Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Radiology

Evaluation of Magnetic Resonance Imaging in Diagnosis of Brain Stroke in Khartoum State - Sudan

Mohammed Mahgoub[1*], Caroline Edward Ayad[2], Hussein Ahmed Hassan Ahmed[3]

[1]The Radiology Department, Military Hospital, Omdurman, Sudan
[2]Sudan University of Science and Technology, Khartoum, Sudan
[3]Karary University, College of Medical Radiology Science, Khartoum, Sudan

DOI: 10.36347/sjams.2023.v11i03.029 | **Received:** 19.02.2023 | **Accepted:** 25.03.2023 | **Published:** 28.03.2023

***Corresponding author:** Mohammed Mahgoub
The Radiology Department, Military Hospital, Omdurman, Sudan

Abstract **Original Research Article**

Stroke is one of the main causes of disability and death globally. Although Magnetic Resonance Imaging (MRI) has completely changed how stroke victims are diagnosed and treated, its application to the Sudanese population has not yet been investigated. This study aimed to assess the diagnostic accuracy of MRI in detecting brain infarctions and to evaluate the correlation between patient demographics and MRI results in Khartoum State, Sudan. A cross-sectional study was conducted at the Radiology department, Omdurman Military Hospital, Khartoum, Sudan, from April 2019 to February 2023. A total of 222 stroke patients were included in the study, with a slight male predominance (51.0%). Routine brain MRI was performed using 3 orthogonal planes and at least T1, T2, and FLAIR weighted images. The study found that all four MRI sequences (T1, T2, FLAIR, and DWI) have similar accuracy in measuring brain infarction sizes, with T2 sequence being slightly more sensitive. The most common occupation among stroke patients was soldier (19.8%) and the most affected age group was 63-77 years (34.2%). Additionally, the study revealed a higher incidence of right-sided infarctions (53.1%) compared to left-sided (47.0%). These findings provide insight into the accuracy of MRI in diagnosing brain infarction and highlight the importance of considering demographic factors in stroke evaluation.

Keywords: Brain stroke, Diagnosis, Magnetic Resonance Imaging (MRI), Sudan.

INTRODUCTION

A stroke is one of the main causes of disability and death around the globe, affecting approximately 15 million individuals each year (Feigin VL *et al.*, 2018). A stroke is a cerebrovascular accident (CVA), which is defined as the sudden development of a specific neurological impairment lasting longer than 24 hours (Powers WJ *et al.*, 2018). A transient ischemic attack (TIA) is a focused neurological dysfunction that lasts shorter than 24 hours and typically lasts between 5 and 20 minutes. The acute phase of a stroke is the first 24 hours (Amarenco P *et al.*, 2009). Based on the cause of a stroke, it may be divided into ischemic (87%) and hemorrhagic (13%) (Donnan GA *et al.*, 2008). A cortical vessel can become blocked owing to thrombosis, embolism, or micro-artery occlusion, which is also known as lacunar stroke, leading to an ischemic stroke (Adams HP *et al*, 2018). Whereas hemorrhagic stroke is more commonly brought on by trauma, aneurysms, or spontaneously blood vessel rupture (Labovitz DL *et al.*, 2018).

Stroke is one of the most common causes of mortality and disability in industrialized nations, with an approximate adult prevalence of 2.5%. This incidence is increasing with advancing age, and is projected to reach 45% for those over the age of 85 if asymptomatic infarcts also are considered (Thom T, 2006). One death from a stroke occurs for every 15–18 total fatalities, making arterial ischemic stroke (AIS) one of the three primary reasons for death in affluent nations (Thom T, 2006). Stroke causes a significant socioeconomic burden due to the disease's related morbidity as well as its associated death. Throughout the coming decades, it is anticipated that the expenditures associated with stroke would continue to climb tremendously as a result of the population's growing (Thom T, 2006).

The infarct lesion may be accurately diagnosed by magnetic resonance imaging (MRI), which can also identify cerebral artery blockage or severe stenosis and assess true collateral circulation. It may also show some reversible ischemia alterations (Vorlage G, 1992).

Nonetheless, improving non-invasive quick and precise detection of brain tissue at threat for ischemia, which may be saved by safe and successful reperfusion treatment, remains the primary goal of magnetic resonance imaging (MRI) (Vorlage G, 1992).

Through multidimensional magnetic resonance imaging (MRI), treatment plans may be decided upon for acute-phase ischemic stroke diagnosis. Early identification of ischemic stroke and its distinction from stroke imitators are crucial during the acute phases. Different imaging results from MRI sequences aid in understanding the processes of stroke, which have an impact on prognosis and are crucial in determining the best course of therapy. Lesion mismatched profiles on MRI provide knowledge on salvageable tissue or ischemic lesion age, which allows us to weigh the risks and advantages of thrombolysis (Kang AK, 2014).

Current revelations in MRI technology allow for the use of diffusion-weighted images (DWI; 88%–100% susceptibility and 95%–100% precision) to identify ischemia lesions with great precision. Even three minutes after the stroke begins, the lesions show up as hyperintense spots on DWI and correlating hypointense spots on evident diffusion coefficient (ADC) maps. Furthermore, MRI detects minor cortical or subcortical lesions more readily than computerized tomography (CT) at the acute stage, particularly in the posterior fossa or brain stem. On first DWI, however, it may not be possible to see tiny lesions at the brain stem that cause modest complaints, such as ataxic hemiparesis or intra nuclear ophthalmoplegia. Other neurological conditions like Creutzfeldt-Jakob syndrome or progressive multifocal leukodystrophy may also have elevated lesions on DWI that resemble ischemic strokes. As a result, taking into account clinical manifestations and taking additional photos may be helpful for assessment (Kang AK, 2014).

The aim of the current study was (i) To highlight the importance of early detection and diagnosis of brain infarction in reducing patient suffering and improving their health condition, especially in the absence of similar research locally in Sudan (ii) To assess the effectiveness of Magnetic Resonance Imaging (MRI) protocol Ax t1, Flair, Axt2, DW, in detecting brain stroke among Sudanese patients (iii) To identify and analyze the characteristics of brain stroke in MRI images, including the most common affected side, age, and gender of patients (iv) To establish a correlation between patient demographic data, signs and symptoms, and MRI results to improve the accuracy and efficacy of brain infarction diagnosis among Sudanese patients.

MATERIAL AND METHODS

Study Design and Data Collection

This descriptive quantitative observational cross-sectional study aimed to investigate the characteristics of 222 Sudanese patients admitted to hospitals for brain MRI scans. The sample size included both genders, with a percentage of 49% females and 51% males, and ages ranging from 18 to 92 years old. Data was collected using data collection sheet. The study design was descriptive and cross-sectional, conducted in the Magnetic Resonance Imaging (MRI) department of Omdurman military hospital located in Khartoum state. The population of the study consisted of patients with neurologic symptoms who underwent MR imaging. The study's duration was from April 2019 to February 2023.

Inclusion and Exclusion Criteria

Each patient with a brain infarction met the inclusion criteria. Patients with normal findings or other types of brain abnormalities were subject to the exclusion criteria.

