Original Article

Diagnostic value of T2-Weighted gradient-echo for diagnosis of cerebral venous thrombosis

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ABSTRACT

Objectives: The role of MRI has been increased for diagnosis of cerebral venous thrombosis during recent years. In this study the efficacy of T2 Gradient echo for diagnosing cerebral thrombosis has been assessed.

Methodology: This study was a descriptive-analytical study, which was focused on diagnostic values. Diagnostic value T2 GRE sequence of MRI is being evaluated and compared with common sequences of T1, T2, and FLAIR. Then, via Golden Standard of MR Venography, different sequences of MRI have been compared. Gathered data had been entered in SPSS software and through using descriptive statistical methods and data frequency, different sequence sensitivities were computed.

Results: Twenty one patients, including three males (14.3%) and 18 females (85.7%) with the average age of 36.00±10.13 participated in this study, and they have had a total number of 55 numbers of thrombosis. The most common clinical symptom, predisposing factor, involved sinus, and common underlying disorder was headache (95.2%), taking OCP (52.4%), superior sagittal sinus (71.4%), and infraction (47.6%) respectively. The sensitivity rates of T1, T2, and T2GRE sequence for diagnosis of acute thrombosis were 30%, 0, and 90% respectively, and for Early Sub-Acute cases they were 92.9%, 92.9%, and 100% respectively.

Conclusions: T2 GRE sequence can be used as a quick diagnostic tool for diagnosing CVT before applying MR venography in patients. Using this sequence can be very effective, especially when it is critical to diagnose the disease quickly.

KEY WORDS: Cerebral venous thrombosis, T2 GRE sequence, T1 sequence, T2 sequence, MRI.

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INTRODUCTION

Diagnosis of cerebral venous thrombosis, which is sometime very problematic, is an important challenge for physicians because it has different clinical symptoms and there is a wide range of signs and symptoms. In addition if it is not diagnosed quickly it may cause debility, or even death. When the problem is diagnosed on time, most damages can be reversed.[1] Right now T1, T2, FLAIR, MRI sequences are common sequences used for diagnosis of cerebral venous thrombosis (CVT) and MR venography method is used as the golden method for diagnosis. Nevertheless, alterations of T1 and T2 sequences do not make extremely high sensitivity (70% and less than 40% respectively) [2-4] and in primary stages it

is probable to consider alterations as normal states (especially in T1 sequences) and on the other hand MR venography is not considered and executed for most patients especially those who are not clinically susceptible, and therefore some cases would not be diagnosed in patients.[5]

Regarding mentioned facts, consequent mortalities, which are greatly the result of inability in diagnosing and treatment of disease, can be significantly reduced if other sequences would be used, especially in primary stages of diagnosis.[5] Recent reports have proved high range of sensitivity of T2 GRE for diagnosing magnetic susceptibility effect of blood products like hemoglobin- dioxide in patients with SAH and intra-parenchyma hemorrhage.[6,7] Recent studies have considered the role of T2 GRE in diagnosis of cerebral venous thrombosis; in limited number of studies the sensitivity of this sequence for diagnosing cerebral venous thrombosis is being reported as 90 to 97%.[8]

However further studies are needed to confirm the effectiveness of T2 GRE sequences for diagnosing cerebral venous thrombosis. If higher sensitivity sequence of T2 Gradient echo would confirm diagnosing cerebral venous thrombosis, this sequence can be used as superior method or at least complementary method for patients susceptible to thrombosis of cerebral veins. This study was conducted to compare diagnostic values of T2 Gradient echo sequence, with T1, T2, FLAIR sequences of MRI, and MRV method, when they are used for diagnosing cerebral venous thrombosis.

METHODOLOGY

This was a descriptive analytical study which was focused on diagnostic value. People undergoing this study were those individuals susceptible to cerebral venous thrombosis, and they had been selected as candidates for MRI in Imam Reza Hospital (Kermanshah) from June 15th, 2009 till June 15th, 2010.

Diagnostic value of MRI with the sequence of T2 Gradient echo was measured and compared with common methods of T1, T2, and FLAIR. In this study, MRV was used as gold standard of diagnosis. Population of the study included those patients who were susceptible to cerebral venous thrombosis and were candidates for MRI. After taking T1, T2, T2GRE sequences, MRV was done as gold standard diagnostic method.

Cerebral venous thrombosis diagnostic criteria was: 1) Records and medical examinations confirming thrombosis diagnosis, 2) Observing signal shifts in T1 or T2 sequences that highly suggest thrombosis, and 3) Complete or proportional vein obstruction observed in MR venography.

