Non-contrast Computed Tomography Imaging Findings and Diagnosis Of Cerebral Venous Sinus Thrombosis

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Abstract

Objective: To ascertain the frequency of abnormal imaging in patients with symptomatic cerebral venous sinus thrombosis.

Method: This was a prospective, Cross-Sectional study done in the Department of Neurology, Mayo hospital, Lahore. The study was conducted after approval from the ethical review board. The study duration was 5 years. Patients with clinically suspected CVST from june 2016 to June 2021 were enrolled. A total of 177 patients with symptoms and signs suggestive of CVST on the initial evaluation, irrespective of age and gender, were involved in the study. Diagnosis of CVST was made clinically and on CT brain plain and was later confirmed with MRI Brain plain & contrast and MRV.

Results: Of the study sample of 177 patients, 36 (20.34%) patients were male and 141 (79.66%) were females. The mean duration of symptoms was 2.53±1.27 weeks. Cord sign was observed in 14(7.9%) patients, hemorrhagic infarct in 35(19.8%), and infarct with edema reported in 37(20.90%) patients.

Conclusion: CT brain plain is non-invasive and is the most sensitive and best modality in detecting cerebral venous sinus thrombosis. In our study infarct with edema (20.90%) was the most observed abnormality followed by hemorrhagic infarct (19.8%). We delineate in this study that non-enhanced CT brain (NECT) can be used as a first-line investigation in suspected cases of CVST.

Keywords: Cerebral venous sinus thrombosis (CVST), Non-contrast computed tomography (NCCT)

How to cite: *Bano S, Farooq MU, Javed MA, Numan A. Non-contrast Computed Tomography Imaging Findings and Diagnosis Of Cerebral Venous Sinus Thrombosis. Esculapio - JSIMS 2022;18(02):158-162*

DOI: ***https://doi.org/10.51273/esc22.2518211***

Introduction

Cerebral venous sinus thrombosis (CVST) accounts for 0.5% to 1% of all stroke patients[1] and has a unpredictable presentation and clinical course. This is most common in the third decade of life with predominance in females and in younger age group.[2] Non-contrast enhanced CT (NCCT) brain is a commonly performed imaging method for the evaluation of patients with CVST.[1,2] Now, MRI combined with MRV is being considered the most sensitive imaging technique and has replaced invasive digital cerebral angiography as a gold standard imaging technique in CVST.[3,5] The imaging finding for the diagnosis of the CVST is divided into direct and indirect findings.[6] Direct findings that are observed on non-contrast CT are dense cord sign, dense dural sinuses, dense jugular vein and dense triangle and empty delta sign on post-contrast. Indirect findings of cerebral venous sinus thrombosis includes hemorrhagic infarcts, non-hemorrhagic infarcts, multifocal hemprhhages and diffuse cerebral edema.[2,3]

Non–contrast CT brain has shown high sensitivity and specificity in detection of intra-cerebral edema (93.7% and 98%) and hemorrhage (94.8% and 98.7% respectively) in literature. Moreover, Contrast-enhanced CT has a sensitivity of 75-100% and specificity of 81-100%.[6]

The aim of the this research was to determine the fre-

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Submission Date: 09/04/2022
1st Revision Date: 17/04/2022
Acceptance Date: 16/05/2022

quency of abnormal non- contrast CT brain in patients with cerebral venous thrombosis.

Material and Methods

This was a prospective, cross-sectional study carried out in the Neurology department of the King Edward Medical University, Mayo Hospital Lahore, from june 2016 to June 2021. The study duration was Five years. The research was approved by an institutional review board and ethical committee of the hospital. Written informed consent was taken from all patients registered in the research. Demographics and imaging findings were recorded on a pre-designed proforma. Patients presenting with symptoms & signs such as headache, seizures, limb weakness, diplopia, decreased vision, and papilledema were labeled as symptomtic cvst and were included in the study. Patients between the ages of 20-60 years were enrolled. NCCT was performed at presentation in all patients and was followed by an MRI brain and MRV for the confirmation of diagnosis. Imaging interpretation was done by experienced radiologist. Patients with abnormal cerebrospinal fluid cytology and biochemistry, history or clinical symptoms suggestive of an arterial stroke or NCCT showing arterial territory infarct or hemorrhage, hydrocephalus, infectious and imaging suggestive of tumor were excluded.

