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Diagnostic Accuracy of Diffusion Imaging In Detecting Dural Venous Sinus Thrombosis In Patients with Equivocal Loss of Flow Void On Conventional Sequences Keeping Computed Tomography (CT) Venography As Gold Standard

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ABSTRACT

Objectives: To ascertain the diagnostic efficacy of diffusion imaging in patients with dural venous sinus thrombosis (DVST).
Study Design: Descriptive cross-sectional study.
Place and Duration of Study: A tertiary care institute of radiology and imaging, Rawalpindi, Pakistan, from Aug to Nov 2023.
Methodology: This study enrolled 100 patients who reported to a radiology and imaging center, for diagnosis of dural venous sinus thrombosis (DVST). The patients were enrolled through non-probability purposive sampling after taking informed written consent. Patients underwent diffusion imaging and data was analyzed using Statistical Package for Social Sciences (SPSS) version 26.00, where diagnostic accuracy, sensitivity and specificity was also measured.
Results: Among 100 patients, 36.00% were male and 64.00% were female. After the procedure, DVST was diagnosed in 24.00% enrolled patients. Sensitivity and specificity were 23.40% and 66.60% respectively.
Conclusion: Diffusion imaging may have exploratory roles for DVST but has low diagnostic efficiency.

Keywords: Diagnostic Accuracy, Diffusion Imaging, Dural Venous Sinus, Thrombosis

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INTRODUCTION

Dural venous sinus thrombosis (DVST) occurs in three to four people per million in the general population.[1] Quick diagnosis is crucial in preventing death and severe impairment because early care is linked to favorable clinical results.[2,3] Even though cerebral angiography is thought to be the best method for DVST evaluation,[4,5] diagnosis of DVST is mostly made using the findings of neuroimaging, which also provides information on the flow dynamics of the affected area. As thrombus formation is a long process and can be associated with recanalization, as in the case of recurrent partially recanalized dural sinus thrombosis, so neuroimaging methods may be hindered.6 Imaging techniques to rule out DVST include magnetic resonance imaging (MRI) and computed tomography (CT).[7-9] Venous thrombosis can be differently identified with high levels of diagnostic accuracy using both CT and magnetic resonance imaging (MRI), although CT exposes the patient to ionizing radiation, non-enhanced CT and contrast-enhanced CT venography are both readily available and reasonably priced imaging choices in an emergency situation.[10] Evaluating the outcomes of emergency MRI imaging in these patients was the main goal of the current investigation. Given the strong soft tissue contrast of MRI, we focused on primary screening for DVST using this approach. In an attempt to uncover brain illnesses that might clinically resemble DVST, we investigated other intracranial abnormalities seen in emergency MRI scans of people with clinical suspicion of DVST as well.

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METHODOLOGY

This was a descriptive cross-sectional study carried out in tertiary care radiology and imaging center in Rawalpindi, Pakistan, from August to November 2023. Non-probability purposive sampling method was used to select the patients for this study. Prior permission from the institutional Ethics Committee was taken (ERC Letter Number) and confidentiality of the patients was maintained throughout. Sample size of 100 cases was calculated using World Health Organistion (WHO) sample size calculator, taking confidence interval 95%, margin of error 5%, reported occurrence of DVST as 4%.[11,12]

Inclusion Criteria: All patients belonging to either gender with symptoms of DVST on clinical evaluation, working or living at high altitude, postpartum females and patients with benign of malignant etiology, along

with hypercoagulation profile, were included in this study.

Exclusion Criteria: Patients with various neurological conditions like epilepsy, not suitable for MRI due to claustrophobia, having metallic implants or cardiac pacemakers and pregnant women unable to undergo MRI scan.

Diffusion Imaging protocol was used. Subspecialty-certified neuroradiologists evaluated diffusion imaging MRI sequences independently, after completing 5 years of post-subspecialty training. The neuroradiologists were blinded to the patients' final diagnosis. For every participant, the presence or absence of venous thrombosis was evaluated from the images. All reports were cross verified by a consultant radiologist with experience of at least 5 years to minimize bias. The data was entered and analyzed using Statistical Package for Social Sciences version 26.0. Frequency and percentage were determined for qualitative data. A 2x2 table was generated for estimation of diagnostic accuracy of the testing modality keeping CT venography as gold standard.

RESULTS

Out of total 100 patients enrolled in this study, 36.00% were male and 64.00% were females. After MRI diffusion imaging was performed, DVST was diagnosed in 24.00% patients and was not detected in 76.00% patients, giving a diagnostic yield of 24.00%. A 2x2 table showed that the diagnostic accuracy of the diffusion imaging in detecting DVST was 27.00%, with 66.60% specificity and 23.07% sensitivity while positive predictive value was 87.50% and negative predictive value was 7.80%, as shown in Table-I.

