Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Evaluation of Value of Computed Tomography Attenuation (Hounsfield Unit Value) Measured along the Dural Venous Sinuses on Non-contrast Computed Tomography Scan in Diagnosing Cerebral Venous Thrombosis

Rajesh Kumar Singh[1], Vishal Kumar Jain[2], Sanjay Agrawal[3], Satya Bhuwan Singh Netam[4], Sanjay Kumar[1]

[1]Associate Professor, Department of Radiodiagnosis, Pt. J.N.M Medical College, Raipur, Chhattisgarh, India, [2]Assistant Professor, Department of Radiodiagnosis, Pt. J.N.M Medical College, Raipur, Chhattisgarh, India, [3]Junior Resident, Department of Radiodiagnosis, Pt. J.N.M Medical College, Raipur, Chhattisgarh, India, [4]Professor and Head, Department of Radiodiagnosis, Pt. J.N.M Medical College, Raipur, Chhattisgarh, India

Abstract

context: Cerebral venous sinus thrombosis (CVST) previously believed to be an uncommon cerebrovascular event, accounting for 0.5–1% of cases of stroke, affecting 1.32/100,000 person/year. CVST is a disease of young adults (<50 years old) predominantly and is diagnosed based on clinical suspicion with confirmatory neuroimaging.

Aims: This study aims to prospectively evaluate the Hounsfield unit (H.U) value of cerebral venous sinus on non-contrast computerized tomography (NCCT) scan and to assess its predictive value in diagnosing cerebral venous thrombosis and to evaluate whether standardizing venous sinus H.U value measurements to those of the corresponding internal cerebral artery would improve diagnostic accuracy.

Materials and Methods: In our study, a total of 80 clinically suspected case of CVST were included and NCCT head scan was done then confirmed by M.R. venography (gold standard). Of 80 cases, a total of 38 cases were diagnosed as CVST on M.R. venography which was considered as Group B and rest 42 cases were normal on M.R. venography which was considered as Group A.

Statistical Analysis: Average HU and H:H ratio were compared using two-tailed *t*-test, and linear regression analysis was used to assess correlation between hematocrit (HCT) and HU.

Results: Linear regression analysis showed positive correlation between HCT with computed tomography attenuation (HU) among both the groups ($P < 0.005$). H:H ratio (HU/HCT) for cutoff point of 1.645 had sensitivity of 71.1%, 97.6% specificity, and 96.4% PPV. A cutoff value of 1.335 for standardized measurement with internal carotid arteries (ICA) had 71.1% sensitivity, 81% specificity, and 77.1% PPV.

Conclusion: We conclude that average HU, H:H ratio, and standardized with ICA were the best predictor for sinus thrombosis.

Key words: Computed tomography, Hounsfield unit, Intracranial venous sinus thrombosis, Magnetic resonance imaging

INTRODUCTION

Cerebral venous sinus thrombosis (CVST) previously believed to be an uncommon cerebrovascular event, accounting for 0.5–1% of cases of stroke, affecting 1.32/100,000 person/year[1] CVST is a disease of young adults (<50 years old) predominantly[2] and is diagnosed based on clinical suspicion with confirmatory neuroimaging.[3] Patients with CVST exhibit a wide range of non-specific signs and symptoms creating a diagnostic challenge for the clinician and radiologist alike.[3] Headache is the most common reported symptom in patients with CVST. It is present in 90% of cases and reflects raised intracranial pressure.[2]

Magnetic resonance imaging (MRI) is the non-invasive imaging technique of choice for diagnosing CVST,

Access this article online

www.ijss-sn.com

Month of Submission : 02-2019
Month of Peer Review : 03-2019
Month of Acceptance : 03-2019
Month of Publishing : 04-2019

