ORIGINAL ARTICLE

Fat Suppression Spectral Adiabatic Inversion Recovery (SPAIR) to Optimize the Quality of MRI Pelvis Image

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ABSTRACT

Introduction: : The ovary is a complex and heterogeneous tissue arrangement, making it easy to trigger ovarian tumors. Magnetic Resonance Imaging (MRI) is a diagnostic tool that is safe to use for ovarian tissue and can produce optimal images on soft tissue. This study aims to optimize the quality of pelvic MRI images using the Fat Suppression Spectral Adiabatic Inversion Recovery (SPAIR) technique. **Methods:** This research was conducted at Brain Clinic Surabaya using MRI GE 1.5 T aircraft. Data analysis used was the ROI and Histogram methods. **Results:** The results of the study based on the SNR, CNR, Variance, and Standard Deviation values showed that the Ovary and Colon tissue was very good in the T1 Contrast SPAIR sequence, because the tissue structure was heterogeneous, containing lots of water and fat. The Vesica Urinaria network is excellent in T1 Fat Saturation sequences. The SPAIR technique is selective against heterogeneous tissue and is able to suppress fat well using adiabatic pulses. The Vesica Urinaria network is optimal in the SPAIR technique, because the intensity and signal distribution at each pixel is very high. **Conclusion:** So the quality of the pelvic MRI anatomical image is influenced by the variation of the sequence in T1 Contrast.

Keywords: Pelvis, Fat saturation, SPAIR, MRI

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INTRODUCTION

Humans reproduce using the genital organs, which are susceptible to abnormalities, especially in the ovaries. The ovaries have a complex and heterogeneous tissue arrangement, thus triggering ovarian tumors (1). Ovarian tumors can be detected using a medical check-up, namely MRI. To detect the presence of ovarian tumors suspected of being malignant using the T1 Contrast sequence with the addition of gadolinium contrast media. The malignant tumor will absorb contrast agent which flows intravenously as blood supply to the tumor (2). The T1 sequence contrast with the addition of gadolinium produces a water signal and a hyperintensity fat signal (3). The fat signal will interfere with the water signal to detect ovarian tumors and the Fat Suppression sequence is used to suppress the fat signal (4).

Detecting lateral adnexal lesions that occur in the ovary area using the Fat Suppression sequence (5). In this study we use the Fat Saturation technique and the Spectral Adiabatic Inversion Recovery (SPAIR) technique. Fat Saturation uses the homo spoil technique to suppress fat signals (6). The SPAIR technique is a more sophisticated technique in suppressing fat signals. Parameters that affect the image results are the Signal to Noise Ratio (SNR), the Contrast to Noise Ratio (CNR), the Variance and the Standard Deviation value.

MATERIALS AND METHODS

Scanning Methods

The research was conducted at the Brain Clinic Surabaya using an MRI Superconductor GE Signa 1.5 tesla. The study was conducted on two patients having abnormalities in the ovaries. The study sample was obtained from scanning patients with T1 Contrast weighted addition of gadolinium contrast media to the axial section. Each sample was given a variation of the Fat Suppression sequence, namely the Fat Saturation technique and the SPAIR technique.

Region Of Interest (ROI) Technique

Each sample was able to show clearly analysed tissues, namely the ovary as a lesion, Vesica Urinaria, and Colon. The resulting image was analysed using the Region Of Interest (ROI) technique and the Histogram technique. Figure 1 shows the results of the image analysed using the ROI technique. Based on the ROI results, the SNR and CNR values were obtained, after which the statistical test was carried out using SPSS.

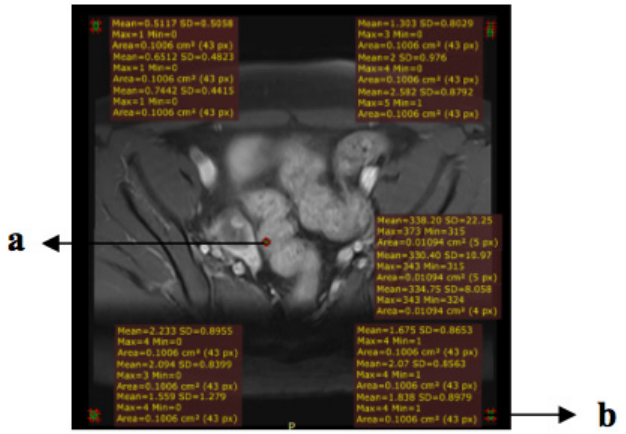

Figure 1 : ROI Technique (a) Network ROI and (b) Background ROI.

Histogram Technique

The histogram technique is a quantitative image processing using the Matlab program, such as variance and standard deviation value. The histogram technique, cropping of the tissue area to be analysed is carried out, then a histogram analysis is carried out. The histogram only displays the signal on the network and does not display the amount of noise. Quantitative analysis (7) of an image are SNR = $\frac{Signal\ (S)}{Noise\ (N)}$; CNR = $\frac{SNR\ (2) - SNR\ (1)}{Noise\ (N)}$; Varians = var (double(data(:))) ; and Standard Deviation = std2(data).