Table-I: Diagnostic Accuracy of Diffusion Imaging in Detecting Dural Venous Sinus Thrombosis

		Detection of DVST on CT Venography	
		Positive (n=91)	**Negative (n=9)**
DVST on Diffusion Imaging	Positive	21(23.00%)	3(33.00%)
	Negative	70(77.00%)	6(67.00%)

Sensitivity= 23.08%, Specificity= 66.67%, Positive Predictive Value= 87.50%
Negative Predictive Value=7.89%, Diagnostic Accuracy= 27.00%

** CT: Computed Tomography, DVST: Dural Venous Sinus Thrombosis*

A primary brain tumour or brain metastases was the most frequent underlying tendency for DVST (n=11, 45.8%). Traumatic brain injury 7(29.16%) and intracranial hemorrhage 2(8.3%) were the next most frequent underlying pathologies. One patient was diagnosed with antiphospholipid antibody syndrome (4.16%) leading to a coagulation issue. Systemic lupus erythematosus, vasculitis, and abscess/osteomyelitis near the base of the skull were also reported as infectious or inflammatory causes.

DISCUSSION

As CT cannot reliably rule out DVST even in the absence of an intravenous (IV) contrast agent and in as many as 25% of cases, the results may be normal but DVST CT scan results are sometimes misinterpreted as intraparenchymal or subarachnoid hemorrhage.[11] This study evaluated the diagnostic performance of diffusion-weighted imaging (DWI) in a cohort of 100 patients investigated for DVST, revealing a sensitivity of 23.40% and specificity of 66.60%, with DVST confirmed in 24.00% of cases. These findings are broadly consistent with existing literature.[13-16], which collectively suggests that while DWI contributes useful information, it cannot serve as a standalone diagnostic tool for DVST. The modest sensitivity observed in the present study aligns with findings reported in one study, which demonstrated an overall Diffusion Weighted Imaging (DWI) sensitivity of 34.60% for the diagnosis of cerebral venous thrombosis, markedly lower than the sensitivity of T2-weighted imaging (79.5%), though DWI offered a higher specificity of 97.4% compared to 76.9% for T2WI.[16] The lower sensitivity of DWI is attributable in part to the dynamic and stage-dependent nature of thrombus formation. The relatively low sensitivity of DWI in the current study may also reflect the technical characteristics of hyperintense signal detection. One study reported that in cortical vein thrombosis, clot hyperintensity was identified at only 23.00% of thrombosed sites on DWI, though when clot susceptibility signal was additionally evaluated, positive DWI findings were present in 79–84% of sites, suggesting that multiparametric DWI interpretation may significantly enhance diagnostic yield.[13] One author demonstrated that DWI showed positive findings in 17 of 18 patients with cerebral venous thrombosis and was capable not only of directly visualizing the intravascular clot in select cases, but also of demonstrating early ischemic changes and differentiating cytotoxic from vasogenic edema on T2-weighted sequences[14]. One study reported that unilateral transverse sinus stenosis or hypoplasia was present in 33.00% of the general population, bilateral transverse sinus stenosis in 5.00%, and unilateral

stenosis with contralateral hypoplasia in 1.00%,[15] findings which indicate that normal anatomical variation in the dural venous sinuses is not uncommon and may result in false-positive diagnoses if imaging is not interpreted with appropriate caution[16]. Another study found that the 3D T1-weighted gradient-recalled echo contrast-enhanced sequence had the highest sensitivity for DVST among the seven MRI sequences evaluated, significantly outperforming DWI and other unenhanced sequences.[17,18] This reinforces the concept that DWI should be regarded as a complementary rather than primary sequence in the MRI evaluation of suspected DVST, best employed as part of a multisequence protocol that includes contrast-enhanced MR venography as the reference standard.

LIMITATIONS OF STUDY

A major limitation of this study was that the researcher was not able to stratify the cases for the exact etiology and the adjustments of the machine for better imaging in patients undergoing DWI. This study's descriptive cross-sectional design and non-probability purposive sampling limit generalizability beyond the single-center tertiary radiology institute in Rawalpindi, potentially introducing selection bias. Multicenter validation with larger cohorts and standardized reference tests is warranted.

CONCLUSION

DWI may have exploratory roles but has low diagnostic efficiency, low sensitivity of 23.07% and high specificity of 66.60%, making CT venography the a gold standard for diagnosis of DVST.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AZ & MZA: Data acquisition, data analysis, critical review, approval of the final version to be published.