The results of MRI were reported first by a resident who was fellow member of the study and then final MRI reports were prepared by an experienced radiologist, and finally the results were compared with gold standard results of MR venography.

CVT categorized as acute (symptoms presentation between 12-72 hour, iso intensity in T1 and hyper intensity in T2), early sub-acute (symptoms presentation between 4-7 day, hyper intensity in T1 and hypo intensity in T2), late sub-acute (symptoms presentation between 8-30 day, hyper intensity in T1 and hyper intensity in T2), and chronic (symptoms presentation >30 day, hypo intensity in T1 and hypo intensity in T2).

Three tools were used in this study:

1. A questionnaire in which demographic data of individuals were recorded by comate resident.
2. MRI was used as a test which has diagnostic value it was assessed and its results were reported by comate resident and radiologist.
3. MR venography was applied as a gold standard and it was performed by another expert radiologist.

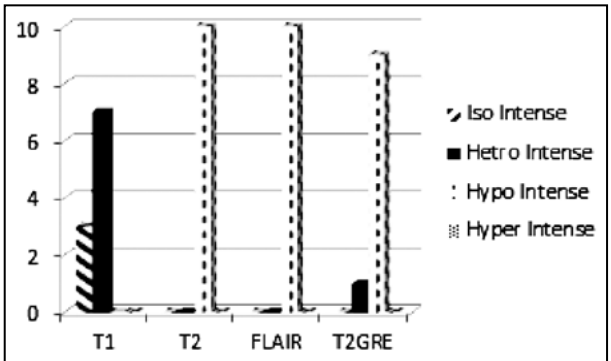
Collected data was entered in SPSS software using descriptive statistical methods and data frequency, different sequence sensitivities were computed.

RESULTS

Population of the study included 21 patients including three men (14.3%) and 18 women (85.7%) with the average age of 36.00±10.13 (range: 18-55); they suffered from 55 numbers of thrombosis. The highest number of concurrent thrombosis was

Table-I: Frequency distribution of participant patients with thrombosis based on symptoms.

Frequency	*With*		*Without*	
Clinical symptoms	*Frequency*	*%*	*Frequency*	*%*
Focal nervous deficit	4	19.6	17	80.95
Headache	20	95.2	1	4.8
Consciousness disorder	4	19.06	17	80.95
Convulsion	10	47.62	11	52.38
Visual changes	3	14.29	18	85.71
Fever	5	23.8	16	76.2
Nausea and vomiting	13	61.9	8	38.1
Cerebral Pulsy	1	4.8	20	95.2
Behavioral disorders	1	4.8	20	95.2
Infections	4	19.05	17	80.95



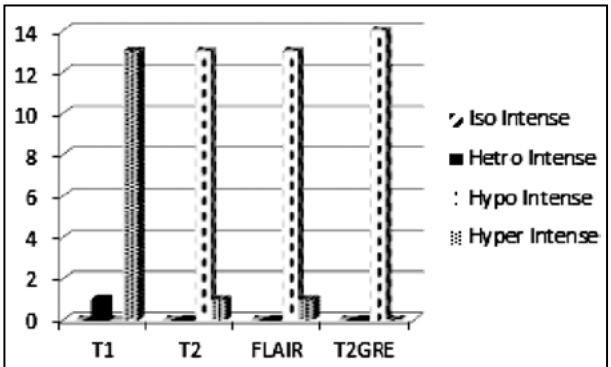
In acute thrombosis case 3 patients had ISO intensity in T1, no one had hyper intensity in T2 and 9 patients had hypo intensity in T2GRE.

Graph-1: Frequency of different MRI sequence indexes in acute thrombosis case in participant patients.

found in a patient with eight coexisting thrombosis. The most observed clinical symptom was headache (98.2%). Clinical symptom frequency in patients is being presented in Table-I. Taking OCP was the most common thrombosis predisposing factor (52.4%) in patients; if we ignore men from population size, the prevalence of taking OCP in females was 61.1 percent.

The most common coexisting disorders in patients with thrombosis are infraction (47.6%) and cortical and sub cortical edema (42.85%). The most common places of thrombosis in sample patients were superior sagittal sinus (71.4%) and right lateral sinus (57.1%) Table-II.

Different categories established for these 55 cases of thrombosis in patients included 10 acute cases, 14 early sub-acute cases, 28 late sub acute cases, and 3 chronic cases. The sensitivities of T1, T2, T2 GRE sequences in diagnosing acute thrombosis were 30%, 0, and 90% respectively [Graph 1]. The sensitivities of T1, T2, T2 GRE sequences in diagnosing



In early sub-acute thrombosis case 13 patients had hyper intensity in T1, 13 patients had hypo intensity in T2 and 14 patients had hypo intensity in T2GER.

