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Infarction Patterns in Posterior Cerebral Circulation: Etiology and Prognosis

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Abstract

Study Objectives: About a quarter of strokes and transient ischemic attacks occur in the vertebrobasilar distribution. Vertebrobasilar stroke is particularly prone to devastating consequences especially brain stem infarctions due to damage of the regional brain tissues that contain vital centers, and is associated with high rates of death and disability. **Study Design:** This was across sectional observational prospective hospital-based study conducted on 60 patients with first-ever acute posterior circulation ischemic stroke. The aim of the current study was to determine the relationship between different risk factors and different infarction patterns in posterior circulation; single small lacunar lesion, single large lesion, or multiple scattered lesions. Diagnosis of ischemic stroke and stroke subtypes were defined using the Trial of ORG 10,172 in Acute Stroke Treatment (TOAST) criteria as well as clinical and brain imaging features. Stroke severity using National Institutes of Health Stroke Scale (NIHSS) score was done on admission, after 24 hours from admission, and at 7 days from onset of symptoms. The patients functional status was assessed by modified Rankin scale (mRS) done on admission and on discharge from hospital and at 7-day follow up from onset of symptoms. Patients were classified according to infarction patterns into a single small lacunar lesion (group I), a single large lesion (group II), and multiple scattered lesions (group III) 20 patients in each group. **Results:** There was no significant difference between the three groups as regard the presence of vascular risk factors and the only significant difference as regard vascular risk factors was atrial fibrillation (AF). There was significant difference between the three groups as regard the occurrence of previous transient ischemic attacks (TIA). There was significant difference between the three groups as regard NIHSS score on admission, after 24 hours, and at 7 days from admission. There were significant differences between the three groups as regard mRS score at discharge and at 7-day follow up from the onset of symptoms and the degree of improvement from admission to discharge. There was significant difference

between the three groups as regard volume of infarction in Brain magnetic resonance imaging (MRI). Group II and group III patients had larger volumes of infarction when compared to group I patients. There was no significant difference between the three groups as regard presence of significant intracranial stenosis in magnetic resonance angiography (MRA). There was significant difference between the three groups as regard stroke etiology. It was found that largeartery atherosclerosis (LAA) was the most common stroke etiology in posterior circulation being present in (53.3%) of the patient group and was common in group II and III in contrast to group I patients. **Conclusions:** Different vascular risk factors such as hypertension, diabetes, dyslipidemia, and smoking are present in all infarction patterns of posterior circulation ischemic stroke either single or multiple infarctions. However, AF and significant vertebrobasilar stenosis were mostly associated with large and multiple infarct lesion patterns. Small vessel disease was the most common stroke etiology for single small lacunar lesion while large artery atherosclerosis was associated with single large lesion and multiple lesions in the posterior circulation. Early MRI and MRA help in define type and prognosis of posterior circulation infarcts. Early diagnosis and control of potentially modifiable risk factors and comorbid conditions are an important aspect in the early management of patients with infarction in the posterior circulation.

Keywords

Posterior Circulation Stroke, Risk Factors for Stroke, National Institutes of Health Stroke Scale (NIHSS), Modified Rankin Scale (mRS), Echocardiography, Brain Magnetic Resonance Imaging and Angiography, Carotid Duplex

1. Introduction

Posterior circulation ischemic stroke is a clinical syndrome that is classically defined by infarction occurring within the vascular territory supplied by the vertebrobasilar arterial system. Posterior circulation ischemic stroke accounts for approximately 20% - 25% of all strokes with different clinical presentations that differ from anterior circulation stroke, with reference to etiology, clinical features, and prognosis [1].

Posterior circulation infarctions have different patterns such as single small lacunar lesion, single large territorial lesion or multiple scattered infarct lesions that are caused by several risk factors. However, it remains unknown which factors contribute to these different infarctions in posterior circulation [2].

The prevalence rate in Egypt for first-ever and recurrent stroke ranged between 508 and 777 per 100,000 populations in 1992 and 2001-2013, respectively [3]. Stroke accounts for 6.4% of all deaths in Egypt and thus ranks 3rd after heart diseases and liver diseases [4]. Prognosis and clinical outcome after posterior circulation infarction are more dangerous than anterior circulation infarction ac-

cording to modified Rankin scale (mRS) 3 months after occurrence of infarction. Disability was 32.3% in minor posterior circulation infarction compared to 30.3% in minor anterior circulation infarction, and death was 1.3% and 1.5%, respectively [5]. Early predictors of functional outcome after stroke are necessary for better planning of treatment and care.

In the current study, we aimed to determine the relationship between different risk factors and different infarction patterns in posterior circulation; single small lacunar lesion, single large lesion, or multiple scattered lesions.

