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Analysis of the Use of Sequence T2 SPACE Dark Fluid in MRI Brain Coronal Slice Examinations with Clinical Epilepsy at the National Brain Center Hospital

Legia Prananto, Khairil Anwar, Riska Sekar Febriani*
Jurusan Teknik Radiodiagnostik dan Radioterapi Prodi Teknologi Radiologi Pencitraan, Poltekkes Kemenkes Jakarta II, Jalan Hang Jebat III F3 Kebayoran Baru, Jakarta Selatan, 12120
Email: riska.sekar.febriani.27@gmail.com*

Abstract

This research centers on Brain MRI examinations in patients with clinical epilepsy, featuring the incorporation of an additional T2 SPACE dark fluid sequence. Brain MRI examination with clinical epilepsy at National Brain Center Hospital is a frequent examination. Epilepsy is such a condition characterized by recurrent seizures caused by disturbances in the brain function. In relation to which, this research aims to analyze the use of dark fluid T2 SPACE sequences and analyze the results of MRI images on dark fluid T2 SPACE sequences for information on coronal MRI Brain anatomical images with clinical epilepsy at National Brain Center Hospital. As for the research design used was descriptive qualitative with a case study approach which was conducted starting from February up to May 2023 at National Brain Center Hospital using a Siemens Skyra MRI aircraft with a power of 3 Tesla. The populations of this research were the patients who had clinical Temporal Lobe Epilepsy (TLE) and the number of samples was 10 patients. The result of this study indicates that the use of the T2 SPACE dark fluid sequence produces more detailed images of the hippocampal structure in terms of slices. In addition, it provides good spatial resolution for assessing the hippocampal structure, allowing the visualization of abnormal signal intensities within the hippocampus, and facilitating the detection of hippocampal abnormalities. Therefore, it can be concluded that the use of T2 SPACE dark fluid sequence is very important and considerably quite informative in diagnosing epilepsy cases.

Keywords: *MRI Brain, Epilepsy, T2 SPACE Dark Fluid*

INTRODUCTION

The human brain serves as the central regulatory organ, constituting about 2% of the total body weight and estimated to house approximately 100 billion nerve cells or neurons. It plays a pivotal role in governing the entire human body and mind, overseeing crucial functions such as regulating and coordinating body movements, neurons, and maintaining homeostatic functions like heart rate, blood pressure, fluid balance, and body temperature. Additionally, the brain handles tasks related to recognition, emotions, memory, motor learning, and various other forms of learning.

The term "epilepsy" finds its origin in the Greek word "epilepsia," which translates to "attack." Epilepsy is a condition characterized by recurrent seizures triggered by disruptions in brain function due to abnormal electrical activity among neurons in the brain. Seizures fall into two primary categories: focal (partial) seizures and generalized seizures. Focal seizures typically result from damage to specific areas of the cerebral cortex, which can lead to loss of consciousness. On the other hand, generalized seizures involve lesions affecting extensive areas of the cortex and typically impact both hemispheres.

MRI is a non-invasive tool, functioning in detecting structural brain lesions and assessing indications before surgery in epilepsy patients. (3) The main role of MRI in epilepsy patients is to identify epileptogenic lesions.

According to Westbrook (2014), the MRI Brain examination protocol for clinical epilepsy, specifically for temporal lobe epilepsy, involves the utilization of several sequences. These sequences include Sagittal SE T1, Axial/Oblique SE/FSE T2, Coronal/Oblique SE/FSE T1, Coronal 3D Incoherent (Spoiled) GRE T1, and Axial/

Oblique/Coronal/Oblique IR-FSE T2. (5)

In contrast, the MRI Brain examination for clinical epilepsy conducted at the Radiology Installation of the National Brain Center Hospital is based on interviews with radiographers who follow routine MRI Brain protocols. These protocols include 3-plane localization, DWI-ADC, T2 TSE TRA, T2 TSE COR, T1 TSE TRA, T1 TSE SAG, T2 Flair, and SWI. For clinical epilepsy cases, specific sequences are added, such as T2 SPACE DARK FLUID COR, T1 SPACE IR COR, and T2 TSE COR OBLIQ. In cases of epilepsy other than Temporal Lobe Epilepsy (TLE), an additional sequence, DIR SPACE SAG, and T1 TIR COR OBLIQ are introduced.