Corresponding Author: Dr. Vishal Kumar Jain, Assisitant Professor, Department of Radiodiagnosis,Pt. J.N.M Medical College, Raipur - 492001, Chhattisgarh, India

it is, however, not universally available in the acute setting.[3-5] Computed tomography venography (CTV) has now emerged as an alternative diagnostic test, which is at least as good as MRI and in some cases better, with the added advantage of being more readily available.[6] Previously, the gold standard for imaging and diagnosing CVST was digital subtraction cerebral angiography. This is not routinely used and has been superseded by CTV and magnetic resonance venography.[3,7-9]

As most patients with CVST present with non-specific symptoms and often CVST is not immediately suspected, patients are likely to have non-contrast head CT non-contrast computerized tomography (NCCT) at presentation. NCCT is the examination of choice for screening patients with non-specific neurological presentations in the context of low suspicion of CVST.[4] NCCT may be reported as normal in up to two-thirds of patients with venous sinus thrombosis, especially in the absence of brain parenchymal changes/venous infarct. When abnormal, the findings on NCCT are often subtle and non-specific in the early stages and include "hyperdense" venous sinuses and cerebral swelling. Small/recent studies have shown that venous sinus hyperdensity is a sensitive sign for CVST.[10,11] Venous infarcts and fragmented hemorrhage are late signs.[4]

Making a timely diagnosis of CVST is of utmost importance as prompt anticoagulation is thought to prevent thrombus propagation. This, in turn, prevents ensuing venous infarcts and hemorrhage, thereby reducing mortality and long-term neurological sequelae.[12] There remains, however, much debate surrounding optimal management of patients with CVST. To the best of our knowledge, there is scarcity of data on clinical features, treatment modalities, and outcome in subjects with cerebral venous thrombosis (CVT) in Indian context, in general, and in Chhattisgarh population, in particular. Hyperdense sign of venous sinuses on NCCT scan has a sensitivity of 84% and 95% and specificity of 96% and 95% with a Hounsfield unit (HU) cutoff value of 65 and 62, respectively, as shown by some recent studies [13,12] Measurement of H:H ratio (average HU vs. hematocrit) in addition to venous sinus attenuation is likely to increase sensitivity.[12]

The primary aim of the present study was to evaluate whether increased attenuation in cerebral venous sinuses in acute condition can be used to diagnose acute CVST and to determine its diagnostic value. The secondary aim was to determine whether there is possible correlation between hematocrit (HCT) and HU.

Our study will help to diagnose and treat the CVT as early as possible in emergency setting. Furthermore, with exploration of clinical features associated with CVT, we will help clinicians to establish diagnostic criteria for CVT. The outcome study with current treatment modality will further be assistive in modifying the treatment and serious neurologic consequences which are potentially reversible with prompt diagnosis and appropriate medical management.

MATERIALS AND METHODS

The study was conducted in the Radiodiagnosis Department, Pt. Jawaharlal Nehru Memorial Medical College and Dr. Bhim Rao Ambedkar Memorial Hospital, Raipur, Chhattisgarh. In this study, a total of 80 clinically suspected case of CVST were included and NCCT head scan was done then confirmed by M.R. venography (gold standard). Of 80 cases, a total of 38 cases were diagnosed as CVST on M.R. venography which was considered as Group B and rest 42 cases were normal on M.R. venography which was considered as Group A.

H.U. value of all clinically suspected case of C.V.T. was calculated on all dural sinuses and intracranial portions of the internal carotid arteries (ICAs) as they exit the carotid canal was measured. A total of 80 cases of clinically suspected case of CVT were included in the study, of which 17 were female and 63 were male.

Statistical Analysis

Baseline parameters such as age, sex ratio, hemoglobin (HB), HCT, and average HU, between patients with and without thrombosis, were compared using two-tailed unpaired *t*-test. To assess the correlation between HGB and HCT with measured CT attenuation, linear regression analysis was used. Two-tailed unpaired *t*-test was used to compare H:H ratio between patients with and without sinus thrombosis.

