Session: Imaging Bone Architecture & Composition
Title: Clinical & Research Applications of Bone Imaging

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Highlights

- Morphological imaging features provide information on pathophysiological bone and bone marrow changes
- Quantitative imaging provides information on bone mineral density but the clinically established technologies use dual energy absorptiometry (DXA) and computed tomography (QCT)
- MRI based quantitative techniques are research applications and target bone quality, these include assessment of bone structure and assessment of bone marrow fat content

Target audience: MDs, PhDs and students with interest in bone research
Objectives: – This lecture will provide an overview of morphological MR findings used to clinically assess bone pathophysiology and of technologies to analyze bone quantitatively. It will highlight strengths and limitations of MRI and will discuss research applications.

Summary:
Morphological standard MR Imaging targets abnormalities of the bone marrow; one of the most frequent abnormalities is the bone marrow edema pattern (Korompilias et al. 2009), which is associated with multiple pathologies including osteoarthritis, fractures, stress related abnormalities, disuse, but also infection, avascular necrosis and tumors. In general bone marrow edema pattern indicates increased bone remodeling which can have multiple etiologies. In osteoarthritis for example it is typically associated with cartilage damage. In disuse not only is there patchy bone marrow signal abnormality but there are also abnormalities of the cortical bone. While bone marrow edema pattern is best seen on fat-saturated fluid sensitive sequences, it should be noted that non fat-saturated T1-weighted sequences are also very important for assessing bone marrow abnormalities. Both too bright and too dark bone marrow signal compared to muscle and intervertebral disc is of concern. Too bright bone marrow signal is typically found in osteoporosis, after radiation and chemotherapy while too dark bone marrow signal suggests bone marrow infiltration by a neoplastic or a metabolic process.

To better assess metabolic bone diseases such as osteoporosis, quantitative imaging was developed. The standard of reference for measuring bone mineral density is dual energy X-ray absorptiometry (DXA) and quantitative CT (QCT). To better understand fracture risk in osteoporosis the National Institutes of Health defined bone quality as opposed to bone density (NIH Consensus Development Panel on Osteoporosis Prevention 2001) and multiple research studies have developed MRI based technologies and sequences to characterize bone quality. These include (i) high resolution techniques to measure trabecular bone architecture, (ii) ultra short TE (echo time) sequences to quantify cortical bone water, (iii) spectroscopic techniques to analyze bone marrow composition such as the degree of bone marrow fat (Link 2012).

In conclusion MRI allows to both morphologically and quantitatively characterize bone and bone marrow. Morphological features are relatively non-specific but have a characteristic appearance in certain pathologies. Quantitative techniques are mostly research applications and serve to characterize metabolic bone diseases and fracture risk.

REFERENCES:

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