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Application Of 3D Fluid Recovery Attenuation Inversion Isotropic As An Alternative Image Quality Improvement Information Anatomy And Efisiensi Inspection Time Magnetic Resonance Imaging Brain

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ABSTRACT

Volume Isotropic Turbo Spin echo Acquisition (VISTA) is a technique in the *Fast Spin Echo* (FSE) / *Turbo Spin Echo* (TSE) sequence with special modifications optimized for 3D *Isotropic* imaging . The term *isotropic* means that the voxels produced by three-dimensional (3D) acquisition measure the same thing [in] every direction. So that the possibility of images can be reformatted with the same resolution in all directions. 3D *isotropic* is one of the 3D *volumetric imaging* that has pixel size equal to x, y and z so that it has the same image quality advantage when changing *views* from axial to sagittal and from sagittal to coronal because from anywhere seen will have pixel size that is same. 3D *isotropic* data provides evaluation data that has the potential to evaluate the smallest body parts, because given that 2D scans cannot optimally evaluate some complex structures in the head. Objective research is that u ntuk analyze the effect of application of 3D FLAIR *isotropic* as an alternative to improve the quality of the image, information about anatomy and efficiency of inspection time MRI *brain* sequences conventional 2D FLAIR. The research is that there is a difference in image quality between the sequence of 2D FLAIR conventional and 3D FLAIR *isotropic* on examination of *the brain* . The statistically significant difference in SNR (*Signal to noise Ratio*) with P- *Value* 0,000 between conventional 2D FLAIR sequences and 3D *isotropic* FLAIR in the whole MRI *brain* sample , because the SNR value of conventional 2D FLAIR sequences and *isotropic* 3D FLAIR p <0.05. Obtained statistically significant difference in CNR (*Contrast to Noise Ratio*) between conventional 2D FLAIR sequences and *isotropic* 3D FLAIR sequences . In organ *gray matter* of the *pons, the white matter* of the *pons* , *the white matter* of the *cerebellum* and *pons* to the *cerebellum* better 3D FLAIR *isotropic* , while the *gray matter* of the *white matter* and *gray matter* of the *cerebellum* is better to use 2D FLAIR conventional and is obtained difference anatomical information the sequence of 2D FLAIR conventional and 3D FLAIR *isotropic* examination MRI *Brain* uses slice axial FLAIR sequences in the sample as a whole and time examination 2D conventional FLAIR more slowly than 3 D FLAIR *isotropic* with the overall examination time difference of 6 minutes 22 seconds

Keywords: 3D *isotropic, Magnetic Resonance Imaging, FLAIR*

INTRODUCTION

Magnetic resonance imaging (MRI) is a medical device that is made non-invasive. This tool is safe to use and without pain[1]. MRI uses high strength magnetic fields, radio frequency pulses and computers to produce images of organs, soft tissues, bones and all internal body structures. Sequences affect the shape of the image on MRI. Types of sequences in clinical studies are sequences of Spin Echo (SE), Turbo Spin Echo / Fast Spin Echo (TSE / FSE), Gradient Echo (GRE), Inversion Recorvery (IR), Planar Echo Imaging (EPI), and Magnetic Resonance Angiography (GRE) MRA) [4].

