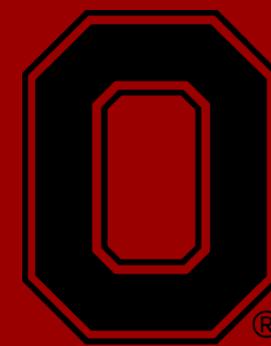


Patterns in Resorptive Spaces in Elderly Rib Cortices

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INTRODUCTION

- As the elderly population continues to increase, understanding the etiology of age-related bone loss becomes of increasing importance. Both trabecular and cortical bone diminish with age. However, in the elderly, trabecular bone within the rib is almost non-existent, while cortical bone loss is characterized by large pores on the endosteal envelope, resulting in trabecularization of the cortex (Zebaze et al., 2009).

- Evidence suggests that bone loss occurs at a differential rate between the pleural and cutaneous regions of the rib, though what drives this remains unclear.

- This study examines the prevalence and location of cortical resorption via porosity in the ribs of elderly individuals. Patterns of bone loss are explored by sex, as well as by intra-individual comparison of the pleural and cutaneous cortices of the rib.

MATERIALS AND METHODS

- The sample is composed of 34 elderly individuals, 18 male and 15 female, between 63–94 years of age (mean = 79.06, SD = 8.36 years). Complete cross-sections were taken at the left, midshaft of the 6th rib and slides prepared following standard histological protocols. All slides were photographed at 40X magnification and all data were collected using ImageJ.

- Ribs were photographed and then digitally bisected into pleural and cutaneous regions for data collection (defined by Imin). Variables collected are listed in Table 1. All areas were manually traced and only those pores with an area ≥ 0.02 mm² were included in the analyses (Fig. 1).

- Normality tests indicated that %Porosity values were not normally distributed, so log transformation was applied to normalize the data. Independent sample t-tests were run to compare %Porosity values between the sexes. Then, paired sample t-tests were used to compare %CuPorosity and %PIPorosity.

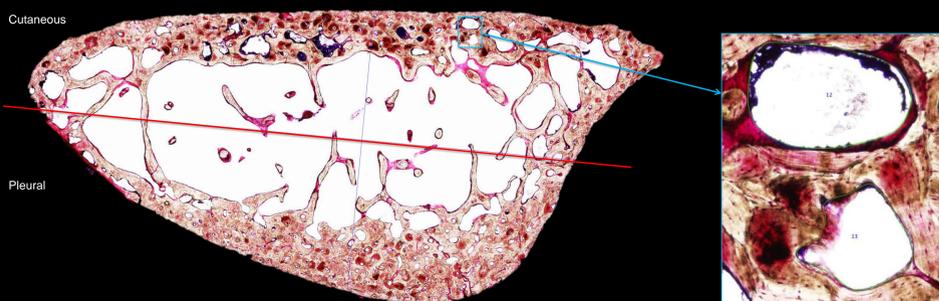


Fig. 1. Rib stained in basic fuchsin, illustrating data collection protocol. Red line indicates delineation between pleural and cutaneous regions. Inset represents two measured pores included in the analyses.

Table 1. Collected Variables^a

Variable	Definition
Ct.Ar	Total area between periosteal and endosteal borders
Po.Ar	Total area of pores within cortex
%Porosity	(Po.Ar/Ct.Ar)*100

^aEach variable was also collected and analyzed for the cutaneous and pleural halves of the rib specifically.

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RESULTS AND DISCUSSION

- Independent sample t-tests indicated no significant differences between males and females in the tested porosity indices (Table 2). Samples were pooled for further analyses.

- Paired sample t-tests indicated that the cutaneous cortex of the rib has a significantly higher %Porosity than the pleural cortex ($p = 0.001$, Table 3)

- Delimiting between cortex and trabeculae was a problem in this study (Fig. 2). Though we used traditional Ct.Ar measurements, it must be noted that these measurements exclude trabecularized cortex, thus underestimating both cortex size and the associated increase in porosity (Zebaze et al., 2009). This may account for seemingly higher %PIPorosity values in some of the study samples. While the trend in increased %CuPorosity is strong enough to remain evident despite this quantification issue, researchers should keep in mind that traditional cortical measurements may be underestimating rates of cortical bone loss.

Table 2. Independent t-test Between Males and Females

	<i>t</i>	<i>df</i>	<i>p</i>
Total Cortex	1.574	31	0.126
Cutaneous Cortex	1.109	31	0.276
Pleural Cortex	0.738	28	0.467

Table 3. Paired Sample t-test^a Means

	Mean	SD
Cutaneous Cortex	1.6957	0.95887
Pleural Cortex	0.8378	1.36962

^a $t(29) = 3.524, p = 0.001^*$

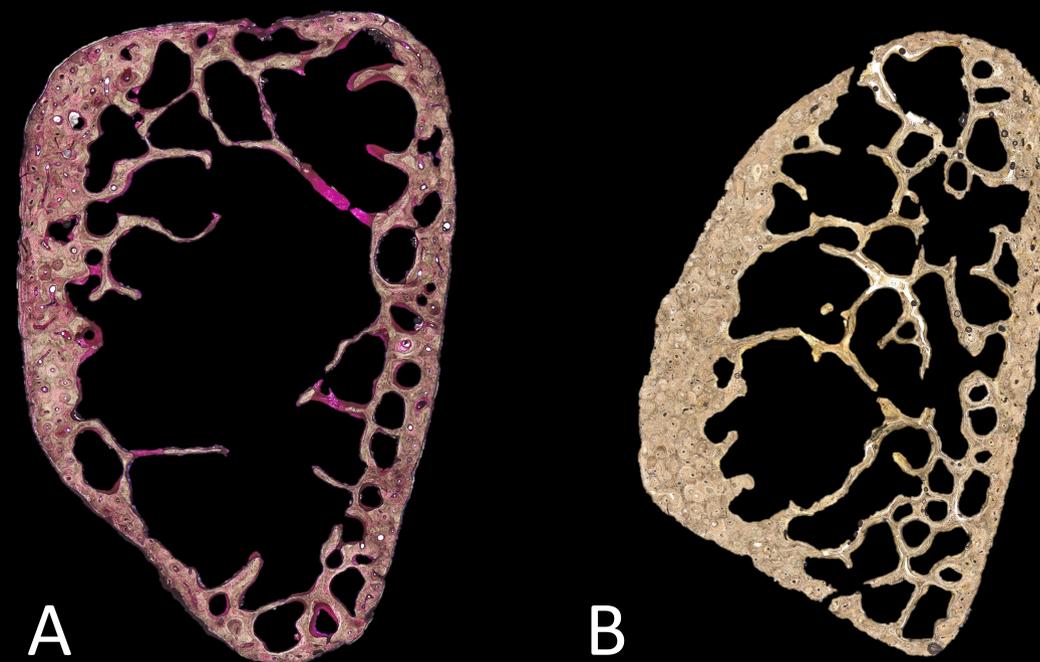


Fig. 2. A. Discernible endosteal border for porous cortex. Rib stained in basic fuchsin. B. Endosteal border degraded by cortical trabecularization.

CONCLUSIONS

- Our results show that in elderly individuals, the cutaneous cortex undergoes higher rates of bone loss than the pleural cortex of the rib. When coupled with previous work that found the same pattern in the ribs of juveniles undergoing modeling drift (Agnew et al., 2013), this suggests a preferential preservation of the pleural cortex over that of the cutaneous cortex throughout life. Future work should examine both juvenile and adult samples to determine if this pattern holds through all decades of life and why.

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