2. Subject and Methods

This was a cross sectional observational prospective hospital based study conducted on 60 patients with first ever acute posterior circulation ischemic stroke. Patients were recruited from the stroke units of Ain Shams university hospitals from December 2017 till December 2018, after the patients or their relatives signed an informed consent. Inclusion criteria included patients with acute cerebral infarction admitted within 48 hours of onset of symptoms within the territory of posterior circulation. Exclusion criteria included; patients with infarction within anterior circulation, patients with cerebral venous thrombosis and patients who refused to participate in the study. Diagnosis of ischemic stroke and stroke subtypes were defined using the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) criteria as well as clinical and brain imaging features Brain magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), transthoracic echocardiography (TOE) and transesophageal echocardiography (TEE) was done only for selected cases [6]. Detailed neurological examination with assessment of stroke severity using National Institutes of Health Stroke Scale (NIHSS) score was done on admission, after 24 hours from admission, and at 7 days from onset of symptoms [7]. The patients functional status was assessed by mRS on admission and on discharge from hospital and at 7-days follow up from onset of symptoms [8]. Experimental procedures were previously approved by the Ethical Committee for Human Research at the faculty of medicine Ain Shams University.

Stroke patients underwent a full medical, neurological history and clinical examinations. Brain MRI and MRA, TTE and TOE, Electrocardiogram (ECG) and full lab studies (Random blood sugar at time of admission and Glycated hemoglobin, Complete blood picture, Erythrocyte sedimentation rate (ESR), Coagulation profile and Lipid profile) were performed on all candidates. Exclusion criteria were; patients with infarction within anterior circulation and patients with cerebral venous thrombosis.

Statistical Analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency

and percentage. The following tests were done:

Post Hoc test: Least Significant Difference (LSD) was used for multiple comparisons between different variables. Chi-square (χ^2) test of significance was used in order to compare proportions between qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant if P-value < 0.05.

3. Results

The study population was divided into 3 groups according to the infarction pattern. Infarction patterns were categorized into a single small lacunar lesion (20 patients) group I, a single large lesion (20 patients) group II, and multiple scattered lesions (20 patients) group III. There was no statistical significant difference as regards age or sex between studied groups (Table 1).

As regarding vascular risk factors, hypertension was present in 52 (86.7%) of all patients. Hypertension was present in 19 (95%) patients of group I compared to 15 (75%) patients of group II and 18 (90%) patients of group III with no significant difference between the three groups (Table 2). Diabetes mellitus was detected in 38 (63.3%) of all patients with no statistical significant difference between the three groups as diabetes was detected among 14 (70%)patients of group I versus 14 (70%) patients among group II and among 10 (55%) patients of group III.

Dyslipidemia was present in 31 (51.7%) patients and there was no statistical significant difference between the three groups as it was detected among 12 (60%) patients of group I versus 8 (40%) patients among group II and among 11 (50%) patients of group III.

Cardiac diseases were present in 25 (41.7%) patients. About 12 (20%) patients had atrial fibrillation (AF), 21 (35%) patients had evidence of ischemic heart disease (IHD), 2 (3.3%) patients had Rheumatic heart disease, and 6 (10%) patients had made Coronary artery revascularization. There was no statistical significant difference between the three groups regarding to the presence of cardiac diseases; 5 (25%) patients of group I versus 10 (50%) patients in group II and 10

Table 1. Demographic features in the studied groups.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Age (yrs.)						
Min. - maximum	38 - 79	38 - 71	38 - 77	40 - 79	1.425	
Mean ± SD	59.20 ± 9.63	56.60 ± 9.78	61.70 ± 8.82	59.30 ± 10.03		0.249
Sex						
Female	27 (45%)	11 (55%)	7 (35%)	9 (45%)	1.616#	0.446
Male	33 (55%)	9 (45%)	13 (65%)	11 (55%)		

#F-ANOVA test; Chi-square test.

Table 2. Vascular risk factors in studied groups.

Vascular Risk Factors	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Hypertension	52 (86.7%)	19 (95%)	15 (75%)	18 (90%)	0.375	0.153
Diabetes	38 (63.3%)	14 (70%)	14 (70%)	10 (50%)	2.297	0.317
Dyslipidemia	31 (51.7%)	12 (60%)	8 (40%)	11 (55%)	1.735	0.420
Cardiac diseases	25 (41.7%)	5 (25%)	10 (50%)	10 (50%)	3.429	0.180
AF	12 (20%)	0 (0.0%)	6 (30%)	6 (30%)	7.500	0.024*
Ischemic heart disease	21 (35%)	5 (25%)	8 (40%)	8 (40%)	1.319	0.517
Rheumatic heart disease	2 (3.3%)	0	2 (10%)	0	4.138	0.126
Coronary revascularization	6 (10%)	1 (5%)	2 (10%)	3 (15%)	1.111	0.574
History of smoking	22 (36.7%)	7 (35%)	7 (35%)	8 (40%)	0.144	0.931

(50%) patients in group III. But there was significant difference that was noticed between the three groups as regard the presence of AF. In group I no patients had AF in comparison with group II 6 (30%) patients and 6 (30%) patients in group III had AF.