FLAIR is a variation of the Inversion Recovery (IR) sequence. In the FLAIR sequence, the selection of Time Inversion (TI) is adjusted to CSF Time Inversion from 1800 to transversal to remove signals from Cerebro Spinal Fluid (CSF), so that no longitudinal magnetization of CSF is seen. FLAIR is used to replace the higher CSF signal at T2WI so that the anatomy that is solved with CSF can be seen more clearly. Time Range of Reversal between 1700 ms to 2200 ms to cancel CSF (variations of T1 values differ depending on the strength of the magnetic field). FLAIR is used in brain MRI and spinal MRI examinations to see periventricular and lesions so that the spinal cord is seen more clearly, according to an acceptable CSF signal[8]. FLAIR T2 can be combined with 3D TSE / FSE with isotropic voxels which will use signals for Noise Ratio (SNR) higher than 2D FLAIR, with this combination will produce abnormal fat in the brain which will produce hyperintense picture[9]. 3D TSE becomes an alternative for scanning 2D multiplanar protocols because of the acceleration of the encoding phase provided by parallel imaging acquisition strategies such as simultaneous spatial harmonic (SMASH) acquisition, Autocalibrating General Parallel Acquisitions (GRAPPA), Parallel Imaging with Local Sensitivity (PILS), or Sensing Sensitivity (SMASH) SENSE). When a 3D TSE scan is longer than when a 2D TSE scan, 3D techniques can reduce the overall scan time by eliminating some orthogonal 2D acquisitions that are completely needed for clinical testing. The acquisition of 3D TSE can improve complex anatomy by facilitating reform of multiplanar imagery in planes specifically designed for specific anatomical fields[10]. Isotropic Turbo Spin echo Acquisition (VISTA) volume is a technique on the Fast Spin Echo (FSE) / Turbo Spin Echo (TSE) sequence with special modifications optimized for 3D Isotropic imaging, owned by Philips vendors. The term isotropic means that the voxels produced by three-dimensional (3D) acquisition measure the same thing in every direction. So that the possibility of images can be reformatted with the same resolution in all directions. 3D isotropic is one of 3D volumetric imaging data that has pixel size equal to x, y and z so that it has the same image quality advantage when changing views from axial to sagittal and from sagittal to coronal because from anywhere seen will have pixel size that is same same. 3D isotropic data provides evaluation data that has the potential to evaluate the smallest body parts, because given that 2D scans cannot optimally evaluate some complex structures in the head. The use of 3D isotropic for the diagnosis of brain disease is a new challenge in scanning MRI images. Today, there are many hospitals that have MRI aircraft with this capability, but not many have applied it.

DATA ANALYSIS

Analysis of the data used is using univariate data, which is an analysis of each variable of the research results. The aim is to describe the characteristics in each of the research variables presented in the frequency distribution table and bivariate data. To find out the further influence of the application of the 3D FLAIR isotropic technique, a data normality test using shapiro wilk is because the sample is less than 50, if the normality test results show results> 0.05 then the Independent t test statistic test is then used if the data is normally distributed.

RESULTS

This study uses 2 respondents, respondents with the longest working period, ie respondent 2 with ten years of service then followed by respondent 1 with a work period of 8 years, but for respondent 1 is a neuroradiology consultant who is directly related to the object in this study, namely brain. After testing the anatomical information by a radiology specialist, then proceed by analyzing the image quality of the two sequences, by providing ROI (Region of Interenst) on the organ to be examined and also the background image .Fig 1

Fig 1. ROI of 2D FLAIR conventional organ pons

The following is an example of giving ROI of puncher organs to conventional 2D FLAIR sequences, giving ROI to 4 organs from each sequence. The provision of ROI will produce signal and noise values which will then be used to

calculate the SNR and CNR values of the pons, cerebellum, white matter, and gray matter organs. Then the data normality test is continued to find out the data distribution. SNR and CNR data have normal data distribution, the test used is the Independent t test and abnormal data, the test used is Man Whitney. Judging from the results of the questionnaire assessed by radiologists, it is known that 3D FLAIR isotropic sequences are superior in showing anatomical images of pons, cerebellum, white matter and gray metter on MRI brain images with better values compared to Conventional 2D FLAIR because they are seen from the average results the two isotropic 3D FLAIR sequences have higher average values than conventional 2D FLAIR. Table 1

Tabel 1. the results of the questionnaire assessed by the radiologist

RESPONDEN	SAMPEL	2D FLAIR KONVENSIONAL				3D FLAIR ISOTROPIK			
		A	B	C	D	A	B	C	D
R1	1	2	2	2	3	3	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	2	3	2	3	3	3	3
	4	2	2	2	2	3	3	2	3
	5	2	2	2	2	2	2	3	3
	6	2	2	2	2	3	3	3	3
	7	3	2	2	2	3	3	3	3
	8	2	2	3	2	3	3	3	3
	9	2	2	2	2	3	3	3	3
	10	2	3	2	2	3	3	3	3
mean		**2,1**	**2,1**	**2,2**	**2,1**	**2,9**	**2,9**	**2,9**	**3**
R2	1	2	2	2	2	3	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	2	3	2	3	3	3	3
	4	2	2	2	2	3	2	2	3
	5	2	2	2	2	2	2	3	3
	6	2	2	2	2	3	3	3	3
	7	2	2	3	2	3	2	3	2
	8	2	2	3	2	3	3	3	3
	9	2	2	2	2	3	3	3	3
	10	2	3	2	2	3	3	3	3
mean		**2**	**2,1**	**2,3**	**2**	**2,9**	**2,7**	**2,9**	**2,9**