MRI examinations for patients with clinical epilepsy at the Radiology Installation of the National Brain Hospital, especially those with Temporal Lobe Epilepsy (TLE), commonly associated with abnormalities in the temporal lobe's hippocampus, may benefit from the addition of a 3D FLAIR sequence. The doctor often recommends incorporating the 3D FLAIR sequence as it enhances the visualization of cortical lesions, making them appear hyperintense. This sequence is particularly valuable in suppressing high CSF/fluid signals, allowing for the differentiation between normal CSF/water signals and abnormal/ pathological ones, especially within the hippocampus area. (6) Furthermore, the T2 SPACE Dark Fluid sequence plays a crucial role in the accurate evaluation of pathology within the hippocampus. It is instrumental in providing a clear assessment of any abnormalities.

In the standard operating procedure (SOP) for MRI brain examinations, especially when dealing with patients having clinical epilepsy at the Radiology Installation of the National Brain Center Hospital, a specific approach is taken to focus on the hippocampus. This approach involves acquiring thin sections of the hippocampus using the coronal FLAIR technique, which positions the section perpendicular to the hippocampus. This practice aligns with the guidance provided in the Handbook of MRI Technique by Westbrook (2014), which recommends the inclusion of an additional sequence known as the Axial/oblique FLAIR sequence for MRI brain examinations involving clinical epilepsy cases.

During an MRI brain examination, various sequences are employed to aid in diagnosis, depending on the clinical condition under consideration. The Brain MRI examination for clinical epilepsy cases conducted at the Radiology Installation of the National Brain Center Hospital is a commonly administered procedure. Given this context, the author was motivated to delve deeper into the utilization of the T2 SPACE Dark Fluid sequence or 3D FLAIR coronal section as an additional sequence in diagnostic protocols for clinical epilepsy. To achieve this, a research study was undertaken to analyze the MRI Brain examination procedures specifically in epilepsy clinical settings at the National Brain Center Hospital.

METHODS

This research employs a qualitative, descriptive methodology, aligning with a case study approach focusing on MRI Brain management in clinical epilepsy. The study was conducted during the period from February to May 2023 at the Radiology Installation of the National Brain Center Hospital.

The study population comprises all patients who underwent MRI brain examinations at the National Brain Center Hospital. This research, however, intensively focuses on ten selected samples of Brain MRI patients with clinical Temporal Lobe Epilepsy (TLE).

Data collection is achieved through multiple avenues, including direct observation of patients from their arrival until the completion of the examination, a comprehensive review of relevant literature encompassing books, scientific articles, online resources, and printed materials related to MRI Brain procedures, standard operating procedures, and examination techniques. Additionally, direct interviews were conducted with three radiographers at RSPON and three radiologists possessing expertise in MRI brain examinations.

RESULTS

1. Use of Sequence T2 SPACE Dark Fluid Coronal Slices in Clinical Epilepsy at the National Brain Center Hospital

a) Patient Preparation

This examination begins with the patient coming to the Radiology Installation according to a predetermined schedule and bringing the results of an Electroencephalography (EEG) examination to confirm the specific type of epilepsy along with a letter requesting an MRI examination from the sending doctor. Then the patient can change clothes into the clothes provided, leaving behind objects that can affect the image results and are contraindications for MRI, such as metal objects, electronics, watches, coins, ATMs, belts, masks, hearing aids and patients with Pacemakers cannot perform MRI examinations.

b) Preparation of Tools and Materials :

1) SIEMENS Skyra 3 Tesla MRI

Figure 1. MRI SIEMENS 3T

2) Head coil
3) Fixation / Immobilization Equipment
4) Blanket
5) Emergency Bell
6) Digital Versatile Disk Recordable (DVD-R)
7) Processing Units
8) Patient clothes
9) Headphones
10) Console or Computer System Operator

c) MRI Brain Examination Techniques

1) Patient position

Patients are introduced to the SIEMENS MRI examination room, featuring a magnetic field strength of 3 tesla. They receive a detailed explanation of the MRI procedure and its implementation. Afterward, patients are positioned in a supine (back) manner on the examination table, head-first. They are informed about the noise generated by the equipment, which will be mitigated by headphones provided. Patients are instructed to alert staff promptly in case they feel nauseous, dizzy, or encounter any urgent conditions, by pressing the emergency bell. A comfortable blanket is provided for the patient's convenience. Following this, a head coil is placed to immobilize the patient's head and maintain its position. The focal point is adjusted to the middle of the glabella, and the patient is gently placed into the gantry. Subsequently, the MRI room is securely sealed, and the examination commences.