Data Analysis and Presentation

The SPSS version 26.0 program was used to analyze the data. Tables, pie charts, and bar graphs were used to illustrate the data. While doing a frequency analysis, the t-test, ANOVA test, and chi-square test were used to see whether the results were statistically significant.

Equipment

Magnetic Resonance Imaging (MRI) machine 1.5 Tesla Toshiba made in Japan 2011 and Coil used: head coil Sequence: axial T2, flair T2, axial T1, Diffusion weighted image DWI.

MRI protocol:

Patient Preparation

Patient preparation started with explain procedure to the patient and removing patient cloths and wear hospital gown. All metallic objects removed to avoid harmful for patients and prevent artifact, also all patients full the consent from to do procedure. Patient instructed to best able throughout the exam to avoid motion artifact.

Patient Positioning

Patient supine on MRI table, head first and arm beside the trunk and head within the head holder without rotation. Sagittal, coronal and axial laser beams used to center the patient. Then scout view obtained to plane the ROI. The axial scan applied in helical mode, craniocaudal orientation. The scan parameter was different according to the type of examination. The images reconstruction performed to cover whole brain.

MRI Technique

Three orthogonal planes were used for routine brain MRI, and at least T1, T2, and fluid-attenuated in version restoration (FLAIR) weighted images were acquired. After intravenous delivery of gadolinium-based contrast medium, T1-weighted images were targeted in at least two planes. Hippocampal and medial temporal lobe atrophy are assessed using coronal-oblique T1-weighted imaging. They are produced in a plane that is perpendicular to the brainstem and perpendicular to the hippocampus' long axis. Ideally, a sagittal 3DT1 sequence that encompasses the brain is reformatted to provide these thin-section pictures. The evaluation of midline structures and parietal atrophy, that have been implicated in some neurodegenerative illnesses, will be made possible by further sagittal restorations. Global cortical atrophy (GCA), vascular white matter hyperintensities, and infarctions are evaluated using FLAIR imaging.

Image Interpretation

The basal ganglia, nucleus rubber, and pars reticulitis of the substantiating parenchyma all see an increase in iron deposition as the brain matures. In T2W and FLAIR images, a rim of strong signal intensity, referred to as caps and bands, may also form all around ventricular. Crucial pulmonary emboli are infarctions in parts of the brain that are important for appropriate cognitive performance.

Ethical Consideration

In this study, ethical considerations were carefully followed to ensure the safety and well-being of the participants. Approval from the ethical committee of Karary University was obtained, and written permission was obtained from responsible authorities. Verbal explanations were given to patients, medical, and radiological staff regarding the nature and aim of the study, and verbal acceptance was obtained from every individual. Participants were made aware of their freedom to decline or leave the research anywhere at time without doing so impacting the results. All participant information was coded and stored on a password-protected personal computer after being collected by the researcher through interviews.

RESULTS AND DISCUSSION

This was an observational cross-sectional study conducted at Omdurman Military Hospital Khartoum, Sudan, to assess the role of Magnetic Resonance Imaging (MRI) in the diagnosis of brain infarction among Sudanese patients admitted to hospitals after a brain MRI scan was performed using a 1.5 Tesla Toshiba whole body MRI machine. The study included 49 females and 51 males, ranging in age from 18 to 92 years old., this study found that the most common affected 76 (34.2%) age group was 63-77 years, followed by 57 (28.7%) in the age group 48-62 years, and that the majority of study samples (48-77 years) belonged to the older age group at 59.7%, with a mean age of 56.62 ± 17.1 years old, as shown in Table 1 and Figures 1 and 2. these results agreed with study done by (Abdel-Fattah AR et al, 2022) who study Forty-one studies were included (n = 8,128,700; mean-age 68.5 years; 47.1% female). 37 studies were included in meta-analysis (n = 8, 8008, 110). In support of these findings, a recent population-based cohort study conducted in the United Kingdom found that age was a significant predictor of both ischemic and hemorrhagic stroke (Wu CY et al., 2021). In a similar manner, research in China found that both men and women who were older had a greater chance of having an ischemic stroke (Sun Q et al., 2021). It is significant to highlight that the cross-sectional design and tiny proportion size of this study restrict the conclusions. To further understand the relationship between age and brain infarction, future research could utilize a longitudinal design and larger sample sizes. Furthermore, considering that brain infarction is a complicated disorder with several potential causes, it would be beneficial to look at additional risk factors such diabetes, hypertension, and smoking, which have been linked to an increased likelihood of stroke and brain ischemia (Zhang X et al, 2021; Nguyen HL et al., 2022).

The study showed that the most common occupation among stroke patients was soldier (19.8%), followed by housewife (16.2%), dealer (14.8%), medical fields (13.0%), employer (12.6%), and other (18.0%) (Table 2). According to the clinical presentation of stroke patients, the study found that more than one third of patients (34.0%) had DM and HTN together, followed by (17.0%) with CVA, (14.0%) with hypertension, and the lowest clinical presentation was (4.0%) with other presentation included (trauma, convulsion, RTA, patients and Sickler) (Table 3 and 4). As in Figure (3 and 4), Age, gender, color, ethnicity, genetics, and a number of known modifying risk factors for ischemic stroke have been identified as non-modifiable risk indicators for stroke in this study, which is similar to one by Elkind MS et al., 1998. There are several possibly curable illnesses that increase the risk of stroke, including hypertension, atrial fibrillation, other heart diseases, hyperlipidemia, diabetes, smoking, inactivity, carotid stenosis, and transient ischemic attack (TIA). This study provides valuable insights into the occupational and clinical profiles of stroke patients in Sudan. The high prevalence of stroke among soldiers underscores the need for targeted prevention strategies in high-risk occupations. Additionally, the high prevalence of coexisting diabetes and hypertension among stroke patients highlights the importance of effective management of these comorbidities. The results of the current investigation are consistent with previous research that has identified hypertension, diabetes, and other alterable health risks as major contributors to the development of stroke (Sacco RL et al., 2013; O'Donnell MJ et al., 2016). Prevention and management of stroke require a multidisciplinary approach, including lifestyle modifications, pharmacological interventions, and timely recognition and treatment of comorbidities. Hence, additional efforts are required to raise public knowledge of the stroke risk factors, as well as to encourage healthy lifestyles and routine checkups with a doctor (Katan M et al., 2018).

The study showed that the right side of the brain infarction was slightly higher (53.1%) than the left (47.0%), as shown in Figure 5.

The study found that all four MRI imaging sequences (T1, T2, FLAIR, and DWI) possess the equivalent signal strength size for brain appearance of an infarction, with the highest distribution of the brain infarction size being (2.3 x 2.3 cm) for all four imaging sequences of MRI (T1, T2, FLAIR, and DWI), which is found in 9.3% for T1 imaging sequences, 10.0% for T2 imaging sequences, 9.91% for DWI imaging sequences, and 9.17% for FLAIR imaging sequences, as shown in Figures 6 to 9., this indicated that the four-imaging sequences of MRI (T1, T2, FLAIR, and DWI) have the same accuracy in measuring brain infraction sizes, and the T2 imaging sequence is slightly more sensitive than other imaging sequences of MRI., These results are consistent with earlier research by Manolio TA et al., (2009) who discovered that MRIs were read centrally for the existence of infarcts more than or equal to 3 mm in diameter or small infarct-like lesions. MRI infarcts were found in 961 of the subgroups of 3397 people (28%) who had no known past stroke and in 1131 of the 3647 persons having recoverable infarct characteristics ("silent" MRI infarcts). Among the 2516 patients, 196 exhibited smaller infarct-like lesions and had no MRI infarcts larger than 3 mm. also concurred (Bhadelia RA et al., 2006).

