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Original Article

A comparative study of anterior versus posterior circulation cerebral infarctions: Clinical outcomes

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Abstract

Introduction: Due to the lack of comprehensive study about the differences between posterior circulation infarction (PCI) and anterior circulation infarction (ACI), this study is performed to determine the clinical consequences of PCI and ACI.

Methods: The required information was retrieved from the Tabriz Stroke Registry. Modified Rankin Score (mRS), National Institutes of Health's Stroke Scale/Score (NIHSS) for severity, and Acute Stroke Treatment (TOAST) classification for types of ischemic stroke as well as the data regarding the risk factors were considered.

Results: 701 eligible patients were included in this study, of which 524 (74.75%) were patients with ACI stroke and 177 (25.24%) with PCI stroke. There was no statistically significant difference in terms of age ($P=0.724$), sex ($P=0.559$), and pre-stroke mRS ($P=0.279$). Cardioembolism (CE), undetermined etiology (ESUS), and large arterial stroke (LAA) showed higher incidence in ACI patients, where lacunar type was more prevalent in PCI patients ($P=0.01$). Hospital NIHSS were significantly different between ACI and PCI groups ($P=0.001$). Also, regarding the discharged NIHSS patients, there was a significant difference between the groups ($P=0.023$). Moderate stroke was prominent in both groups in hospitalized (PCI: 57.6% and ACI: 48.9%) and discharged NIHSS patients (PCI: 38.4% and ACI: 42.4%).

Conclusion: ACI is about 3-times more prevalent than PCI. There is no relation between the incidence of ACI or PCI and the stroke risk factors. Three months' mortality did not significantly differ between PCI and ACI.

Introduction

Stroke is a condition generated by a gradual or sudden decrease in brain's blood flow and has an incidence of 250 to 400 per 100 000 and a 20–30% mortality rate.[1,2] Today, subsequent to cardiovascular diseases, which are the leading cause of death in Iran,[3] stroke is considered as the second leading cause of death.[4] According to prior studies, about 80% of stroke deaths occur in developing countries.[5] Although many risk factors can potentially cause stroke, the most important factors are older ages, male sex, hypertension (HTN), hypercholesterolemia, hyperlipidemia (HLP), smoking, diabetes mellitus (DM), and alcohol use.[6]

Since the symptoms and area of vascular stenosis determine which intervention is going to be applied, the physician must be aware of the exact location of the infarction.[7] Studies found that the clinical manifestations of posterior circulation infarction (PCI) and anterior circulation infarction (ACI) are more alike than dissimilar, which makes neuroimaging a vital procedure to ensure accurate localization of cerebral infarction.[8] Recent evidence shows that, based on magnetic resonance imaging (MRI), unilateral limb weakness, unilateral limb numbness, nausea, vomiting, and headache are the main manifestations of PCI in the brain, while symmetrical limb paralysis, sensory disturbances, visibility dysfunction, dizziness, urinary tract involvement, and dysphagia are less common in patients with PCI.[9,10] Results of a prospective European multicenter stroke imaging study found that the structural information of brain damage, derived from MRI could be an appropriate prognostic factor of functional outcome in stroke patients.[11]

Several studies have been performed to compare the different aspects and manifestations of ACI and PCI. The results of a study based on the Chengdu Stroke Registry found that PCI and ACI have many similar etiology and risk factors.[7] Another study performed in the United States found better long-term outcomes and different responses to anticoagulants in PCI and ACI patients.[12] Moreover, another study was conducted in

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Iran found a higher prevalence of HTN and smoking in PCI patients; however, in terms of DM or HLP, there was not a significant difference between the two groups.[13] Zürcher et al detected a significant difference in clinical manifestations, etiology, and arterial pathology between ACI and PCI. They also found similar clinical outcomes between these groups of patients from Lausanne, Switzerland.[14]

There are a lot of controversies among the several studies regarding the differences between ACI and PCI. In this study, we aimed to evaluate the clinical consequences of ischemic stroke in the range of anterior and posterior circulation in patients and its correlation with the stroke.

Materials and Methods

The present study is a cross-sectional analytical study, which had been conducted from December 2018 to December 2019 in the neurology department of Tabriz University of Medical Sciences. The study protocol has been reviewed and approved by the local ethics committee.