Data were entered and analyzed with SPSS version 22. Mean and the standard deviation was calculated for quantitative variables like age. Descriptive statistics like gender and abnormal findings on NCCT were calculated and presented as frequencies and percentages. The data were stratified for age, gender, duration of symptoms to control the effect modifiers. Data was also analysed for gender specific differences in imaging findings. Post-stratification chi-square test was used and a p-value less than 0.05 was taken as significant.

Results

In this study total of 177 patients were enrolled. The mean age was 28.45±4.13 years with minimum and maximum ages of 21 and 36 years respectively. 36 (20.34%) patients were male while 141(79.66%) patients were females. The male to female ratio was observed to be 0.25:1.

The study results depicted that the mean duration of symptoms was 2.53±1.27 weeks. Generally, no evidence of signs of venous thrombosis on NCCT was shown in 70(39.55%) cases and 107(60.45%) showed abnormal NCCT.(Fig-1)

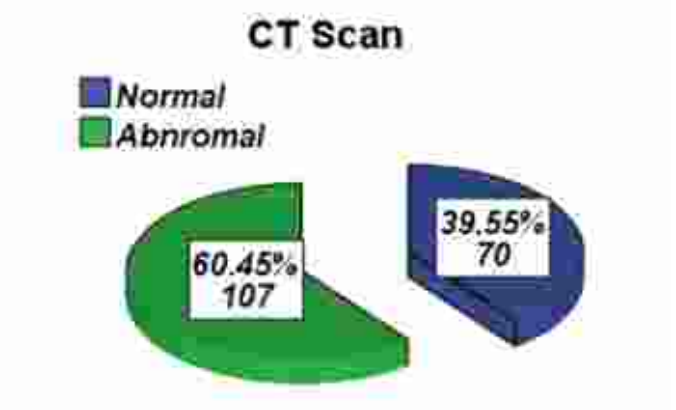

Figure:1 *Distribution of CT Scan Finding*

Among patients with age 30 years the normal NCCT was reported in 42(36.8%) patients (males 27.8% & females 42.6%). In subjects with age >30 years 28(44.4 %) had normal CT with p- value =0.322. For the duration of symptoms 3 weeks, the normal CT brain was reported in 63(47.0%) patients. However, patients who presented later than 3 weeks had abnormal findings on NCCT (16.3%, n=7). Significant relation between duration of symptoms and abnormal imaging was documented (p-value =<0.001).

Regarding abnormal NCCT, patients with age ≤30 years the abnormal NCCT was reported in 72 (63.2%) cases and with age >30 years 35(55.6%) cases had (P-value=0.322). The gender distribution of males and females is 72.2% and 57.4%, respectively.
Concerning the duration of symptoms ≤3 weeks, the 71(53.0%) had abnormal NCCT and with >3 weeks 36(83.7%) cases demonstrated abnormal NCCT imaging. (p-value= <0.001)

Table 1: *Comparison of CT scan findings with effect modifiers*

		CT Scan		Total	p-value
		Normal	Abnormal		
Age (years)	⩽30	42	72	114	0.322
		36.8%	63.2%	100.0%	
	>30	28	35	63	
		44.4%	55.6%	100.0%	
Gender	Male	10	26	36	0.106
		27.8%	72.2%	100.0%	
	Female	60	81	141	
		42.6%	57.4%	100.0%	
Duration of symptoms (weeks)	⩽3	63	71	134	<0.001
		47.0%	53.0%	100.0%	
	>3	7	36	43	
		16.3%	83.7%	100.0%	

Direct signs (cord sign) were observed in 7.9% (n=14) patients whereas indirect signs (hemorrhagic infarct

(n=35,19.85%) and infarct with edema (n=37, 20.90%). Besides cord sign in direct signs, hemorr-hage and infarct with edema in indirect signs, no other direct and indirect signs were noted in this study. Imaging findings according to age group, duration of symptoms, and gender distribution are outlined in Table 1 to Table 3.

Stratification of our data by age, gender distribution, and duration of symptoms demonstrates the following results. A relatively higher proportion of males exhibited abnormal non-contrast CT as compared with to female. Furthermore, this study showed a significantly increased prevalence of abnormal CT brain findings in patients who were less than 30 years compared to those who were more than 30 years old (p-value =0.003).

Regarding the duration of symptoms patients presented in acute phase (⩽ 3 weeks) were more likely to manifest evidence of thrombosis on imaging findings compared to cases who presented late (⩾3 weeks) (p-value= 0.001).