RESULTS

In patients without sinus thrombosis (Group A), the age group ranged from 18 to 65 years (mean and SD was 34.9 ± 11.07). Average age of males was 34.03 years and that of females was 37.08 years. In patients with sinus thrombosis (Group B), age group ranged from 19 to 66 years (mean and SD was 87 ± 11.6). Average age of male patients was 35.12 years, whereas in female patients, it was 25.6 years.

The majority of patients were between 30 and 39 years (37.5%). 30% of patients were between 20 and 29 years and 16.2% of patients were between 40 and 49 years old. Similarly, 7.5% of patients were between 50 and 59 years and 5% of patients were <20 years. Furthermore, 3.8% of patients were between 60 and 69 years old. The "*t*" test indicates that there is no significant difference between the groups with respect to the age ($P = 0.684$).

Pearson Chi-square test indicates that hyperdensity in dural sinus is highly significant in our study ($P < 0.001$). There was statistically significant difference between both the groups in terms of HCT, average HU, and H:H ratio ($P < 0.005$). Linear regression analysis showed positive correlation between HCT with CT attenuation (HU) among both the groups ($P < 0.005$).

M R venography results showed that 16 (20%) patients had SSS.

The receiver operating characteristic curves showed that the best cutoff point for the prediction of sinus thrombosis for HCT was 41.4, for Hb was 13.75, for average H.U value was 61.25, for H:H ratio (HU/HCT) was 1.645, and for standardized measurement with ICA was 1.335.

The sensitivity analysis results showed that average H.U value had sensitivity of 97.4% and H:H ratio (HU/HCT) had sensitivity of 71.1%. Furthermore, the sensitivity of standardized measurement with ICA was 71.1%, Hb was 57.9%, and HCT was 57.9%.

Analysis was carried out as shown in Table 1.

DISCUSSION

Thrombosis of the dural sinus and/or cerebral veins (CVT) is an uncommon form of stroke, usually affects young individuals.[1] Thrombosis of the cerebral veins and sinuses is a distinct cerebrovascular disorder that, unlike arterial stroke, most often affects young adults and children. The symptoms and clinical course are highly variable. During the past decade, increased awareness of the diagnosis, improved neuroimaging techniques, and more effective treatment have improved the prognosis. More than 8.0% of all patients now have a good neurologic outcome[14] in literature.

The majority of patients in our study group were male 63 (78.8%) and only 17 (21.2%) patients were female. In patients without sinus thrombosis (Group A), 30 (71.4%) patients were male and 12 (28.6%) were female. The male-to-female ratio was 30:12. In patients with sinus thrombosis (Group B), 33 (86.8%) patients were male and 5 (13.2%) were female. The male-to-female ratio was 33:5. The Chi-square test results showed that there is no significant difference between the groups with respect to the sex ($P = 0.092$). Overall, 77 (96.2%) patients had headache. 40 (95.2%) patients had headache in patients without sinus thrombosis and 37 (97.4%) patients had headache in patients with sinus thrombosis. The Chi-square results show that there is no significant difference between the groups with respect to the presence of headache ($P = 0.616$). Headache is common symptom in both Group A and Group B.

Overall, only 14 (17.5%) patients had vomiting. 8 (19%) patients without sinus thrombosis and 6 (15.8%) patients with sinus thrombosis. The Chi-square results show that there is no significant difference between the groups with respect to the presence of vomiting ($P = 0.702$). Of 80 patients, only 7 (8.8%) had fever. In patients without sinus thrombosis (Group A), 3 (7.1%) had fever and in patients with sinus thrombosis (Group B), 4 (10.5%) had fever. The Chi-square results show that there is no significant difference between the groups with respect to the presence of fever ($P = 0.593$).

