On local micro-architecture analysis of trabecular bone in three dimensions

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We read with great interest the article by Djuric et al. [1] on 3D micro-computed tomography (micro-CT) analysis of trabecular bone from femoral neck (Fig. 1 in their paper) of osteoarthritic (OA, $n=9$) patients compared with a control group (CTL, $n=13$). The excised bone sections show a trend towards increased bone volume fraction (BV/TV), significantly higher connectivity density (Conn.D), lower structure model index (SMI) and reduced degree of anisotropy (DA) in OA compared with CTL.

We would like to emphasise the importance of specifying the physical thickness of the bone slice they analysed, which is related to the maximum volume of interest (VOI) available for analysis, and thus to the reported results in 3D. However, there is no such information in their paper, and we can only guess, or infer from 3D images of a similar publication of theirs, that the slices were quite thin, maybe one to three trabecular strut lengths [2]. For accurate analysis, certain 3D parameters—in particular, DA, SMI and Tb.Sp—require a minimum bone volume in order to provide an accurate description in 3D.

The reported anisotropy findings were indeed opposite to those of Tassani et al. [3], who found a significant increase in 3D orientation along the z axis and therefore in anisotropy, of the trabecular framework in OA ($n=30$) compared with CTL ($n=30$). In Tassani et al., the specimen comprised a cylindrical

volume of 19.5 mm in height and 9 mm in diameter (main compressive region, femoral head). DA is calculated by dividing the principal axes of an ellipsoid describing the orientation of the trabecular micro-architecture [4], calculated as a regression of mean intercept length (MIL) points in space and based on the assumption of orthotropy. If the selected trabecular VOI is too thin (narrow), or unbalanced in size among the three dimensions (1–2 mm in one direction, capturing maybe two trabeculae, vs. 10–20 mm in another), the ellipsoid might be (misleadingly) squashed because of the choice of the thin VOI, rather than representing the spatial arrangement of the trabeculae in 3D. Moreover, the coefficient of determination of the ellipsoid regression might also be small, revealing a suboptimal fit and hence the possibly an unsuitable MIL analysis over that volume. For instance, the difference in anisotropy findings compared with those by Tassani et al. might also be due to the thin VOI used by Djuric et al. and linked to the thin bone slice used in the 3D examination by Djuric et al.

In order to enable better interpretations of the 3D results of Djuric et al.'s study and comparisons with the published literature, we suggest the authors to indicate the dimensions of the bone slice and VOI used, of the MIL values along the three axes used to compute the DA, and possibly of the coefficients of determination (R^2) of the fitted ellipsoid. We understand that this last parameter in particular is often ignored and is almost never reported in the scientific literature; however, in cases in which large disproportions in VOI dimensions may exist, and which may impact the DA outcomes, reporting that parameter might also be suggested.

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