Table 2: *Comparison of hemorrhagic infarct with effect modifiers*

		Hemorrhagic infarct		Total	p-value
		Yes	No		
Age (years)	⩽30	28	86	114	0.031
		24.6%	75.4%	100.0%	
	>30	7	56	63	
		11.1%	88.9%	100.0%	
Gender	Male	9	27	36	0.378
		25.0%	75.0%	100.0%	
	Female	26	115	141	
		18.4%	81.6%	100.0%	
Duration of symptoms (weeks)	⩽3	21	113	134	0.016
		15.7%	84.3%	100.0%	
	>3	14	29	43	
		32.6%	67.4%	100.0%	

Table 3: *Comparison of infarct with edema with effect modifiers*

		Infarct with Edema		Total	p-value
		Yes	No		
Age (years)	⩽30	16	98	114	0.003
		14.0%	86.0%	100.0%	
	>30	21	42	63	
		33.3%	66.7%	100.0%	
Gender	Male	9	27	36	0.498
		25.0%	75.0%	100.0%	
	Female	28	113	141	
		19.9%	80.1%	100.0%	
Duration of symptoms (weeks)	⩽3	22	112	134	0.010
		16.4%	83.6%	100.0%	
	>3	15	28	43	
		34.9%	65.1%	100.0%	

Discussion

Cerebral venous sinus thrombosis has variable clinical presentation and therefore requires a high index of clinical suspicion. Clinical presentation can vary considerably based on the anatomical location and extension of thrombosis.[1] NCCT is a first-line modality to establish the proper diagnosis. Also commencement of early treatment translates to a better prognosis.

It has been seen in literature that CT scan conducted with detailed techniques that include plain and dynamic sequences and careful analysis of sources images is a simple and effective method to diagnose acute, subacute, and chronic venous thrombosis.[16] Initial NECT scan was done in all of our patients with symptomatic CVST, and diagnosis of venous thrombosis was later confirmed by MRV and MRI brain. In our study, 60.45% of patients had an abnormal finding on initial CT scan brain plain. In contrast, a study done by Jernej Avsenik et al[8] demonstrated 24.53% of the cases of CVST on initial NCCT.

Brain parenchymal abnormalities in cerebral venous thrombosis include diffuse cerebral edema, hemorrhage, and hemorrhagic infarct.[17,20,21]. A recent multicenter retrospective study demonstrated high sensitivity of 100% of hyperdensity on non-enhanced CT scans with specificity reaching 95%.[17] Another study presented that edema without hemorrhage is visualized on CT brain plain in ≈ 8% of cases and on MRI in 25% of cases.[18] And yet another study demonstrated that focal parenchymal changes with edema and hemorrhage may be identified in up to 40% of patients.[19] However, in our study hemorrhage on NCCT was demonstrated in 35.7 (19.8%) of patients, and infarct with edema was presented in 37 (20.90%).

NCCT is more likely to show evidence of thrombosis in the acute phase rather than in the chronic phase of venous thrombosis due to the signal changes of the clot with time on CT.[22] These results are in congruence with our research results which illustrates that patients who presented with symptomatic CVST early in their course in less three weeks had abnormal imaging com-

pared to who presented after the acute phase. In addition, in our study we also observed more abnormal finding in relatively younger age group of which no evidence was found in literature. Though this can be attributed to increased prevelance among younger age group.[20] Although, in our research there was notable prominence of abnormal imaging in males compared to females by 13%. Nevertheless, we did not found any evidence of this disposition in the literature. Because of diverse presentations in CVST, it must be put in the differential diagnosis in patients presenting with acute headache or other neurological complaints. Delay in recognition of CVST can lead to fatal consequences and worse outcomes and morbidity. Although, MRI with MRV is the imaging modality of choice. Despite that it is not readily available in every setup. Emergency NCCT brain should be performed to rule out the possibility of cerebral sinus thrombosis in symptomatic patients. Commencing heparin therapy on the day of presentation until a definitive diagnosis is made with MRI and MRV can potentially be lifesaving.

Conclusion

CT brain plain is a non-invasive and readily available neuro-imaging in emergency settings. It is highly sensitive in detecting the suspected cases of cerebral venous sinus thrombosis presenting in the emergency department. Moreover, our study illustrated the important differences between males and females in imaging findings.

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MUF, UF: Literature Search
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AN, SB: Writing of Manuscript