Table 1: Comparison of baseline parameters, HU, and H:H ratio values between both the groups

Parameters	Group A (42)	Group B (38)	*P* value
Average age (range±SD)	34.9 (18−65±11.07)	33.87 (19−66±11.6)	0.68
Male	34.03 (19−56±9.86)	35.12 (19-66±11.79)	
Female	37.08 (18−65±13.9)	25.6 (19−35±5.89)	
Sex (M:F)	30:12	33:5	
HGB (range±SD)	13.61 (12−15.2±0.9)	13.55 (12−15.6±0.92)	0.75
Male	13.84 (12.3-15.2±0.82)	13.57 (12−15.6±0.86)	
Female	13.05 (12−14.8±0.9)	13.36 (12−15.3±1.37)	
HCT (range±SD)	40.64 (32.5−48.9±4.77)	41.43 (33.7−49.2±4.51)	0.45
Male	41.02 (34.4−48.9±4.07)	41.55 (33.7−49.2±4.52)	
Female	39.71 (32.5−48±6.3)	40.66 (33.8−47.4±4.88)	
HU (range±SD)	53.3 (46.5−60.5±3.09)	72.05 (58.5−77.5±4.18)	0.00
Male	53.02 (46.5−60.5±3.24)	72.35 (58.5−77.5±4.1)	
Female	54 (48.7-57±2.67)	70.06 (62−73.5±4.66)	
H:H ratio (range±SD)	1.31 (1.07−1.68±0.15)	1.75 (1.26−2.22±0.2)	0.00
Male	1.28 (1.07−1.49±0.11)	1.75 (1.26−2.22±0.19)	
Female	1.38 (1.12−1.68±0.21)	1.74 (1.3−2.1±0.28)	
Standardized with internal carotid artery (range±SD)	1.24 (1.02−1.5±0.13)	1.52 (1.16−1.9±0.21)	0.00
Male	1.22 (1.02−1.44±0.12)	1.52 (1.16−1.9±0.21)	
Female	1.28 (1.10−1.5±0.13)	1.52 (1.31−1.82±0.21)	

SD: Standard deviation

Overall, 20 (25%) patients had generalized tonic-clonic seizures (GTCS) and 18 (22.5%) patients had partial seizure. In patients without sinus thrombosis (Group A), only 1 (2.4%) had GTCS and 3 (7.1%) patients had partial seizure. Similarly, in patients with sinus thrombosis (Group B), 19 (50%) had GTCS and 15 (39.5%) had partial seizure. The Chi-square results show that there is a significant difference between the groups with respect to the presence of seizure ($P < 0.001$). That is majority of patients had seizure in Group B (89.5%) which is significantly higher than Group A.

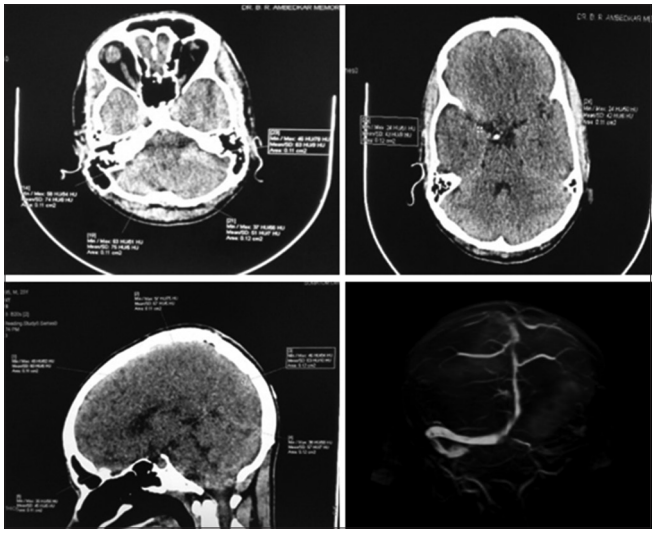

Figure 1: A 23-year-old male came in emergency department with a history of headache and seizure. On non-contrast computerized tomography head, Hounsfield unit value of the right transverse and sigmoid sinus is 74 and75, respectively, while rest sinus show <68