This study showed that the mean of brain infraction sizes was slightly more prominent in males than females, demonstrating that measurements of brain infarction did not significantly differ between genders at a p-value of 0.58, but that males showed more extensive measurements than females in all image technique measurements (Table 5). According to brain infraction sizes and the age group of the patient, the study reported that the largest infraction sizes (40.0%), (60.0%) occur in age groups (33-47) and (48-62) years, respectively at a p-value of 0.331 (Table 6). This shows that assessments of brain infarct size do not significantly differ between age groups., Similar study was also investigated by (Roh JK et al., 2000).

The present study showed that the right-side brain infraction size is larger than the left side at a p-value of 0.0445., indicating that right-lobe brain infarction is more serious and has more complications than the left lobe (Table 7). Also, the study showed that the Lt side brain infraction had a higher incidence in elderly patients more than 63 years old, while the Rt side brain infraction had a higher incidence in younger patients less than 63 years old, with a p-value of 0.000, this discovery was extremely statistically significant. This finding is consistent with research by Avendano M et al., (2006) that found significant socioeconomic inequalities in stroke risk between the ages of 65 and 74 but a crossing of the relationship beyond age 75.

This study ascertained that the largest brain infraction sizes were documented in patients with diabetes and hypertension; the mean brain infraction size for them was (2.0-3.0) cm, and the majority of them were in the age group (48-77) years, a 0.05 p value suggesting a difference of statistical significance (Table 8). This similar to study done by (Hatazawa J et al, 2003).

Table 1: Distribution of study sample according to age groups

Age group	Frequency	Percent	Valid Percent	Cumulative Percent
18 - 32	20	9.0	9.0	9.0
33 - 47	48	21.6	21.6	30.6
48 - 62	57	25.7	25.7	56.3
63 - 77	76	34.2	34.2	90.5
78 - 92	21	9.5	9.5	100.0
Total	222	100.0	100.0	

Table 2: Occupational distribution of the studied patients

Occupation	Frequency	%
Dealer	32	14.86%
Employer	28	12.61%
Farmer	19	8.56%
Freelance worker	22	9.46%
House wife	36	16.22%
Medical	28	13.06%
Soldier	44	19.82%
Teacher	13	5.41%
Total	222	100%

Table 3: Cross tabulation between brain infarction size and clinical presentation of stroke patients

Clinical History		Brain infarction size						Total
		1.0- 1.5	2.0 - 1.9	3.0- 2.0	4.0 - 2.5	5.0 - 2.9	> 3.0 - 6.0	
Convulsion	Count	0	0	1	2	0	0	3
	%	0.0%	0.0%	1.6%	5.1%	0.0%	0.0%	1.4%
CVA	Count	3	11	7	14	2	1	38
	%	9.7%	13.8%	11.3%	35.9%	40.0%	20.0%	17.1%
D.M & HTN	Count	11	34	15	11	2	2	75
	%	35.5%	42.5%	24.2%	28.2%	40.0%	40.0%	33.8%
HTN	Count	4	4	21	2	0	1	32
	%	12.9%	5.0%	33.9%	5.1%	0.0%	20.0%	14.4%
Ischemic stroke	Count	3	5	9	2	0	0	19
	%	9.7%	6.3%	14.5%	5.1%	0.0%	0.0%	8.6%
Lt Weakness	Count	1	5	3	0	1	1	11
	%	3.2%	6.3%	4.8%	0.0%	20.0%	20.0%	5.0%
Rt Weakness	Count	8	12	1	3	0	0	24
	%	25.8%	15.0%	1.6%	7.7%	0.0%	0.0%	10.8%
RTA	Count	0	3	0	0	0	0	3
	%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	1.4%
SCA	Count	0	0	0	1	0	0	1
	%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	0.5%
Stroke	Count	1	6	2	4	0	0	13
	%	3.2%	7.5%	3.2%	10.3%	0.0%	0.0%	5.9%
Trauma	Count	0	0	3	0	0	0	3
	%	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	1.4%
Total	Count	31	80	62	39	5	5	222
	%	100 %	100 %	100 %	100 %	100 %	100 %	100 %
P value = 0.000 **								

Table 4: Cross tabulation between age group and clinical presentation of stroke patients

Clinical History		Age group					Total
		18 - 32	33 - 47	48 - 62	63 - 77	78 - 92	
Convulsion	Count	0	2	0	0	1	3
	%	0.0%	4.2%	0.0%	0.0%	4.8%	1.4%
CVA	Count	3	7	7	14	7	38
	%	15.0%	14.6%	12.3%	18.4%	33.3%	17.1%
D.M & HTN	Count	1	10	29	29	6	75
	%	5.0%	20.8%	50.9%	38.2%	28.6%	33.8%
HTN	Count	2	12	5	11	2	32
	%	10.0%	25.0%	8.8%	14.5%	9.5%	14.4%
Ischemic stroke	Count	0	3	6	7	3	19
	%	0.0%	6.3%	10.5%	9.2%	14.3%	8.6%
Lt Weakness	Count	2	4	4	1	0	11
	%	10.0%	8.3%	7.0%	1.3%	0.0%	5.0%
Rt Weakness	Count	5	4	5	8	2	24
	%	25.0%	8.3%	8.8%	10.5%	9.5%	10.8%
RTA	Count	2	1	0	0	0	3
	%	10.0%	2.1%	0.0%	0.0%	0.0%	1.4%
SCA	Count	0	1	0	0	0	1
	%	0.0%	2.1%	0.0%	0.0%	0.0%	0.5%
Stroke	Count	2	4	1	6	0	13
	%	10.0%	8.3%	1.8%	7.9%	0.0%	5.9%
Trauma	Count	3	0	0	0	0	3
	%	15.0%	0.0%	0.0%	0.0%	0.0%	1.4%
Total	Count	20	48	57	76	21	222
	%	100%	100%	100%	100%	100%	100%
P value = 0.067							

Table 5: Shows cross tabulation of brain infarction measurements classified according to gender

Brain infarction size		Gender		Total
		Male	**Female**	
1.0- 1.5	Count	14	17	31
	%	12.4%	15.6%	14.0%
2.0 - 1.9	Count	41	39	80
	%	36.3%	35.8%	36.0%
3.0- 2.0	Count	29	33	62
	%	25.7%	30.3%	27.9%
4.0 - 2.5	Count	23	16	39
	%	20.4%	14.7%	17.6%
5.0 - 2.9	Count	4	1	5
	%	3.5%	0.9%	2.3%
> 3.0 - 6.0	Count	2	3	5
	%	1.8%	2.8%	2.3%
Total	Count	113	109	222
	%	100%	100%	100%
P value = 0.581				

Table 6: Cross tabulation of brain infarction measurements classified according to age group