About 22 (36.7%) of all studied patients were smokers and 38 (63.7%) patients were non-smokers. Seven(35%) patients of group I, 7 (35%) patients of group II and 8 (40%) patients of group III, were smokers with no statistical significant difference between these groups (Table 2).

Previous TIA attacks were present in 29 (48.3%) patients. Also previous TIAs were present in 8 (40%) patients of group I compared to 7 (35%) patients of group II and 14 (70%) patients of group III with significant statistical difference; multiple acute infarcts were associated with previous TIAs. Previous stroke was present in 19 (31.7%). Previous stroke was present in 5 (25%) patients of group I compared to 6 (30%) patients of group II and 8 (40%) patients of group III with no statistically significant difference between studied groups (Table 3).

The systolic blood pressure (SBP) at the time of admission to the hospital ranged from 110 to 230 mmHg among all patients with a mean of 157.17 ± 30.81 mmHg. There was no statistical significant difference between the three groups; group I patients (ranged from 110 to 230 mmHg with a mean of 159.50 ± 31.20 mmHg), group II patients (ranged from 110 to 220 mmHg with a mean of 155.00 ± 29.11 mmHg), and group III (ranged from 110 to 220 mmHg with a mean of 157.00 ± 33.42 mmHg). The diastolic blood pressure (DBP) at the time of admission to the hospital ranged from 70 to 120 mmHg among all patients with a mean of 89.17 ± 12.25 mmHg. There was no statistical significant difference between the three groups. Group I patients (ranged from 70 to 120 mmHg with a mean of 89.17 ± 12.25 mmHg), group II patients (ranged from 70 to 120 mmHg with a mean of 88.50 ± 13.09 mmHg), and group III (ranged from 70 to 110 mmHg with a mean of 90.50 ± 12.76 mmHg) (Table 4).

Table 3. Comparison among groups according to previous TIA attacks and previous stroke.

Vascular Risk Factors	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Previous TIA attacks	29 (48.3%)	8 (40%)	7 (35%)	14 (70%)	5.740	0.037*
Previous stroke	19 (31.7%)	5 (25%)	6 (30%)	8 (40%)	1.078	0.583

Table 4. Comparison among groups according to blood pressure (mmHg).

Vascular Risk Factors	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
SBP						
Mean ± SD	157.17 ± 30.81	159.50 ± 31.20	155.00 ± 29.11	157.00 ± 33.42		
Range	110 - 230	110 - 230	110 - 220	110 - 220	0.104	0.902
DBP						
Mean ± SD	89.17 ± 12.25	88.50 ± 11.37	88.50 ± 13.09	90.50 ± 12.76		
Range	70 - 120	70 - 120	70 - 120	70 - 110	0.173	0.842

The results of echocardiography revealed that the ejection fraction ranged from 20% to 80% with a mean of 51.50% ± 10.82% in all patients. There was no significant statistical difference between the three groups; ranging from 30% to 80% with a mean of 56.65% ± 11.90% among group I patients versus a range from 25% to 70% with a mean of 48.93% ± 10.27% among group II patients, and a range from 20% to 65% with a mean of 43.78% ± 9.19% among group III patients (Table 5).

The NIHSS score on admission ranged from 1 to 18 with a mean of 7.03 ± 4.46 in the study population. Group I patients had significantly lower NIHSS scores on admission as it ranged from 1 to 10 with a mean of 5.30 ± 2.62, compared to group II patients where it ranged from 2 to 17 with a mean of 6.45 ± 3.56 and group III patients where it ranged from 2 to 18 with a mean of 9.35 ± 5.74.

The NIHSS score done after 24 hours from admission ranged from 1 to 20 with a mean of 6.20 ± 2.25 in the study population. Group I patients had significantly lower NIHSS scores as it ranged from 1 to 7 with a mean of 4.05 ± 2.09, compared to group II patients where it ranged from 1 to 19 with a mean of 5.30 ± 3.88 and group III where it ranged from 1 to 20 with a mean of 9.25 ± 3.12.

The NIHSS score done at 7 days from onset of symptoms ranged from 0 to 34 with a mean of 5.02 ± 2.12 in the study population. Group I patients had significantly lower NIHSS scores as it ranged from 0 to 3 with a mean of 1.45 ± 0.99, compared to group II patients where it ranged from 0 to 28 with a mean of 2.95 ± 1.00 and group III where it ranged from 0 to 34 with a mean of 10.65 ± 5.03.

When comparing the NIHSS scores on admission to the scores after 7 days from onset of symptoms, it was noticed that there was statistically significant

Table 5. Comparison among groups according to echo.

