Comparison of Grayscale Value in T1-Weighted Pre- and Post-Contrast Brain MRI Images: with and without Fat Suppression Technique

Isnindar Tandya Asri, Chomsin Sulisty Widodo, Yuyun Yueniwati Prabowowati Wadjib
Department of Physics, Faculty of Science, Brawijaya University
Jl. Veteran, Malang 65145, East Java, Indonesia
tiez.nindar@gmail.com

Abstract. The MRI T1-weighted image can provide information on the pre- and post-contrast images. Post-contrast images is an image obtained after the administration of GBCA In some cases, not all post-contrast images can show clear lesions so it requires additional technique in the form of Fat Suppression (FS), which works by suppressing the fat signal in an image. The T1-weighted images with and without FS have a different signal intensity. Therefore, the purpose of this study is to compare the signal intensity of the pre- and post-contrast T1-weighted images with and without the FS technique. The signal intensities are indicated with a grayscale value. There are seven T1-weighted images with FS and seven T1-weighted images without FS. Each of the image have a pre- and post-contrast. Image reading is done by a radiology specialist. Area plot was performed on abnormal tissues in each image. Each area will be measured with an ImageJ software to obtain the grayscale mean value. The measurements of the post contrast T1-weighted image showed an increase in the grayscale mean value with or without the FS technique. This showed that the administration of GBCA can increase the signal intensity on the T1-weighted images with or without the FS technique.

1. Introduction
Administration of a contrast agent on a patient is indispensable in almost every MRI examination. The commonly used medical contrast agent is Gadolinium-Based Contrast Agent (GBCA). GBCA shortens the relaxation time of T1-weighted and T2-weighted. This causes a signal intensity increase in the T1-weighted images and gives positive contrast to abnormal tissues especially fat and tumour, while the T2-weighted have a decreased signal intensity. Thus, GBCA is often named T1-weighted amplifier agent [1–3].

Unfortunately, not all pre- and post-contrast T1-weighted images could display a normal image of an abnormal tissue. This happens due to the position of the tumour that is located in a fat tissue making the display of the tumour boundaries in the post contrast image hardly visible [4]. The solution to this problem is to suppress the strong signal from the fat tissue (adipose tissue). This technique is named Fat Suppression or FS. The FS technique provides a clear visualization of the abnormal and normal tissue boundaries [4–6]. There are different signal intensities in both pre- and post-contrast T1-weighted images.
This study is aimed to compare the signal intensities of the T1-weighted pre- and post-contrast images, with and without the FS technique quantitatively. The signal intensity in this research is shown in a grayscale value.

2. Material and Methods

2.1. Patient Images
There were seven T1-weighted images with FS and seven T1-weighted images without FS. Each of the technique used have their own pre- and post-contrast images. This study ignores the age, gender, type of disease, the dosage, and brand GBCA used. The image was taken using a Philips Ingenia 3.0 T MRI scanner in the Radiology Installation of Saiful Anwar General Hospital Malang.

2.2. Image Sorting
The whole image file of the brain was opened in RadiAnt DICOM Viewer version 2021.1 (64 bit) program with a DICOM (.dcm) extension. The brain images then sorted to obtain the pre- and post-contrast T1-weighted images, both with and without FS. The selected file was stored in a JPEG (.jpg) format.

2.3. Image Processing
Image reading is done by a radiology specialist. The doctor determined the lesions in every image and continued with an area plot in those lesion areas. The plotted areas will be processed with ImageJ 1.52 (64 bit) software to obtain the mean grayscale value.

3. Results and Discussion
The term Grayscale on the MRI digital image refers to the value of every pixel that contains information of signal intensities from the body tissue. The produced image value ranges from 0 (darkest) to 255 (brightest) and anything in between is grayscale [7–9]. Every digital parameter in an MRI scan have different ways in capturing an image contrast so the image produced have different signal intensities or grayscale mean value.

Table 1 and Table 2 showed that the post-contrast images have an increase in grayscale mean value with and without FS compared to the pre-contrast images. Administration of GBCA to a patient could increase the signal intensity of an image.

GBCA is a paramagnetic contrast agent that is often used in a MRI scan because it can increase the signal intensity of diseased or abnormal tissue in an image. GBCA creates a chemical reaction between the Gadolinium with water so it shortens the relaxation of the water proton on both T1 and T2 therefore it can give a positive contrast on T1 and decrease the signal intensity on T2. Thus, GBCA is often named T1-weighted amplifier agent. The use of GBCA can help doctors to diagnose a disease because it eases locating an abnormal tissue. The boundaries between normal and abnormal tissue is clearer compared to the image without the contrast [1,2,10–13].

| Patient | Pre-Contrast | Post-Contrast |
|---------|--------------|---------------|
| 1       | 50.19        | 83.48         |
| 2       | 95.21        | 196.41        |
| 3       | 147.93       | 151.66        |
| 4       | 90.61        | 145.74        |
| 5       | 116.69       | 202.80        |
| 6       | 28.45        | 75.36         |
| 7       | 60.44        | 103.84        |
In accordance to Figure 1, every post-contrast image with and without FS have a different increase in mean grayscale value or signal intensities. Metabolically, abnormal tissues have a higher uptake of the contrast. It is based on the tissue's characterization ability in absorbing GBCA on each completely different tissue or organs [13].

According to the facts on the ground, a high signal intensity caused by the GBCA administration often found in a tissue that contains fat or tumour. However, in some cases, tumours often found located in a fat tissue. This causes the boundaries of the tumour on the post-contrast images hardly visible [4].

One of the efforts to improve the information in the T1-weighted images is to add a Fat Suppression (FS) technique in the MRI image capturing. This technique suppresses strong signals from the fat tissue (adipose tissue). The goal is to reduce artifacts so it can increase the visibility of the boundaries between normal and abnormal tissues and make a better tissue visualizations such as optical nerves since it will not be overwhelmed with the high signal intensity coming from fat tissues [4–6].

This study still uses random patients data. Therefore, in the future, it is necessary to conduct further studies by taking into account the type of disease, gender, brand of GBCA used and the age of the patient in order to provide more accurate information.

## Table 2. The mean grayscale of pre- and post contrast on T1-weighted brain images without FS technique

| Patient | Pre-Contrast | Post-Contrast |
|---------|--------------|---------------|
| 1       | 70.54        | 145.27        |
| 2       | 144.36       | 208.82        |
| 3       | 212.39       | 214.21        |
| 4       | 149.11       | 168.80        |
| 5       | 108.02       | 133.51        |
| 6       | 127.88       | 150.38        |
| 7       | 91.24        | 169.71        |

**Figure 1.** Mean grayscale value in T1-weighted pre- and post-contrast image, (a) with dan (b) without FS technique

### 4. Conclusion

There is an increase in the grayscale mean value on the post-contrast image with and without the FS technique. This showed that the administration of GBCA can increase the signal intensity on the T1-weighted images with or without the FS technique.
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