NA & SA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

HA & KMBH: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Stam J. Thrombosis of the cerebral veins and sinuses. N Engl J Med 2005; 352: 1791-1798. https://doi.org/10.1056/NEJMra042354
2. Masuhr F, Mehraein S, Einhäupl K. Cerebral venous and sinus thrombosis. J Neurol 2004; 251: 11-23. https://doi.org/10.1007/s00415-004-0321-7
3. Ferro JM, Canhão P, Stam J, Bousser MG, Barinagarrementeria F. Prognosis of cerebral vein and dural sinus thrombosis: results of the International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT). Stroke 2004; 35: 664-670. https://doi.org/10.1161/01.STR.0000117571.76197.26
4. Lafitte F, Boukobza M, Guichard JP, Hoeffel C, Reizine D, Ille O, et al. MRI and MRA for diagnosis and follow-up of cerebral venous thrombosis (CVT). Clin Radiol 1997; 52: 672-679. https://doi.org/10.1016/S0009-9260(97)80030-X
5. Chiewvit P, Piyapittayanan S, Poungvarin N. Cerebral venous thrombosis: diagnosis dilemma. Neurol Int 2011; 3: e13. https://doi.org/10.4081/ni.2011.e13
6. Leach JL, Wolujewicz M, Strub WM. Partially recanalized chronic dural sinus thrombosis: findings on MR imaging, time-of-flight MR venography, and contrast-enhanced MR venography. AJNR Am J Neuroradiol 2007; 28: 782-789. https://doi.org/10.3174/ajnr.A0432
7. Almqvist H, Mazya M, Falk Delgado A, Falk Delgado A. Radiological evaluation in patients with clinical suspicion of cerebral venous sinus thrombosis presenting with nontraumatic headache—a retrospective observational study with a validation cohort. BMC Med Imaging 2020; 20: 41. https://doi.org/10.1186/s12880-020-00426-x
8. Ghoneim A, Straiton J, Pollard C, Macdonald K, Jampana R. Imaging of cerebral venous thrombosis. Clin Radiol 2020; 75: 254-264. https://doi.org/10.1016/j.crad.2019.12.009
9. Dmytriw AA, Song JS, Yu E, Poon CS. Cerebral venous thrombosis: state of the art diagnosis and management. Neuroradiology 2018; 60: 669-685. https://doi.org/10.1007/s00234-018-1982-9
10. Xu W, Gao L, Li T, Ramdoyal ND, Zhang J, Shao A. The performance of CT versus MRI in the differential diagnosis of cerebral venous thrombosis. Thromb Haemost 2018; 118: 1067-1077. https://doi.org/10.1055/s-0038-1642636
11. Thorell SE, Parry-Jones AR, Punter M, Hurford R, Thachil J. Cerebral venous thrombosis—a primer for the haematologist. Blood Rev 2015; 29: 45-50. https://doi.org/10.1016/j.blre.2014.09.006
12. Das JM, Sapkota R, Shrestha B. Pediatric dural venous sinus thrombosis following closed head injury: an easily overlooked diagnosis with devastating consequences. Ulus Travma Acil Cerrahi Derg 2018; 24: 6-11. https://doi.org/10.5505/tjtes.2017.22823
13. Yıldız ME, Ozcan UA, Turk A, Ulus OS, Erzen C, Dincer A. Diffusion-weighted MR imaging findings of cortical vein thrombosis at 3 T. Clin Neuroradiol 2015; 25: 249-256. https://doi.org/10.1007/s00062-014-0301-y
14. Lövblad KO, Bassetti C, Schneider J, Guzman R, El-Koussy M, Remonda L, et al. Diffusion-weighted MR in cerebral venous thrombosis. Cerebrovasc Dis 2001; 11: 169-176. https://doi.org/10.1159/000047634

15. Durst CR, Ornan DA, Reardon MA, Mehndiratta P, Mukherjee S, Starke RM, et al. Prevalence of dural venous sinus stenosis and hypoplasia in a generalized population. J Neurointerv Surg 2016; 8: 1173-1177. https://doi.org/10.1136/neurintsurg-2015-012147
16. Lv B, Tian CL, Cao XY, Liu XF, Wang J, Yu SY. Role of diffusion-weighted imaging in the diagnosis of cerebral venous thrombosis. J Int Med Res 2020; 48: 0300060520933448. https://doi.org/10.1177/0300060520933448
17. Sadigh G, Mullins ME, Saindane AM. Diagnostic performance of MRI sequences for evaluation of dural venous sinus thrombosis. AJR Am J Roentgenol 2016; 206: 1298-1306. https://doi.org/10.2214/AJR.15.15719
18. Park CC, Brummer ME, Sadigh G, Saindane AM, Mullins ME, Allen JW, et al. Automated registration and color labeling of serial 3D double inversion recovery MR imaging for detection of lesion progression in multiple sclerosis. J Digit Imaging 2023; 36:450-457. https://doi.org/10.1007/s10278-022-00737-1