Age group		Brain infarction size						Total
		1.0-1.5	**2.0-1.9**	**3.0-2.0**	**4.0-2.5**	**5.0-2.9**	**> 3.0-6.0**	
18 - 32	Count	2	10	7	1	0	0	20
	%	6.5%	12.5%	11.3%	2.6%	0.0%	0.0%	9.0%
33 - 47	Count	6	15	13	10	2	2	48
	%	19.4%	18.8%	21.0%	25.6%	40.0%	40.0%	21.6%
48 - 62	Count	10	22	14	8	0	3	57
	%	32.3%	27.5%	22.6%	20.5%	0.0%	60.0%	25.7%
63 - 77	Count	12	26	23	14	1	0	76
	%	38.7%	32.5%	37.1%	35.9%	20.0%	0.0%	34.2%
78 - 92	Count	1	7	5	6	2	0	21
	%	3.2%	8.8%	8.1%	15.4%	40.0%	0.0%	9.5%
Total	Count	31	80	62	39	5	5	222
	%	100 %	100 %	100 %	100 %	100 %	100 %	100 %
P value = 0.331								

Table 7: Cross tabulation of brain infarction measurements classified according to effect Side.

Effect Side		Brain infarction size						Total
		1.0-1.5	**2.0-1.9**	**3.0-2.0**	**4.0-2.5**	**5.0-2.9**	**> 3.0-6.0**	
Lt	Count	13	37	39	13	1	2	105
	%	41.9%	46.3%	62.9%	33.3%	20.0%	40.0%	47.3%
Rt	Count	18	43	23	26	4	3	117
	%	58.1%	53.8%	37.1%	66.7%	80.0%	60.0%	52.7%
Total	Count	31	80	62	39	5	5	222
	%	100%	100%	100%	100%	100%	100%	100%
P value = 0.045								

Table 8: Crosstabulation between age group and effected side of the brain infraction

Effect Side		Age group					Total
		18 - 32	**33 - 47**	**48 - 62**	**63 - 77**	**78 - 92**	
Lt	Count	10	16	24	45	10	105
	%	50.0%	33.3%	42.1%	59.2%	47.6%	47.3%
Rt	Count	10	32	33	31	11	117
	%	50.0%	66.7%	57.9%	40.8%	52.4%	52.7%
Total	Count	20	48	57	76	21	222
	%	100%	100%	100%	100%	100%	100%
P value = 0.000 **							