Graph-2: Frequency of different MRI sequence indexes in early sub-acute thrombosis case in participant patients.

Table-II: Frequency distribution of participant patients with thrombosis based thrombosis place.

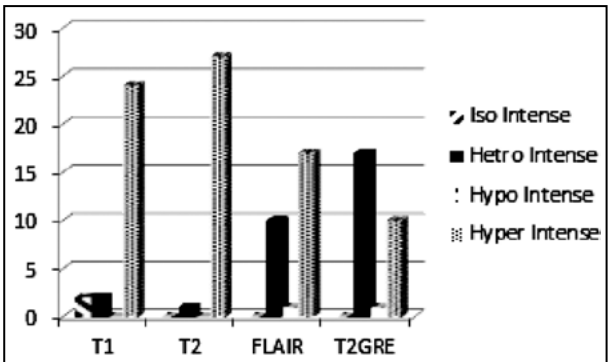
Frequency	*With*		*Without*	
Place of Thrombosis	*Frequency*	*%*	*Frequency*	*%*
Superior sagittal	15	71.4	6	28.6
Left lateral	8	38.1	13	61.9
Right lateral	12	57.1	9	42.9
Left sigmoid	3	14.3	18	85.7
Right sigmoid	8	38.1	13	61.9
Straight	2	9.5	19	90.5
Left jugular	1	4.8	20	95.2
Right jugular	2	9.5	19	90.5
Superficial veins	4	19.05	17	80.95

Early Sub-acute thrombosis were 92.9%, 92.9%, and 100% respectively [Graph 2]. The sensitivities of T1, T2, T2 GRE sequences in diagnosing Late Sub-acute thrombosis were 85.8%, 96.4%, and 3.6% respectively [Graph 3]. The sensitivities of T1, T2, T2 GRE sequences in diagnosing chronic thrombosis were 100%, 100%, and 0 respectively [Graph 4].

DISCUSSION

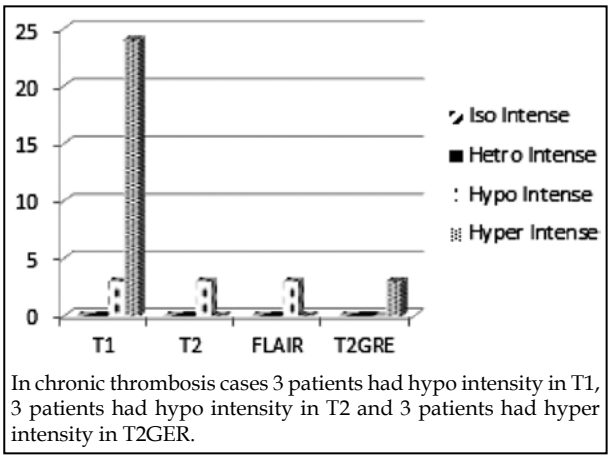
The role of T2 GRE in diagnosing cerebral venous thrombosis is being speculated in recent years and the few implemented studies assigned a sensitivity of 90-97% in diagnosing cerebral venous thrombosis to this sequence.[1,2,8] This study was conducted to compare diagnostic value of T2 Gradient echo sequences of MRI with T1, T2 and FLAIR sequences, and MRV, when they are used for diagnosing cerebral venous thrombosis.

According to the 2006 census, population of Kermanshah city was 1938060 (ninteen lac thirty eight thousand and sixty), in view of that Population prevalence of CVT in our study is 10.83 per one



In late sub-acute thrombosis case 24 patients had hyper intensity in T1, 27 patients had hyper intensity in T2 and 1 patient had hypo intensity in T2GER.

Graph-3: Frequency of different MRI sequence indexes in late sub-acute thrombosis case in participant patients.



In chronic thrombosis cases 3 patients had hypo intensity in T1, 3 patients had hypo intensity in T2 and 3 patients had hyper intensity in T2GER.