Our inclusion criteria were: (a) Patients with ischemic stroke or transient ischemic attack (TIA) (with 24-hour symptom criterion) with lesions in diffusion-weighted imaging (DWI) that had appeared within 7 days after stroke. (b) Patients aged > 18 years old. (c) Patients with 1- disabilities before the stroke, 2- previous lesions in the posterior circulation and anterior circulation in DWI, and 3- incomplete data in medical records were excluded from this study. All eligible patients with ischemic stroke experience in the mentioned period were included in the study.

In this study, all of the data was collected from the Tabriz stroke registry which has been founded in 2014 and provided an efficient setting for clinical and research promotion of stroke care. In this structure, patients data, including demographics, pre-hospital and emergency medical service conditions, clinical findings, primary imaging, lab findings, risk factors, drug history, discharge, follow up, Glasgow Coma Scale (GCS), Modified Rankin Score (mRS), The National Institutes of Health's Stroke Scale/Score (NIHSS), rehabilitation, complications, instructions, diagnoses, and treatments (medical, surgical, interventional) of stroke patients, are recorded and collected and then entered to the software and the registry.[15]

The data regarding the risk factors (e.g. age, sex, pre-stroke mRS, HTN, DM, dyslipidemia, smoking, atrial fibrillation, myocardial infarction, previous coronary disease, vascular problems, anti-platelet usage, statin usage, and using diabetes medication) were considered in this study. In the present study, in terms of pre-stroke mRS score, patients were divided into two groups.

According to the Acute Stroke Treatment (TOAST) classification, patients were divided into five types of ischemic stroke, including 1) large arterial stroke (LAA), 2) cardio-embolism (CE), 3) small-vessel occlusion (Lacunar) 4) stroke of other determined etiology, and 5) stroke of undetermined etiology (ESUS).[16]

On the other hand, patients were divided into five groups according to NIHSS, based on the following criteria; no evidence of stroke (score 0), minor stroke (score 1-4), moderate stroke (score 5-15), moderate to severe stroke (score 16-20) and severe stroke (score 21-42).

To analyse the data obtained from the study, descriptive statistical methods (frequency and percentage), chi-square relationship test, or Fisher's exact test were used for quantitative variables and mean and standard deviation, for the qualitative variables the independent sample t-test or its non-parametric equivalent (Mann-Whitney U test) were used. Logistic regression analysis was performed for assessing the relationship between the occurrence of an event along with another variable by determining the correlation and probability of occurrence. We also grouped the participants based on discharge mRS to < 2 and 2-6 (mRS on Discharge category 1), < 3 and 3-6 (mRS on Discharge category 2); 3-months follow up mRS to < 2 and 2-6 (mRS after 3 months, discharge category 1), and < 3 and 3-6 (mRS after 3 months, discharge category 2). All statistical calculations were performed using the SPSS statistical software and a *P* values less than 0.05 were considered as statistically significant test result.

Results

A total of 701 eligible patients were included in the study, of which 524 (74.75%) had ACI and 177 (25.24%) had PCI stroke. The studied parameters are demonstrated in Table 1. There were no statistically significant differences in terms of age ($P = 0.724$), sex distribution ($P = 0.559$), and pre-stroke mRS ($P = 0.279$) between the patients.

Statistical analysis showed that CE, ESUS, and LAA strokes were higher in ACI patients; however, lacunar type was more prevalent in PCI patients ($P = 0.01$). There was a significant correlation between hospital NIHSS scores and stroke location in our study. Moderate stroke (57.6%) and minor stroke (21.5%) were observed more in PCI patients where the moderate (48.9%) and moderate to severe strokes (21%) were more prevalent in ACI patients ($P = 0.001$).

Also, there was a significant relationship between patients NIHSS scores in discharge ($P = 0.01$). Moderate (38.4%) and minor strokes (36.7%) were detected more in PCI patients. Between the ACI patients moderate and minor stroke were more observed with a prevalence of 42.4% and 26%. On the other hand, there was no crucial relation between the type of stroke and history of HTN ($P = 0.956$), diabetes ($P = 0.226$), dyslipidemia ($P = 0.099$), smoking ($P = 0.297$), atrial fibrillation (AF) ($P = 0.643$), TIA ($P = 0.266$), history of previous stroke ($P = 0.985$), history of coronary artery disease ($P = 0.078$), history of antiplatelet drug use ($P = 0.418$), statin use ($P = 0.940$), antihypertensive drug ($P = 0.983$), anti-diabetes drugs ($P = 0.931$) and anticoagulant drug use ($P > 0.05$).

