Histomorphology of the Subadult Rib:

A test of Streeter's method on a medieval Polish sample

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Introduction:

- Streeter[1] was able to successfully identify age-associated developmental trends in histomorphological structures present in cortical bone of ribs from a modern sample of subadults based on 1) the presence and location of woven and lamellar bone, 2) changes in patterns and the frequency of characteristic types of histomorphological structures, 3) changes in relative cortical thickness, and 4) evidence of cortical drift. Subadult age was divided into four phases with patterns described for cortices characterizing each phase (Figures 1-4).

- **The purpose of this research is to determine whether patterns in the cortical bone of subadult ribs as defined by Streeter are observable in archaeological skeletal remains and to test the methods ability to estimate age relative to other methods in an archaeological population.**

Methods:

- The archaeological sample is comprised of subadults of the medieval Giecz collection (n=38) from Giecz, Poland (11th– 12th c). Sections were cut from the middle third of the left 4th-7th rib and thin-sections prepared according to standard histological procedure[2].

- All ribs were assigned to one of Streeter's four histomorphological phases (Figures 1-4).

- Individual age was estimated by diaphyseal length[3,4] and dental eruption[5]. Long bone lengths were used to create a 'summary diaphyseal age' (SDA)‡ for each subadult in the sample. Dental, individual long bone, and SDA estimates were compared to the age range for the histomorphological phase determined from the rib (Figure 5).

- ‡ Clavicles are excluded from the SDA estimate and examined separately because they consistently give an age range well outside that for the other long bones.

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References:

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Figure 1:

Phase I

Primary lamellar bone: rare

Remodeling: rare

Woven bone: encompassing the majority of both cortices

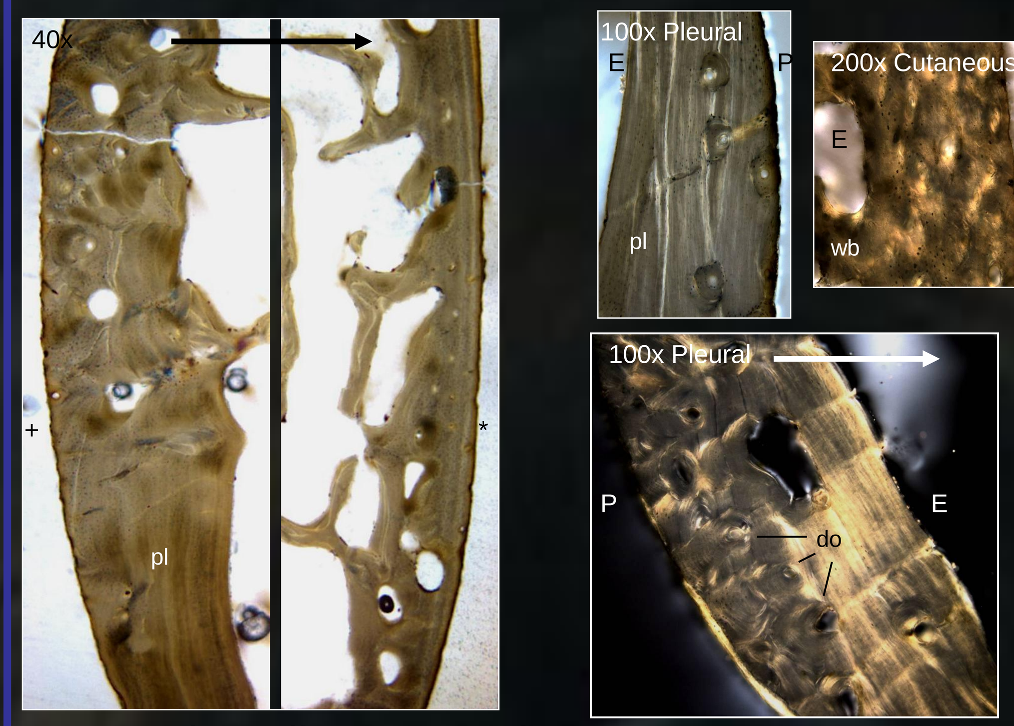
Cutaneous cortex (*): thinner than pleural, mostly woven bone with many primary vascular canals

Pleural cortex (+): thicker than cutaneous, some woven bone, primary lamellae first forms here endosteally

Streeter's age-range: < 5 yrs

Figure 2:

Phase II



Primary lamellar bone (pl): new on pleural cortex

Remodeling (r): large drifting osteons (do) on pleural cortex; periosteum (P) to endosteum (E)

Woven bone (wb): still on cutaneous, but rare on pleural cortex

Cutaneous cortex: thinner than pleural, mostly intracortical woven bone with many primary vascular canals