2) Data Input:

Once the patient is inside the gantry and the MRI room is sealed, the radiographer returns to the operator's room to input patient data from the request sheet. The data includes the patient's name, date of birth, weight, height, examination type, and the radiographer's name responsible for the procedure. The radiographer selects the appropriate protocol or sequence, labeled as 'RSPON Routine NON-Contrast Head MRI,' and initiates the scan.

3) Scanning Process

Following data input, the scanning process proceeds. The radiographer chooses the protocol and configures the parameters specific to the MRI Brain examination for Temporal Lobe Epilepsy. This comprises the standard brain sequence, with three additional sequences for Temporal Lobe Epilepsy cases: T2 SPACE DARK FLUID COR (3D FLAIR sequence), T1 SPACE IR COR (3D T1 IR), and T2 TSE COR OBLIQ. Consequently, the sequence employed for this examination includes AA Head Scout, DWI-ADC TRA, T2 TIRM TRA DARK FLUID, T1 MPRAGE TRA, T1 MPRAGE SAG, T2 TSE COR, T2 TSE TRA, SWI, T2 SPACE DARK FLUID COR, T1 SPACE IR COR, and T2 TSE COR OBLIQ.

4) Post Processing

Upon completing the examination, the image results are transferred to the Picture Archiving and Communication System (PACS). The radiographer reviews the image results to ensure they are free from artifacts and optimized for interpretation by radiologists. Subsequently, the images are sent to Synaps and copied onto DVD-R. The images are provided in DVD-R format since the National Brain Center Hospital has discontinued the use of radiology film. However, if patients request hard copies of their images, they can be printed on film. Patients can collect both the MRI Brain examination results on DVD-R and the doctor's interpretation in a folder within a maximum of 72 working hours following the examination's completion.

2. MRI Image Results on T2 SPACE Dark Fluid Sequence Coronal Slices with Clinical Epilepsy at the National Brain Center Hospital

This additional sequence is specifically for clinical epilepsy recommended by radiologists at the Radiology Installation of the National Brain Center Hospital, namely it can clearly show the image of the hippocampus on a coronal section.

In Figure 4.11, it can be seen that the volume of the left hippocampus is smaller than the right accompanied by widening of the left lateral ventricular system of the temporal horn. The left hippocampus appeared hyperintense on T2/FLAIR with abnormal morphology. Figure 2 shows the results of a coronal MRI brain image in patient 1.

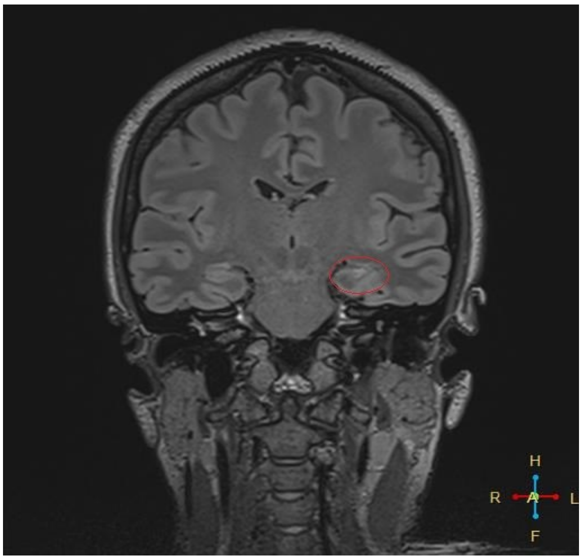

Figure 2. Patient No 1

In Figure 3, malrotation can be seen in the left hippocampus and in the right hippocampus the shape and size appear good.

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Figure 3 shows the results of a coronal MRI brain image in patient 2.