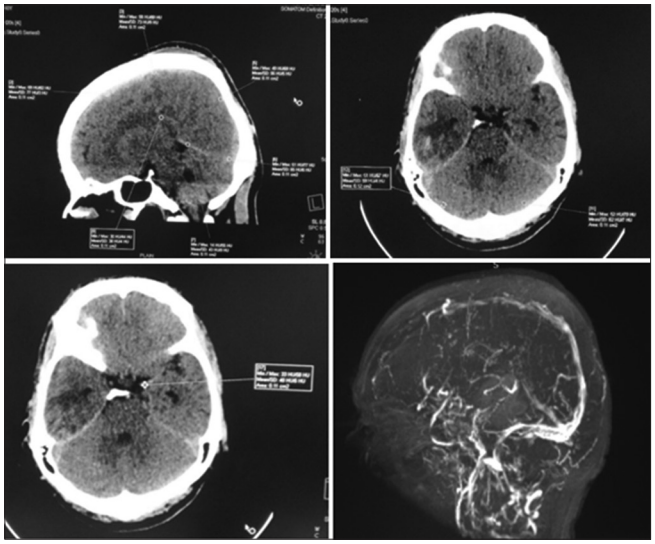

Figure 2: A 40-year-old male came in emergency department with a history of headache and seizure. On non-contrast computerized tomography head, Hounsfield unit value of anterior 1/3rd and middle 1/3rd of superior sagittal sinus is 77 and 73, respectively, while rest sinus show <64

Of 80 patients, 10 (12.5%) of them had altered sensorium. In patients without sinus thrombosis (Group A), only 1 (2.4%) had altered sensorium and in patients with sinus thrombosis (Group B), 9 (23.7%) had altered sensorium. The Chi-square results show that there is a significant difference between the groups with respect to the presence of altered sensorium ($P = 0.004$). That is 23.7% of patients had altered sensorium in Group B which is significantly higher than Group A. As overall 19 (23.8%) patients were alcohol addict in our study group. In Group A, 7 (16.7%) patients were alcohol addicts, and in Group B, 12 (31.6%) patients were alcohol addicts. The Chi-square results show that there is no significant difference between the groups with respect to the presence of alcohol addiction ($P = 0.118$). There are 13 (16.2%) smokers in our study group. 4 (9.5%) smokers without sinus thrombosis (Group A) and 9 (23.7%) smokers with sinus thrombosis (Group B). The Chi-square results show that there is no significant difference between the groups with respect to the presence of smoking addiction ($P = 0.086$).

HU values were higher in Group B patients (72.05 vs. 53.3) ranging from 58.5 to 77.5 [Figures 1 and 2]. Except for three patients in Group B, all patients had HU values >68. HU values in Group A ranged from 46.5 to 60.5. Average hematocrit value was higher in Group B patients, 41.43 (standard deviation [SD] 4.51), whereas it was 40.64 (SD 4.77) in Group A patients. H:H ratio in patients without thrombosis ranged from 1.07 to 1.68 (mean 0.15), and in patients with thrombosis, it ranged from 1.26 to 2.22 (mean 0.2).

Figure 4 shows the comparison of HU values. HU values were higher in Group B patients (72.05 vs. 53.3) ranging from 58.5 to 77.5. Except for four patients in Group B, all

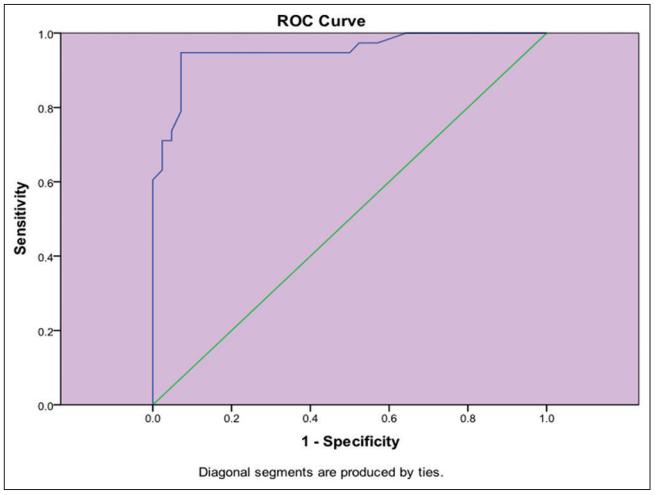

Figure 3: Receiver operating characteristic curves shows the best cutoff point for the prediction of sinus thrombosis which is equal to 1.645