Based on the calculation of SNR values from all brain MRI research samples, the SNR on the conventional 2D FLAIR sequence of images is 169.6 while the isotropic 3D FLAIR sequence is 267.6. In the conventional FLAIR 2D sequence cerebellum image has an SNR value of 179.7 while the Isotropic 3D FLAIR sequence is 303.3. White conventional 2D FLAIR sequence has a value of 196.0 while Isotropic 3D FLAIR sequence is 319.1. In the conventional Gray FLAIR 2D matter image the SNR value is 137.2 while the 3D FLAIR Isotropic sequence is 238.6. Based on descriptive data it can be seen that isotropic 3D FLAIR has a higher SNR value than conventional 2D FLAIR. Table 2 & 3

Table 2. SNR independent t test results

Organ	Mean		P-Value
	2D FLAIR Konvensional	3D FLAIR *isotropic*	
Pons	169,6	267,6	0,000
Cerebellum	179,7	303,3	0,000
White Matter	196,0	319,1	0,000
Gray Matter	137,2	238,6	0,000

Table 3. CNR independent t test results

Organ	Mean		P-Value
	2D FLAIR Konvensional	3D FLAIR *isotropic*	
GM-WM	435	461	0,404
GM-P	240	164	0,007
GM-C	313	370	0,056
WM-P	195	297	0,000
WM-C	122	91	0,014
P-C	82	206	0,000

Tabel 2 Based on the SNR independent t test results, there is a statistically significant difference where the independent t test results are 0,000 in conventional 2D FLAIR sequences and 3D Isotropic FLAIR so that there are statistically significant differences in SNR between conventional 2D FLAIR and 3D isotropic FLAIR because p <0 .5. The value of the CNR calculation results is carried out in advance the data normality test to determine the data distribution. Following are the results of normality test data on CNR. The data normality test results show a significance value> 0.05 which means that the data distribution is normal because P> 0.05. Tabel 3 Based on the CNR independent t test results, all samples showed a gray matter organ CNR against white matter of 0.404 where there was no statistically significant difference between conventional 2D FLAIR sequences and 3D isotropic FLAIR is meaningful p value> 0.05. In the gray matter organ to the puncher is 0.007 where there is a statistically significant difference between the conventional 2D FLAIR sequence and 3D isotropic FLAIR which means p value <0.05. In gray matter organ to cerebellum of 0.056 where there is no statistically significant difference between conventional 2D FLAIR sequences and 3D isotropic FLAIR which means p value> 0.05. The white matter organ has a punch of 0,000 where there is a statistically significant difference between the conventional 2D FLAIR sequence and the 3D isotropic FLAIR meaning p value <0.05. The white matter organ of cerebellum is 0.14 where there is a statistically significant difference between conventional 2D FLAIR sequences and 3D isotropic FLAIR which means p value <0.05. In the puncher organ to the cerebellum of 0,000 where there is a statistically significant difference between the conventional 2D FLAIR sequence and the 3D isotropic FLAIR meaning p value <0.05.