Table 1. Comparing the posterior and anterior circulation infarctions

Variable	PCI (n = 177)	ACI (n = 524)	*P* value
Age (y)	67.97 ± 13.407	68.39 ± 13.512	0.724
Gender			
Female	71 (40.1%)	222 (42.4%)	0.559
Male	106 (59.8%)	302 (57.6%)	
Pre-stroke mRS			
0	126 (71.1%)	350 (66.7%)	0.279
1	51 (28.9%)	174 (43.4%)	
Cause of stroke			
CE	47 (26.7%)	156 (29.9%)	0.012*
LAA	26 (14.8%)	85 (16.3%)	
Lacunar	48 (27.3%)	84 (16.1%)	
Others	0 (0%)	0 (0%)	
ESUS	55 (31.2%)	197 (37.7%)	
NIHSS score			
Minor stroke	38 (21.5%)	59 (11.0%)	0.001*
Moderate stroke	102 (57.6%)	256 (48.9%)	
Moderate to severe stroke	15 (8.5%)	110 (21.0%)	
Severe stroke	22 (12.4%)	100 (19.1%)	
NIHSS score in discharge			
No stroke symptoms	19 (5.6%)	19 (3.6%)	0.023*
Minor stroke	65 (36.7%)	136 (26.0%)	
Moderate stroke	68 (38.4%)	222 (42.4%)	
Moderate to severe stroke	9 (5.1%)	45 (8.6%)	
Severe stroke	25 (14.2%)	102 (19.4%)	
Hypertension	122 (68.9%)	360 (68.7%)	0.956
Diabetes	56 (31.6%)	141 (26.9%)	0.226
Dyslipidemia	33 (18.6%)	71 (13.5%)	0.099
Smoking	22 (12.4%)	82 (15.6%)	0.297
Atrial fibrillation	10 (5.6%)	25 (4.8%)	0.643
Prior TIA	2 (1.1%)	2 (0.3%)	0.266
Myocardial infarction	34 (19.2%)	101 (19.2%)	0.985
History of coronary disease	34 (19.2%)	135 (25.7%)	0.078
Vascular problems	1 (0.005%)	0 (0%)	0.252
Antiplatelet usage history	49 (27.7%)	162 (30.9%)	0.418
Statin usage history	34 (19.2%)	102 (19.5%)	0.940
DM	36 (20.3%)	105 (20%)	0.931
mRS.Discharge.cat1			
<2	42 (23.7%)	61 (11.6%)	<0.001*
2-6	135 (76.3%)	463 (88.4%)	
mRS.Discharge.cat2			
<3	84 (47.5%)	170 (32.4%)	<0.001*
3-6	93 (52.5%)	354 (67.6%)	

ACI: anterior circulation infarction; PCI: posterior circulation infarction; mRS: Modified Rankin Score, NIHSS: National Institutes of Health Scale for Severity; TOAST: Acute Stroke Treatment; DM: Diabetes Mellitus; TIA: transient ischemic attack; CE: Cardioembolism; LAA: large arterial stroke; ESUS: undetermined etiology.
*Significant.

Tables 2 and 3 are logistic regression analyses of mRS discharge and 3-months mortality categories. There was a significant correlation between the location of the stroke and both the mRS Discharge.cat1 and mRS Discharge.cat2, even after adjusting for the possible cofounders. The associations between the location of the stroke and mRS after 3months categories were lost after adjusting for the cofounders.

Discussion

Our study stated that the probability of ACI stroke or PCI was not significantly related to age, sex, pre-stroke mRS, HTN, DM, dyslipidemia, smoking, AF, Prior TIA, myocardial infarction, history of coronary artery disease, or vascular problems. Our findings could also detect a significant difference between PCI and ACI patients in terms of the cause of stroke, hospital NIHSS, and NIHSS score in discharge. After adjusting for the possible cofounders, 3 months mortality did not significantly differ between PCI and ACI groups.

