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Study the carotid Doppler and computed tomography of head in ischemic stroke patients

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ABSTRACT

Background: A stroke is an episode of acute neurological dysfunction from either ischemic infarction or a collection of blood within the brain or ventricular system with resultant focal injury of the central nervous system. The estimated global incidence of stroke is 2–3/1000 person-years, with older patients and patients with carotid artery stenosis or atrial fibrillation having the highest risk. Hence, carotid studies may help with early prevention and management in patients. **Aims and Objectives:** We aimed to study the prevalence of carotid artery stenosis in acute ischemic stroke and the association of risk factors. **Materials and Methods:** This was a descriptive study conducted in the department of internal medicine over a period of 6 months. It was carried out in 125 ischemic stroke patients' inpatient departments. The ischemic stroke was established with history, examination, and computed tomography (CT) with carotid color Doppler study for percentage of stenosis. **Results:** The 47 (37.6%) stroke patients had carotid stenosis <50% and 78 (62.4%) had >50%; out of them, 32% (40) had (≥50–69%) stenosis, 24% (30) exhibited 70–99%, and 6.4% (8) reported total occlusion. In the CT brain, lacunar infarcts were found in 42 (33.6%), normal and middle cerebral artery infarcts in 27 (21.6%), anterior cerebral artery infarcts in 17 (13.6%), and posterior cerebral artery infarcts in 12 (9.6%). In clinical profiles, 75 (60%) patients presented with right-sided hemiparesis, 50 (40%) with left-sided hemiparesis, 62 (49.6%) with loss of consciousness, 28 (22.4%) with dizziness, and 31 (24.8%) with motor aphasia. Conventional risk factors include hypertension in 68 (54.4%), diabetes in 39 (31.2%), dyslipidemia in 58 (46.4%), heart disease in 65 (52%), and smoking in 51 (40.8%). In the present study, the majority of patients found carotid stenosis >50%, lacunar infarcts were the most common CT findings, and right hemiparesis was common paresis. Hypertension was the most common risk factor among others, and all were significant (P<0.05) for the stroke. **Conclusion:** There is a high prevalence of carotid stenosis, with >50% in ischemic stroke patients with hypertension being the most common risk factor.

Key words: Carotid; Doppler; Hypertension; Ischemic; Lacunar

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INTRODUCTION

Stroke is defined as the abrupt onset of a neurologic deficit due to a vascular cause.[1] It is a major cause of disability and remains the second leading cause of death worldwide.[2] Early diagnosis and treatment are necessary to prevent mortality and morbidity. The risk factors for stroke are a previous ischemic attack, a history of diabetes, hypertension, dyslipidemia, the presence of asymptomatic carotid plaques, and a high degree of carotid stenosis.[3]

There are many investigations to confirm the diagnosis of stroke, among which computed tomography (CT) and magnetic resonance imaging (MRI) play major roles.[4] Plain CT remains the standard tool for initial assessment in most centers because the large thrombolysis trials were all CT based.[5]

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CT plays a major role in stroke to assess the site, size, and nature of the lesion. 85% of stroke causes are due to infractions, and 15% are due to hemorrhage. Carotid atherosclerosis remains an important cause of ischemic stroke.[6]

Sabetai et al., in their study, concluded that the more severe the carotid stenosis, the higher the incidence of cerebral infraction ipsilateral to the stenosis.[7]

Introduction to color Doppler imaging has dramatically changed the diagnostic evolution of suspected carotid disease. Doppler sonography provides a rapid, non-invasive, relatively inexpensive, and accurate means of diagnosing carotid stenosis and highlights the importance of Doppler sonography in stroke prevention.[8]

Das et al., conducted a study, on 157 patients in northeast India with their first ischemic stroke by carotid Doppler ultrasonography. They found the prevalence of significant (50%) extracranial carotid stenosis to be 8.92% with color Doppler carotid sonography.[9]

A simple, non-invasive screening procedure like Doppler sonography of the carotid arteries could therefore have profound diagnostic and therapeutic implications in predicting and preventing the potentially fatal and devastating consequences of stroke. Hence, this study is carried out to evaluate the color Doppler findings of carotid artery stenosis in patients presenting with ischemic stroke with CT head in a tertiary care center at Lumbini Medical College and Teaching Hospital.