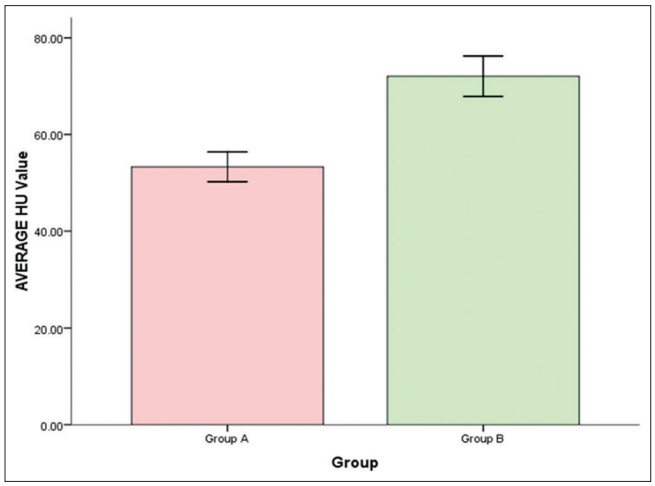

Figure 4: The average HU values compared between the groups

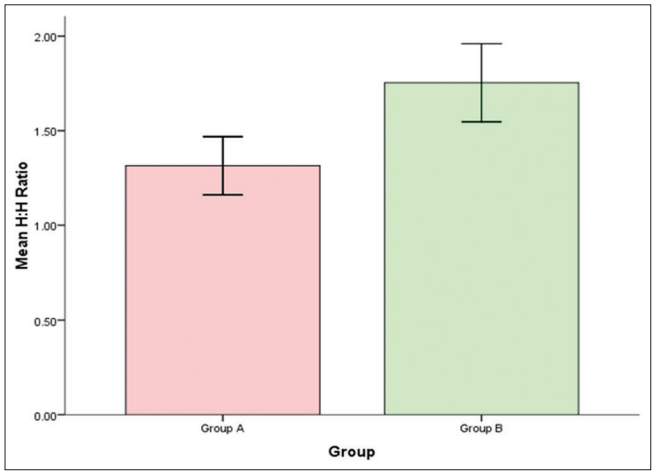

Figure 5: The H:H ratio compared between the groups

patients had HU values >68. HU values in Group A ranged from 46.5 to 60.5. ROC curve analysis of HU shows an area under the curve of 1.0 with cutoff of 68 as well as sensitivity of 97.4% and specificity of 100%.

Figure 5 shows the comparison of H:H ratios. H:H ratio in patients without thrombosis (Group A) ranged from 1.07 to 1.68 (mean 0.15) and in patients with thrombosis (Group B), it ranged from 1.26 to 2.22 (mean 0.2).