In a study performed in 2017, Kim et al. examined the clinical consequences of posterior circulation infarcts in comparison with anterior circulation infarcts in patients with a low NIHSS scale score. 7,178 patients with a mean age of 65.2 years were included in this study. The mean age of ACI patients was 65.9 and the mean age of PCI patients was 64.0 and the age difference between patients in ACI and PCI groups was significantly different; so, they concluded that PCI patients have a lower mean age.[17] In our study, although PCI patients were younger, the difference between the mean ages of the ACI and PCI groups was not significant. In terms of sexual distribution of patients, our study included 302 men (57.6%) and 222 women (62.4%) in the ACI group and 106 men (59.8%) and 71 women (40.2%) in the PCI group; therefore, there was no statistically significant difference in terms of sex distribution between groups. However, this difference was significant in the previous study by Kim et al. and the proportion of men in the PCI group was significantly higher than ACI.

The probable reason for these controversies could be the larger studied population in the mentioned study. In our study, in terms of pre-stroke mRS score the difference between the two groups was not statistically significant. This finding is in line with the results reported by Kim et al.[17]

In a study conducted by von Sarnowski et al, they compared the aetiologies and risk factors of stroke in the anterior and posterior circulation. The age range of patients in this study was from 18 to 55 years. Posterior circulation stroke was diagnosed through 612 patients and 1489 patients had anterior circulation stroke. The results of this study showed that posterior circulation strokes are more common in males.[18] This study suggested a different pattern of aetiology and risk factors which were in contrast with our results. We could not detect any notable differences between ACI and PCI patients regarding to

Table 2. Logistic regression analysis of mRS discharge categories

Predictors	Outcome			
	mRS.Discharge (mRS score 2–6)		mRS.Discharge (mRS score 3–6)	
	Crude OR (95% CI) [*P* value]	Adjusted OR (95% CI) * [*P* Value]	Crude OR (95% CI) [*P* Value]	Adjusted OR (95% CI) * [*P* Value]
RAD				
PCI	-	-	-	-
ACI	2.361 (1.525-3.656) [<0.001]	1.990 (1.121-3.533) [0.019]	1.881 (1.329-2.661) [<0.001]	1.403 (0.862-2.283) [0.173]

*Adjusted variables: AGE, sex, NIHSS, mRS baseline, HTN, DM, AF, Previous TIA, Previous PAD, TOAST, relevant arterial diseases, discharge antihypertensive medication, discharge antidiabetic medication, and discharge statin medication.

Table 3. logistic regression analysis of 3-months mortality categories

Predictors	Outcome					
	mRS3mo (mRS score 2–6)		mRS3mo (mRS score3–6)		Death.3mo	
	Crude OR (95% CI) [*P* value]	Adjusted OR (95% CI) * [*P* value]	Crude OR (95% CI) [*P* value]	Adjusted OR (95% CI) * [*P* value]	Crude OR (95% CI) [*P* value]	Adjusted OR (95% CI) * [*P* value]
RAD						
PCI	-	-	-	-	-	-
ACI	1.734 (1.203-2.499) [0.003]	1.539 (0.867-2.733) [0.141]	1.554 (1.104-2.189) [0.012]	1.148 (0.654-2.015) [0.630]	1.312 (0.813-2.117) [0.266]	0.707 (0.377-1.326) [0.279]

*Adjusted variables: AGE, sex, NIHSS, mRS baseline, HTN, DM, AF, Previous TIA, Previous PAD, TOAST, relevant arterial diseases, discharge antihypertensive medication, discharge antidiabetic medication, and discharge statin medication.

the stroke risk factors.

The aetiology of ischemic stroke influences the prognosis, management, and treatment of the disease. based on clinical manifestations and results of diagnostic tests, the TOSAT classification of ischemic stroke has been developed in 1993.[16] Statistical analysis of the present study showed that the prevalence of CE, ESUS, and LAA strokes were significantly higher in ACI patients and lacunar type was more observed through PCI patients. Kim et al[17] reported that, LAA was more observed in PCI patients which was in contrast with the results of our study, but in the case of distribution of CE stroke, the findings of Kim et al. were similar to ours.

