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Variations of the trabecular bone microarchitecture through the period of locomotor behaviour development of a late 19th century post-industrial Italian population.

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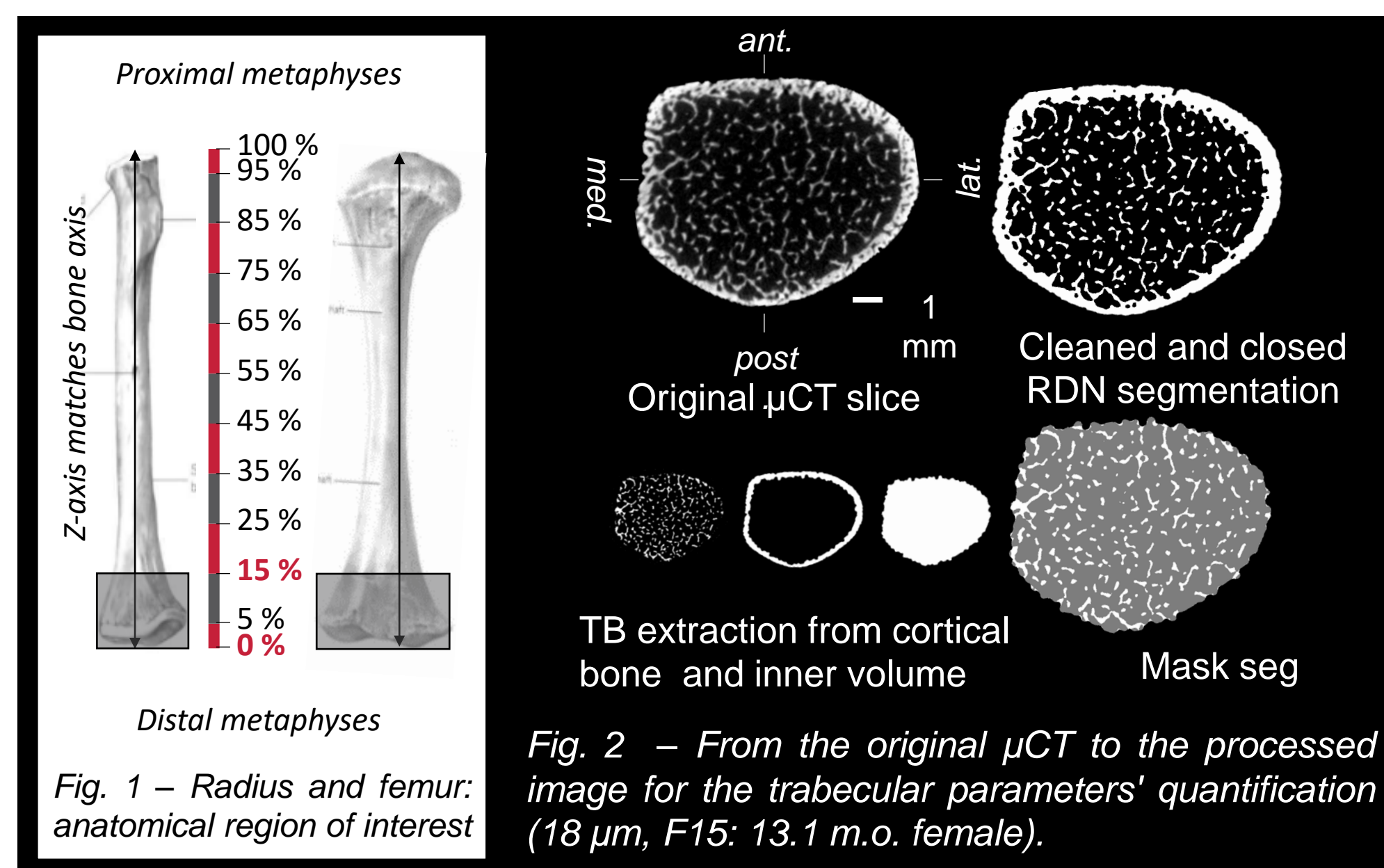
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INTRODUCTION

- Trabecular bone microarchitecture (TBMA) adapts to variations in loading experienced during locomotion [1].
- TBMA variations is useful in the study of **locomotor behaviour** [2] but still misunderstood during the development of human locomotion.
- The **crawling phase** is an important step before bipedal walking in children [3] leading to biomechanical modification on the **wrist and knee**.
- Rickets** due to a severe vitamin D deficiencies is one of the most common diseases identified in archaeology, especially interesting for period of cultural transition, as the **industrialisation** [4].

This study aims to characterise trabecular changes in radius and femur during locomotor development in normal and pathological contexts.