DISCUSION

There was a statistically significant difference in the conventional 2D FLAIR SNR value and the 3D isotropic FLAIR value with a p value <0.05, 0.000. While for the CNR value there is a significant difference with a p value <0.05 so that it can be concluded that there is a difference in the image quality values between the conventional 2D FLAIR sequence and the 3D FLAIR isotropic MRI brain examination. MRI examination really needs to be known by a radiographer by knowing the factors that affect image quality. SNR and CNR are two basic factors that can affect image quality. Signal to noise ratio (SNR) is the ratio of the signal amplitude received at the average amplitude of the noise. The signal is received from the receiving coil from precession on the transverse NMV plane. Increasing the signal can increase the SNR, conversely decreasing the signal can decrease the SNR while the CNR (Contrast to Noise Ratio) is a comparison of the SNR value between two adjacent organs4. SNR value obtained from the signal value divided by the average value of the standard deviation (SD) in this case is noise. Based on the independent t test between conventional FLAIR 2D sequences and isotropic 3D FLAIR shows that the images of pons, cerebellum, white matter and gray matter have SNR and CNR values there are statistically significant differences between conventional 2D FLAIR sequences compared to 3D isotropic FLAIR. Based on the P-value of the independent t test of conventional 2D FLAIR SNR values with isotropic 3D FLAIR SNR values, p values <0.05, which means there is a statistically significant difference between conventional 2D FLAIR sequences and 3D isotropic FLAIR SNRs, 3D isotropic FLAIR SNRs high compared to conventional 2D FLAIR, high SNR values will affect CNR4 results. The P-value of the independent t test of the CNR value in conventional 2D FLAIR with the 3D FLAIR isotropic CNR value obtained p <0.05 for gray matter to the pons, white matter to the pons, white matter to the cerebellum and puncher to the cerebellum which means there are differences statistically significant between conventional 2D FLAIR sequences and isotropic 3D FLAIR sequences. Whereas gray matter to white matter and gray matter to cerebellum have p>0.05 which means there is no statistically significant difference between conventional 2D FLAIR sequences and 3D isotropic FLAIR. According to the research of respondents, there are significant differences in the value of conventional 2D FLAIR anatomical information and 3D isotropic FLAIR with a p value <0.05. Based on the results of the man whitney test of conventional 2D FLAIR sequences and 3D FLAIR isotropic MRI examination of Brain value p value <0.05 so it can be concluded that there is a difference in information between conventional 2D FLAIR sequences and 3D FLAIR isotropic Brain examinations. In conventional 2D FLAIR examination requires a longer time than 3D isotropic FLAIR, where the conventional 2D FLAIR examination time for axial pieces for 1 minute 39 seconds, for coronal pieces 1 minute 48 seconds and for sagittal pieces 2 minutes 15 seconds. Whereas 3D isotropic FLAIR requires a total time of 4 minutes 34 seconds. this time does not include sample preparation and radiographer preparation in determining the parameters at the time of examination. In the brain examination there will also be the addition of different sequences in each hospital such as the DWI, T1 axial and T2 axial sequences and will increase the length of time of each sequence. So the time needed for the whole 2D FLAIR convensinal sequence is 12 minutes 3 seconds while the overall time of 3D FLAIR isotropic is 6 minutes 21 seconds where the time difference of the two sequences is 6 minutes 22 seconds beyond the sample preparation time. This is in accordance with the journal Ali Naraghi et al (2012), that 3D Isotropic can provide high image information, good resolution and short acquisition. It can be concluded that the 3D FLAIR isotropic technique can provide less time for the sample to be in an MRI gantry which will facilitate the sample to reduce the fear of being in a gantry hall with less time. Whereas for conventional FLAIR 2D techniques, it takes longer for samples to be in the gantry tunnel which can add to the anxiety of the sample when doing an MRI Brain examination. However, for certain cases, consideration is needed in the use of the 3D isotropic FLAIR sequence, where for anxious patients it is recommended to use conventional 2D FLAIR because it minimizes repetition from the initial examination.

CONCLUSIONS

The results of this study indicate differences in image quality between conventional 2D FLAIR sequences and

isotropic 3D FLAIR on brain examination. Statistically significant SNR (Signal to noise Ratio) differences were obtained with a P-Value of 0,000 between conventional 2D FLAIR sequences and 3D isotropic FLAIR in the whole MRI brain sample, because the SNR values of conventional 2D FLAIR sequences and isotropic 3D FLAIR p <0.05. Obtained a statistically significant difference in CNR (Contrast to Noise Ratio) between conventional 2D FLAIR sequences and isotropic 3D FLAIR sequences. In the gray matter organ against the puncher, white matter on the puncher, white matter on the cerebellum and puncher on the cerebellum are better 3D FLAIR isotropic, whereas on gray matter on the white matter and gray matter on the cerebellum it is better to use conventional 2D FLAIR. Anatomical information was obtained between conventional 2D FLAIR sequences and isotropic 3D FLAIR sequences on MRI Brain examination using axial sliced FLAIR sequences on the whole sample. The conventional 2D FLAIR examination time is slower than the 3D isotropic FLAIR with a difference in the overall inspection time of 6 minutes 22 seconds.

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