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Intersectional differences in microscopic age estimation in the anterior cortex of the femur

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1) Introduction

In prehistoric anthropology knowledge of age at death of the examined individuals is essential, for example for the reconstruction of demographic events using mortality tables. In case of heavily fragmented remains, macroscopic methods for age determination are often insufficient and thus microscopical methods are applied instead. Since bone is subject to changes within its structure depending on mechanical strain, which normally is not distributed evenly between different locations along the femoral midshaft, it is of interest, if the established methods used for histological age estimation are equally reliable for different regions, regardless of adaptations to mechanical strain. Finally it is of interest, whether or not intra- and inter-observer bias has an influence on age estimation.

2) Material

Femoral bones of four individuals of known age and sex (Table 1) were analysed. Each bone was divided into 11 sections along the anterior femoral midshaft. In each section 3 microsopic fields of the subperiosteal region were evaluated.

Table 1: Age & sex of the individuals.

Individual	Sex	Age
WF9	m	68
WF22	w	77
WF26	w	72
WF37	w	87

3) Methods

Histological age determination was carried out by applying the methods by Kerley & Ubelaker (1978) and Ericksen (1991). For the regression formulas, the following parameters were counted (Fig. 1):

1. Kerley & Ubelaker (1978): Number of osteons per microscopic field
2. Ericksen (1991): Number of osteons, fragments, type-II-osteons and non-Haversian canals per mm^2, as well as percentage of osteonal, fragmental and unremodeled bone

For the determination of the intra- and inter-observer error, some of the microscopic fields were analysed two times, either by the same or a second observer, using the regression formula by Ericksen (1991).

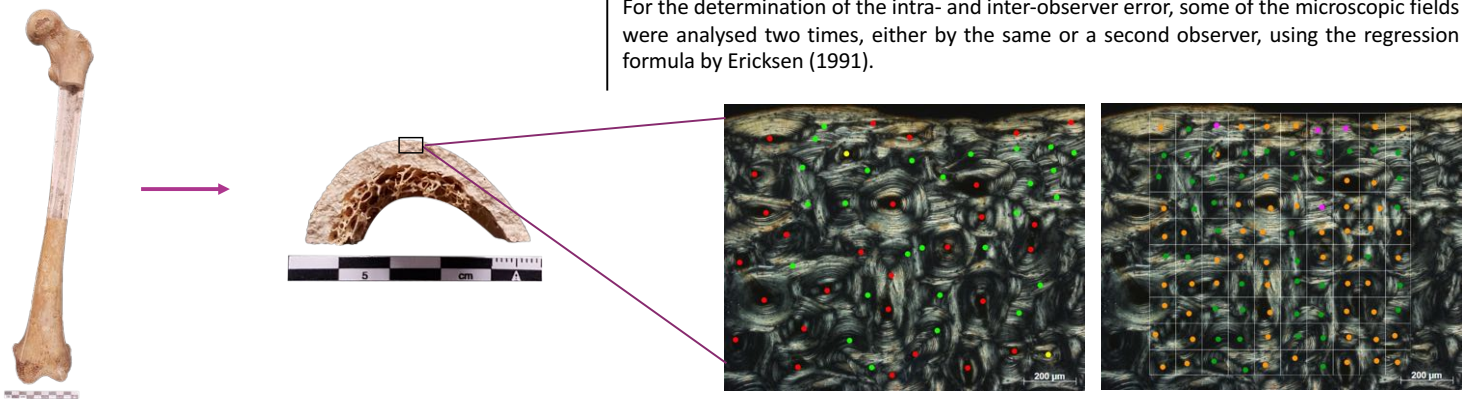

Figure 1: Histological preparation of a femoral bone for age determination; the histological slides show an example for the evaluation using the method by Ericksen (1991): red = osteons, yellow = type II – osteons, light green = fragments, orange = percentage osteoneal bone, dark green = percentage fragmented bone, pink = percentage unremodeled bone; non-Haversian canals were missing in all histological slides.