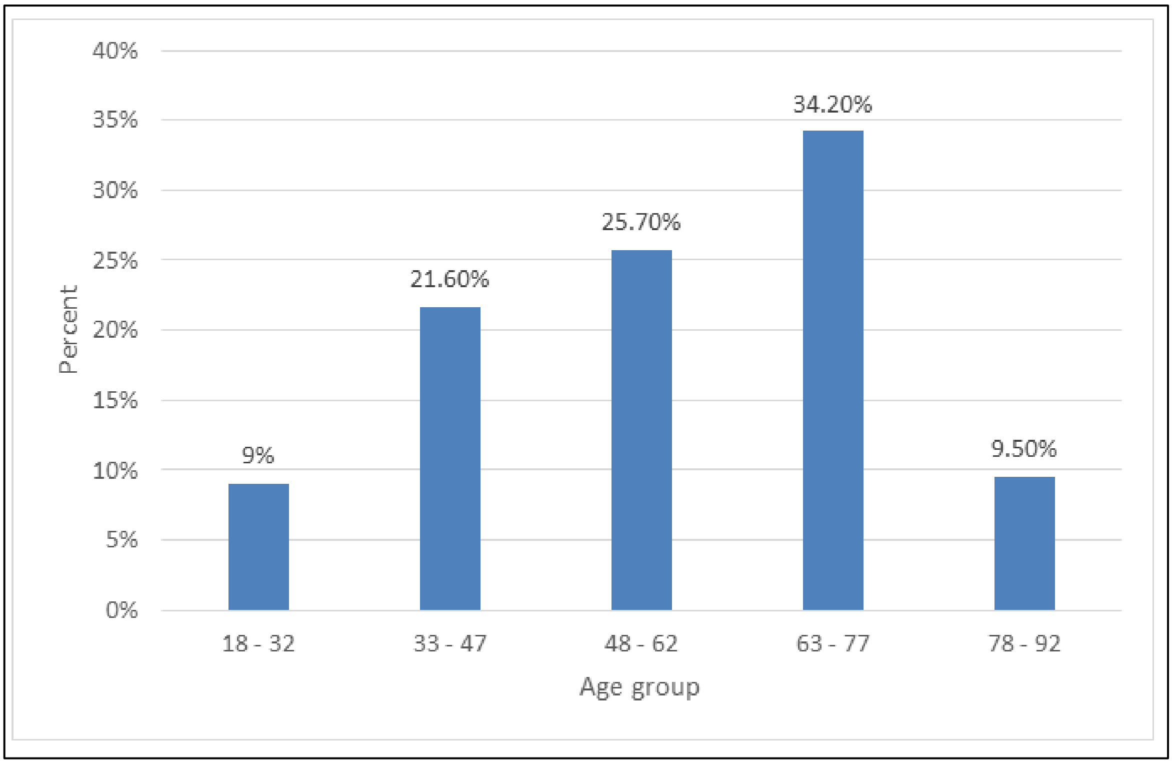

Figure 1: Bar chart shows frequency distribution of the age groups

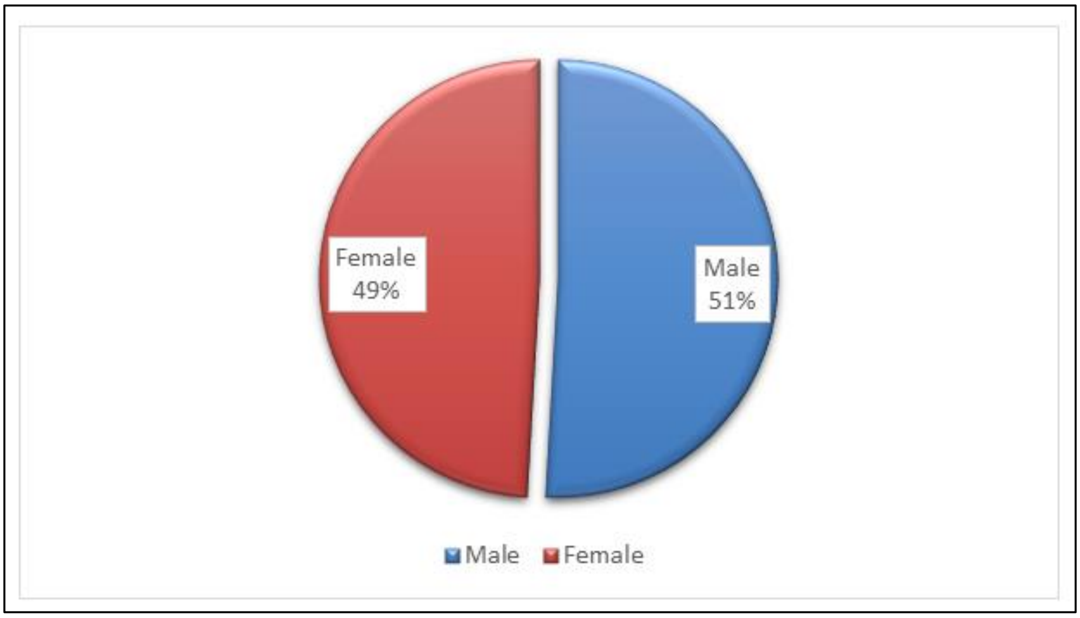

Figure 2: Pie chart shows distribution of gender

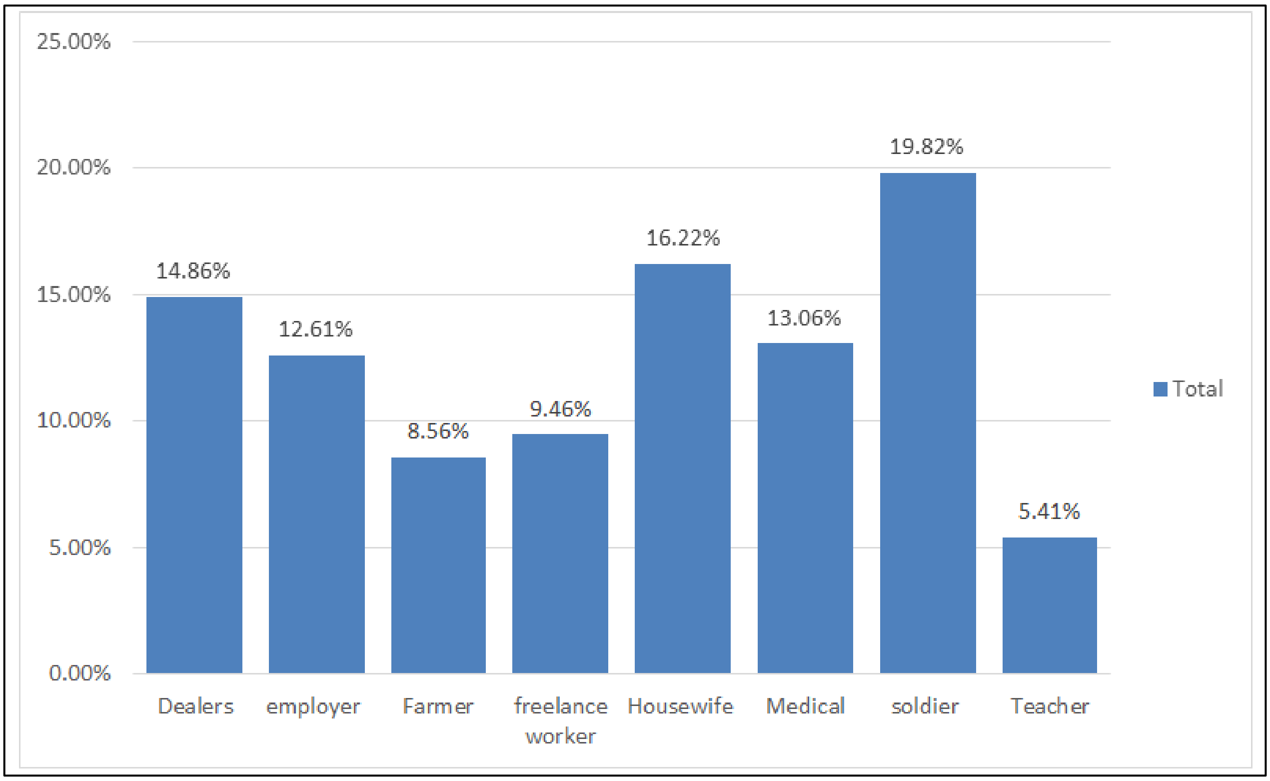

Figure 3: Bar chart showed the distribution of patients occupational

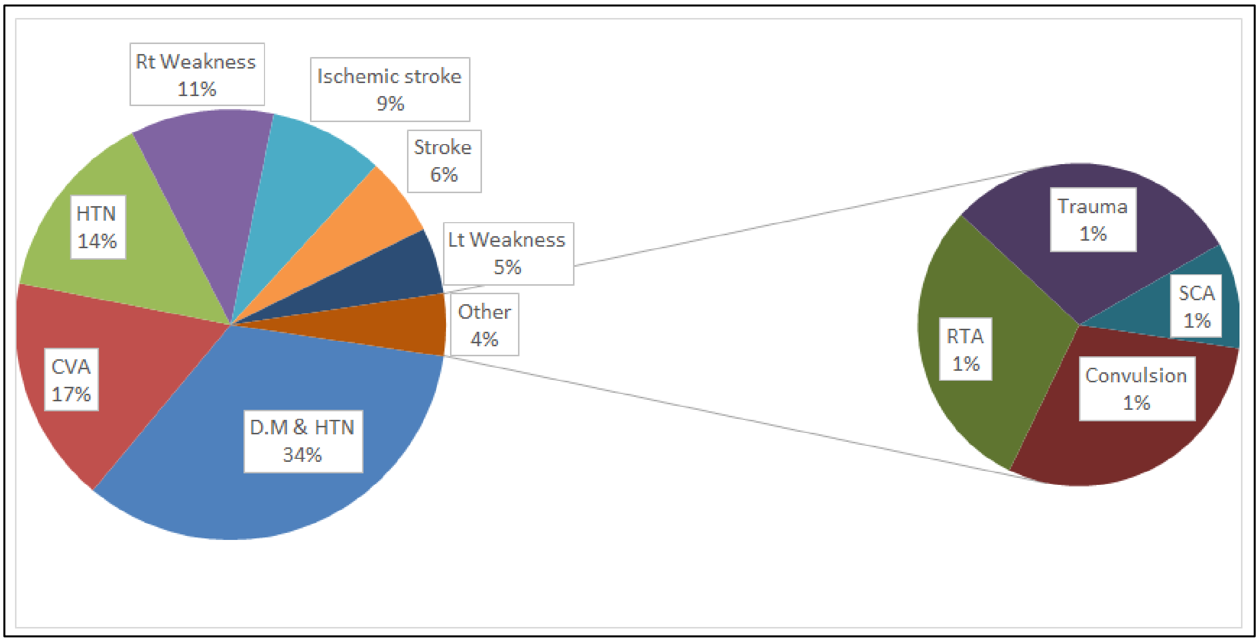

Figure 4: Bar chart shows distribution according to clinical presentation of brain infarction among Sudanese