RESULTS

The examination of ovarian tumours, the 5 best images capable of displaying the analysed tissue clearly. The mean value as signal and the SD value as background noise. The results of the ROI technique on each network are shown in Figures 2 (a), (b), and (c) as follows. Figure 3 shows a graph of the technical relationship between the lesion tissue, the lesion edge, Vesica Urinaria, Vesica Urinaria Edge and Colon to the SNR value. Based on Figure 3, it has a p-value less than 0.05 so Fat Saturation and SPAIR technique has a difference. Lesion Margin and Colon tissue, SNR values were higher in the SPAIR technique.

Figure 4 shows a graph of the relationship between the technique in the Lesion - Lesion Edge and Vesica Urinaria - Vesica Urinaria Edge tissue, to the CNR

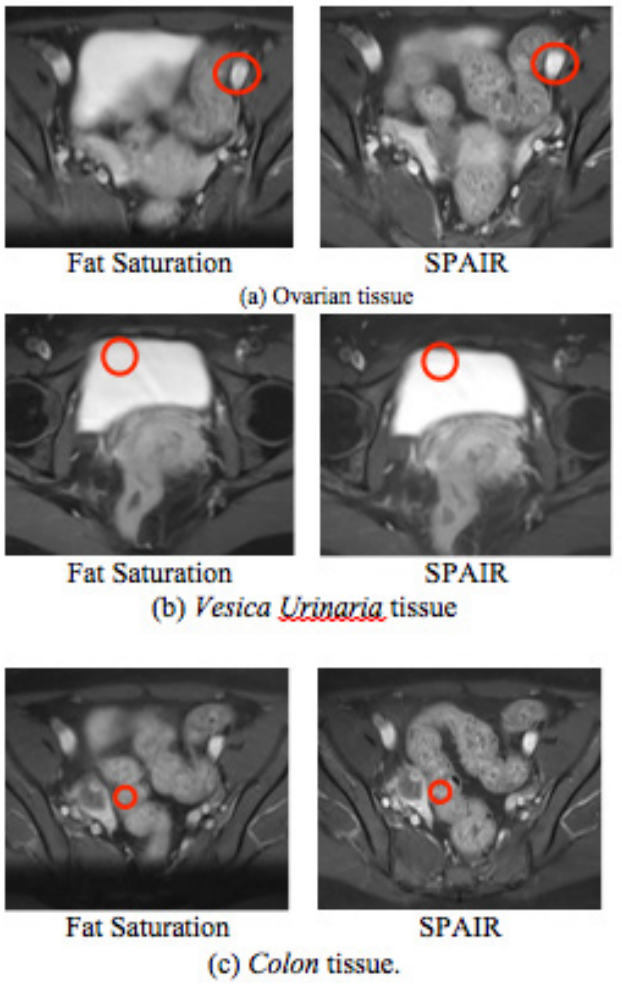

Figure 2 : Analysed Network ROI Results.

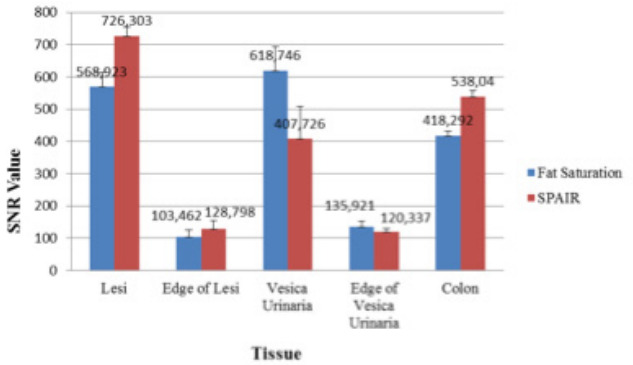

Figure 3 : Graph of T1 Contrast Fat Saturation and SPAIR Relationship to SNR Value.

value. Based on Figure 4, it has a p-value less than 0.05 so Fat Saturation and SPAIR technique has a difference. Lesion margins had a higher CNR value in the SPAIR technique. Meanwhile, the Vesica Urinaria - Vesica Urinaria edge tissue has a higher CNR value in the Fat Saturation technique. Figure 5 and Figure 6 below show the graph of the technical relationship of the lesion, Vesica Urinaria, and Colon tissue to the values of variance and standard

deviation. A quantitative test is the histogram by considering the variance value and standard deviation.

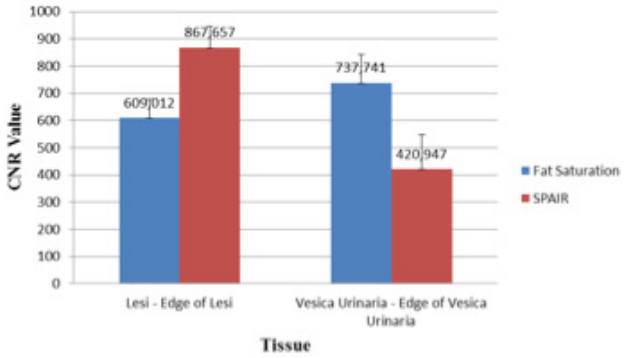

Figure 4 : Graph of T1 Contrast Fat Saturation and SPAIR Relationship to CNR Value.