Echo EF%	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Mean ± SD	51.50 ± 10.82	56.65 ± 11.90	48.93 ± 10.27	43.78 ± 9.19		
Range	20 - 80	30 - 80	25 - 70	20 - 65	1.076	0.296

decrease in the mean of NIHSS scores in group I and group II patients, while there was increase in the mean of NIHSS scores in group III patients (Table 6).

The mRS scores on admission ranged from 1 to 5 with a mean of 2.95 ± 1.42 in the study population. Group I patients had lower mRS scores on admission as it ranged from 1 to 4 with a mean of 2.45 ± 1.28, compared to group II patients where it ranged from 1 to 5 with a mean of 2.95 ± 1.32 and group III patients where it ranged from 1 to 5 with a mean of 3.45 ± 1.54 with no statistically significant difference.

The mRS scores at discharge ranged from 0 to 6 with a mean of 1.90 ± 1.09 in the study population. Group I patients had lower mRS scores at discharge as it ranged from 0 to 3 with a mean of 1.00 ± 0.98, compared to group II patients where it ranged from 0 to 6 with a mean of 1.75 ± 0.52 and group III where it ranged from 0 to 6 with a mean of 2.95 ± 1.31 with statistically significant difference (Table 7).

The mRS scores at 7 days follow up from the onset of symptoms ranged from 0 to 6 with a mean of 1.82 ± 1.05 in the study population. Group I patients had lower mRS scores at 7 days follow up as it ranged from 0 to 3 with a mean of 0.96 ± 0.94, compared to group II patients where it ranged from 0 to 6 with a mean of 1.68 ± 0.50 and group III where it ranged from 0 to 6 with a mean of 2.83 ± 1.26 with statistically significant difference.

When comparing the mRS scores on admission to the scores after 7 days from onset of symptoms, it was noticed that there was statistically significant decrease in the mean of mRS scores in group I and group II patients, in contrast to group III patients.

Comparing the mRS scores on admission and at discharge, it was noticed that all the three groups had improved. The degree of improvement was about 35.6% in the study population. It was noticed that the degree of improvement was the highest among group I population and the lowest among group III population. It was about 59.2% among group I population, while group II patients was about 40.7%, and group III patients was about 14.5% with statistically significant difference (Table 7).

The duration of admission to the hospital ranged from 2 to 15 days among all the study population with a mean of 8.76 ± 1.84 days. The duration of admission ranged from 2 to 5 days with a mean of 3.61 ± 0.76 among group I patients, while it ranged from 4 to10 days with a mean of 7.21 ± 1.51 among group II patients and it ranged from 7 - 15 days with a mean of 11.33 ± 2.38 among group III patients. There was statistically significant difference between groups according to duration of admission of hospital (days) (Table 8).

Table 6. Comparison among groups according to NIHSS.

NIHSS score	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
On admission						
Mean ± SD	7.03 ± 4.46	5.30 ± 2.62	6.45 ± 3.56a	9.35 ± 5.74ab		
Range	1 - 18	1 - 10	2 - 17	2 - 18	4.977	0.010*
24 hrs after admission						
Mean ± SD	6.20 ± 2.25	4.05 ± 2.09	5.30 ± 3.88a	9.25 ± 3.12ab		
Range	1 - 20	1 - 7	1 - 19	1 - 20	6.301	0.003*
7 days after onset of illness						
Mean ± SD	5.02 ± 2.12	1.45 ± 0.99	2.95 ± 1.00a	10.65 ± 5.03ab		
Range	0 - 34	0 - 3	0 - 28	0 - 34	7.063	0.002*

a: Significant difference with group I; b: Significant difference with group II.

Table 7. Comparison among groups according to mRS score.

mRS score	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
On admission						
Mean ± SD	2.95 ± 1.42	2.45 ± 1.28	2.95 ± 1.32	3.45 ± 1.54		
Range	1 - 5	1 - 4	1 - 5	1 - 5	2.618	0.082
24 hrs after admission						
Mean ± SD	1.90 ± 1.09	1.00 ± 0.98	1.75 ± 0.52a	2.95 ± 1.31ab		
Range	0 - 6	0 - 3	0 - 6	0 - 6	6.616	0.003*
7 days after onset of illness						
Mean ± SD	1.82 ± 1.05	0.96 ± 0.94	1.68 ± 0.50a	2.83 ± 1.26ab		
Range	0 - 6	0 - 3	0 - 6	0 - 6	4.291	0.024*
Degree of Improvement on admission and at discharge	35.6%	59.2%	40.7%a	14.5%ab	8.498	<0.001*

a: Significant difference with group I; b: Significant difference with group II.

Table 8. Comparison among groups according to duration of admission to the hospital.

