

ORIGINAL PAPER

Post-contrast Three-dimensional MP RAGE T1WI Sequence Compared to Brain MRV Sequence for Diagnosing Brain Sinus Venous Thrombosis

Maysoon Banihani¹,
Qamar Malabeh¹, Jameel
Shawaqfeh¹, Maher
Khawaldeh¹, Mohammad
AlHazaimeh²

¹Faculty 1Radiology Department at Royal
Medical Services, Amman, Jordan

²General Physician at Ministry of Health,
Amman, Jordan

Corresponding author: Jameel Shawaqfeh,
MD. Radiology Department at Royal Medical
Services, Amman, Jordan. E-mail: jshawaqfeh@
yahoo.com. ORCID ID: [http://www.orcid.
org/0000-0000-0000-0000..](http://www.orcid.org/0000-0000-0000-0000..)

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Jameel Shawaqfeh, Maher Khawaldeh, Mohammad
AlHazaimeh

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ABSTRACT

Background: Dural sinus thrombosis is considered as a one of the clinical and radiological emergencies that require special attention and high index of suspicion and needs combined effort of both the treating physician and the radiologist to obtain proper diagnosis and subsequently proper management. **Objective:** The aim of this article was to compare the accuracy of MRV TOF and post contrast MP-RAGE sequences in diagnosis of cerebral sinus venous thrombosis. **Methods:** After all informed consents were obtained and upon ethical committee approval from the ethical committee in Jordanian Royal medical services in Amman we perform this study as a retrospective study done on 50 patients with cerebral sinus venous thrombosis with 50 patients control group done at King Hussein medical center in Amman Jordan. **Results:** The guidelines and regulations of studies conducted in Royal medical services were followed. 68 females and 32 males with age range between 19 and 52 years. All patients underwent brain MRI for evaluation of cerebral sinus thrombosis, all studies were done on Siemens Skyra 3 Tesla machine with standardized protocol including 2 D TOF MRV, axial T2WI, axial FLAIR, Axial T1, SWI and diffusion weighted images along with 3D MP-RAGE post contrast. Images were reviewed by two well experienced neuroradiologists (Maysoon and Qamar) in separate sessions, each MRI sequence was reported separately without knowing patients name or clinical history. **Conclusion:** The results for T2 WI, SWI, MRV TOF and MP-RAGE post contrast were reported. We used a confidence level score to standardize the results. Then the results were analyzed using simple statistical methods.

Keywords: dural, sinus, thrombosis, sequences.

1. BACKGROUND

Dural sinus thrombosis is considered as a one of the clinical and radiological emergencies that require special attention and high index of suspicion and needs combined effort of both the treating physician and the radiologist to obtain proper diagnosis and subsequently proper management (1). The role of the clinician is to guide the radiological investigations toward dural sinus thrombosis diagnosis. but this is not the case in some cases so the radiologist should be familiar with the radiological signs of sinus thrombosis in routine MRI sequences and then to confirm by special sequences (2).

2. OBJECTIVE

The aim of this study was to compare the accuracy of MRV-TOF and

postcontrast MP-RAGE sequences in the diagnosis of cerebral sinus venous thrombosis.

3. MATERIAL AND METHODS

In this study we compared various magnetic resonance sequences used routinely in imaging of brain such as T2WI and susceptibility weighted images to sequences used specifically to evaluate the dural sinuses such as post contrast 3-D MP-RAGE T1 WI and brain MRV.

After informed consent was obtained and upon ethical committee approval from the ethical committee of the Jordanian Royal Medical Services in Amman, we performed this retrospective study on 50 patients with cerebral sinus venous thrombosis and 50 patients in the control group. Allied

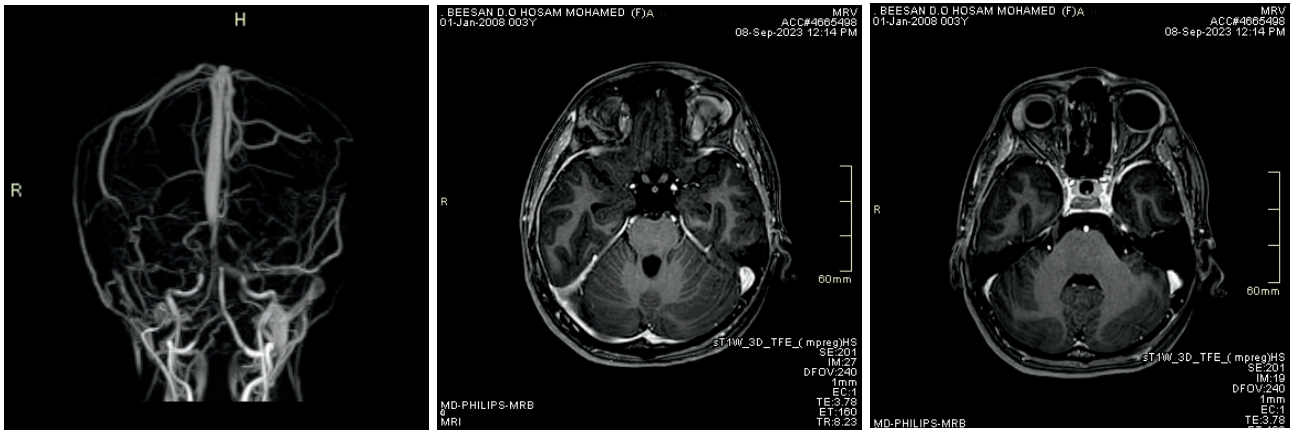


Figure 1. Mp rage post contrast confirming that the hypoplastic sinuses were mistaken for thrombosed sinus in TOF patients

patients were treated at King Hussein Medical Center in Amman, Jordan. The guidelines and regulations of studies conducted in Royal Medical Services were followed.

