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CT Measurement of Cerebral Venous Sinus Attenuation Using Hounsfield Unit for Non-Invasive Diagnosis of Anaemia

Surendhar[1]*, Tharun Kumar[2], Jayaiswarya[3], Vayshak[4], Deepika[5], Ilankathir[6], Divya[7], Rajkumar[8]

[1,2,3,4]Assistant Professor, Faculty of Allied Health Science, Dr. MGR Educational and Research Institute, ACS Medical College, Chennai, Tamil Nadu.

[5]Tutor, Department of Radiology, Vadamalayan Institute of Medical and Allied Health Sciences Madurai, Tamil Nadu

[6]Lecturer, School of Allied and Healthcare Sciences, Malla Reddy University, Hyderabad, Telangana

[7,8]Assistant Professor, School of Allied and Healthcare Sciences, Malla Reddy University, Hyderabad, Telangana

Email ID: [1*]surendhar.rist@drmgrdu.ac.in , [2]tharunkumar0297@gmail.com , [3]jayaishwarya.rist@drmgrdu.ac.in, [4]vayshak.rist@drmgrdu.ac.in , [5]deepikanrit2020i@gmail.com , [6]karthikeyan@mallareddyuniversity.ac.in, [7]divya_gopu@mallareddyuniversity.ac.in, [8]raj_kumar@mallareddyuniversity.ac.in

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ABSTRACT

Background: Computed Tomography (CT) is a widely used imaging modality for evaluating brain structures, including cerebral venous circulation. The attenuation of cerebral veins, measured in Hounsfield Units (HU), can provide crucial insights into various neurological conditions. This non-invasive technique has gained attention as a potential diagnostic tool for assessing cerebral venous thrombosis (CVT), increased intracranial pressure, and blood-brain barrier disruptions.

Objective: To determine the correlation between computed tomography attenuation of the cerebral venous sinuses and haemoglobin level with the goal of detecting anaemia

Methods: This is the prospective study of 60 patients with traumatic elbow pain, suspected with occult fracture and fat pad sign, patient including RTA, Assault injuries, Sports injuries and other trauma occurs in elbow. All the patients in this study underwent x- ray.

Results: Among 60 patients, we measured the Hounsfield unit from the transverse sinus of each patient. Then the HU value is correlated with the haemoglobin concentration from patient’s blood report. It clearly shows 81% of patient were anaemic when their HU value of 32-35 were correlated with haemoglobin concentration.

Conclusion: The integration of CT- based hemoglobin estimation could revolutionize the approach to diagnose anemia making it quicker, less invasive and more accessible benefiting both patients and healthcare providers.

Keywords: *Computed tomography attenuation, Anaemia, Hounsfield Units, cerebral venous sinuses, haemoglobin, anaemia, cerebral venous thrombosis,..*

1. INTRODUCTION

The human brain controls nearly every aspect of the human body ranging from physiological functions to cognitive abilities[1]. The brain, along with the spinal cord constitutes the central nervous system[2,3]. Cerebral veins, are responsible for draining deoxygenated blood from the brain tissue and transporting it back to the heart[4,5]. They form an intricate network that collects blood from various regions of the brain and converge into larger veins, such as the superior sagittal sinus and transverse sinuses[6-8]. The transverse sinus is a major venous channel located within the dura mater of the human brain[9]. Red blood cells are also known as erythrocytes are responsible for transporting oxygen from lungs to the body's tissues. They grow in bone marrow and contain a protein called haemoglobin[10]

Materials and Methods

This study was conducted in department of radio diagnosis, Private medical college and hospital, period of January 2023 to July 2023 after getting clearance from institutional ethical community, informed consent was obtained from all patients prior to examinations. 60 patients were included in this study. All the patients were underwent CT scan on SIEMENS SOMATOM

SCOPE 32 SLICE with field of view from base of the skull to the vertex and centering is Glabella. Immobilization pads were provided to the patients. CT brain is acquired and the data is reconstructed using multi-planar reconstruction. The sagittal plane is used to provide a clear visualization of the transverse sinus.

Machine Specifications

Equipment	**SIEMENS SOMATOM SCOPE 32 SLICE**
Max table load	200 kg
Scan field	50cm/19.7” /27.6" with extended FOV
Tube current range	25-345mA Max tube current equivalent to 627mA utilizing IRIS
Tube voltage	80,110 and 130Kv
Max number of Slices/ rotation	32
Slice thickness	0.6-19.2mm
Number of detectors Channels/slice	736

Inclusion Criteria:

Prolonged symptoms of headache, giddiness, seizures, insomnia, fatigue

Exclusion Criteria:

Trauma patients, patient mettalic foreign bodies and pregnant women.

Procedure:

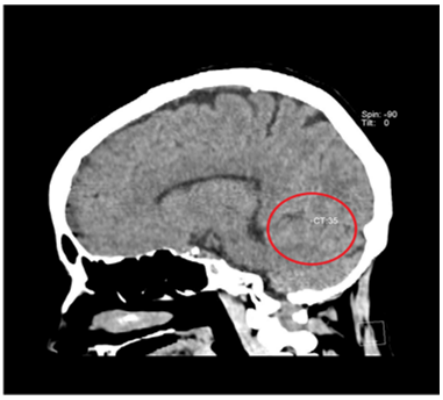
The patient is asked to remove the metal object from the region of interest and to switch on to the hospital attire.Then the image is acquired using the protocol given below.