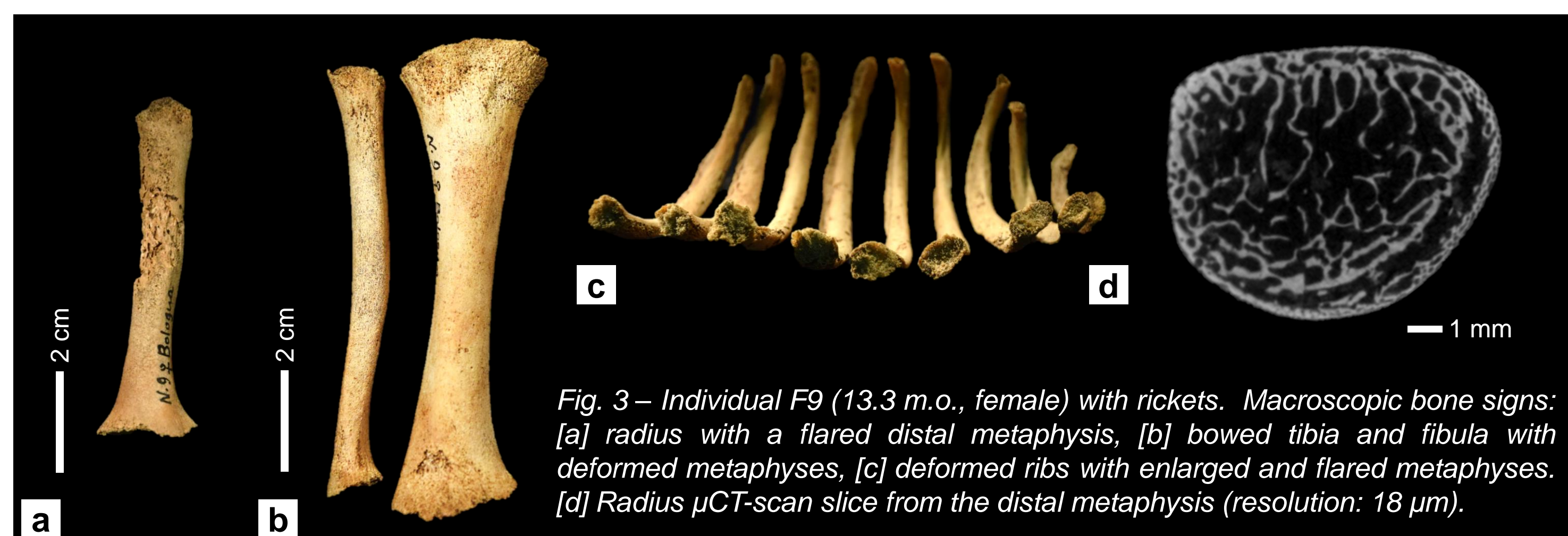
MATERIAL & METHODS



- Sample:** 46 children (25 girls, 14.3 \pm 9.7 months), **distal radial and femoral metaphysis** (Fig. 1), Certosa identified skeletons collection, Univ. Bologna [5].
- μ CT-scans:** 9 or 18 μ m resolution, SkyScan Brüker 1276 (0.5 Al, 70 kV, 141 μ A, 495 ms, 0.5°, 360° rotation mode, frame averaging of 3).
- Analysis protocol** (Fig. 2): **RDN segmentation** [6], **Medtool 4.4** image processed & parameters quantified [7]: **bone volume fraction (BV/TV)**, **degree of anisotropy (DA)** and **trabecular thickness (Tb.Th)** and **spacing (Tb.Sp)**.

RESULTS

- Paleopathological diagnosis (Fig. 3)** : 20 children with signs consistent with rickets.



- TBMA variations in the non-pathological sample (n=26) : comparison between radius and femur metaphyses (Fig. 4 and Fig. 5)**

- TBMA varies in **both radial** (BV/TV) and **femoral** (BV/TV, DA, Tb.Th) metaphyses (Fig. 4, 5).

