

Modic (Endplate) Changes in the Lumbar Spine: a preliminary Report on Bone Microarchitecture and Remodeling

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INTRODUCTION:

This is a preliminary report on the bone microarchitecture and remodeling characteristics of Modic changes in adult human lumbar vertebrae of individuals undergoing spinal surgery for degenerative disease.

Modic et al. in 1988 first described characteristic MRI changes in the vertebral body bone marrow and endplates, adjacent to degenerating intervertebral (iv) discs. Depending on the changes in T1 and T2 MRI signals, three types of lesions were identified: Type I lesions (low T1 and high T2 signal) are thought to be clinically active, due to increased blood flow within the bone. Type II lesions (high T1 and T2 signals) possibly reflect fatty degeneration of the bone marrow. Type III lesions (low T1 and T2 signals) are assumed to correlate with sub-chondral bone sclerosis / thickening [1]. Their occurrence appears to increase with age [2] and is associated with low back pain.

No thorough histological or microarchitectural analysis of such changes has, however, been published.

METHODS:

Twenty patients underwent elective spinal surgery with lumbar vertebrae showing Modic changes on pre-operative lumbar MRI. With patient consent, a transpedicular vertebral body end plate biopsy was taken using an 8G Jamshidi needle. The biopsy was about 25 mm long, 3 mm diameter (Figure).

Inclusion criteria: all patient undergoing Spine Surgery involving pedicle screw fixation and who's MRI of the spine showed Modic changes were included. The patients were asked to read an information sheath and to sign an Ethics Committee approved specific Informed Consent Form prior to surgery.

A micro-computed tomography (micro-CT) scan of the biopsy was carried out to provide a 3D analysis of the bone structure, for the calculation of bone volume fraction, trabecular thickness, trabecular number and structure model index.

Then, histological sections (von Kossa and H&E) were prepared for analysis of tissue-level bone remodeling. The erosion surface to bone surface ratio and osteoid surface to bone surface ratio were determined.

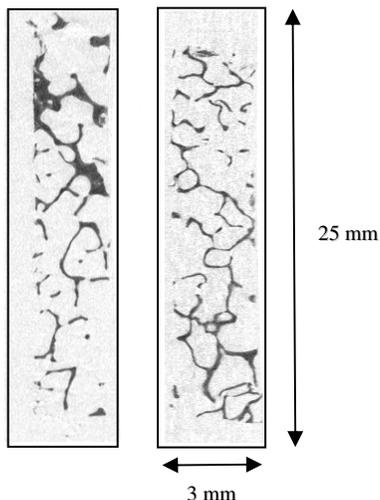


Figure: micro-CT cross-sections of two lumbar spine bone biopsies examined in the study.

RESULTS:

Eleven biopsies have undergone micro-CT and tissue-level analyses. The age of the patients was 62.5±7.6 years (range 50-71 years).

The average bone volume fraction was 19%, 14% and 30% for Modic I, II and III, respectively. The increase in bone volume fraction was related with both trabecular thickening ($R^2= 0.82$, $p<0.01$) and increase in trabecular number ($R^2= 0.54$, $p<0.05$). Modic III samples showed a more plate-like microarchitecture compared with Modic I and II (structure model index =0.9, 1.4 and 1.4, respectively).

Tissue-level analysis showed comparable osteoid surface to bone surface ratio between the three Modic types, but reduced erosion surface to bone surface ratio in Modic III compared with Modic I and II (2.4%, 3.8% and 3.0%, respectively).

DISCUSSION:

Vertebral biopsies performed by Modic et al. in Modic Type I lesions showed a fibrous degenerative process with hypervascularization of the endplates [1]. Modic Type I lesions were assumed to indicate an ongoing active degenerative process. Type II lesions were thought to manifest a more stable and chronic process, reflecting fatty degeneration of the bone marrow. Type III lesions, on the other hand, were thought to correlate with subchondral bone sclerosis.

The preliminary findings of this ongoing study suggest bone microarchitectural differences between Modic types. It can be postulated, notwithstanding the small size of the current data, different Modic types represent different stages of the same pathological process linked to the adjacent disc. Whilst Modic II changes are suggestive of a reduced formation/remodeling stage due to reduction in BV/TV, Modic III changes are consistent with a more stable sclerotic phase associated with higher BV/TV due to reduced resorption.

REFERENCES:

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