LETTER TO EDITOR

High Signal Intervertebral Disc in T1W MRI

Dear editor:

We present two cases of high signal intervetebral disc in T1-weighted MRI with the differential diagnoses. The first case was a 60-year-old obese man who presented with back pain. The patient underwent an MR examination with a 0.3T permanent scanner (Hitachi, IRIS-II Japan). Spin–echo T1W, T2W images in orthogonal planes and STIR sequences were also obtained (Fig. 1). Hypersignal intensity was demonstrated in T1W and T2W images at the T_{12}–L_1 intervertebral disc space. Suppression of this signal was revealed in the STIR sequence (Fig. 2). These findings were compatible with presence of fat in the intervertebral disc space.

The second case was a 52-year-old man who presented with splenomegaly, anemia and back pain. Vertebral MRI showed a decreased bone marrow signal in T1W /T2W images with high signal intensity at multilevel intervertebral discs (Fig. 3).

The intervertebral disc is a fibrocartilaginous gap between the vertebral bodies which is completely occupied by disc material. It has a centrally located nucleus pulposus and a peripherally located annulus fibrosus. Nucleus pulposus is a semiliquid substance and annulus fibrosus has obliquely arranged connective tissue fibers.[1,2] Nucleus pulposus is surrounded by annulus fibrosus which also divides the nucleus by an annular horizontal band resulting in a characteristic biconvex appearance of the adult nucleus pulposus.[3] The normal intervertebral disc is intense to muscle on T1W and bright on T2W images. Sometimes, the intervertebral disc appears high signal in T1W images. High signal discs are demonstrated in proliferative and infiltrative bone marrow lesions due to effects of hematopoiesis, iron deposition, fibrosis and tumoral involvement. In these conditions, change in the bone marrow signal leads to reversal of the normal disc/marrow signal, which is prominent in T1W images. As a rule, in T1W images, an increased signal may represent fat, hemorrhage or a paramagnetic substance (melatonin) in melanoma.[1] In rare reports, a high signal disc demonstrates calcification and fat deposition or changing. Gadolinium postdiscography MRI should be considered. The pathophysiology of these changes is unknown but here we explain the probable mechanisms of increased intervertebral disc signal intensity on T1W.

Fig. 1. Sagittal MR T1W image. Hypersignal intensity in the T_{12}-L_1 level.

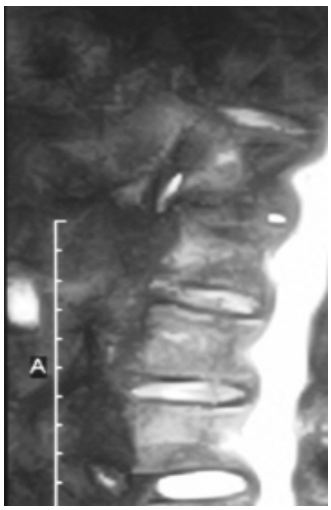

Fig. 2. Sagittal scanning with STIR sequence demonstrates no signal at this level.

Fig. 3. Typical cervical multilevel disc reversal due to diffuse replacement of the marrow by fibrous tissue, myelofibrosis.

1. Hyperintense Disc Sign/Reversal Disc Sign

A normal disc is a homogeneous structure on MRI, isointense to muscle on T1W and becomes bright because of the water content in T2W images. In the normal intervertebral disc, the gel structure of the nucleus pulposus gives a high intensity signal on T2W sequence.[4] The normal vertebral bone marrow contains a variable amount of fat usually sufficient to increase the signal intensity compared to the medullary regions of the vertebrae. For this reason, the vertebral body has higher signal intensity than the adjacent disc on T1W images. Changing discal density and signal intensity is observed in various diseases. Hypersignal discs on images are reported in different diseases such as iron overload, radiotherapy, severe anemia, repeated blood transfusion, AIDS, multiple myeloma, myelofibrosis (Fig. 3), Waldenstrom macroglobulinemia and metastasis.[5-7] The change of signal intensity in the vertebral bone marrow due to conversion of yellow marrow to red marrow, iron deposition, fibrosis and diffuse tumoral infiltration results in diffuse decreased signal intensity in the marrow.[7,8] Thus the disc signal appears brighter than the marrow signal (reversal of the normal disc / marrow signal) and this condition is called the disc reversal sign or the hyperintense disc sign. Therefore, multiple hypersignal discs can be an indirect sign of abnormal spinal bone marrow on T1W images. On the other hand, in these conditions, the discal substance has a normal texture in spite of generalized vertebral involvement.[8]

2. Discal Calcification

Most of the investigators believe that calcification appears signal void (dark) on T1W images, because of immobile protons in calcium and complete maturity of calcium (cortical bone).[9] Sometimes calcification is shown as high signal intensity on T1W images, probably due to the presence of mobile protons (liquid state or milk of calcium) in calcium.[10-12] These mobile protons induce decreased relaxation time that leads to high signal intensity on T1W images. Therefore, the signal pattern of intervertebral disc calcification depends on the actual structure, degree of calcification, hydration of the calcium and presence of bone marrow (fatty element) in ossification.[13,14] In this situation, we recommend spinal x-ray examination to rule out IDC (Intradiscal calcification). Macroscopic calcification is seen in spinal radiography without inframacroscopic calcification.

3. Fat Replacement

Disc spaces were hyper-signal on T1W, T2W images and signal void in STIR sequences in favor of fat presence in the discal space. There was no vertebral body destruction and signal abnormality. Fat replacement in the disc space may have become an additional and rare sign of degenerative changes. Multiple theories, such as the vacuum phenomenon, migration of fat from the surrounding tissues (epidural space) into clefts with an abnormal nucleus or annulus attachment, inframacroscopic calcification and fatty change in the bone marrow of ossification can also be propounded.

4. Gadolinium Discography

Gadolinium postdiscography MR imaging can be used for excellent delineation of disc architecture. Dilute gadolinium enhancement increases the signal intensity of the disc space which is clearly distinguishable in fat saturated T1W sequences. Gadolinium documents the number and nature of annular tears. Gadolinium leaves the disk space later than the other joints spaces (TMJ, knee, elbow), because of the lack of blood supply to the nucleus. After one day, the contrast media was completely washed out from a severely degenerated disc. Contrast media spreads throughout the annulus fibrosus and persists for over 2-3 days.[15] We recommend CT scanning or MRI with special fat suppression sequences to rule out fat replacement in a patient with the disc reversal sign or calcified deposit at intervertebral spaces. We also recommend designing a study to evaluate the role of impaired blood flow or other causes in discal desiccation with MRD (diffusion), PMRI (perfusion) and MRA. Further researches are also necessary for better determination and differentiation of the histology and biochemistry of degenerative disc tissue.

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