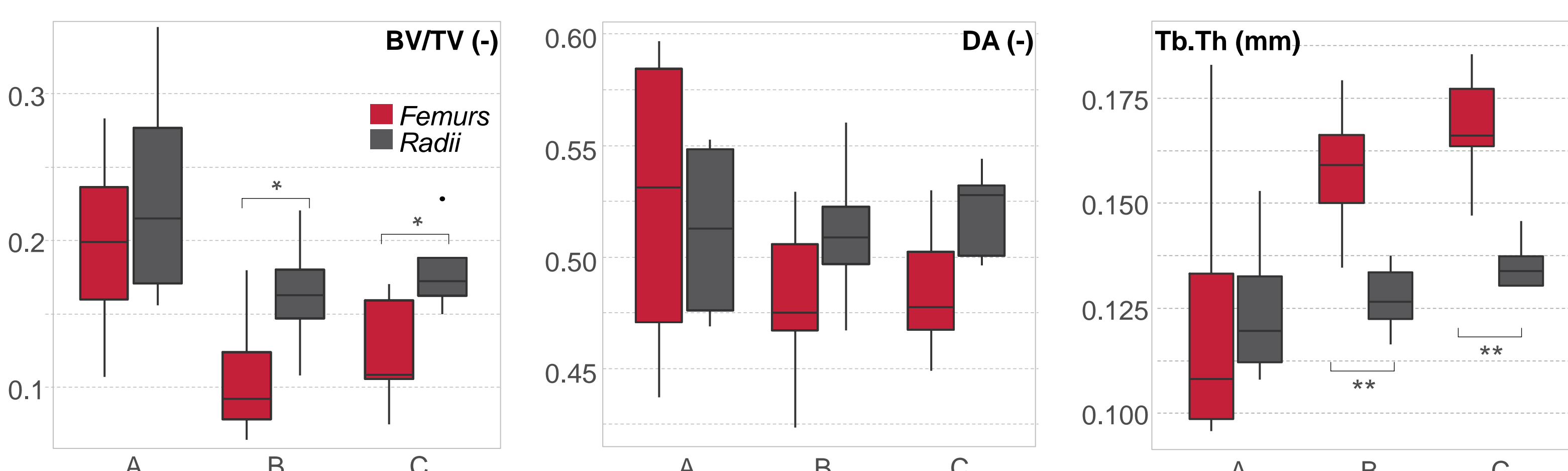


Fig. 4 – Comparison of the quantified microarchitectural parameters for the femoral and radial metaphyses per age group (A: [0-9], B: [9-18], C: \geq 18 months old) between radius and femur metaphysis samples (Wilcoxon non-parametric test: * $p < 0.05$, ** $p < 0.01$).

- TBMA variations in the pathological and non-pathological samples : comparison between radial metaphyses (Fig. 6 and Fig. 7)**

- Pathological radii with **lower BV/TV** and **more variable DA** for the 3 age groups. Lower **Tb.Sp** and **Tb.Th** for the youngest age group and significantly **higher** for the age group B (Fig. 6).
- TBMA organisation (Fig. 7) in the pathological bone similar to the **younger individuals** from the normal sample. High Tb.Th values and BV/TV concentric organization for the non pathological group B the pathological group C. Highly variable DA organization for the pathological sample.

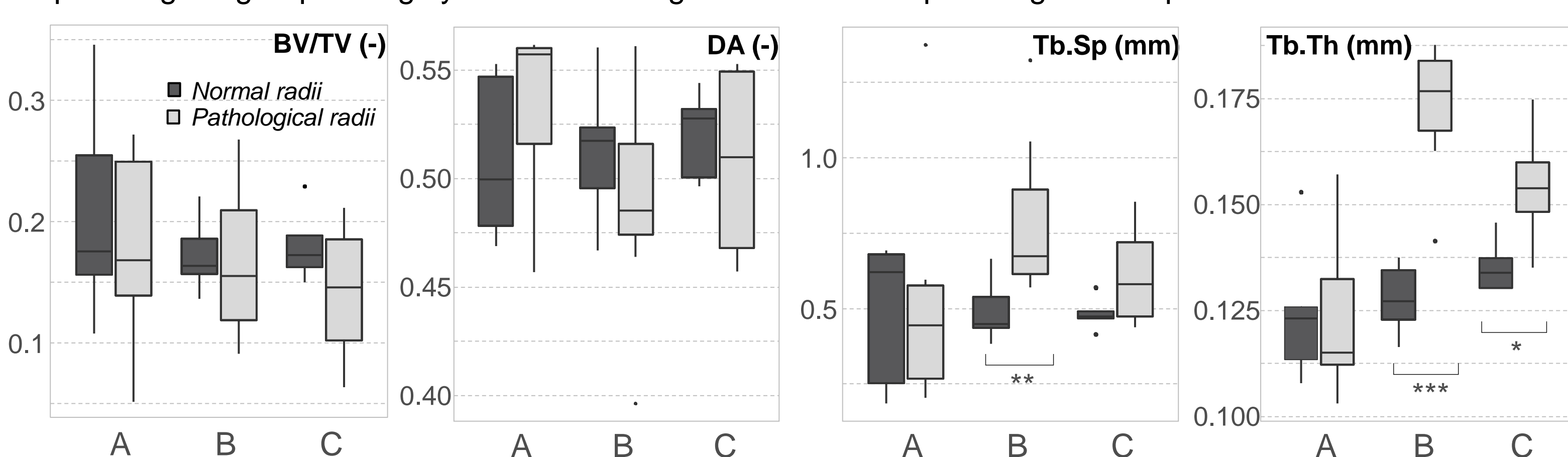


Fig. 6 – Comparison of the quantified microarchitectural parameters for the pathological and non-pathological radial metaphyses per age group (A: [0-9], B: [9-18], C: \geq 18 months old) between normal and pathological samples (Wilcoxon non-parametric test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

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DISCUSSION & CONCLUSION

- Even though locomotion studies through TBMA analysis are more common, e.g. [2] in the last decade, **structural changes related to the development of human locomotion are not fully understood**, especially in a pathological context, which can impair bone growth and locomotion.
- Microarchitectural patterns in the radius and femur in the non-pathological sample may reflect the acquisition and maturation of bipedal walking. This specific phase of development is a key period of development of children locomotor abilities [3].
- The pattern observed in the pathological sample confirms a degraded trabecular network, perhaps also due to delayed locomotor development as rickets mainly affects infants aged 6-24 months and is known to **delay** the psychomotor development [8].