Metaphyseal Trabecular Bone Separation is Bimodal

Carmen Huesa[a], Jonathan A. Williams[b]

[a]School of Infection and Immunity, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, G12 8QQ, UK

[b]Department of Biomedical Engineering, Wolfson Building, University of Strathclyde, Glasgow, G4 0NW, UK

Micro-computed tomography is the gold standard methodology for skeletal phenotyping of small animal models of bone disease. Specifically, it can quantify the 3-dimensional morphology of trabecular bone. Metaphyseal trabecular bone, within load bearing long bones, is the most common assessment site. The 2010 guidelines paper for bone microstructural assessment recommends a minimal set of four parameters be used to described trabecular bone morphometry[1]. These are bone volume fraction (BV/TV), and trabecular thickness, separation (Tb.Sp) and number, calculated using the maximal sphere fitting method[2]. One caveat of assessing the average of metaphyseal trabecular bone is that it assumes the distribution, shape and thickness of trabeculae and pores are equally distributed, which in most cases they are not.

Here we showcase, on two separate species (rat and mouse), and two different osteoporosis models (spinal cord injury-induced and ovariectomy-induced), at two distinct sites (proximal tibia and distal femur), that metaphyseal Tb.Sp is bimodal (Figure A-C). We propose that Tb.Sp should be separated into two distinct values, Tb.Sp1 and Tb.Sp2 (Figure B). This bimodality is the consequence of two bone remodelling events, thickening and/or thinning of trabeculae, and marrow cavity expansion. Furthermore, information of the osteoporosis type can be gleamed from quantification of the standard deviation, skew and kurtosis (Figure C). Moreover, the methodological tweak is easy to implement. This methodological update will enable a more sensitive distinction of skeletal phenotypes and provide a greater understanding of the trabecular distribution within the metaphysis.

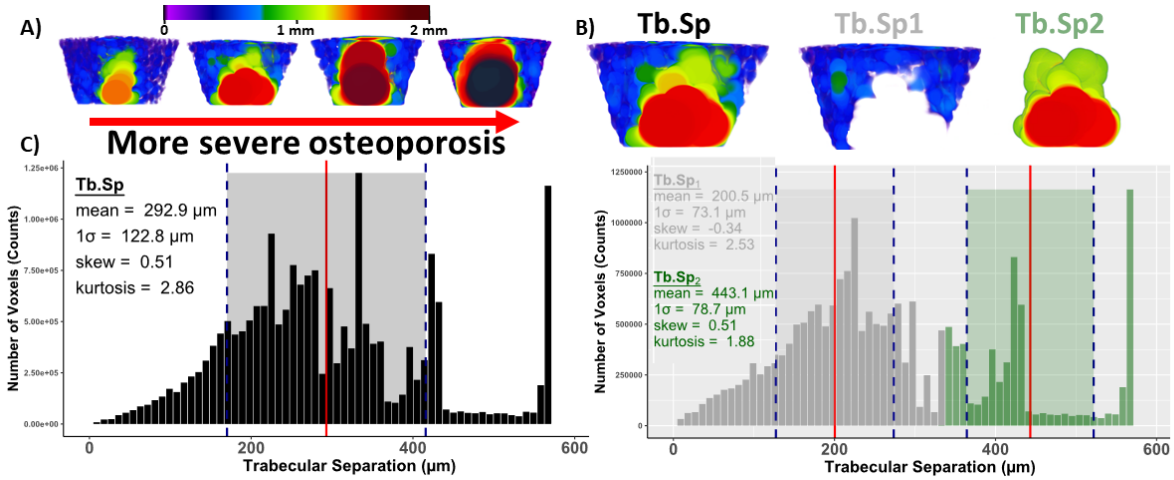

Figure. Metaphyseal Tb.Sp is bimodal. A) Tb.Sp colour thickness maps, illustrating progressive marrow cavity expansion, compared to trabecular thinning, as a mechanism for trabecular separation increase, in increasingly severe spinal cord induced osteoporosis models. B) Comparison of intra-trabecular (Tb.Sp1) and marrow cavity separation (Tb.Sp2). C) TbSp histograms, highlighting the fact that metaphyseal Tb.Sp takes the average of a non-normal distribution.

References

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