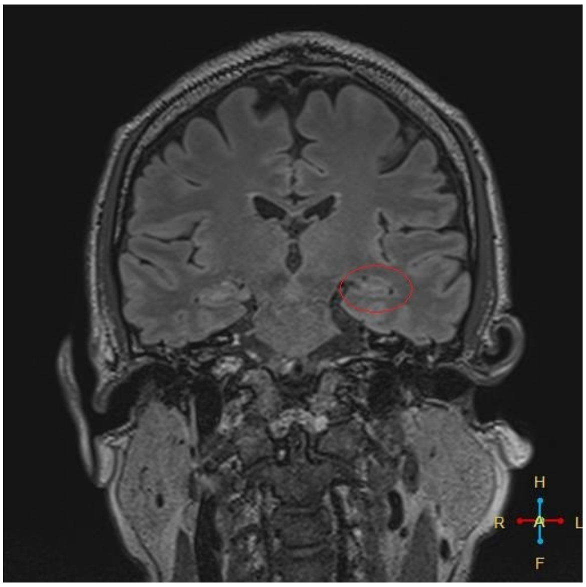

Figure 3. Patient No 2

In Figure 4, you can see left hippocampus atrophy or its size is smaller than the right accompanied by sclerosis or shrinkage of the left hippocampus. Figure 4 shows the results of a coronal MRI brain image in patient 3.

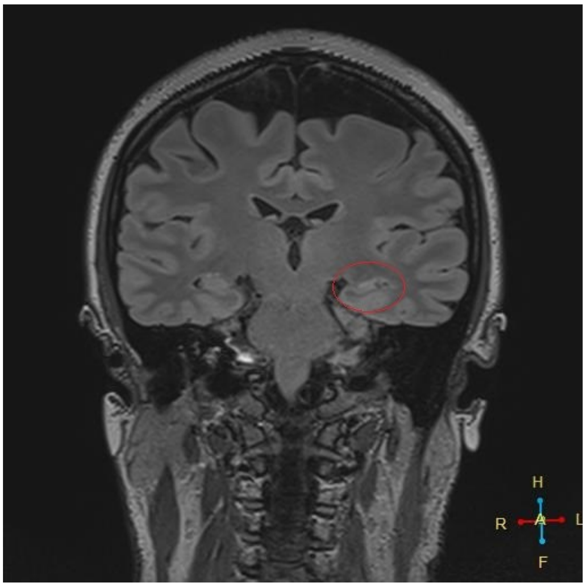

Figure 4. Patient No 3

In Figure 5, it can be seen that the right hippocampus is smaller than the left and an old infarct can be seen in the right and left insula. Figure 5 shows the results of a coronal MRI brain image in patient 4.

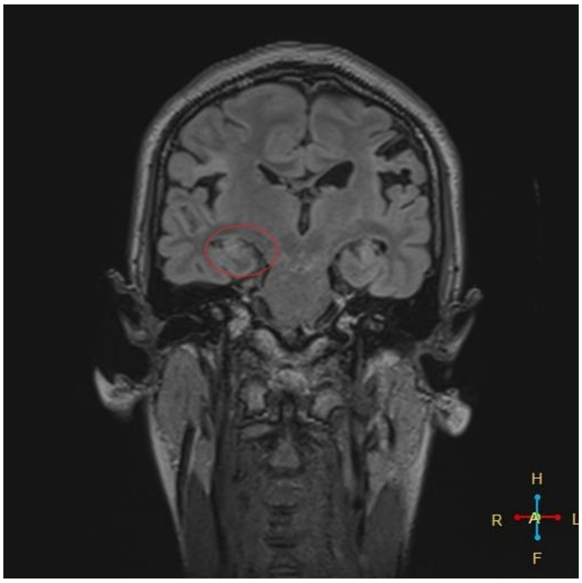

Figure 5. Patient No 4

In Figure 6, it can be seen that the left hippocampus is smaller than the right and is accompanied by signs of sclerosis. Figure 6 shows the results of a coronal MRI brain image in patient 5.