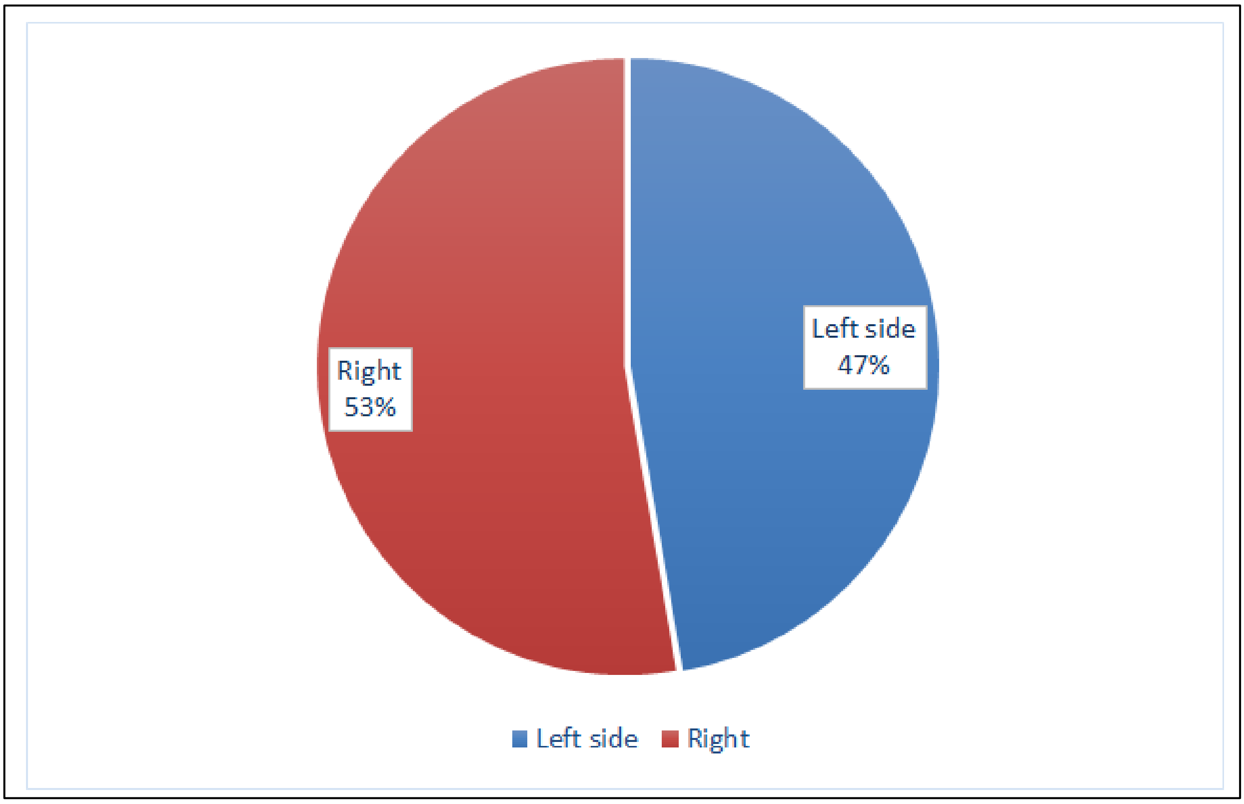

Figure 5: Pie chart shows distribution according to side of brain infarction among Sudanese

