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# "COMPARISON OF CONVENTIONAL FAST SPIN ECHO SEQUENCES WITH T2 FAST SPIN ECHO DIXON SEQUENCE IN EVALUATION OF LUMBAR DEGENERATIVE DISC DISEASE"

**Radio-Diagnosis**

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## ABSTRACT

**Aim:** The objective of the study is to compare lumbar disc degenerative disc disease, Modic endplate changes, and High-intensity zones in the routine protocol (T1W FSE, T2W TSE, and STIR) with the T2W FSE Dixon sequence. **Methods:** The study included forty patients who presented with clinically suspected low back pain. Each patient underwent an MRI examination of the lumbar spine, which included routine protocol sagittal T2W FSE, T1W TSE, and STIR sequences, along with an additional T2W FSE Dixon sequence. The assessment of lumbar disc degeneration (DDD), high-intensity zones (HIZ), and Modic endplate changes (MEPC) was performed independently by three readers using both the routine protocol and the Dixon sequence. **Results:** The study group comprised of 40 patients, with 23 males and 17 females. The mean age of the patients was 51 years (15 to 84 years). Among the 200 discs reviewed by the three readers, 107 discs (53.4%) were classified as normal, 57 discs (28.5%) showed early degenerative disc disease (DDD), 21 discs (10.5%) exhibited moderate DDD, 17 discs (7.83%) were identified as advanced DDD. Type 1 Modic endplate changes (MEPC) were observed in 15 discs (7.5%), while type 2 MEPC was seen in 4 discs (2%). Additionally, high-intensity zones (HIZ) were detected in 16 discs (7.9%). The Dixon protocol has high significance in the evaluation of DDD, MEPC, and HIZs compared to routine sagittal sequences. **Conclusion:** A single sagittal T2W FSE Dixon sequence may serve as a viable alternative to the conventional sagittal T1W TSE, T2W FSE, and STIR sequences commonly employed in lumbar spine imaging. This substitution can lead to a significant reduction in scan time, approximately 65%, when performed at 3T.

## KEYWORDS

Lumbar disc degeneration, high-intensity zones, Modic endplate changes, T2W FSE Dixon, T1W TSE, T2W FSE, and STIR

## INTRODUCTION

The most frequent cause of back pain and the main contributor to disability in people over 45 is lumbar disc degenerative degeneration. Sciatica is the primary symptom of disc degeneration following low back pain(1). One side of the body typically only experiences sciatica pain. The pain is piercing and intense. Men are more likely than women to suffer from low back pain caused by degenerative disc degeneration. The pain could radiate to the calf or the sole of the foot. Age, smoking, obesity, trauma, high weight lifting, height, genetic variables, and hereditary factors are all risk factors for disc degeneration in the lumbar spine.(1,2)

The diagnostic process involves several components, including a physical examination, collecting medical history, and performing imaging studies including X-rays, Computed Tomography scans, and MRIs. Instead of using radiographs to directly diagnose degenerative disc disease, they are frequently utilized to rule out alternative diagnosis. The radiographs are generally used to evaluate the alignment and bone structure. The disc and soft tissue are not directly visible. CT scans have limited diagnostic value in accurately identifying lumbar disc degenerative disease.

Typically, MRI lumbar spine studies involve a combination of imaging sequences, including sagittal T1-weighted turbo spin echo (T1 TSE), T2-weighted fast spin echo (T2 FSE), axial T2 and T1-weighted fast spin echo (FSE), as well as myelogram sagittal and coronal, and short tau inversion recovery (STIR) sequences in sagittal and coronal plane. These sequences are commonly suggested and result in a scanning time of approximately 30 minutes. The T2W FSE Dixon sequence is recommended for assessing malignant marrow illness as an alternative to the T1W TSE sequence, resulting in shorter scan times(3). It can also be used to suppress fat. Most recently, Zanchi et al demonstrated that by using the T2W FSE Dixon sequence in patients with non-specific LBP, the sagittal T1W TSE sequence was not required for the assessment of focal marrow lesions, facet arthropathy, spondylolysis, vertebral fractures and foraminal stenosis. (4)

The Dixon sequence is a widely recognized method that finds extensive use in musculoskeletal applications. It provides images specifically highlighting fat-only (FO), water-only (WO), in phase (IP), and out-of-phase (OP) signals within a single sequence. The T2-weighted FSE Dixon sequence serves as an alternative to the T1-weighted TSE for evaluating bone marrow diseases and as an alternative method to suppress the fat.(5)

The basic purpose of the study is to evaluate different grades of degenerative disc disease, MEPC, and HIZs. MRI is considered the gold standard imaging modality for the detection of disc pathology. It offers several advantages, including the absence of radiation exposure, the ability to acquire images in multiple planes, excellent contrast resolution for visualizing soft tissues within the spine, and precise localization of changes in intervertebral discs.