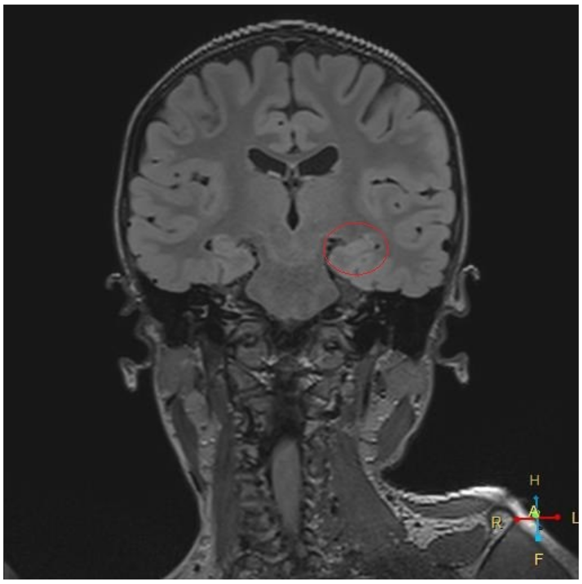

Figure 6. Patient 5

In Figure 7, it can be seen that the volume of the right hippocampus appears

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smaller than the left with abnormal morphology and signal intensity that appears hyperintense on T2 and FLAIR. Figure 7 shows the results of a coronal MRI brain image in patient 6.

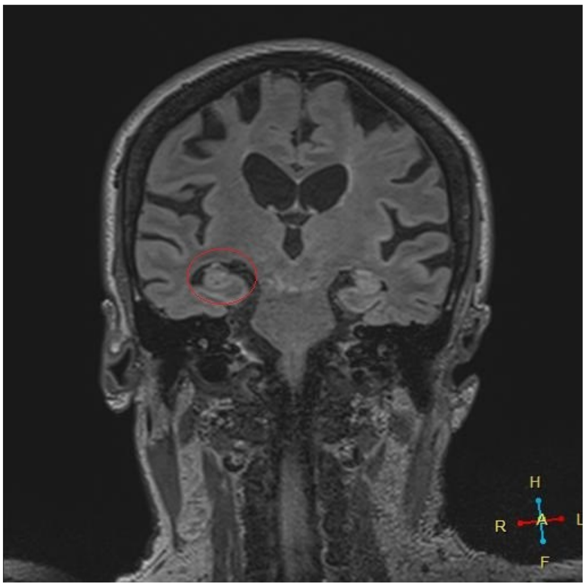

Figure 7. Patient No 6

In Figure 8 you can see mild atrophy in the right hippocampus so that the right hippocampus appears slightly smaller than the left hippocampus. Figure 8 shows the results of a coronal MRI brain image in patient 7.

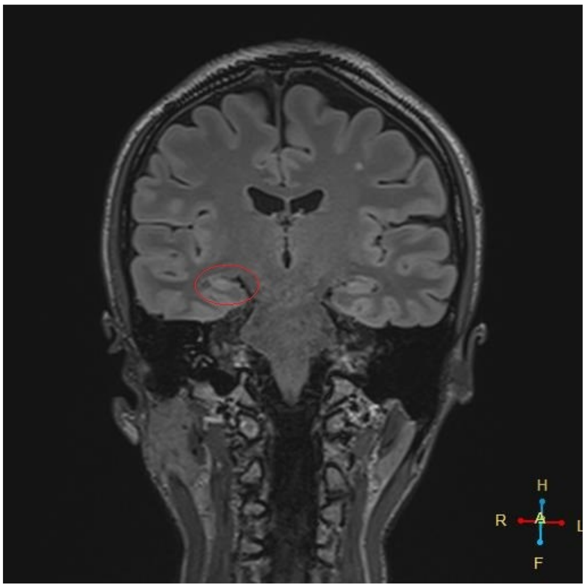

Figure 8. Patient No 7

In Figure 9, it can be seen that the left hippocampus is smaller than the right hippocampus with hyperintensity on T2 and accompanied by signs of sclerosis. Figure 9 shows the results of a coronal MRI brain image in patient 8.