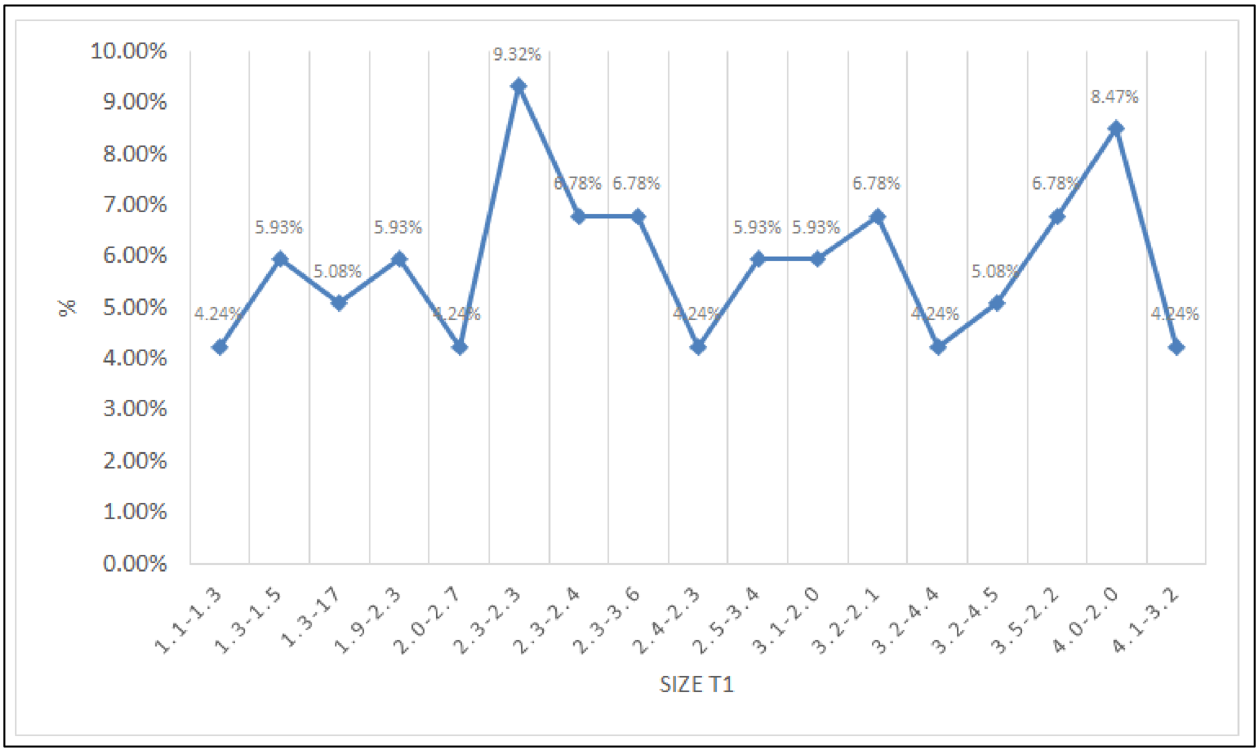

Figure 6: Show frequency distribution of Size T1 for all patients

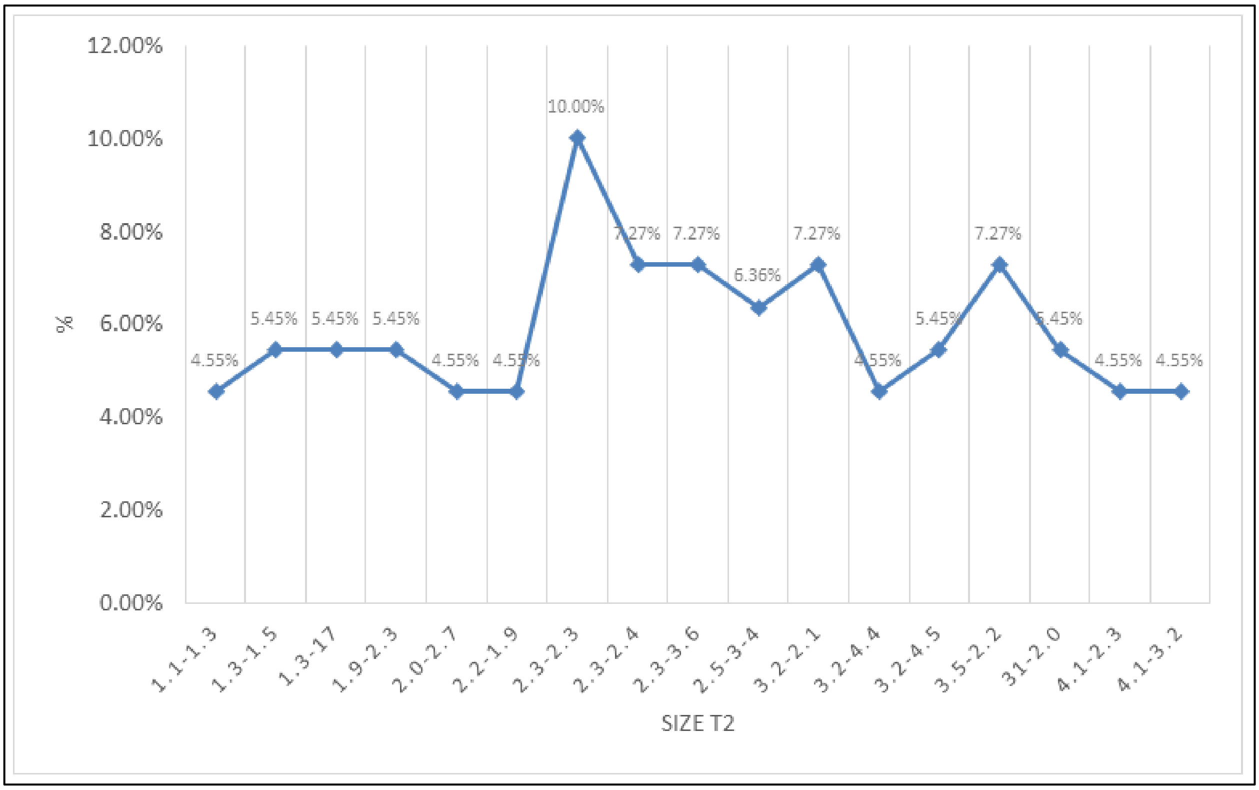

Figure 7: Show frequency distribution of Size T2 for all patients

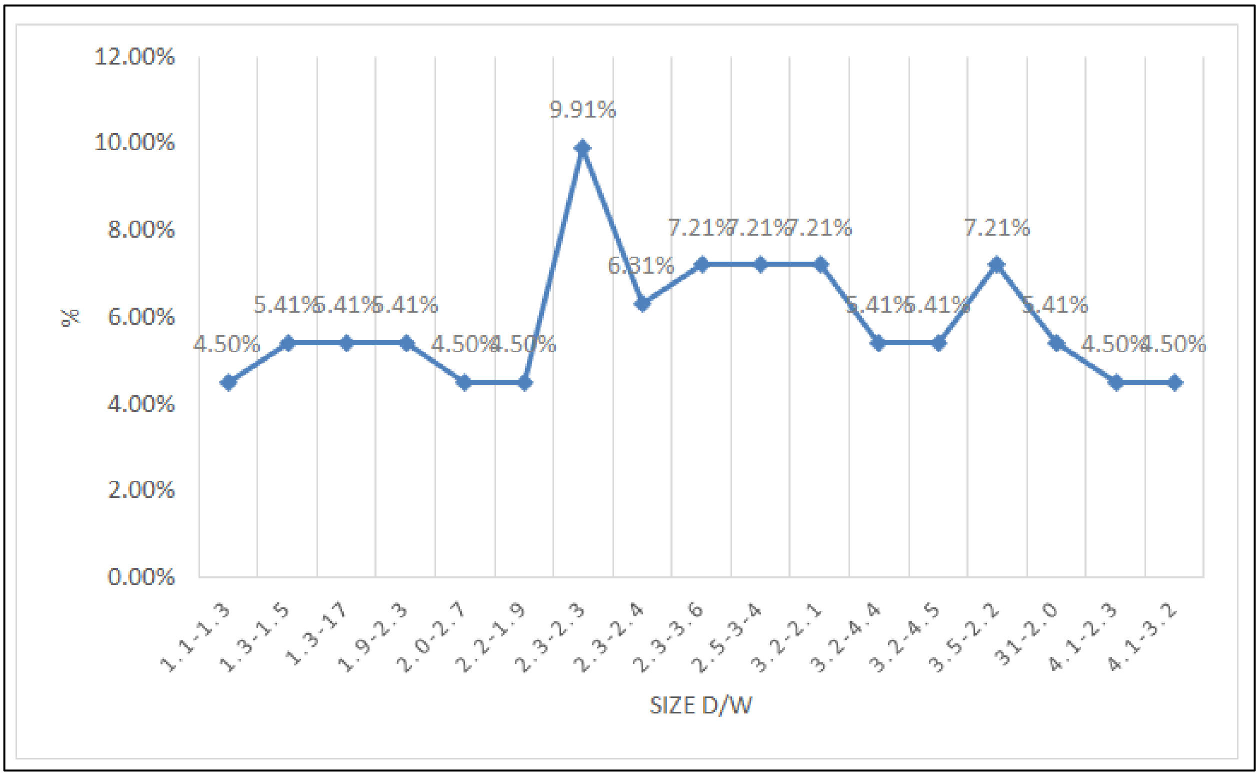

Figure 8: Shows frequency distribution of Size D/W for all patient

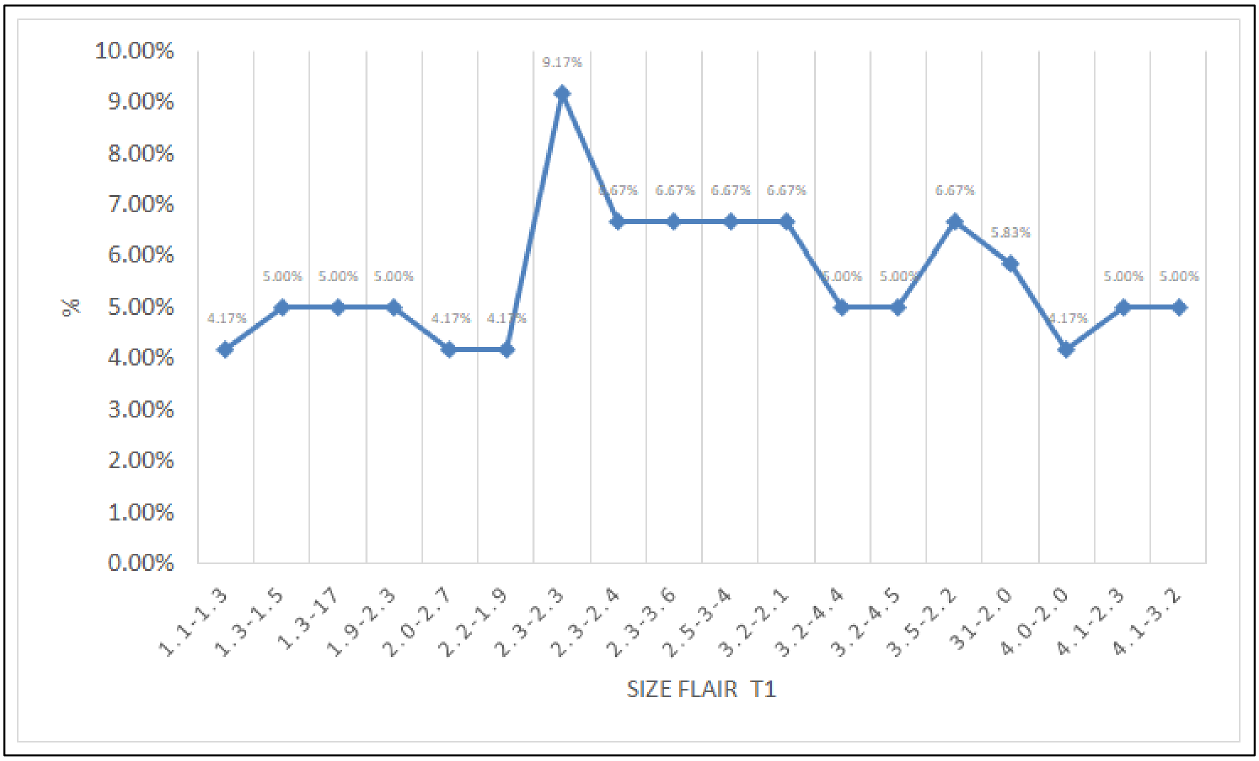

Figure 9: Shows frequency distribution of Size D/W for all patient

CONCLUSION

The present study has demonstrated that Magnetic Resonance Imaging (MRI) is a reliable diagnostic tool for accurately detecting brain infarction lesions regardless of signal intensity imaging. Moreover, MRI can help detect cerebral artery occlusion or severe stenosis, identify reversible ischemia alterations and assess auxiliary circulation. This study also identified the prevalence of the largest infarctions in elderly individuals with diabetes and hypertension, with a higher incidence of left-side brain infarction in elderly patients over 63 years of age. The results suggest that MRI should be recommended for clinical cases with positive stroke symptoms. The results of the study show a significant relationship between age and ischemia size, with infarction size increasing with age. Additional studies are needed to confirm these results with more extensive data collection. The implementation of MRI in diagnosing brain infarction can contribute to improved clinical outcomes for patients and warrants further investigation.

REFERENCES

- Abdel-Fattah, A. R., Pana, T. A., Smith, T. O., Pasdar, Z., Aslam, M., Mamas, M. A., & Myint, P. K. (2022). Gender differences in mortality of hospitalized stroke patients: systematic review and meta-analysis. *Clinical Neurology, Neurosurgery*, 220, 107359.
- Adams, H. P., Biller, J., & Caplan, L. R. (2018). Classification of Subtypes of Ischemic Stroke: History of the Trial of Org 10172 in Acute Stroke Treatment Classification. *Stroke*, 49(11), 2573-2578.
- Amarenco, P., Lavallée, P. C., Labreuche, J., & Albers, G. W. (2009). TIA registry investigators. One-Year Risk of Stroke after Transient Ischemic Attack or Minor Stroke. *New England Journal of Medicine*, 360(25), 2598-2607.
- Avendano, M., Kawachi, I., Van Lenthe, F., Boshuizen, H. C., Mackenbach, J. P., Van den Bos, G. A., Fay, M. E., & Berkman, L. F. (2006). Socioeconomic status and stroke incidence in the US elderly: the role of risk factors in the EPESE study. *Stroke*, 37(6), 1368-1373.
- Bhadelia, R. A., Price, T. R., & Gorelick, P. B. (2006). High prevalence of MRI cerebral abnormalities in elderly with TIA with and without cognitive impairment. *Neurology*, 67(9), 1637-1642.
- Donnan, G. A., Fisher, M., Macleod, M., & Davis, S. M. (2008). Stroke. *The Lancet*, 371(9624), 1612-1623.
- Elkind, M. S., & Sacco, R. L. (1998). Stroke risk factors and stroke prevention. Seminars in Neurology, 18(4), 429-440.