Aims and objectives

The objective of this study was to know the prevalence of carotid artery stenosis using ultrasonography in acute ischemic stroke with CT head proven and the association of risk factors.

MATERIALS AND METHODS

The present study was a hospital-based descriptive study conducted at Lumbini Medical College and Teaching Hospital, Pravash, Palpa, Nepal. The study was conducted over a period of 6 months, and 125 patients with clinical symptoms of acute ischemic stroke within a week were recruited for this study after taking ethical clearance from the institutional review committee and written consent was obtained from all the participants.

All patients irrespective of age, sex, socio-economic status, or ethnicity, with clinical features of stroke and showing evidence of ischemia in CT or MRI and who gave consent, were enrolled in the study.

Patients in whom the duration of stroke is >1 week. Patients with hemorrhagic stroke, patients with history of head injury, and systematic illnesses such as hemodynamically unstable patients, malignancy, unconscious patients, stroke-like syndromes such as TB, metabolic emergencies, and poor general conditions were excluded from our study. A detailed clinical history, physical examination, and risk factors such as hypertension, diabetes mellitus, cardiac disease, dyslipidemia, alcohol, and smoking were collected using a structured questionnaire.

Samples were collected from patients attending out-door patients and stable indoor patients from the department of internal medicine. Cases were enrolled in the study after meeting selection criteria.

Sample size calculation

From the previous study, the prevalence was 8.92% of carotid stenosis in the Doppler study.[9] With the help of this p value, the sample size was calculated with the formula 2 P(1-P) 2 using the standard sample size calculation (n) = (Z 1-α/2x)/d, where n=sample size and p=estimated prevalence for this study (8.92%), z= 1.96 at a 95% confidence interval, α= type 1 error (0.05), d = margin of error (5%), so our sample size is 125.

A minimum of one hundred and twenty-five patients with ischemic stroke of both sexes were enrolled after carefully applying the inclusion and exclusion criteria. The diagnosis of an ischemic stroke is considered on the basis of history, clinical examinations, and confirmation by CT head.

Carotid Doppler was done with a 6 to 11 MHz linear-array variable frequency transducer used at 9 MHz for B- mode. B-mode sonograms were used to search for plaques within the arterial wall. Measurements of each plaque at its point of maximum stenosis and the vessel diameter at that point were taken in the transverse axis and later used to calculate the percentage stenosis caused by that plaque. Lumen diameter, intimo-medial complex thickness, and characters of plaques were recorded, and the calculation of luminal diameter reduction in terms of cross-sectional area was done by using the existing program in the ultrasonography itself.

Quantification of the degree of narrowing was categorized as normal, <50% narrowing, significant stenosis was defined as ≥50–69% stenosis, severe stenosis was defined as ≥70–99% stenosis, and total occlusion.[10]

The patients underwent a CT scan of the brain before the color Doppler sonography of carotid arteries, and various findings such as the side of the infarct (right or left) and vascular territory (middle cerebral artery [MCA], anterior

cerebral artery [ACA], and posterior cerebral artery [PCA]) were noted.

Data were collected covering all the relevant parameters along with conventional risk factors for stroke and carotid stenosis for the study. All categorical data, including findings on carotid Doppler, were expressed in percent and absolute numbers. The risk factors were presented in terms of percentage and number as the prevalence of the study in the form of tables and figures. The statistical method employed was Chi-square tests to compare data and obtain statistically significant differences in two variables. All tests were analyzed and were considered statistically significant if P<0.05. The Statistical Package for the Social Sciences 20 was used for data analysis.

RESULTS

After using carotid sonography to evaluate the carotid arteries of 125 ischemic stroke patients, 47 (37.6%) had carotid stenosis <50% and the majority of patients, 78 (62.4%), had carotid stenosis >50%. Similarly stratification in >50% carotid artery Doppler study, 32% (40) of them exhibited substantial (≥50–69%) luminal stenosis, 24% (30) exhibited 70–99% luminal stenosis, and 6.4% (8) reported total occlusion of carotid arteries (Table 1). There was an association between carotid stenosis above 50% and smoking (P=0.032), diabetes (P=0.054), and alcoholic (P=0.032).

CT brain findings showed normal and MCA infarct findings in 27 (21.6%) cases, ACA in 17 (13.6%) cases and PCA infarct findings in 12 (9.6%) cases, whereas lacunar infarcts in 42 (33.6%) cases were the most common pathological involvement (Table 2).