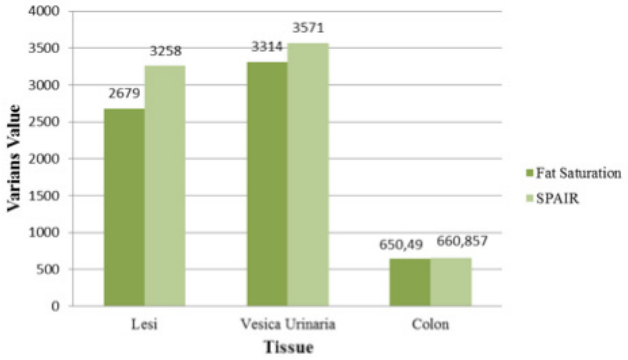

Figure 5 : Graph of T1 Contrast Fat Saturation and SPAIR Relationship to Variance Value.

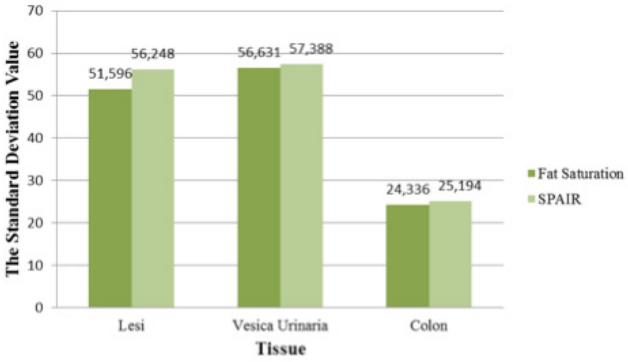

Figure 6 : Graph of T1 Contrast Fat Saturation and SPAIR Relationship to Standard Deviation Value.

DISCUSSION

It was found that the variance and standard deviation values in the Ovary, Colon, and Vesica Urinaria tissue in the SPAIR were higher than the variance and standard deviation values in the Fat Saturation. This is because the number of pixels in an image in the SPAIR is higher than the Fat Saturation, which causes the contrast of the image in the SPAIR to be very high. Based on Figure 2 and 3, it is found that the higher the SNR value, the signal obtained on the analysed network has a higher value than the resulting noise value, the image has a good image quality. Likewise, the CNR value, the image will have good quality. This is because the contrast between one network and another is clearly visible. Ovarian tissue is tissue that has abnormalities (lesions), the structure of the tissue is irregular or heterogeneous and the ovaries contain lots of blood vessels, nerves, glands, and water which contain very much hydrogen. This causes ovarian tissue to have higher SNR and CNR values in the SPAIR. Colon is composed of muscle, nerve fibers, blood, fat, and water. This is why the Colon network has a higher SNR value in the SPAIR. Meanwhile, Vesica Urinaria has a homogeneous composition of the bladder and urine walls. The Vesica Urinaria has less fat content, this causes Vesica Urinaria to have higher SNR and CNR values (8).

The histogram test of pelvic organs, especially in ovarian disorders, produce optimal images using the SPAIR. Several parameter settings in the SPAIR that are superior to the Fat Saturation. These include Strong Radiofrequency, High Bandwidth, 1800 Turning Angle, and using Adiabatic Pulses. The radiofrequency pulse is a signal that is applied so that the water and fat hydrogen protons resonate to the -Z axis. When a high-strength RF is applied, the Time Inverse used will be of high value, so that the gradient field can completely negate the fat signal without leaving any fat signals (9).

The SPAIR applies high bandwidth, because frequency modulation occurs which can produce low frequencies, so the resulting noise will be lower (10). The SPAIR uses an inversion angle of 1800, it is the Specific Absorption Rate (SAR), which is the energy absorption rate from the environment to the MRI system. This can cause network heating. However, the SPAIR uses adiabatic physics principles, namely maintaining the energy that enters and leaves the system to the environment and vice versa. Thus, there is no increase in energy absorption that is too high (2). SPAIR also occurs amplitude and frequency modulated. That is, the signal used to display image information has a frequency average value of the unmodulated carrier frequency, but according to the amplitude when modulated. This can cause the resulting image to be more detailed and contain less noise (11). In adiabatic conditions, it is relatively insensitive to off-resonance effects. Off-resonance can cause the Bo and B1 fields to be inhomogeneous, resulting in artifacts in the image (12).

CONCLUSION

The results of the study based on the SNR, CNR, Variance, and Standard Deviation values showed that the Ovary and Colon tissue was very good in the T1 Contrast SPAIR sequence, because the tissue structure was heterogeneous, containing lots of water

and fat. The Vesica Urinaria network is excellent in T1 Fat Saturation sequences. The Vesica Urinaria network is optimal in the SPAIR technique, because the intensity and signal distribution at each pixel is very high. So the quality of the pelvic MRI anatomical image is influenced by the variation of the sequence in T1 Contrast.

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