Accidental versus Intentional Head Injuries: A Comparative Pilot-Study of Cranial Depressed Fractures.

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Introduction

Human remains from archaeological sites are a unique source of data which allow the reconstruction of the environmental, economic and sociocultural factors that predispose people to both violent conflict and peaceful coexistence. (Walker 2001)

In the context of a new project addressing the social status of motherhood in Bronze Age Europe (Rebay-Salisbury/Pany-Kucera 2015 – Austrian Research Foundation FWF P26820), we revealed an interesting "side-effect" in the field of violence of past populations. Central in this research is the differentiation between accidental or intentional traumatic injuries and their chronological, regional and sex-specific distribution.

Material and Methods

The unique opportunity given by three culturally and socio-economically different Early Bronze Age identity-communities within a relatively narrow geographical area in Lower Austria, Hainburg-Teichtal/*Wieselburg Culture* (Spannagl et al. 2011), Pottenbrunn/*Unterwölblinger Culture* (Novotny 2005) and Unterhautzental/*Unetice Culture* (Teschler-Nicola 1992) motivated us to a detailed study of features of violence. In this study, we investigated the healed depressed fractures (impression fracture IF) of the skull of a total of 236 adult individuals (Hainburg N=172, Pottenbrunn N=36, Unterhautzental N=28), the frequencies and the distribution of the injuries at the neuro- and viscerocranium by bearing the "hat brim line" (HBL) in mind.

Anthropological investigations include the use of a reflector microscope and radiography to characterize the variety of changes and remodelling processes, additionally 3D surface scans for comparative purpose were performed.

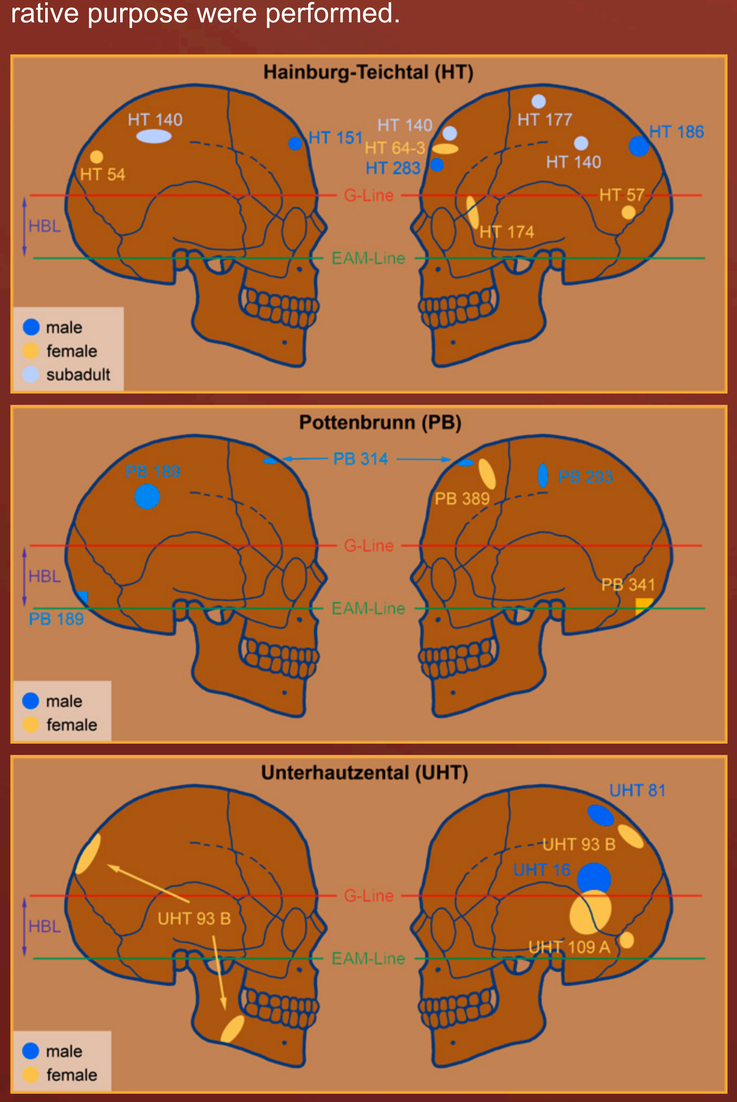

fig. 1
Schematic representation of lateralization, the localisation (HBL), the number and shape of depressed fracture subdivided into male (blue) and female (yellow) of the specific Early Bronze Age sites: Hainburg-Teichtal, Pottenbrunn and Unterhautzental.