Duration of admission to the hospital (days)	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Mean ± SD	8.76 ± 1.84	3.61 ± 0.76	7.21 ± 1.51a	11.33 ± 2.38ab		
Range	2 - 15	2 - 5	4 - 10	7 - 15	13.819	**<0.001**

According to modified Rankin Score (mRS) done at 7 days from onset of symptoms, patients were subdivided into two groups. Group A (patients with favorable early outcome) that included patients with mRS score at 7 days from onset of symptoms ranging from 0 to 2 (patients can perform his daily activities independently) and included 44 patients (73.3% of all patients), and group B (patients with unfavorable early outcome) that included patients with mRS score at 7 days form onset of symptoms ranging from 3 to 6 (dependent patients or death) and included 16 patients (26.7% of all patients).

As regards group I population there were 19 (95%) patients with favorable outcome and 1 (5%) patient only with unfavorable outcome. Among group II population, 15 (75%) patients had favorable outcome and 5 (25%) patients had unfavorable outcome. Among group III population, 10 (50%) patients had favorable outcome and 10 (50%) patients had unfavorable outcome. It was noticed that early outcome (7 days after the onset) was significantly worse among group III population compared to groups I and II (Table 9).

Data of the MRI showed that the volume of infarction among the study population ranged from 0.1 to 200 cm^3 with a mean of 26.41 ± 14.24 cm^3. It was noticed that group II patients and group III patients had larger volumes of infarction when compared to group I and was statistically significant, as the volume of infarction in group I ranged from 0.1 to 1.1 cm^3 with a mean of 0.48 ± 0.14 while in group II it ranged from 2 to 200 cm^3 with a mean of 41.77 ± 15.32 and in group III it ranged from 0.37 to 148 cm^3 with a mean of 36.97 ± 14.08.

MRA data revealed that significant intracranial stenosis was present among 26 (43.3%) patients, while about 34 (56.7%) patients had no significant intracranial stenosis. About 5 (25%) patients in group I, 10 (50%) patients in group II and 11 (55%) patients in group III had significant intracranial stenosis. The comparison between the three groups revealed that the presence of intracranial stenosis was more common among group II and group III patients than group I yet statistically insignificant (Table 10).

Regarding the subtypes of stroke according to TOAST classification, the most common subtype of stroke was stroke due to large artery atherosclerosis (LAA); 32 (53.3%) patients. It was present among 16 (80%) patients of group II patients, 16 (80%) patients of group III but, no patients in group I with high significant difference (Table 11).

Table 9. Comparison among groups according to the early functional outcome (based on mRS at 7 days from onset of symptoms).

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Favorable Outcome (0 - 2)	44 (73.3%)	19 (95.0%)	15 (75.0%)	10 (50.0%)		
Unfavorable Outcome (3 - 6)	16 (26.7%)	1 (5.0%)	5 (25.0%)	10 (50.0%)	10.398	0.006*

Table 10. Comparison among groups according to MRI and MRA.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Volume of infarction (cm^3)						
Mean ± SD	26.41 ± 14.24	0.48 ± 0.14	41.77 ± 15.32a	36.97 ± 14.08ab		
Range	0.1 - 200	0.1 - 1.1	2 - 200	0.37 - 148	6.114	0.004*
Presence of significant intracranial stenosis						
Negative	34 (56.7%)	15 (75%)	10 (50%)	9 (45%)		
Positive	26 (43.3%)	5 (25%)	10 (50%)	11 (55%)	4.208#	0.122

a: Significant difference with group I; b: Significant difference with group II.

Table 11. Comparison among groups according to type of stroke.

Stroke etiology	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
LAA	32 (53.3%)	0 (0.0%)	16 (80%)	16 (80%)	34.286	<0.001**
Cardio embolic	5 (8.3%)	0 (0.0%)	3 (15.0%)	2 (10.0%)	3.055	0.217
SVD	20 (33.3%)	20 (100%)	0 (0.0%)	0 (0.0%)	60.00	<0.001**
Undetermined etiology	3 (5.0%)	0 (0.0%)	1 (5.0%)	2 (10.0%)	0.002	0.963

Small vessel disease (SVD) stroke was the second most common subtype and it was present among 20 (33.3%) patients of study population. All of them were in group I and no patients were found in group II or III.

Cardio embolic stroke was present among 5 (8.3%) patients, 3 (15%) patients in group II and 2 (10%) patients of group III without statistically significant difference.

Stroke of undetermined etiology was present among 3 (5%) patients of study population; one (5%) patient of group II and 2 (10%) patient of group III without any statistically significant difference.

When comparing the three groups, it was noticed that LAA was the most common stroke etiology of posterior circulation in group II and III compared to SVD in group I (Table 11).

As regards the laboratory results, in CBC the platelets count was significantly higher among group I patients (ranged from 80 - 555 with a mean of 310.50 ± 125.02) compared to group II patients (ranged from 88 - 392 with a mean of 233.85 ± 86.72) and group III (ranged from 109 - 412 with a mean of 234.25 ± 69.27) (Table 12).