We found that there was not any significant relationship observed between HTN history and stroke type. As well, there was no significant relation between none of DM, dyslipidemia, smoking, AF, TIA, history of stroke, history of coronary heart disease, PAD, history of antiplatelet drug use, history of statin use, an antihypertensive drug, anticoagulant drug use, and the incidence of stroke in the anterior or posterior circulation. However, the statistical analysis by Kim et al showed that the history of DM was higher in PCI patients. Also, this study noted that the history of TIA was significantly higher in ACI patients.[17]

There was a significant relationship between NIHSS score and the stroke location in our study. According to our findings, based on hospital NIHSS score, moderate (57.6%) and minor (21.5%) stroke was more presented in PCI patients and moderate (48.9%) and moderate to severe stroke (21%) were more frequent in ACI patients. When it comes to NHISS score in discharge, moderate stroke was more seen in both groups with a prevalence of 38.4% in the PCI group and 42.4% in the ACI group. Also, based on the NIHSS in discharge, patients with no stroke symptoms were detected more in PCI patients (5.6%) compared to ACI patients (3.6%). In other words, in our study, the ACI patients had a higher NIHSS score than PCI patients. In Kim, et al.'s study, a higher NIHSS score was seen in ACI patients and a lower NIHSS score was demonstrated in PCI patients,[17] which was consistent with our findings.

Another finding of our study was that the patients with PCI involvement had a higher rate of disability, but because the number of PCI patients in the community was lower, the involvement in these patients was not as evident as in patients with ACI involvement. On the other hand, it was predicted that patients with LAA, were associated with higher mortality and disability rates, which is more evident in patients with PCI involvement. In this study, some factors such as NIHSS scores were significantly different between PCI and ACI patients so ACI patients had higher NIHSS scores. Our findings suggest that while patients who undergo PCI are at a higher risk of disability and mortality, the most significant factor affecting a patient's survival is the type of vascular involvement in the stroke, rather than the type of stroke itself (LAA or lacunar); but in case of equal NIHSS scores of the patients, PCI patients' condition at discharge was much worse. The results of Kim and colleagues' study, stated that patients with mild PCI had a 26% higher chance of developing disability than patients with mild ACI. Out of 1000 patients, in the population of patients with mild PCI, there were 46 more patients with disability in 3 months and 23 more patients in need of help in 3

Study Highlights

What is current knowledge?

- There are limited and controversial results about the clinical consequences of anterior versus posterior circulation cerebral infarctions.

What is new here?

- Cardioembolism (CE), undetermined etiology (ESUS), and large arterial (LAA) strokes were higher in anterior circulation infarction (ACI) patients; however, lacunar type was more prevalent in posterior circulation infarction (PCI) patients. There were no statistically significant differences in terms of age, sex distribution, and pre-stroke Modified Rankin Score (mRS) between the patients. There was a significant correlation between hospital NIHSS scores and stroke location in our study. Moderate stroke (57.6%) and minor stroke (21.5%) were observed more in PCI patients where the moderate (48.9%) and moderate to severe strokes (21%) were more prevalent in ACI patients.

months than mild ACI.[17]

In the study by Kim et al, DWI was used to ensure the exact location of the stroke.[17] Most previous studies classify patients to have posterior circulatory and anterior circulatory infarction based on neurological defects and computed tomography rather than diffuse magnetic resonance imaging. The lack of DWI examination to ensure the exact location of the stroke was one of the limitations of this study, which is suggested to be considered in future studies. Also, the other important limitation of this study was the limited number of patients with PCI stroke.

Conclusion

In our study, the prevalence of ACI stroke was 75.76% and PCI stroke was 25.24%. The present study found that there is no relation between the risk of ACI or PCI stroke and age. Moreover, we concluded that patients with PCI involvement had a higher rate of disability, but the number of PCI patients among the population we studied was lower, which can affect these findings. On the other hand, it was predicted that patients with LAA demonstrated higher mortality and disability rates, which is more evident in patients with ACI involvement. In this study, some factors such as NIHSS scores were significantly different between PCI and ACI patients so ACI patients had higher NIHSS scores. There is still a need for further studies on this topic to reach a comprehensive conclusion.

Authors' Contribution

Conceptualization: Mazyar Hashemilar.
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Supervision: Mazyar Hashemilar.
Validation: Mazyar Hashemilar.
Writing–original draft: Sepideh Seyedi-Sahebari.
Writing–review & editing: Mazyar Hashemilar.

Competing Interests

The authors had no conflict of interests to be mentioned.

Ethical Approval

The study protocol has been reviewed and approved by the ethics committee of Tabriz University of Medical Sciences under the ethics code of IR.TBZMED.REC.1398.1038 (11 June 2019).

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