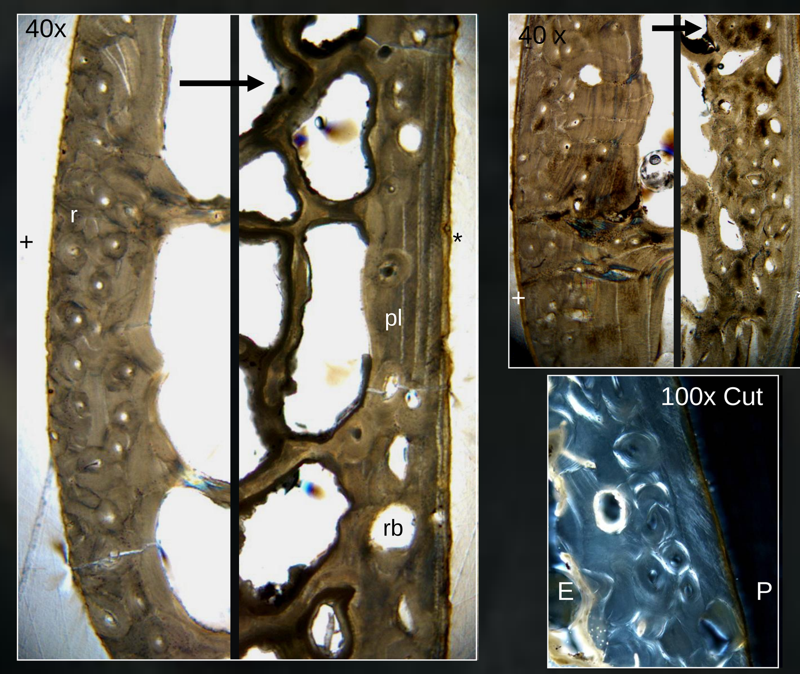
Pleural cortex: thicker than cutaneous, mostly primary lamellar bone with many Volkmann's canals

***evidence of drift (in direction of arrow)

Streeter's age-range: 5-9 yrs

Figure 3:

Phase III



Primary lamellar bone (pl): both cortices (intracortically)

Remodeling: drifting osteons on both cortices

Woven bone (wb): thin rind on cutaneous periosteal surface

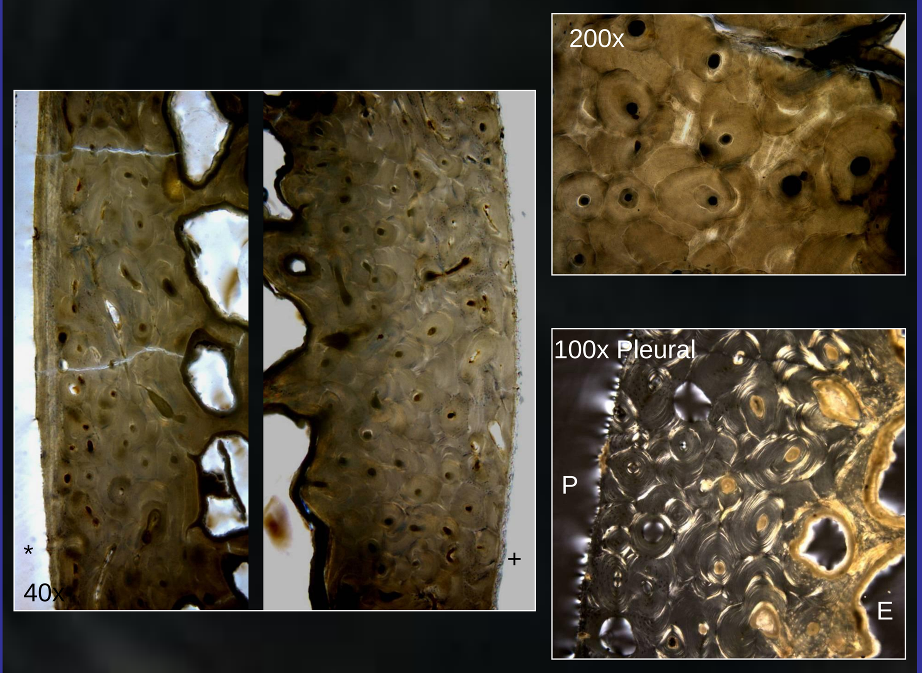
Cutaneous cortex: thinner than pleural, mostly lamellar bone with some remodeling, small area of periosteal woven bone, large resorptive bays (rb) from drifting osteons

Pleural cortex: thicker than cutaneous, dense remodeling with some areas of primary lamellar bone

Streeter's age-range: 10-17 yrs

Figure 4:

Phase IV



Primary lamellar bone: both cortices (periosteal)

Remodeling: dense in both cortices with less drifting and more Type I osteons

Woven bone: none

Cutaneous cortex: thinner than pleural, dense osteons 3-4 rows thick, primary lamellar bone periosteally

Pleural cortex: thicker than cutaneous, dense osteons 4-5 rows thick, occasional areas of primary lamellar bone

Streeter's age-range: 18-21 yrs

Results:

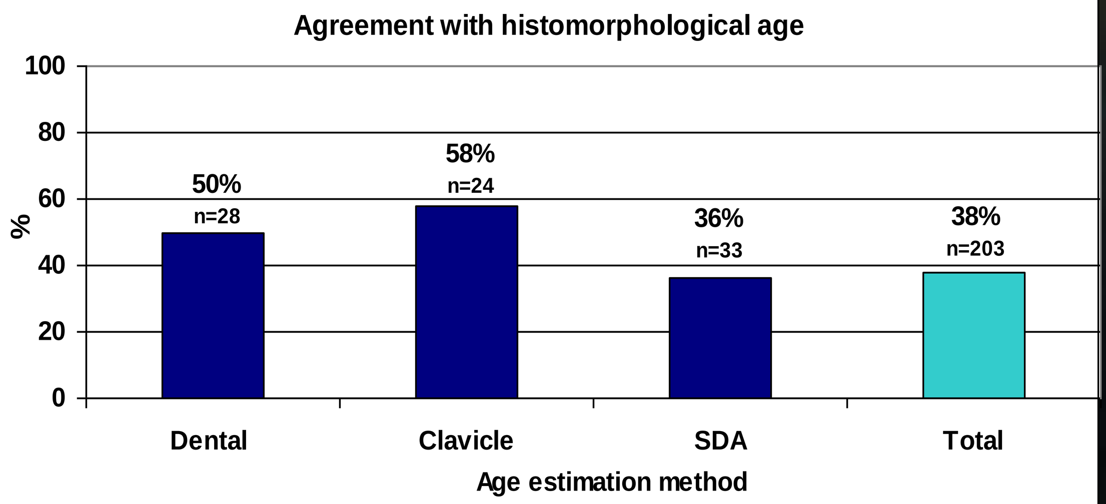


Figure 5: Comparison between histological age estimations and those from dental eruption, clavicle length, a combination of the femur, tibia, humerus, radius, and ulna (SDA), and a category (total) consisting of all age estimating indicators.

	Histology			
SDA	I: <5 yr	II: 5- 9 yr	III: 10- 17 yr	IV: 18- 21 yr
<5 yr	**100% (n=3)	*83% (n=15)	20% (n=2)	0%
5- 9 yr	0%	**17% (n=17)	*70% (n=7)	0%
10- 17 yr	0%	0%	**10% (n=1)	*100% (n=2)
18- 21 yr	0%	0%	0%	**0%

Table 1: Estimated SDA compared to the assigned histomorphological age-ranges. Yellow areas (**): where the majority of individuals were *expected* to fall. Blue areas (*): where the majority of individuals are *observed* to fall.

- The estimated age ranges based on different methods are often not in agreement (Figure 5); only 38% of the time do the ranges overlap. However, a trend appears as the histomorphology consistently overestimates age by only one phase relative to estimated ages from dental formation and eruption, clavicle length, and SDA (example in Table 1).

- Diaphyseal lengths were seriated to rank individuals developmentally (Table 2). Regardless of chronological age, this order represents individuals ranging from least to most skeletally mature (i.e. approximately youngest to oldest). When corresponding histological phases for each individual are added to the seriation of long bones, the results appear promising. Only 3 cases fall outside the expected pattern.

	Histological Phases				
ID	I	II	III	IV	max SDA
22	I				1.5 mo
7	I				3 mo
11	I				3 mo
33		II			1 yr
25		II			1 yr
19		II			1 yr
37		II			1 yr
30		II			1.5 yr
15		II			2 yr
24		II			2 yr
16		II			2 yr
20		II			2 yr
29		II			2 yr
36		II			3 yr
31		II			3 yr
4		II			5 yr
17		II			5 yr
18		II			5 yr
21			III		5 yr
10			III		5.5 yr
13			III		7 yr
34			III		7 yr
2		II			7 yr
35			III		8 yr
23			III		9 yr
12			III		9 yr
5			III		
8			III		9 yr
3		II			9.5 yr
9			III		10 yr
38		II			11.5 yr
14			III		12 yr
1				IV	11.5 yr
26				IV	12 yr

Table 2. Seriation by diaphyseal lengths.

Discussion & Conclusions:

- Streeter's age-estimation method did not show close agreement with age ranges determined by non-histological methods for the Giecz collection. It was found to be a poor indicator of subadult age in this sample. A continuation of testing on known-age samples is necessary before further application of the method.

- Consistent with Streeter's observations on a modern sample, definite patterns of lamellar and woven bone, apposition and resorption through modeling drifts, and histomorphological structures are observable in the cortical bone of the Giecz sample ribs.

- Differences between the age for phases reported by Streeter and those observed in this study probably reflect population variation in the nature and timing of bone formation and development. A slowed growth rate in the Giecz sample compared to modern (Figure 6) may contribute to the lack of agreement between histomorphological and other age estimating methods. This method may not be appropriate for age estimation of archaeological skeletal remains, though it may be used to describe and compare patterns of growth and development.

Figure 6. Standard growth profile for femoral diaphyseal length: Giecz, Moravia[6] and a modern population (10th, 50th, and 90th percentiles)[7]. Giecz appears to fall below the modern size-for-age pattern.