Results and Discussion

The present study revealed that the frequencies of healed depressed fractures of adult individuals are similar in the sites of Pottenbrunn (13,9%) and Unterhautzental (14,3%) whereas Hainburg-Teichtal (4,1%) shows a considerable lower frequency (tab.1). Whereupon the distribution between males and females is equal in Unterhautzental (7,1%), higher in males of Pottenbrunn (8,3% : 5,6%) and lower in males of Hainburg-Teichtal (1,7% : 2,3%).

Site	n/N total	male total	female total
Hainburg-Teichtal	7/172 (4,1%)	3/172 (1,7%)	4/172 (2,3)
Pottenbrunn	5/36 (13,9%)	3/36 (8,3%)	2/36 (5,6%)
Unterhautzental	4/28 (14,3%)	2/28 (7,1%9	2/28 (7,1%)

tab. 1 Number and frequencies (%) of healed depression fractures of adult individuals in total and subdivided into males and females of the Bronze Age Sites.

Site	n/N male	n/N female
Hainburg-Teichtal	3/59 (5,1%)	4/89 (4,5%)
Pottenbrunn	3/16 (18,8 %)	2/17 (11,8%)
Unterhautzental	2/13 (15,4%)	2/15 (13,3%)

tab. 2 Number and frequencies (%) of healed depression fractures of adult individuals particular within males and females of the Bronze Age Sites.

Furthermore, analyses of healed depressed fractures within males and within females exhibit a higher frequency in males of all three Early Bronze Age populations (tab.2).

Other criteria of interest are the localisation, the lateralization, the number and shape of injuries at the neuro- and viscerocranium by bearing the "hat brim rule" (HBL) in mind (fig.1).

We observed merely 3 individuals out of 18 with multiple cranial injuries, interestingly 1 juvenile of Hainburg-Teichtal with 3 depressed fractures (fig.2) and 2 females of Unterhautzental with respectively 2 cranial injuries (fig.3).

According to the definition of the "hat brim line" (HBL) representing an area defined by anthropometric landmarks, the G-line (glabella-line) and the EAM-line (external auditory meatus-horizontal line), previously provided by Kremer at al. (2008), the present study revealed 17 injuries above the HBL but only 5 within the HBL, conspicuously only females (fig.1+4).

Side lateralization of fracture is another useful criterion for differentiation, as the majority of our cases are located on the left side at the rate of 16:6 (left:right), amongst them females are more often affected. On the contrary, males exhibit a higher prevalence on the right side (fig.4). For the purpose of our study we divided the neurocranium into an anterior and posterior section (external auditory meatus-vertical line) and identified 13 depressed fractures in the anterior part with a higher percentage in females and 9 in the posterior region with a slightly higher rate in males (tab.3 and fig. 5). Furthermore, all cranial depressed fractures of the Unterhautzental individuals are located in the posterior part of the skull whereas the distribution pattern in the other Early Bronze Age identity-communities is more widespread (fig.1+4). It is interesting to note that 4 out of the 5 females showing fractures within the HBL-zone were affected on the left posterior part.

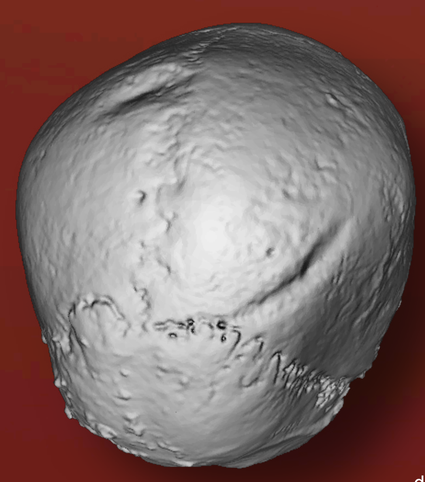

fig. 3
3D scan:
2 healed cranial depressed fractures in a 35-45 years old female of Unterhautzental (UHT 93B).

Site/sex	N individual with IF	N individual with N IF	Localisation left side	Localisation right side	HBL	Above HBL	anterior part	posterior part
HT male	3	3 x 1	2	1	0	3	2	1
HT female	4	4 x 1	3	1	2	2	2	2
HT juv.	1	1 x 3	2	1	0	3	1	2
HT inf.	1	1 x 1	1	0	0	1	1	0
	9		**8**	**3**	**2**	**9**	**6**	**5**
PB male	3	3 x 1	1	2	0	3	2	1
PB female	2	2 x 1	2	0	1	1	1	1
	5		**3**	**2**	**1**	**4**	**3**	**2**
UHT male	2	2 x 1	2	0	0	2	0	2
UHT female	2	2 x 2	3	1	2	2	4	0
	4		**5**	**1**	**2**	**4**	**4**	**2**
total	18	**22**	**16**	**6**	**5**	**17**	**13**	9

tab. 3 Number of individuals with impression fracture (IF), number of individuals with N IF and localisation of IF (left - right side/HBL/above HBL/anterior-posterior part)

In general, the majority of cases didn`t exhibit an additional osseous trauma with the exception of 3 females: they exhibited not only a healed cranial depression fracture within the HBL-area, but also a healed fracture of the left zygomatic bone (HT 174), the right mandible (UHT 93B) and the left ulna (UHT 109A).

