
HB14	94	24	38	61	41	50	9	103	10	107	24	56	5	107
%	**79.7%**		**38.4%**		**45.1%**		**8.0%**		**8.5%**		**30.0%**		**4.5%**	
HB27	60	23	32	12	51	24	10	113	15	72	35	40	6	158
%	**72%**		**73%**		**68%**		**8%**		**17%**		**47%**		**4%**	
HB34	54	7	15	38	32	20	11	43	4	51	17	37	4	51
%	**89%**		**28%**		**62%**		**20%**		**7%**		**31%**		**7%**	
HB45	159	97	135	59	50	155	22	278	21	274	75	116	8	263
%	**62%**		**70%**		**24%**		**7%**		**7%**		**39%**		**3%**	
HB65	44	2	5	24	23	7	2	40	3	39	6	25	3	27
%	**96%**		**17%**		**77%**		**5%**		**7%**		**19%**		**10%**	

Figure 7: Post-cranial scores raw data and percentage present

Discussion and Conclusion

Mostly Even Distribution: This study compared the distribution of fracture types that might indicate different pre-incineration state of the human remains. Because the burials in our sample did not show evidence of independence of the variables, there is support for the conclusion that the individuals were possibly cremated in the same fleshed state. If there was evidence that remains were cremated with very different conditions of flesh, the distribution of fracture types would be testable for independence. In the most extreme case, dried or calcined bones would have a different distribution of fracture types than fully fleshed remains. With a sample of only 5 urn burials out of 58 urn burials of the Békés 103 site, different conditions are not visible. Importantly, this does not dismiss the possibility that differences did occur in cremation, but they were not expressed by variation in pre-incineration condition of the remains.

Different Levels of Patina: Although distribution of patina was not found to be associated between burials at a statistically significant level, it is possible the discrepancy is due to other factors. One possible interpretation is that the relatively small sample size for fragments that were scorable for patina failed to capture a wider pattern across burials, as patina had the fewer fragments scored than any other. As patina is associated with sustained heat applied to flat bone with collagen present (not thoroughly calcined), it is possible that some bodies were burned in funeral pyres for longer periods than others before being buried in urns. Alternatively, the variability of the presence of patina can relate to the position of the body being burned by an uneven heat source. A larger sample across many more burials studying patina may discover a wider pattern.

Future Research: Analysis of more burials across the Békés 103 site should be conducted to determine if the pattern holds. With more data, it may be possible that trends will be become evident in association with demographic characteristics such as sex or age group. This project is a part of a larger effort, where more and more urns will be analyzed in replicable ways, yielded further insight into the nature of the culture's mortuary custom.

Materials and Methods

As part of a larger project (Choi et al., 2017; Friese et al., 2019), this analysis focuses on five cremation urns' osteological material. Diagnostic fragments were analyzed as well as fragments larger than 5cm . In addition, a representative 20% sample of the burial fragments was obtained from each burial (Bontrager and Nawrocki, 2015). A simple random sampling method was achieved by evenly distributing equal quantities of human bone fragments from a single burial on 5cm x 4cm grid and using a random number generation method to identify 5 random grid squares that make up 20% of the material.

Each postcranial fragment was then scored for the presence or absence of the following fracture types: longitudinal, nondirectional, straight transverse, curved transverse, patina, and delamination (Symes, et al. 2015). Fragments which could not be conclusively scored for presence and absence were excluded from the total of the fracture type. Cranial bone fragments were scored for delamination, linear fractures, curved tissue regression, and patina. All cranial and postcranial fragments were also scored for the presence of warping.

The fracture data for each burial was grouped in four categories which represent distinct patterns associated with different pre-burning conditions at the time of cremation (Perez, et al., 2017). Associated with **calcined and de-fleshed bones**, longitudinal, non-directional, straight transverse fracture, and linear fractures are grouped as **"Straight Fractures"** (Symes, et al. 2015). The groups associated with **intact, fleshed bones** at the time of cremation are **"Curved Fractures"** (includes curved transverse (thumbnail) fractures and curved tissue regression of cranial bone), and the group **"Warping"** which includes evidence of structural modification/warping on both cranial and post-cranial bones. The group "**Patina**" includes presence of patina on both cranial and sub-cranial bone fragments, which can be an evidence of long exposure to lower levels of heat.

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