The sample was 68 females and 32 males aged between 19 and 52 years. All patients underwent brain MRI for the evaluation of cerebral sinus thrombosis. All studies were performed on a Seimens skyra 3 Tesla machine with a standardized protocol that included 2D TOF MRV , axial T2WI , axial FLAIR , axial T1 , SWI and diffusion weighted images along with 3D MP-RAGE postcontrast.

Images were reviewed by two well -experienced neuroradiologists (Maysoon and Qamar) in separate sessions , and each MRI sequence was reported separately without knowing the patient’s name or clinical history. The results for T2WI, SWI, MRV TOF and MP-RAGE post contrast were reported. We used a confidence level score to standardize the results. The results were subsequently analysed using simple statistical methods.

4. RESULTS

For each patient, 4 sequences were reported for evidence of sinus thrombosis, and a score indicating the level of confidence was given by each of the two neuroradiologists. The scoring system is shown below in Table 1. The means of the scores given by the two radiologists were subsequently assigned to each sequence . A score of 4 or 5 was considered positive, and a score of 1 or 2 was considered negative.

Descrip- tion	Definitely absent	Probably absent	Uncertain	Probably present	Definitely present
score	1	2	3	4	5

Table 1. The scores for level of confidence used in the study.

Sequence	True positive	True negative	False positive	False negative
T2WI	42	32	21	5
SWI	40	30	25	5
MRV-TOF	46	36	15	3
MP-RAGE	48	46	4	2

Table 2. Net results after averaging the results from neuroradiologists

sequence	T2WI	SWI	MRV TOF	MP-RAGE POST CONTRAST
sensitivity	90	89	94	96
specificity	60	54	71	92

Table 3. Specificity and sensitivity of each sequence

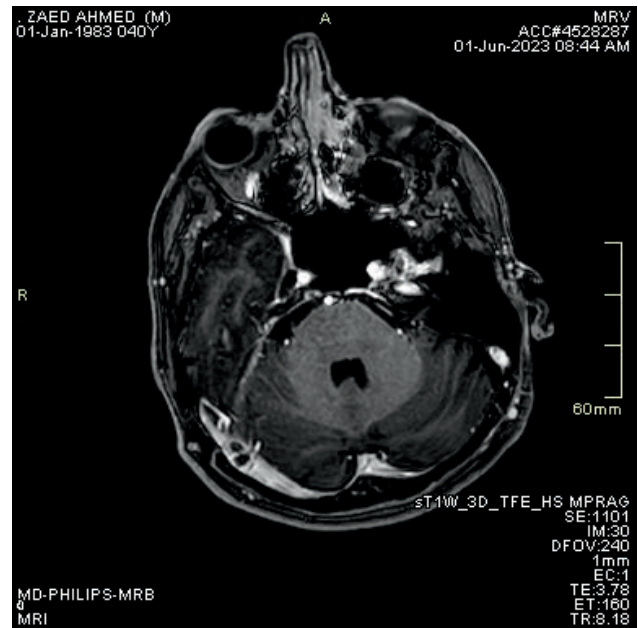


Figure 2. Chronic thrombus with recanalization where the MRV is considered superior to the MP RAGE

The sequences evaluated were T2 WI images, and the findings considered positive is loss of signal void of the sinuses.

The 2nd sequence was susceptibility weighted imaging (SWI), which was considered positive when blooming artefacts were present within sinuses or cortical veins.

The 3rd sequence was the MRV-TOF images with maximum intensity projection (MIP) images, and these images were considered positive if there was no visualization of part of the sinus or the presence of a filling defect. In cases of suspicion of hypoplasia or aplasia of the dural sinuses, access to the source images is given to the radiologists before the sequence is scored.

The 4th sequence, which was the MP-RAGE postcontrast, was considered positive when the thrombus within the cerebral sinuses was visualized.

The results are shown in Table 2. The sensitivity and specificity for each sequence were subsequently calculated using simple statistical methods as follows:

- Sensitivity = true positive results divided by true positive results added to false negative results.
- Specificity = true negatives divided by true negatives added to the number of false positives.