## MATERIALAND METHODS

All studies were performed on 3 Tesla MRI machine (Philips Ingenia)

**Study Design** - This descriptive study took place within a hospital environment. Before its initiation, the study received approval from the Human Ethical Committee of the institution.

**Subject Selection**: Patients undergoing MRI Lumbar spine study

**Inclusion Criteria:** Patients undergoing MRI Lumbar spine
**Exclusion Criteria:** Patients with metallic implants, pacemakers, Scoliosis, and patients who are having claustrophobia.

**Study Place:** The study was carried out at the Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute.

**Coil Specifications:**
**Type of coil:** Phased array detection with receive coil
**Design**: Volume coil, Which is an integrated coil solution that indicates the dS posterior coil,dS base coil, and ds head top coil.
**Coverage:** 90 cm with 52 channels for LS spine.
**User Interface:** Posterior, base, head.
**Connector:** Flex connect socket/connector

**Acquistion:** All the patients were scanned at 3 T Philips Ingenia MRI using a d Stream spine coil. A total of 40 patients were included in the study, with data collected from December 2022 to May 2023. Based on the radiological features, a tentative diagnosis was established by considering the clinical features. The imaging protocol is presented in Table 1

**Table 1 MRI parameters for routine lumbar spine and Dixon Sequence**

| Sequence | TR (ms) | TE (ms) | TI (ms) | FOV | ST (mm) | No of slices | Matrix | BW (Hz) | NEX | Scan time (min:s) |
|---|---|---|---|---|---|---|---|---|---|---|
| T2W TSE SAG | 3329 | 110 | N/A | 30x30 | 3 | 16 | 356 x 256 | 31.25 | 2 | 03:50 |
| T1W FSE SAG | 420 | Min | N/A | 30x30 | 3 | 16 | 356 x 224 | 31.25 | 2 | 03:46 |
| STIR SAG | 4690 | 43.6 | 180 | 30x30 | 3 | 16 | 288 x 192 | 31.25 | 2 | 03:44 |

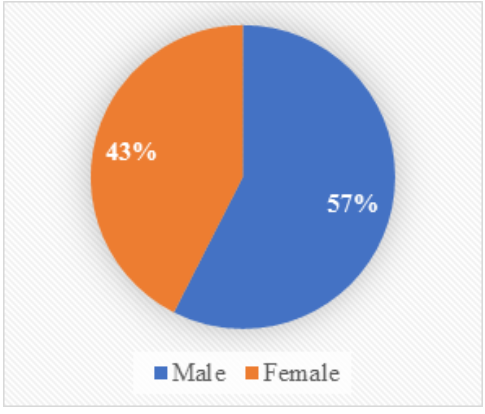
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | | | | | | | | | | 10.4 |
| T2W DIXON SAG | 4054 | 99.5 | N/A | 30x30 | 3 | 16 | 260 x 192 | 62.50 | 1 | 03:27 |

TR-Repetition time, TE- Echo time, TI-Inversion time, FOV- Field of view, ST -Slice thickness, BW-Bandwidth, and number of excitation pulses.

Three readers independently viewed the conventional sagittal T2W FSE sequence for grading lumbar DDD and identifying HIZs: a Consultant Musculoskeletal Radiologist with 26 years' experience (Reader 1), a Consultant Musculoskeletal Radiologist with 4 years' experience (Reader 2), and an 8-year-experienced Consultant Musculoskeletal Radiologist (Reader 3). Readers identified and classified MEPC using sagittal T1W TSE and STIR sequences. After about three months, the same three readers evaluated the sagittal IP T2W FSE Dixon sequence independently for evaluating lumbar DDD and recognizing HIZs, and they also used the sagittal FO and WO T2W FSE Dixon sequences to identify and classify MEPC.

## RESULT AND ANALYSIS

The study group comprised 40 patients, with 23 males and 17 females. The mean age of the patients was 51 years (15 to 84 years).