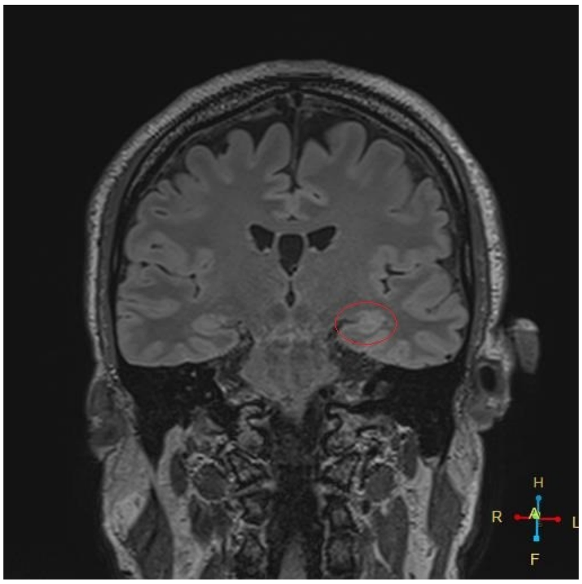

Figure 9. Patient No 8

Figure 10 shows atrophy of the left hippocampus so that it appears smaller than the right hippocampus with hyperintensity on T2-FLAIR and accompanied by signs of sclerosis. Figure 10 shows the results of a coronal MRI brain image in patient 9.

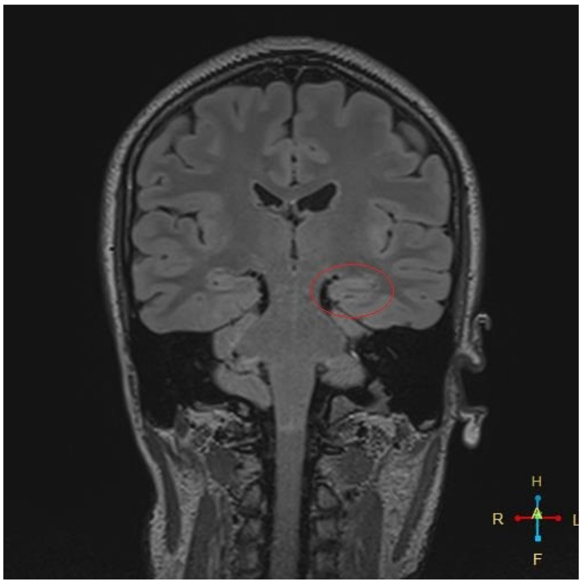

Figure 10. Patient 9

In Figure 11, it can be seen that the anterior part of the left hippocampus appears smaller than the right hippocampus and is accompanied by signs of sclerosis. Figure 11 shows the results of a coronal MRI brain image in patient 10.

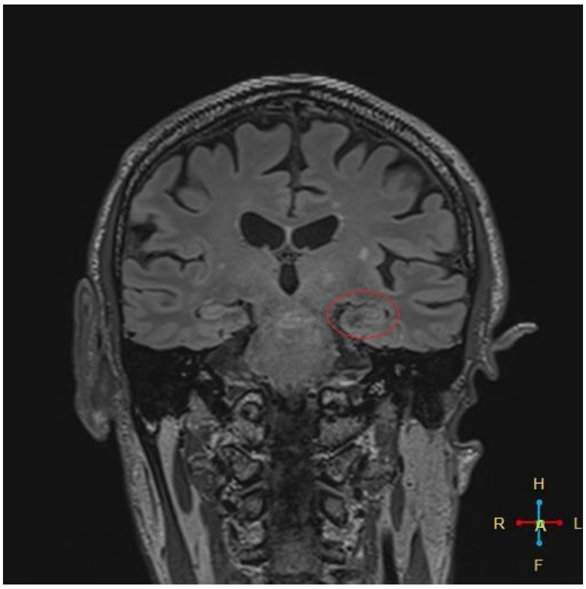

Figure 11. Patient No 10

DISCUSSION

Implementation of T2 SPACE Dark Fluid Sequence in Clinical Epilepsy Brain MRI at the National Brain Center Hospital

The Brain MRI examination for clinical epilepsy conducted at the National Brain Center Hospital aligns with established literature concerning standard operating procedures for patient preparation and positioning. However, the use of protocols or sequences in clinical epilepsy Brain MRI examinations differs between theoretical knowledge and practical implementation. According to Westbrook (2014) (5), the MRI Brain examination protocol for clinical epilepsy, specifically temporal lobe epilepsy, typically comprises several sequences, including Sagittal SE T1, Axial/Oblique SE/FSE T2, Coronal/ Oblique SE/FSE T1, Coronal 3D Incoherent (Spoiled) GRE T1, and Axial/ Oblique/Coronal/Oblique IR-FSE T2. In theory, there is no inclusion of an additional T2 SPACE dark fluid or 3D FLAIR sequence.