As regards the coagulation profile (PT, INR and PTT), there was no statistically significant difference between the three groups. As regards lipid profile (total cholesterol, LDL, HDL and triglycerides), there was no statistically

Table 12. Comparison among groups according to CBC.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Hemoglobin						
Mean ± SD	13.38 ± 1.63	12.94 ± 1.80	13.54 ± 1.56	13.68 ± 1.51	1.171	0.317
Range	9 - 16.9	9 - 15.6	10 - 16.9	10.5 - 15.7		
Leuckocytic count						
Mean ± SD	9.53 ± 4.04	9.91 ± 3.98	7.95 ± 3.61	10.72 ± 4.19	2.614	0.082
Range	3.7 - 22.5	4.2 - 16.7	3.7 - 20.9	4.7 - 22.5		
Platelets count						
Mean ± SD	259.53 ± 101.59	310.50 ± 125.02	233.85 ± 86.72a	234.25 ± 69.27a	4.182	0.020*
Range	80 - 555	80 - 555	88 - 392	109 - 412		

significant difference between the three groups. As regards the random blood sugar (RBS) at admission and glycated hemoglobin, It was noticed that group II patients had the highest mean of RBS on admission (ranged from 132 to 453 mg/dl with a mean of 278.90 ± 103.10), followed by group III patients (ranged from 133 to 396 mg/dl with a mean of 225.50 ± 85.89), followed by group I patients (ranged from 32 to 452 mg/dl with a mean of 237.88 ± 94.74) with statistically significant difference. There was no significant difference as regards the level of glycated Hb (Table 13).

As regards ESR, it was noticed that group III patients had the highest mean of ESR at one hour (ranged from 5 to 30 with a mean of 15.30 ± 6.01), followed by group II patients (ranged from 5 to 25 with a mean of 12.35 ± 4.40), followed by group I patients (ranged from 5 to 18 with a mean of 11.25 ± 3.97), and this was statistically significant difference (Table 14).

The site of infarction was distributed as the following among the study population. Occipital infarction was present in 28 (46.7%) patients, medial temporal infarction was present in 9 (15%) patients, cerebellar infarction was present in 15 (25%) patients, and posterior thalamic infarction was present in 7 (11.7%) patients. As regards brainstem infarctions; 3 (5%) patients had midbrain infarctions, 25 (41.7%) patients had pontine infarctions, and 2 (3.3%) patients had medulla oblongata infarctions.

There were some statistical significant differences between the three groups as regard the site of infarctions:

1) Occipital infarctions were more common among patients of group II in about 16 (80%) patients compared to 2 (10%) patients in group I and 10 (50%) patients in group III with statistical significant differences;

2) Medial temporal infarctions were more common among patients of group III in about 5 (25%) patients compared to 4 (20%) patients in group II and non in group I patients with statistically significant difference;

Table 13. Comparisonamong groups according to RBS & Glycated Hb.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
RBS						
Mean ± SD	237.88 ± 94.74	209.25 ± 84.08	278.90 ± 103.10a	225.50 ± 85.89ab	3.177	0.049*
Range	32 - 452	32 - 367	132 - 452	133 - 396		
Glycated Hb						
Mean ± SD	6.72 ± 1.65	6.76 ± 1.40	7.05 ± 1.70	6.36 ± 1.83	0.889	0.417
Range	4 - 9.6	4.3 - 9.0	4.2 - 9.6	4 - 9.5		

a: Significant difference with group I; b: Significant difference with group II.

Table 14. Comparison among groups according to ESR.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Mean ± SD	12.97 ± 5.09	11.25 ± 3.97	12.35 ± 4.40	15.30 ± 6.01ab	3.691	0.031*
Range	5 - 30	5 - 18	5 - 25	5 - 30		

3) Cerebellar infarctions were more common among patients of group III in about 12 (60%) patients compared to 2 (10%) patients in group I and 1 (5%) patient in group II with statistical significant differences;

4) Posterior thalamic infarctions were more common among patients of group III in about 7 (35%) patients compared to group I & II patients with no infarctions in posterior thalamic and this showed statistically significant difference;

5) As regard brain stem infarctions; pontine infarctions were more common among patients of group I patients in about 15 (75%) patients compared to 3 (15%) patients in group II and 7 (35%) patient in group III with statistically significant difference;

6) Midbrain infarctions were present in 1 (5%) patient of group I and in 2 (10%) patients of group III but group II patients had no midbrain infarction, and without statistically significant difference;

7) Medulla oblongata infarctions were present in 2 (10%) patients of group III but group I & II patients had no medulla oblongata infarctions and without statistically significant difference (Table 15).