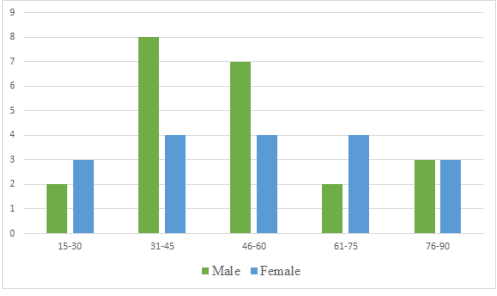



**Pie-chart of gender in the study population**

**Table 2 Age Group Distribution**

| AGE | FREQUENCY | PERCENTAGE |
|---|---|---|
| 15 -30 | 5 | 12.5% |
| 31-45 | 12 | 30% |
| 46-60 | 11 | 27.5% |
| 61-75 | 6 | 15% |
| 76-90 | 6 | 15% |
| Range | 68 | |
| Mean | 51 | |
| SD | 18.55 | |

A total of 40 patients were included in this study. The number of peoples with the age between 15 to 35 were 5 (12.5%),the age between 31 to 45 were 12 (30%), age between 46 to 60 were 11 (27.5%) and the age between 61 to 75 were 6 ( 15%) and the age between 76 to 90 were 6 (30%).




**Bar chart of age distribution in the study population**

In the present study, the three readers independently assessed the sagittal T2W FSE sequence to grade lumbar degenerative disc disease (DDD) and identify high-intensity zones (HIZs). They also reviewed the T1 TSE and STIR sagittal sequences to identify MEPC. Furthermore, the same three readers evaluated the sagittal T2W TSE Dixon sequence for DDD, HIZs, and MEPC. Table shows the synopsis of responses of both sequences by three readers.

**Table 3 Summary of responses to both methods for three readers**

| Variable | Category | Reader 1 | | Reader 2 | | Reader 3 | |
|---|---|---|---|---|---|---|---|
| Sequences | | T2W FSE | Dixon | T2W FSE | Dixon | T2W FSE | Dixon |
| Grade DDD | 1 | 112(56%) | 108(54%) | 101(50.5%) | 100(50%) | 109(54.5%) | 111(55.5%) |
| | 2 | 52(26%) | 47(23.5%) | 63(31.5%) | 65(32.5%) | 58(29%) | 54(27%) |
| | 3 | 26(13%) | 24(12%) | 22(11%) | 18(9%) | 17(8.5%) | 19(9,5%) |
| | 4 | 10(5%) | 21(10.5%) | 14(7%) | 17(8.5%) | 16(8%) | 16(8%) |
| MEPC | None | 180(90%) | 175(87.5%) | 182(91%) | 184(92%) | 178(89%) | 186(93%) |
| | 1 | 16(8%) | 19(9.5%) | 13(6.5%) | 12(6%) | 18(9%) | 12(6%) |
| | 2 | 4(2%) | 6(3%) | 5(2.5%) | 4(2%) | 3(1.5%) | 2(1%) |
| | 3 | 0(0%) | 0(0%) | 0(0%) | 0(0%) | 1(0.5%) | 0(0%) |
| HIZ | No | 186(93%) | 187(93.5%) | 185(92.5%) | 184(92%) | 180(90%) | 183(91.5%) |
| | Yes | 14(7%) | 13(6.5%) | 15(7.5%) | 16(8%) | 20(10%) | 17(8.5%) |

DDD- Degenerative Disc Disease, MEPC- Modic endplate changes, HIZ-High intensity Zones, T2 FSE-T2 weighted Fast Spin Echo

## OBSERVATION AND DISCUSSION

According to the findings of the study, among the 200 discs reviewed by the three readers, 107 discs (53.4%) were classified as normal, 57 discs (28.5%) showed early degenerative disc disease (DDD), 21 discs (10.5%) exhibited moderate DDD, and 15 discs (7.5%) were identified as advanced DDD. Type 1 Modic endplate changes (MEPC) were observed in 15 discs (7.5%), while type 2 MEPC was seen in 4 discs (2%). Additionally, high-intensity zones (HIZ) were detected in 16 discs (7.9%). The presence of HIZ was used as an indicator for evaluating the grading of lumbar disc degenerative disease and the type of MEPC.(6)

The single sagittal T2 weighted Fast spin echo Dixon sequence of the lumbar spine gives FO, OP, IP, and WO images to replace the sagittal T1 weighted Turbo spin echo, T2 weighted fast spin echo, and STIR sequences. The total scan time for three routine sagittal sequences was, and Dixon sequence was. Utilizing a single sagittal T2W Dixon sequence instead of the three routine sagittal sequences (T1W FSE, T2W FSE, and STIR), the scanning time can be significantly reduced to approximately 7 minutes and 30 seconds.

The single sagittal T2W Dixon sequence should produce images without any significant loss of diagnostic information and it could be used as only a sagittal sequence for lumbar Spine MR. The Result shows that we can use the combination of a single sagittal T2W FSE Dixon sequence and an axial T2W FSE sequence to reduce the scan time by ~ 65%.