CT Brain protocol

Scout view	**Side. Length about 250/6 mm.**
FOV	250mm
Exploration	From the base of the skull to the vertex.
Table movement	Axial
Cut thickness and Gap	The thickness and interval will be 5mm
Rotation time	0.5s
Pitch	0.55
kV	110- 130
mAs	140-345
Bone window	W 1500-2000 L 350-500
Brain parenchyma	W 80-120 L 20-50
Recon slice thickness	1.5mm
Post processing	MPR

CASE 1

	NORMAL VALUES	PATIENT VALUE
CT Number	40HU	35HU
Haemoglobin Value	12.0 – 14.5 g/dl	9.60 g/dl
RBC COUNT	4.2 to 5.4 million/mm^3	5.24 million/mm^3



CASE 2

	NORMAL VALUES	PATIENT VALUE
CT Number	40 HU	40HU
Haemoglobin Value	12.0 – 14.5 g/dl	13.5 g/dl
RBC COUNT	4.2 to 5.4 million/mm3	4.82 million/mm3

2. RESULTS

In this study we included 60 patients out of which 31 were female and 29 were male patients. Comparing gender distribution out of 60 patients'male patients with anemic is 22 and female patients with anemic is 27, So our study, shows a wide variation of anemia among female than male. It is evidently from the above data, 49 patient's results are correlated, that the statistical analysis value of p = 0.00, which less than 1, so that proves the study is positively correlated, thus by analyzing this data with blood report.

Age distribution among the study population

AGE GROUP	MALE	FEMALE
5-20	**5**	**7**
21-35	**8**	**5**
36-50	**5**	**7**
51-65	**7**	**6**
66-80	**3**	**7**

Hounsfield unit range variations among the patients

HOUNSFIELD UNIT RANGE	NO. OF PATIENTS
32-34 HU	9
35 HU	40
40 HU	11

RBC range variations among the patients

RED BLOOD CELL RANGE	NO. OF PATIENTS
<3.5 million/mm^3	24
3.5 – 4.5 million/mm^3	27
4.5 – 5.5 million/mm^3	9

Gender distribution among anemic patients

	MALE	FEMALE
TOTAL POPULATION	(29) 100%	(31) 100%
ANEMIC	(22) 75%	(27) 87%

Correlation of CVS attenuation in HU with anemia

diagnosis among the study population

STUDY TYPE	COUNT
CORRELATED	49
NON-CORRELATED	11

3. DISCUSSION

This study was conducted by us in the department of RADIOLOGY in Private medical college and hospital after obtaining the Institutional Ethics Committee's approval (. CT brain protocol offers precise, efficient, and versatile imaging capabilities that are crucial for diagnosing a wide range of neurological conditions promptly and accurately[11,12]. These protocols are continuously refined to optimize diagnostic accuracy and patient care. The early detection and treatment of anaemia is an important condition as the early diagnosis and treatment can prevent patient with complications of severe anemia, fatigue, weakness and difficulty concentration. The CT Hounsfield Unit (HU) value in the transverse sinus can be used to detect anemia[13-15]. The HU value in the transverse sinus reflects the density of the blood, which is affected by the concentration of red blood cells[11]. The normal blood HU value in the transverse sinus around 40 HU. Low HU value indicating anemia is between 32 - 35 HU. Therefore, Computed tomography provides a non- invasive tool for diagnosing anaemia.

CT numbers of the human body organs

Tissue	Ct number (HU)
Bone, Calcium, Metal	+1000
Iodinated CT contrast	100 to 600
Punctate calcifications	30 to 500
Intracranial haemorrhage	60 to 100
Grey matter	35
White matter	25
Blood	40
Muscle, Soft tissue	20 to 40

CSF	15
Water	0
Fat	-30 to -70
Air	-1000

4. CONCLUSION

The study examined the relationship between cerebral venous sinus attenuation values, measured in Hounsfield Units (HU) via CT imaging, and hemoglobin concentrations from patient blood reports. The analysis revealed a significant correlation, notably at the 35 HU threshold, indicating that these CT measurements could serve as a non-invasive surrogate marker for anemia detection. This finding holds substantial clinical promise, suggesting that clinicians might diagnose anemia through CT imaging alone, bypassing the need for invasive blood draws. Such a method would streamline the diagnostic process, reduce patient discomfort, and potentially enhance the efficiency of anemia diagnosis. By providing a non-invasive, reliable alternative for anemia detection, this approach could lead to improved patient experiences and more timely medical interventions. The integration of CT-based hemoglobin estimation into routine clinical practice could revolutionize the approach to diagnosing anemia, making it quicker, less invasive, and more accessible, ultimately benefiting both patients and healthcare providers. This study's results underscore the potential of CT imaging as a valuable tool in the diagnostic arsenal against anemia, paving the way for further research and clinical applications.

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