4. Discussion

Posterior circulation ischemic stroke is a clinical syndrome associated with ischemia related to stenosis, in situ thrombosis, or embolic occlusion of the vertebrobasilar arterial system. It accounts for 20% - 25% of ischemic strokes [9]. Early recognition of posterior circulation stroke may prevent functional disability and

Table 15. Comparison among groups according to site of infarctions.

	All patients	Group I (n = 20)	Group II (n = 20)	Group III (n = 20)	F/χ^2#	P value
Occipital	28 (46.7%)	2 (10%)	16 (80%)	10 (50%)	19.821	<0.001*
Medial temporal	9 (15%)	0 (0%)	4 (20%)	5 (25%)	6.490	0.044*
Cerebellum	15 (25%)	2 (10%)	1 (5%)	12 (60%)	19.733	<0.001*
Thalamic	7 (11.7%)	0 (0%)	0 (0%)	7 (35%)	15.849	<0.001*
Midbrain	3 (5%)	1 (5%)	0 (0%)	2 (10%)	2.105	0.349
Pons	25 (41.7%)	15 (75%)	3 (15%)	7 (35%)	15.360	<0.001*
Medulla oblongata	2 (3.3%)	0 (0.0%)	0 (0.0%)	2 (10%)	4.138	0.126

save lives. Delayed or incorrect diagnosis may have catastrophic consequences, including potentially preventable death or severe functional disability, if acute treatment or secondary prevention is delayed [10].

The aim of this study was to determine the relationship between different risk factors and different patterns of infarctions in posterior circulation. This was across sectional observational prospective hospital based study conducted on 60 patients with first ever acute posterior circulation ischemic stroke. Patients were recruited from the stroke units of Ain Shams University hospitals. Infarction patterns were categorized into a single small lacunar lesion group I, a single large lesion group II, and multiple scattered lesions group III; 20 patients in each group.

In this study there were no significant difference between the three groups regarding age and gender of the patients. Similar findings were reported by Depuydt *et al.* (2014) who founded no significant differences between patients with single infarction and those with multiple infarctions on DWI in terms of age and sex [11]. While Hong-tao *et al.* (2014) showed that vertebrobasilar artery tortuosity was significantly more common in elderly patients aged > 60 years than <60 years and there was strong association between vertebral artery tortuosity and multiple small posterior circulation infarctions in brainstem and cerebellum [12].

In this study there were no significant statistical differences as regards the presence of vascular risk factors such as hypertension, diabetes, dyslipidemia, presence of cardiac diseases, and smoking in relation to the type of the vascular lesion. In the study, there was no statistically significant difference between presence of vascular risk factors and pattern of posterior circulation infarctions [11] [13]. However, the presence of AF was common findings in group II & III patients. Similar findings were reported in patients with AF; patients with AF were more prone to develop multiple lesions in posterior circulation than single small lesion due to cardio embolism that block either a large territorial vessel or small penetrating arteries [13], while others did not report such findings [14].

In this study there was a significant statistical difference between the groups as

regard the occurrence of previous TIA attacks and the occurrence of posterior circulation stroke especially of multiple scattered lesion patterns. As the presence of vertebrobasilar stenosis was more common among the patients with multiple scattered lesions than other types and hence these patients were more prone to recurrent TIAs and multiple micro embolic signals that can lead to multiple acute infarctions [15]. Also, in patients with clinically definite vertebrobasilar TIA, the absolute risk of stroke at one year was 17.1% [1].

There were no significant differences between the three groups as regard the result of echocardiography ejection fraction as a risk of posterior circulation stroke. However, previous studies revealed that heart failure and low ejection fraction was a risk factor for ischemic stroke and associated with poor outcome in acute ischemic stroke [16] while others revealed that preserved ejection fraction were associated with early favorable outcome of acute ischemic stroke patients [17].

In this study it was found that group III patients had significantly higher scores of NIHSS compared to group I & group II. This can be explained by multiple brain areas affection that may affect stroke severity assessment by NIHSS score. Similar results were reported by others [18] [19].

When comparing NIHSS score on admission to the scores after 7 days, it was noticed that group I patients & group II patients improved unlike group III patients who developed deterioration in their neurological status manifested by increase of mean NIHSS score, this was explained by multiple brain areas affection that might worsen the functional outcome & prolonged hospital stay which may be associated with an increased risk of neurological and medical complication during hospitalization. Also early neurological worsening was associated with extracranial and intracranial large-vessel stenosis or occlusions that were usually more common in group III patients than other patterns of posterior circulation stroke [20].

As regard mRS score at discharge, and at 7 days follow up from the onset of symptoms and the degree of improvement from admission to discharge it was found that the degree of improvement and hence favorable functional outcome was the highest among group I followed by group II patients in comparison to group III which had the least degree of improvement and hence poor functional outcome. Previous studies revealed that in-hospital medical complications (vascular, urinary, and infections) are relevant factors influencing duration of hospitalization after acute stroke [21] [22]. Therefore, prevention of potentially modifiable risk factors for medical complications is an important aspect of the early management of patients with ischemic stroke.