Graph-4: Frequency of different MRI sequence indexes in chronic thrombosis case in participant patients.

million; it is comparatively higher than prevalence rates mentioned in previous studies.[9,10] In a study conducted in Namazi Hospital in Shiraz, 61 cases of thrombosis were reported in a time interval of 20 months.[11] In a study conducted in France during 2002 till 2004, 39 patients with cerebral venous thrombosis were reported.[2] Compared with developing countries like Iran, lower rates of thrombosis prevalence in western countries[2,8] have been reported[12] and it was somehow confirmed in our study as well. It seems lowering infectious cases in western countries is an effective factor for this phenomenon.[12]

In reviewed studies, the most common etiologic factor in forming thrombosis in Shiraz was taking OCP with the percentage of 62.2%[10] and in Brazil it was infection with a percentage of 30%.[13] In our study, taking OCP with 52.4% was the most common thrombosis susceptibility. As average age of patients is lower and taking OCP as susceptibility factor is more common in this province, it seems it is necessary to do more comprehensive studies to evaluate the potential impacts of genetic factors and coagulopathy disorders and their relation with taking OCP. Extensive epidemiologic studies reveal that taking OCP especially third-generation drugs increases the risk of venous thrombosis in users.[14]
The most common observed symptoms in this study were headaches (95.2%) and nausea and vomiting (61.9%) which is similar to study conducted in the United States in which headache was the most prevalent symptom (77.8%), and its also like Shiraz study which reported headache with a percentage of 91.8.[8] But in Brazil study[13] the most prevalent symptom was neural focal deficit (80.95%) and headache was the second prevalent symptom (41.2%).

In this study the most common places of thrombosis were superior sagittal sinus (71.4%) and right lateral sinus (57.1%); this is totally analogous with the results of studies conducted in Namazi Hospital in shiraz and Brazil.[11,13] In performed study in the United States the most involved places were lateral and sigmoid sinuses.[2]

From 2002, using T2 GRE sequences for diagnosing cerebral venous thrombosis was proposed.[1] In our study, sensitivities of this sequences in acute, early sub-acute, late sub-acute, and chronic were 90%, 100%, 3.6% and 0% respectively; this is in complete agreement with results taken from previous limited studies, especially about acute phase.[1,2,5,8] Leys et al attributed the highest sensitivity of T2 GRE to the three beginning days of thrombosis occurrence.[3] and in our study the highest sensitivity was in the seven early days of thrombosis while in this study the sequence sensitivities of T1 in acute and early sub-acute phases were 30% and 92.9% respectively. In Leys study, T1 sequence sensitivity in three beginning days was 70%.[3] In the study executed in the United States T2 GRE sequence sensitivity for thrombosis diagnosis in the seven beginning days has been reported as 90.6% as well.[3] The study that was carried out in France says that sequence sensitivities of T1 and T2 GRE for diagnosing thrombosis in the first and third day are 90% and 71% respectively.[2]

MRI and MR venography imaging are primary techniques applicable for diagnosing CVT. The most important finding of MRI is the alteration of secondary veins signals which is the result of clot formation, whereas CVT Signal intensity and some phases of normal flow could be the same and make diagnostic faults.[15] It seems alterations in hemoglobin oxygenation and Ferro-oxidation phase within caught red globules or outside the cells inside the clot are the most important reasons for emerging venous thrombosis variable.[16,17] Signal alteration in different days following clot formation is the result of several magnetic changes. In acute phase the changes are affiliated to paramagnetic impact of hemoglobin-deoxide and in sub-acute phase it is the result of methemoglobin in thrombosis enclosed by hyaline[16] and in chronic phase it is probably the result of adherent vascular tissues of chronic clot.[15,16,18] Comparing with other sequences, T2 GRE sequence is more sensitive to paramagnetic effects and it seems it is a good choice for judging pathologic states like intravascular thrombosis. Paramagnetic elements (including hemoglobin-dioxide, intracellular met hemoglobin and hemosiderin) can cause

significant decline of secondary signal intensity in dissimilar local magnetic fields caused by rapid de-phasing of proton elements.[19] As radiological diagnosis of CVT in early days of infection onset can be mingled with diagnostic errors and sometime it may be misleading and delay in diagnosing illness and consequently delay in treatment can cause severe complications and even increase patients' mortality, therefore it is very useful to use T2 GRE sequence, especially in early stages of disease and when there is a strong clinical susceptibility and also when sequence changes of T1 and T2 is not diagnostic; regarding the high sensitivity of T2 GRE sequence asserted by this study and pervious studies[1,2,5,8] this can be used as a useful and suitable sequence for early diagnosis and treatment of the disease.

As T2 GRE sequence was used for patients after getting doubtful about T1 and T2 sequences, we lost time for diagnosing Hyper Acute cases and thus we were not able to assess this sequence effect on diagnosing Hyper Acute thrombosis.