4) Results

- Ericksen (1991) → smaller variation between age estimates
- Kerley & Ubelaker (1978) → higher variation between age estimates
- Intra-observer error → deviation of up to one year
- Inter-observer error → deviation of up to three years
- Intra-observer error < inter-observer error

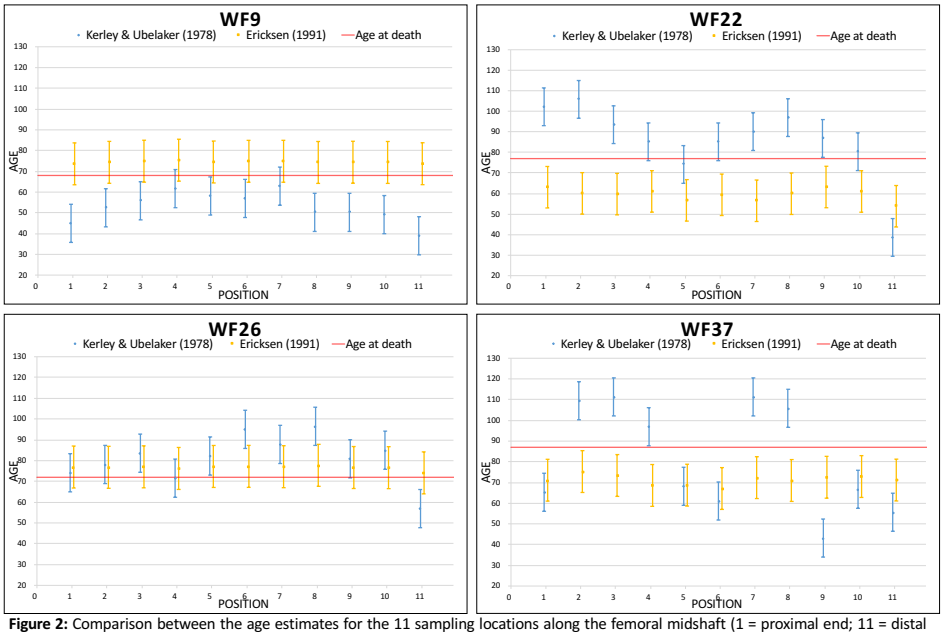

Figure 2: Comparison between the age estimates for the 11 sampling locations along the femoral midshaft (1 = proximal end; 11 = distal end) using the methods by Kerley & Ubelaker (1978) and Ericksen (1991) for each individual WF9, WF22, WF26 and WF37. All individuals are from the Westfriedhof in Munich.

5) Discussion

From a certain age onward, the chronological and the biological age of an individual are no longer equivalent. This might be attributed to the fact that from 50 to 60 years of age onwards, there exists a plateau in osteon population density, beyond which every trace of previous osteon populations is erased by the following ones (Walker et al. 1994; Robling & Stout, 2008; Walker, 1989 in Walker et al., 1994). Furthermore factors like sex and ethnicity of the individuals affect the bone microstructure and thus affect the results of histologic age estimation as well as other factors concerning the methods itself, like the number of structures used for a specific regression formula or the varying definitions of single structures.

6) Conclusion

It appears that depending on the method used for histologic age estimation different sampling locations can lead to different results. Less variability between the age estimates by Ericksen's method could be attributed to the determination of more than just one parameter for the same regression formula. Finally subjectivity, though its effects could have been stronger between two different observers, does not seem to have a significant influence on the age estimates.

7) Literature: ***ERICKSEN, M.F.* (1991)**: Histologic estimation of age at death using the anterior cortex of the femur. Am. J. Phys. Anthrop., Vol. 84 (2): 171-179. **—** ***KERLEY, E.R. & UBELAKER, D.H.* (1978):** Revisions in the microscopic method of estimating age at death in human cortical bone. Am. J. Phys. Anthrop., Vol. 49: 545- 546. **—** ***ROBLING, A.G. & STOUT, S.D.* (2008):** Histomorphometry of human cortical bone: applications to age estimation. In: Katzenberg M.A. & Saunders, S.R., ed., Biological anthropology of the human skeleton. 2. Auflage; Hoboken, New Jersey: John Wiley & Sons Inc., pp. 149 – 182. **—** ***WALKER, R.A.* (1989)**: Assessments of human cortical bone dynamics and skeletal age at death from femoral cortical histomorphology. Doctoral dissertation, Kent State University, Kent, Ohio. In: *WALKER, R.A., LOVEJOY, C.O. & MEINDL, R.S.* (1994): Histomorphological and geometric properties of human femoral cortex in individuals over 50: implications for histomorphological determination of age-at-death. American Journal of Human Biology, Vol. 6 (5): 659 – 667. **—** ***WALKER, R.A., LOVEJOY, C.O. & MEINDL, R.S.* (1994):** Histomorphological and geometric properties of human femoral cortex in individuals over 50: implications for histomorphological determination of age-at-death. American Journal of Human Biology, Vol. 6 (5): 659 – 667.