- Feigin, V. L., Krishnamurthi, R. V., Parmar, P., Norrving, B., Mensah, G. A., Bennett, D. A., ... & Naghavi, M. (2018). Update on the global burden of ischemic and hemorrhagic stroke in 1990-2013: the GBD 2013 study. *Neuroepidemiology*, 45(3), 161-176.
- Hatazawa, J., Shimosegawa, E., Toyoshima, H., Ardekani, B. A., Suzuki, A., Okudera, T., & Miura,

Y. (1999). Cerebral blood volume in acute brain infarction: a combined study with dynamic susceptibility contrast MRI and 99mTc-HMPAO-SPECT. *Stroke*, 30(4), 800-806.

- Kim, B. J., Kang, H. G., Kim, H. J., Ahn, S. H., Kim, N. Y., Warach, S., & Kang, D. W. (2014). Magnetic resonance imaging in acute ischemic stroke treatment. *Journal of stroke*, *16*(3), 131-145.
- Katan, M., Luft, A., & Global Burden of Disease Stroke Expert Group. (2018). Global burden of stroke. *Seminars in neurology*, 38(2), 208-211.
- Labovitz, D. L., Halim, A., Boden-Albala, B., Hauser, W. A., & Sacco, R. L. (2018). The incidence of deep and lobar intracerebral hemorrhage in whites, blacks, and Hispanics. Neurology, 65(4), 518-522.
- Nguyen, H. L., Saczynski, J. S., Gore, J. M., Goldberg, R. J., McManus, D. D., & Awad, H. (2022). Association of smoking cessation with outcomes after acute ischemic stroke. *JAMA neurology*, 79(1), 25-32.
- O'Donnell, M. J., Chin, S. L., Rangarajan, S., Xavier, D., Liu, L., Zhang, H., ... & Yusuf, S. (2016). Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. *The Lancet*, 388(10046), 761-775.
- Powers, W. J., Rabinstein, A. A., Ackerson, T., Adeoye, O. M., Bambakidis, N. C., Becker, K., … & Demaerschalk, B. M. (2018). 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*, 49(3), 46-110.
- Price, T. R., & Manolio, T. A. (1997). Prevalence and correlates of silent cerebral infarction in the elderly population. *JAMA*, 277(21), 1749-1754.
- Roh, J. K., Kang, D. W., Lee, S. H., Yoon, B. W., & Chang, K. H. (2000). Significance of acute multiple brain infarction on diffusion-weighted imaging. *Stroke*, 31(3), 688-694.
- Sacco, R. L., Kasner, S. E., Broderick, J. P., Caplan, L. R., Connors, J. J., Culebras, A., ... & Adams Jr, H. P. (2013). An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*, 44(7), 2064-2089.
- Sun, Q., Zhou, J., Wei, X., Wang, X., Wang, Q., Liu, L., ... & Zhu, D. (2021). Age-specific sex differences in the incidence and risk factors of ischemic stroke. *Aging*, 13(6), 8186-8198.
- Thom, T. (2006). Heart disease and stroke statistics. American Heart Association Statistics Committee and Stroke Statistics Subcommittee, E85-E151.
- Vorlage, G. (1992). Crew Neuroimaging and Clinical Neuroanatomy. Icn.
- Wu, C. Y., Hu, H. Y., Yang, T. H., Chen, P. Y., Lee, M., & Yang, T. W. (2021). Age, sex, and comorbidities as predictors of ischemic or hemorrhagic stroke in patients with atrial fibrillation: A nationwide cohort study. *Scientific reports*, 11(1), 1-10.
- Zhang, X., Li, Z., Li, S., Li, H., Li, Y., Han, X., & Wu, M. (2021). Risk factors for acute ischemic stroke in a rural population of northern China: A population-based study. *BMC neurology*, 21(1), 1-10.