However, the National Brain Center Hospital adopts a distinctive approach by incorporating an additional and specific sequence, the T2 SPACE dark fluid sequence, tailored for clinical epilepsy cases. Interviews with three radiologists from the National Brain Center Hospital revealed unanimous consensus on the critical role of the T2 SPACE dark fluid sequence in MRI brain examinations for clinical epilepsy, especially Temporal Lobe Epilepsy (TLE). The inclusion of the T2 SPACE dark fluid sequence significantly enhances sensitivity and facilitates the detection of abnormalities, thus bolstering diagnostic accuracy. Without this additional sequence, there is a substantial risk of missing lesions of interest. Specific sequences designed for particular diseases improve diagnostic precision.

The T2 SPACE dark fluid sequence is consistently integrated into MRI brain examinations for clinical epilepsy at the National Brain Center Hospital. This sequence offers the advantage of more detailed visualization of the hippocampal structure, enhances the detection of abnormal signal intensities, and presents image results in a Multiplanar Reconstruction (MPR) format. This MPR format enables the display of sagittal, coronal, and axial cross-sections, providing informative views for accurate hippocampal assessment.

Notably, the utility of the T2 SPACE dark fluid sequence extends beyond clinical epilepsy cases at the National Brain Center Hospital. It finds application in various clinical settings, such as multiple sclerosis clinical trials. The sequence proves invaluable in enhancing the visibility of small or otherwise challenging-to-detect lesions, ultimately improving diagnostic resolution in routine MRI Brain sequences.

MRI Image Outcomes Using the T2 SPACE Dark Fluid Sequence in Clinical Epilepsy at the National Brain Center Hospital

In clinical epilepsy, Bernasconi's theory (2019) highlights the remarkable capabilities of the 3D FLAIR or T2 SPACE dark fluid sequence. This sequence excels in rendering high-quality images with a distinct contrast between gray matter and cerebrospinal fluid (CSF). Notably, the signal intensity for key structures, such as the amygdala, hippocampus, cingulate gyrus, subcallosal area, and insula, registers significantly higher in gray matter. The T2 SPACE dark fluid sequence, known for its thin slices, measuring less than 1 mm, plays a pivotal role in the comprehensive assessment of hippocampal anatomical structures, ensuring exceptional detail.

This sequence's spatial resolution is also commendable, facilitating the meticulous scrutiny of the hippocampus's structural integrity. Its capabilities extend to the identification of abnormal signal intensities within the hippocampus, simplifying the detection of anomalies, even beyond the hippocampus, potentially encompassing other brain structures like sulci or gyri.

For MRI image outcomes to be deemed optimal in the T2 SPACE dark fluid sequence, it is imperative that the images exhibit a high differentiation between gray and white matter, present a clear depiction of hippocampal anatomy, boast excellent resolution, and remain free from artifacts, be they metal-induced or motion-related. The minimal occurrence of artifacts is pivotal to maintain image quality. The principal anatomical focus of this sequence centers on the hippocampus, encompassing both the right and left medial temporal lobes.

In comparison to other sequences, the T2 SPACE dark fluid sequence offers distinct advantages, notably in enhancing the clarity of abnormal lesions when compared to standard procedures. Its 3D nature allows for post-processing adjustments, accommodating instances where patient positioning may not be entirely straight, such as in pediatric cases with anesthesia. This sequence excels in rendering abnormalities conspicuously, rendering it particularly helpful for the detection of pathological conditions.

Furthermore, the fundamental display of the T2 SPACE dark fluid sequence itself fulfills the requisites for identifying abnormalities in epilepsy patients. Its use remains substantially informative in the diagnosis of clinical epilepsy disorders, despite the advent of newer sequences.

CONCLUSIONS

The utilization of the T2 SPACE Dark Fluid sequence in MRI Brain examinations conducted for clinical epilepsy at the National Brain Center Hospital is of paramount importance. This sequence provides an enhanced visualization of the hippocampal structure, allowing for intricate, high-detail assessment. Its adeptness in delineating signal intensity, coupled with its 3D imaging capability, renders it a highly informative tool for comprehensive hippocampal evaluation.

MRI image results on the T2 SPACE Dark Fluid sequence produce thin-section images which make it easier to assess the anatomical structure of the hippocampus in more detail.

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