The results are shown in Table 3. The results were subse-

Name of study	T2WI	SWI	MRV TOF	MP-RAGE POST CONTRAST
Meckel, reisinger et.al	62	49	42	76
Luxia liang et.al	7.7	na	51	83
Galareh sadigh et.al	58	42	na	86

Table 4. Sensitivity of sequences in similar studies

Name of study	T2WI	SWI	MRV TOF	MP-RAGE POST CONTRAST
Meckel, reisinger et.al	98	98	96	99
Luxia liang et.al	92	NA	92	99
Galareh sadigh et.al	97	90	NA	97

Table 5. Specificity of sequences in similar studies

quently linked to the stage of the thrombus, whether acute, subacute or chronic, and also linked to the anatomical segment involved in the thrombosis. Furthermore, the data were recorded and will be discussed later in this paper.

5. DISCUSSION

Cerebral dural sinus thrombosis is a life-threatening clinical condition that has a major impact on health and life (1-3). Luckily, this serious condition can potentially be completely reversed if it is diagnosed early and accurately, and then treated properly (2, 4-6).

Cerebral sinus thrombosis accounts for approximately 1% of all strokes worldwide (7-10). and affects relatively younger age groups than arterial strokes, especially women of reproductive age (1, 5, 7, 9).

The necessity for prompt and accurate diagnosis has made diagnosis challenging for both clinicians and radiologists. Therefore, advances in imaging via both software and hardware are mandatory to improve the diagnostic yield and, eventually, the prognostic outcome (2, 4, 6, 8).

MRI is the gold standard method for diagnosis (1-4). Routine or basic MRI sequences are subject to misdiagnosis mostly due to variations in the signal intensity of flowing blood, anatomic variations in the venous system and changes in the signal intensity of the thrombus according to the clot age (1-10).

Susceptibility weighted imaging (SWI) is a sequence in which artefacts are used to aid in diagnosis. SWI is used to detect compounds that distort local magnetic fields, such as blood products and calcium, by causing blooming artefacts (1-10). It has been proven to be sensitive for detecting micro-hemorrhage and in acute sinus thrombosis, and in our case, it proved helpful in detecting cortical vein thrombosis (3-7).

The MRV-TOF sequence improves the accuracy of MRI studies because it reveals blood flow in the sinus system and filling defects without the use of IV contrast (3, 5, 8). This is not that specific due to many factors, such as the presence of arachnoid granulation, the normal variants, such as hypoplasia or aplasia of the dural sinuses, the anatomical variations in the number and position of cortical veins. It should always be performed as an add-on sequence to routine brain MRI studies and never performed as a stand-alone study (1-10).

The use of a magnetization-prepared rapid, gradient echo sequence in 3 dimensions (MP-RAGE) is one of the most recent advances in imaging of the brain. This sequence captures high tissue contrast and provides high spatial resolution with whole-brain coverage in a short scan time. It is highly im-

portant for evaluating structural brain changes. It has many uses in imaging of multiple sclerosis and evaluation of neuronal migration disorders (1-10).

When performed postcontrast, it provides superior visualization of the intracranial venous system compared to other imaging modalities (2-5).

In our study, it showed higher sensitivity and specificity in the detection of brain sinus thrombosis. It can easily detect anatomic variations in dural sinuses and cortical veins, and can easily delineate thrombi and arachnoid granulation. The confidence level and the time needed for diagnosis are relatively better with this technique than with other imaging sequences (1-10).

The drawback of this sequence is chronic sinus thrombosis because the clot might enhance in chronic stage (3, 5, 7). This is the only case in which the TOF-MRV was superior to the MP-RAGE postcontrast.

Similar studies were performed, and the results were comparable to our study; some of these results are shown in Tables 4 and 5. All these studies agreed that postcontrast MP-RAGE is both a highly sensitive and specific sequence for evaluating sinus thrombosis.

In this study, several observations should be addressed because of the clinical and radiological implications on the patient prognosis. First, because of the value of SWI in assessing cortical vein thrombosis, it has been proven to be the best imaging sequence for assessing cortical vein thrombosis, with high sensitivity compared with MRV-TOF, which has nearly no value in assessing cortical veins. Second, MRV-TOF should not be evaluated separately from other imaging sequences, which is important in cases of arachnoid granulation, hypoplasia of the dural sinuses, cortical vein thrombosis and tumors compressing the dural sinuses.

6. CONCLUSION

MP-RAGE postcontrast has higher sensitivity and specificity than MRV-TOF in most cases of cerebral sinus thrombosis except for chronic dural sinus thrombosis.

The combination of imaging sequences improved diagnostic yield and patient prognosis.

The SWI is useful for assessing cortical veins.

All these sequences should be evaluated as complementary to routine MRI sequences.

- **Ethical approval:** After all the informed consent was obtained, ethical approval was obtained from the Jordanian Royal Medical Services Ethics Committee before the study was conducted. the necessary approval from the head of the radiology department. The ethical committee approval for conducting the study and for publication is attached to the declaration section .
- **Patient Consent Form:** All participants were informed about subject of the study.
- **Materials and data:** All the materials and data used in this study are available from the AGFA enterprise PACS system in the King Hussein Medical Center in Jordanian Royal Medical Services and may be presented upon request. The person to be contacted regarding this issue is Jameel Shawaqfeh at email jshawaqfeh@yahoo.com.
- **Author's contribution:** All authors were involved in all steps of preparation this article. Final proofreading was made by the first author.
- **Conflict of interest:** None to declare.

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