CONCLUSION

The total numbers of 42 patients were selected in Group A (without sinus thrombosis) and 38 patients were selected in Group B (with sinus thrombosis). In patients without sinus thrombosis (Group A), the age group ranged from 18 to 65 years (mean and SD was 34.9±11.07). Moreover, in patients with sinus thrombosis (Group B), age group ranged from 19 to 66 years (mean and SD was 87 ± 11.6). The results showed that there is a significant difference between the groups with respect to the presence of seizure ($P < 0.001$) and altered sensorium ($P = 0.004$). There was statistically significant difference between both the groups in terms of HCT, average HU, and H:H ratio ($P < 0.005$). Linear regression analysis showed positive correlation between HCT with CT attenuation (HU) among both the groups ($P < 0.005$). The receiver operating characteristic curves showed that the best cutoff point for the prediction of sinus thrombosis for HCT was 41.4, for Hb was 13.75, for average H.U value was 61.25, for H:H ratio (HU/HCT) was 1.645 [Figure 3], and for standardized measurement with ICA was 1.335. The sensitivity analysis results showed that average H.U value had sensitivity of 97.4% and H:H ratio (HU/HCT) had sensitivity of 71.1%. Furthermore, the sensitivity of standardized measurement with ICA was 71.1%, hemoglobin (Hb) was 57.9%, and HCT was 57.9%. We conclude that average HU, H:H ratio, and standardized with ICA were the best predictor for sinus thrombosis.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Bousser MG, Ferro JM. Cerebral venous thrombosis: An update. Lancet Neurol 2007;6:162-70.
2. Canhao P, Ferro JM, Lindgren AG, Bousser MG, Stam J, Barinagarrementeria F. Causes and predictors of death incerebral venous thrombosis. Stroke 2005;36:1720-5.
3. Saposnik G, Barinagarrementeria F, Brown RD, Bushnell CD, Cucchiara B, Cushman M, *et al*. Diagnosis and management of cerebral venous thrombosis: astatement for healthcare professionals from the American heart association/ American stroke association. Stroke 2011;42:1158-92.
4. Poon CS, Chang JK, Swarnkar A, Johnson MH, Wasenko J. Radiologic diagnosis of cerebral venous thrombosis: Pictorial review. Am J Roentgenol 2007;189: Suppl 6:S64-75.
5. Qu H, Yang M. Early imaging characteristics of 62 cases of cerebral venous sinus thrombosis. Exp Ther Med 2013;5:233-6.
6. Ozsvath RR, Casey SO, Lustrin ES, Alberico RA, Hassankhani A, Patel M. Cerebral venography: Comparison of CT and MR projection venography. Am J Roentgenol 1997;169:1699-707.
7. Janjua N. Cerebral angiography and venography for evaluation of cerebral venous thrombosis. J Pak Med Assoc 2006;56:527-30.
8. Rizzo L, Crasto SG, Ruda R, Gallo G, Tola E, Garabello D, *et al*. Cerebral venous thrombosis: Role of CT, MRI and MRA in the emergency setting. Radiol Med 2010;115:313-25.
9. Wasay M, Azeemuddin M. Neuroimaging of cerebral venous thrombosis. J Neuroimaging 2005;15:118-28.
10. Black DF, Rad AE, Gray LA, Campeau NG, Kallmes DF. Cerebral venous sinus density on noncontrast CT correlates with hematocrit. Am J Neuroradiol 2011;32:1354-7.
11. Buyck PJ, De Keyzer F, Vanneste D, Wilms G, Thijs V, Demaerel P. CT density measurement and H:H ratio are useful in diagnosing acute cerebral

venous sinus thrombosis. AJNR Am J Neuroradiol 2013;34:1568-72.
12. Coutinho J, de Bruijn SF, Deveber G, Stam J. Anticoagulation for cerebral venous sinus thrombosis. Cochrane Database Syst Rev 2011;10:CD002005.
13. Besachio DA, Quigley EP 3rd., Shah LM, Salzman KL. Noncontrast computed tomographic Hounsfield unit evaluation of cerebral venous thrombosis: A quantitative evaluation. Neuroradiology 2013;55:941-5.
14. Stam J. Current concepts-thrombosis of cerebral veins and sinuses. N Engl J Med 2005;352:1791-8.

How to cite this article: Singh RK, Jain VK, Agrawal S, Netam SBS, Kumar S. Evaluation of Value of Computed Tomography Attenuation (Hounsfield Unit Value) Measured along the Dural Venous Sinuses on Non-contrast Computed Tomography Scan in Diagnosing Cerebral Venous Thrombosis. Int J Sci Stud 2019;7(1):80-85.

Source of Support: Nil, **Conflict of Interest:** None declared.