CONCLUSION

The results of this prospective study showed that T2 GRE sequence can be used as a quick diagnostic sequence for diagnosing CVT before applying MR venography in patients. When other sequences provide uncertain diagnosis, it is greatly useful to use this sequence because it is very sensitive in primary stages of disease (7 beginning days), and it is a good choice since MR venogarphy is rarely executed for these patients. In addition, by using this sequence and on time diagnosis of disease we can prevent further complications.

REFERENCES

1. Selim M, Fink J, Linfante I, Kumar S, Schlaug G, Caplan LR. Diagnosis of cerebral venous thrombosis with echo-planar T2*-weighted magnetic resonance imaging. Arch Neurol 2002;59:1021-6.
2. Idbaih A, Boukobza M, Crassard I, Porcher R, Bousser MG, Chabriat H. MRI of clot in cerebral venous thrombosis: high diagnostic value of susceptibility-weighted images. Stroke 2006;37:991-5.
3. Leys D, Cordonnier C. Cerebral venous thrombosis: Update on clinical manifestations, diagnosis and management. Ann Indian Acad Neurol 2008;11:79-87.
4. Bousser MG, Ferro JM. Cerebral venous thrombosis: an update. Lancet Neurol 2007;6:162-70.
5. Fellner FA, Fellner C, Aichner FT, Mölzer G. Importance of T2*-weighted gradient-echo MRI for diagnosis of cortical vein thrombosis. Eur J Radiol 2005;56:235-9.
6. Linfante I, Llinas RH, Caplan LR, Warach S. MRI features of intracerebral hemorrhage within 2 hours from symptom onset. Stroke 1999; 30:2263-7.
7. Vymazal J, Brooks RA, Baumgarner C, Tran V, Katz D, Bulte JW, et al. The relation between brain iron and NMR relaxation times: an in vitro study. Magn Reson Med 1996;35:56-61.
8. Leach JL, Strub WM, Gaskill-Shipley MF. Cerebral venous thrombus signal intensity and susceptibility effects on gradient recalled-echo MR imaging. AJNR Am J Neuroradiol 2007;28:940-5.
9. Bousser MG, Ferro JM. Cerebral venous thrombosis: an update. Lancet Neurol 2007;6:162-70.
10. Stam J, Cerebral venous and sinus thrombosis: incidence and causes in ischemic stroke. Adv Neurol 2003;92:225-32.
11. Azin H, Ashjazadeh N. Cerebral venous sinus thrombosis-clinical features predisposing and prognostic factors. Acta Neurologica Taiwanica 2008;17:82-87.
12. Ferro JM, Canhao P, Stam J, Bousser MG, Barinagarrementeria F, et al. Prognosis of cerebral vein and dural sinus thrombosis: Results of the international study on cerebral vein and dural sinus thrombosis (ISCVT). Stroke 2004;35:664-70.
13. Ferreira CS, Pellini M, Boasquevisque E, de Souza LAM. Parenchymal abnormalities in cerebral venous thrombosis: Finding of magnetic resonance imaging and magnetic resonance angiography. Radiol Bras 2006;39:315-321.
14. World Health Organization Collaborative Study of Cardiovascular Disease and Steroid Hormone Contraception. Venous thromboembolic disease and combined oral contraceptives: Results of international multicentre case-control study. World Health Organization Collaborative Study of Cardiovascular Disease and Steroid Hormone Contraception. Lancet 1995;346:1575-1582.
15. Leach JL, Fortuna RB, Jones BV. Imaging of cerebral venous thrombosis: Current techniques, spectrum of findings, and diagnostic pitfalls. Radiographics 2006;26(Suppl 1):S19-41.
16. Dormont D, Anxionnat R, Evrard S, Louaille C, Chiras J, Marsault C. MRI in cerebral venous thrombosis. J Neuroradiol 1994;21:81–99.
17. Hinman JM, Provenzale JM. Hypo intense thrombus on T2-weighted MR imaging: A potential pitfall in the diagnosis of dural sinus thrombosis. Eur J Radiol 2002;41:147–152.
18. Cervos-Navarro J, Kannuki S. Neuropathological findings in the thrombosis of cerebral veins and sinuses: Vascular aspect. In: Einhaupal K, Kempski O, Baethmann A, eds. Cerebral Venous Thrombosis. New York: Plenum Press; 1990: 15-25.
19. Atlas SW, Mark AS, Grossman RI. International hemorrhage: gradient-echo MR imaging at 1.5 T, comparison with spin-echo imaging and clinical applications. Radiology 1998;168:803-807.

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Dr. Yousefinejad; Interpretation of data.
Dr. Rezaie: Designing the study, , Interpretation of data.
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