When it comes to lumbar spine MRI sequences, the T2W FSE Dixon sequence offers a number of additional potential advantages over standard ones, such as enhanced fat suppression (3)and the ability to detect myeloma and vertebral metastases.(7) The Dixon sequence additionally offers quantitative CSI to evaluate indeterminate vertebral marrow alterations using the IP and OP sequences Gradient echo techniques have generally been utilised in the spine for this purpose, and it has demonstrated its usefulness in distinguishing between benign osteoporotic compression fractures and pathological vertebral compression fractures, as well as in differentiating non-neoplastic marrow lesions from neoplastic marrow replacement.(8) A recent study found that gradient echo CSI is effective for identifying localised nodular marrow hyperplasia. The grading systems used in the study did not involve the assessment of disc bulge or prolapse. These factors were also not taken into consideration in the current study, as they can be more accurately evaluated using the axial T2W FSE

sequence, which provides a better understanding of their impact on nerve root compression and canal stenosis.(10) The T2W FSE Dixon sequence offers several additional advantages compared to standard MRI sequences in the lumbar spine, one of which is enhanced fat suppression.(3) Zanchi et al. evaluated the T2W FSE Dixon sequence in patients with non-specific LBP and/or lumbar radiculopathy at 3T, which is similar to the current investigation(4).

## CONCLUSION

Lumbar disc degeneration is a prevalent cause of low back pain, with men being more commonly affected than women. The findings of the current study propose that a single sagittal T2W FSE Dixon sequence, incorporating the FO, IP, and WO images, may serve as a viable alternative to the conventional sagittal T1W TSE, T2W FSE, and STIR sequences commonly employed in lumbar spine imaging. This substitution can lead to a significant reduction in scan time, approximately 65%, when performed at 3T.

MRI is considered the gold standard imaging technique for detecting disc pathology due to several advantages it offers. These include its lack of radiation, ability to produce multiplanar images, excellent soft-tissue contrast in the spinal region, and precise localization of intervertebral disc changes.

## REFERENCES:


1. Osman NM, Fawzy FM, Lateef HM. MRI Evaluation of Lumbar Disc Degenerative Disease. Egyptian Journal of Hospital Medicine. 2017 Jul;68(2):1202–7.
2. Suthar P. MRI Evaluation of Lumbar Disc Degenerative Disease. JCDR [Internet]. 2015 Available from: http://jcdr.net/article_fulltext.asp?issn=0973-709x&year=2015&volume=9&issue=4&page=TC04&issn=0973-709x&id=5761
3. Pokorney AL, Chia JM, Pfeifer CM, Miller JH, Hu HH. Improved fat-suppression homogeneity with mDIXON turbo spin echo (TSE) in pediatric spine imaging at 3.0 T. Acta Radiol. 2017 Nov;58(11):1386–94.
4. Zanchi F, Richard R, Hussami M, Monier A, Knebel JF, Omoumi P. MRI of non-specific low back pain and/or lumbar radiculopathy: do we need T1 when using a sagittal T2-weighted Dixon sequence? Eur Radiol. 2020 May;30(5):2583–93.
5. Van Vucht N, Santiago R, Lottmann B, Pressney I, Harder D, Sheikh A, et al. The Dixon technique for MRI of the bone marrow. Skeletal Radiol. 2019 Dec;48(12):1861–74.
6. Saifuddin A, Rajakulasingam R, Santiago R, Siddiqui M, Khoo M, Pressney I. Comparison of lumbar degenerative disc disease using conventional fast spin echo T 2W MRI and T 2 fast spin echo dixon sequences. The British Journal of Radiology. 2021 May 1;94(1121):20201438.
7. Danner A, Brumpt E, Alilet M, Tio G, Omoumi P, Aubry S. Improved contrast for myeloma focal lesions with T2-weighted Dixon images compared to T1-weighted images. Diagnostic and Interventional Imaging. 2019 Sep;100(9):513–9.
8. Suh CH, Yun SJ, Jin W, Park SY, Ryu CW, Lee SH. Diagnostic Performance of In-Phase and Opposed-Phase Chemical-Shift Imaging for Differentiating Benign and Malignant Vertebral Marrow Lesions: A Meta-Analysis. American Journal of Roentgenology. 2018 Oct;211(4):W188–97.
9. Ract I, Meadeb JM, Mercy G, Cueff F, Husson JL, Guillin R. A review of the value of MRI signs in low back pain. Diagnostic and Interventional Imaging. 2015 Mar;96(3):239–49.