MRI of bone marrow in competitive athletes: Is there any correlation between hematological data and performance?

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Abstract
Bone marrow hyperplasia is often seen in competitive athletes as a response to "sports anemia". The purpose of this study was to evaluate the influence of sports on MRI of hematopoietic active bone marrow in the lumbar spine in professional cyclists. Hematological data and performance (Pmax=maximum output (w/kg body weight)) were related to the bone marrow changes depicted by MRI. There was no significant linear correlation between the mentioned parameters and bone marrow signal in MRI. Performance sports and laboratory data do not influence bone marrow imaging of the lumbar spine in MRI.

Introduction
MRI provides valuable diagnostic information about the alterations of bone marrow due to narrow infiltration, application of hematopoietic growth factors and bone marrow hyperplasia caused by sports and other clinical conditions. 

Methods
Twenty healthy competitive athletes (mean age 22 years, range: 18-26) were included in this prospective study. Clinical examination, initial laboratory tests excluded a bone marrow disorder. The measurements of the lumbar spine in a sagittal plane with a slice thickness of 5mm were performed on 1.5 Tesla tomograph (Magnetom Symphony, Siemens, Erlangen, Germany) using a spine coil for signal reception. Sagittal T1-weighted, TIRM- and two gradient recalled echo sequences for in phase and out of phase imaging of fat and water protons were obtained with the following parameters: T1-weighted SE (TR 400/TE 15), TIRM (TR 4500/TE 60/TI 150), In-phase (IP)-GRE (TR 180/TE 4,6) Opposed-phase (OPP) GRE (TR180/TE 6,8). Two radiologists experienced in musculoskeletal imaging visually assessed the MRI studies by consensus reading.

A quantitative assessment of marrow signal was performed by calculating the average of the signal of three adjacent lumbar vertebrae to the signal of a normal nucleus pulposus in the midsagittal slice. These ratios (OPPIDISC) were compared to hematological data (hemoglobin, hematocrit) and performance (Pmax=maximum output (w/kg body weight)). For statistical analysis of quantitative data, the Spearman-Rank correlation coefficient was calculated to evaluate linear correlation of data. P-values < 0.05 were considered to represent significant differences. 

Results
In our population of competitive athletes no significant correlation between hemoglobin, hematocrit and quantitative assessment of the lumbar spine were seen (p>0.05).

In 11/19 competitive athletes, the relative mean corpuscular volume correlated significantly with MRI-data only in TIRM-sequence. The performance (Pmax) did not show any correlation to either quantitative assessment or visual analysis. OPP-sequences showed alterations of bone marrow as hematopoietic bone marrow hyperplasia (Fig.1a) which did not correlate with the hematological data and performance of the competitive athletes.

Discussion
MRI of red bone marrow is highly sensitive to bone marrow disorders, application of hematopoietic growth factors and bone marrow hyperplasia (1). Using MRI with low field strength the bone marrow cellularity is most sensitive depited with a GRE-sequence for out of phase imaging (OPP). Hematopoietic bone marrow hyperplasia is a reaction of yellow to red bone marrow as a response to anaemia, low oxygen tension, cigarette smoking and sports anaemia.

Our results suggest that there is no linear correlation between hematological data of hemoglobin and hematocrit and the quantitative assessment of the bone marrow of the lumbar vertebrae. In agreement to the published data, the hematopoietic bone marrow hyperplasia which can be detected with OPP-sequences does not correlate with the duration of training and hematological parameters (4). The authors stressed that depleted iron reserves or increased hematopoiesis with elevated erthrocytopen levels and reticuloocyte counts probably contributes to the development of hematopoietic hyperplasia. Shellock et al. (3) demonstrated hematopoietic hyperplasia in the knees of marathon runners and interpreted this finding as a response to sports anaemia, although it could be caused due to mechanic stress.

In conclusion, hematopoietic bone marrow hyperplasia can be detected in MRI in competitive athletes especially using OPP-sequences, although the imaging findings and the quantitative assessment do not correlate with hemoglobin, hematocrit and performance of the competitive athletes.

References