As regards MRI findings; group II patients and group III patients had larger volumes of infarction when compared to group I patients and this was statistically significant. Previous studies reported that in patients with hyperacute posterior circulation ischemic strokes, the volume of lesions assessed by diffusion-weighted imaging (DWI) were correlated with the clinical outcome, re-

gardless of the initial neurological status [23]. However, many studies reported that DWI lesion volume did not significantly correlate with NIHSS score; large lesions or multiple lesions may have lower NIHSS score than single small lacunar lesion. As, relatively large infarct in the occipital cortex might only cause a hemianopia, whereas small (<1 cm^3) pontine or midbrain infarction can cause severe deficits. Therefore, although NIHSS represents an easy-to-administer and widely validated scale, it seems more useful in patients with anterior circulation stroke than posterior circulation stroke [24]. The only exception was in case of pontine infarcts that tended to be associated with poorer long-term outcome compared with infarcts in other posterior fossa regions [25].

In this study there was no significant difference among the three groups in relation to intracranial stenosis in MRA. As, posterior circulation stroke due to intracranial stenosis may be due to; hypoperfusion, artery-to-artery embolism, and plaque extension over small penetrating artery ostia [26]. This could point to the fact that intracranial stenosis had a role in the etiology of different patterns of posterior circulation infarctions.

In this study large artery disease (LAA) was the most common stroke etiology in group II patients (80%) and group III patients (80%). Previous studies reported that large artery atherosclerotic disease was frequently associated with large size of infarction and acute multiple brain infarction pattern on DWI in the posterior circulation [27] [28]. In contrary to that cardioembolic stroke was present only in 3 (15%) patients of group II and among 2 (10%) patients of group III patients with no significance difference. However, previous studies reported that AF might be an etiology for large territorial and multiple posterior circulation infarcts [29].

The laboratory results of the study groups revealed that the significant statistical differences between the three groups were the platelets count, random blood sugar on admission and ESR.

In this study the platelets count was significantly higher among group I compared to group II patients and group III patients. Previous studies revealed that elevated platelets count increases the risk for ischemic stroke [30]. The pathology of lacunar infarctions is mainly thrombus formation in the small vessels and the platelets may play a definite role in such cases.

In this study as regards the random blood sugar, it was noticed that group II patients had the highest mean of random blood sugar on admission, followed by group III patients followed by group I patients. This can be explained, as elevated blood glucose levels provoke anaerobic metabolism, lactic acidosis, and free radical production, which in turn result in disruption of BBB and hence larger area of infarction [31].

In this study it was noticed that group III patients had the highest mean of ESR at one hour followed by group II patients followed by group I patients. Previous studies had similar results and reported that the increase in ESR correlates with early brain damage in acute ischemic stroke [32]. A possible explanation for

that finding inflammation mediates a key role in the pathogenesis of atherosclerosis which is an important cause of ischemic stroke. An elevated ESR may, therefore, be a marker of the extent and or intensity of a general atherosclerotic process and thus a marker for advanced atherosclerosis heralding increased risk of arterial thrombosis in large artery disease leading to large ischemic stroke [33].

5. Limitations and Strengths

This study has some limitations which have to be taken into consideration. First, the sample size was relatively small, resulting in low statistical power for detecting significant differences between groups. However, the strengths of this study is the correlation between the clinical criteria, risk factors, different investigation modalities; MRI, MRA, TTE, TEE and functional outcome assessment in different patterns of infarctions in posterior circulation for better prognostic evaluation.

6. Conclusions

Different vascular risk factors such as hypertension, diabetes, dyslipidemia, and smoking are present in all infarction patterns of posterior circulation ischemic stroke either single or multiple infarctions. However, AF and significant vertebrobasilar stenosis were mostly associated with large and multiple infarct lesion patterns. Small vessel disease was the most common stroke etiology for single small lacunar lesion while large artery atherosclerosis was associated with single large lesion and multiple lesions in the posterior circulation. Stroke severity can be judged clinically, based upon the degree of neurologic impairment, and the size and location of the infarction on neuroimaging with early MRI and MRA. Factors affecting functional outcome include location of infarctions, mechanism of ischemic stroke, associated comorbid conditions, and stroke complications. Patients with high NIHSS and mRS scores on admission, high serum levels of RBS on admission, intracranial stenosis, large volume of infarction, and LAA stroke, cardioembolic stroke, should be carefully monitored in the hospital due to high incidence of unfavorable outcome and mortality.

Early diagnosis and control of potentially modifiable risk factors are an important aspect in the early management of patients with infarction in the posterior circulation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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