In many forensic pathology handbooks the hat brim line (HBL) rule was proposed as a single criterion to distinguish between intentional and accidental head fractures explaining that lesions above the HBL-zone are more frequent in blow rather than in fall injuries. Kremer et al (2008/2009) defined the HBL-area in a new way and recommended that it should be used in conjunction with other tested criteria, such as the side lateralization and the number and the length of lacerations. Moreover, their study revealed that the majority of cranial fractures induced by blows were located on the left side, while the right side was predominant for fall fractures.

Analog to their results, we found that the majority of our cases are located on the left side as well and could be intentional. Consistently, the present study revealed a higher percentage of injuries above the HBL-zone than within the HBL-zone.

With reference to the archaeological findings, the small frequency of healed depressed cranial fractures in the Hainburg-Teichtal population ("Wieselburg Culture") can be seen as further evidence of a rather stable political and social community (Krenn-Leeb 2011). Compared to this culture, the other simultaneously existing communities, e.g. the "Unterwölblinger Culture", were more involved in producing and trading with bronze and were thus probably prone to a higher potential for conflict. Unfortunately, conclusions for the Pottenbrunn population ("Unterwölblinger Culture") cannot yet be drawn due to its highly eroded state of conservation, only in the case of a woman from grave 341 an accident appears to be most likely. (fig.5) In the Unterhautzental population, females stand out for their multiple fractures. This seems to suggest, that females from this settlement pertaining to the "Unetice Culture" might have been exposed to a higher degree of interpersonal violence. Interestingly, some individuals of this Population were deposited in settlement pits. Whether the frequency of fractures and the deposition in pits can be seen as an expression of a socio-economic crisis remains to be discussed.

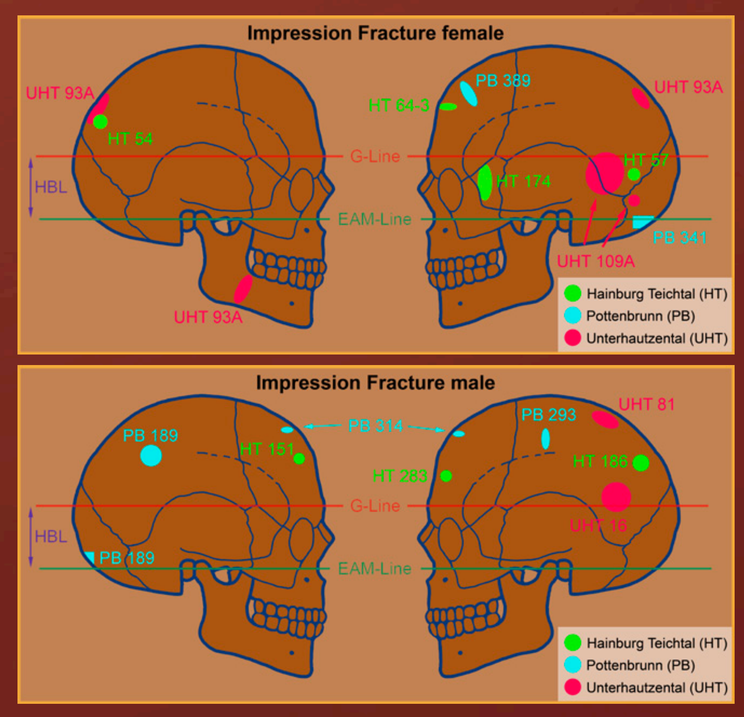

fig. 4
Schematic representation of lateralization, the localisation (HBL), the number and shape of depressed fracture in males and females of the Early Bronze Age sites.

fig. 2
Image of a healed cranial depressed fracture in a juvenile of Hainburg-Teichtal (HT 140).

fig. 5
Image of a healed cranial depressed fracture in the posterior part obove HBL-zone in a 35 – 45 years old male of Unterhautzental (UHT 16).

fig. 6
Image of a healed cranial depressed fracture possibly induced by a fall in a 20-30 years old female of Pottenbrunn (PB 341).

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