

The Use of DIXON Method in Imaging of Ankle and Foot

Vid Di Lenardo^{1,2}, Tomaž Cvetko¹, mag. Milka Kljaić Dujčić¹, doc. dr. Mitja Rupreht^{1,3}

¹ Department of Radiology, University Medical Centre Maribor

² Department of Radiology, General Hospital Ptuj

³ Faculty of Medicine, University of Maribor

Introduction

The majority of signals obtained during an MRI scan originate from hydrogen nuclei in water and fat. The resonance frequency value of hydrogen nuclei in water is slightly bigger than in fat. In a magnetic field of 1.5 Tesla they are offset every 2.4 ms. The Dixon exploits this phase difference to gather data and create images. (1, 3)

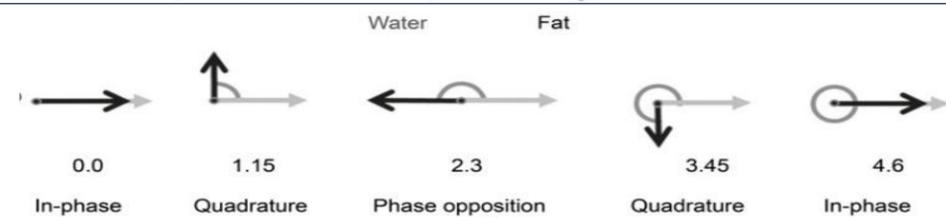


Figure 1. Representation of transverse magnetization vectors of water and fat in acquisitions with different TE (indicated in ms), based on the resonant frequency of water, in a 1.5 T scanner.

Technical aspects of the DIXON technique

This method allows gathering of separate signals for water and fat in post-processing - while other techniques gather images during the scanning process.

The first acquisition is made at a time when the protons are aligned - in-phase (IP image), followed by an acquisition when protons are out of phase (OP image). By adding the IP to OP image a water proton - water only (WO) image is generated, by subtracting the OP from IP image a fat only (FO) image is obtained. (1,2).

In this way 4 sets of different images are generated.

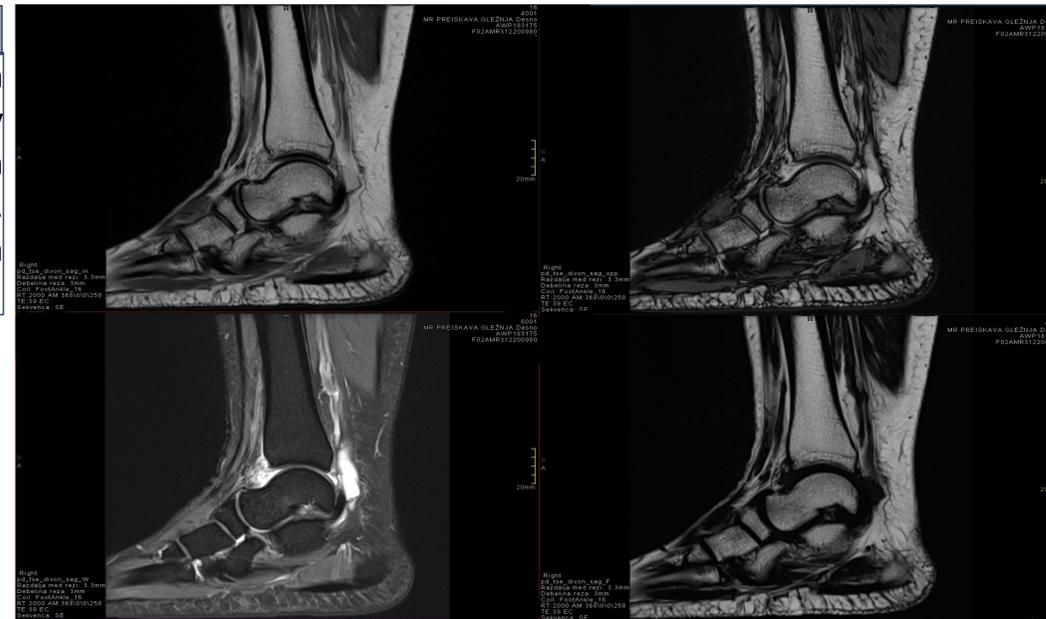


Figure 2. MRI of the right ankle in sagittal sequences. (A) Sequence made in time when the protons are aligned - "In phase" (IP) image, (B) sequence when the protons are in phase opposition - "out of phase" (OP) image, (C) adding the IP to OP image gives us a water proton - "water only" image and (D) by subtracting the OP from IP image a "fat only" image is generated.



Figure 3. MRI of the left foot. Sagittal Proton Density Dixon Water Only (1), and Sagittal Proton Density Fat Sat sequence (2). In the Dixon water only image the interface between the calf muscles, tendon and Kager fat pad are much more evident and clear, compared to the proton density fat sat. Moreover the pathological changes in the soft tissues surrounding the tarsal bones are better delineated with the Dixon technique.

Advantages of DIXON method in MR imaging of ankle and foot

Sagittal plane: Fat suppression in the Kager's fat pad, fatty areas of heel and around the tarsal bones is almost always homogeneous with Dixon method, which differentiates it from other chemically selective fat suppression methods.

With the availability of fluid-sensitive sequences with or without fat suppression, stress fractures of the calcaneus and tarsal bones are easier to identify.

Axial plane: With fluid-sensitive Dixon sequences with fat suppression, pathological changes with high signal intensity are easier to differentiate. In sequences without fat suppression applied, there is better visibility of the ligament structures morphology of the ankle.

Conclusion

Because of its advantages, the use of Dixon method has good application and increasing role in imaging of the musculoskeletal system, as it better demonstrates the uniform fat signal suppression in extremities and other investigated areas, where magnetic field homogeneity is often impaired.

References:

1. Lins, C. F., Salmon, C., & Nogueira-Barbosa, M. H. (2021). Applications of the Dixon technique in the evaluation of the musculoskeletal system. *Radiologia brasileira*, 54(1), 33–42. <https://doi.org/10.1590/0100-3984.2019.0086>
2. Guerini H, Omoumi P, Guichoux F, Vuillemin V, Morvan G, Zins M, Thevenin F, Drape JL. Fat Suppression with Dixon Techniques in Musculoskeletal Magnetic Resonance Imaging: A Pictorial Review. *Semin Musculoskelet Radiol*. 2015 Sep;19(4):335-47. doi: 10.1055/s-0035-1565913. Epub 2015 Nov 19. PMID: 26583362.
3. Delfaut, E. M., Beltran, J., Johnson, G., Rousseau, J., Marchandise, X., & Cotten, A. (1999). Fat Suppression in MR Imaging: Techniques and Pitfalls. *RadioGraphics*, 19(2), 373–382. doi:10.1148/radiographics.19.2.g99mr03373
4. Guichoux, F., Vuillemin, V., Morvan, G., Zins, M., Thevenin, F., Guerini, H., ... Drape, J. (2015). Fat Suppression with Dixon Techniques in Musculoskeletal Magnetic Resonance Imaging: A Pictorial Review. *Seminars in Musculoskeletal Radiology*, 19(04), 335–347. doi:10.1055/s-0035-1565913