Once more, the relationship between the site of infarcts and the frequency of cases with a percentage of carotid artery stenosis was revealed by CT brain findings and carotid Doppler testing. According to the Doppler investigation, 47 (37.6%) out of 125 ischemic stroke patients had carotid stenosis that was <50%, while 78 (62.4%) instances had carotid stenosis that was >50%. There were 18 patients (38.3%) with lacunar infarct, 12 patients (25.5%) with MCA infarct, 6 patients (12.8%) with ACA infarct, and 3 patients (6.4%) with PCA infarct with carotid stenosis <50%, while there were 8 normal results (17.0%). 50–100% of patients with carotid stenosis had lacunar infarcts; Table 3 shows that there were 24 (30.8%) lacunar infarcts, 15 (19.2%) MCA infarcts, 11 (14.1%) ACA infarcts, and 9 (11.5%) PCA infarcts, while the normal results were 19.4%.

Seventy-five (60%) patients presented with right sided hemiparesis, 50 (40%) had left sided hemiparesis, 62 (49.6%) had loss of consciousness and 28 (22.4%) had history of ataxia and dizziness. Motor aphasia was observed in 31 (24.8%) patients. Hemiparesis both right and left, loss of consciousness, ataxia and aphasia were more in carotid stenosis 50–100% shown in Figure 1.

Table 1: Carotid Doppler study and number of patients

<50% stenosis n=47 (37.6%)	50–100% stenosis n=78 (62.4)	n=125 (%)
50–69% stenosis		40 (32)
70–99% stenosis		30 (24)
Total occlusion		8 (6.4)

Table 2: CT head findings

Site/type	n=125 (%)
Lacunar infarct	42 (33.6)
MCA infarct	27 (21.6)
ACA infarct	17 (13.6)
PCA infarct*	12 (9.6)
Normal	27 (21.6)

*PCA infarct a/w carotid stenosis. MCA: Middle cerebral infarct; ACA: Anterior cerebral artery, PCA: Posterior cerebral artery

Table 3: CT Head and Carotid study findings

Site/Type	<50% stenosis n=47 (37.6%)	50–100% stenosis n=78 (62.4%)
Lacunar infarct	18 (38.3)	24 (30.8)
MCA infarct	12 (25.5)	15 (19.2)
ACA infarct	6 (12.8)	11 (14.1)
PCA infarct*	3 (6.4)	9 (11.5)
Normal	8 (17)	19 (24.4)

*PCA infarct associated with carotid stenosis. MCA: Middle cerebral infarct; ACA: Anterior cerebral artery, PCA: Posterior cerebral artery

Conventional risk factors shown in Figure.2, in the study participants were hypertension in 68 (54.4%), diabetes in 39 (31.2%), dyslipidemia in 58 (46.4%), documented heart disease in 65 (52%), actively smoking in 51 (40.8%), and history of alcohol intake in 47 (37.6%) patients. A strong association with stroke was observed with patients with diabetes, hypertension, dyslipidemia, and heart disease; those with active smokers and a history of alcohol were significant results (P<0.001) in stroke patients.

DISCUSSION

The present study has demonstrated the prevalence of carotid stenosis in first-time ischemic stroke patients (Table 1). When carotid arteries were scanned (with sonography), a higher number of patients 78 (62.4%) carotid Doppler study were found to have above 50% stenosis, while 47 (37.6%) had <50% carotid stenosis. Few previous studies also found a high prevalence of carotid stenosis >50% in ischemic stroke patients.[9,11] On further

stratification, in the above 50% carotid study, a majority of 47 (37.6%), 40 (32%) cases with 50–69% stenosis were found, 30 (24%) cases with 70–99% stenosis, and a few 8 (6.4%) cases were found to be normal. In a study conducted by Garg et al., out of 354 cases, the prevalence of mild stenosis (<50%) was quite large, with 291 (82.20%) cases. However, the prevalence of severe stenosis (>50%) was quite low.[12] In a study done by Gyawali et al. in the Nepali population, the prevalence of <50% carotid stenosis in stroke patients was 48 (62.3%), ischemic patients who had carotid artery >50–70% stenosis were 18 (23.4%), and carotid artery stenosis >70% patients were 11 (14.3%), which was almost similar findings with our study.[3] However, higher the incidence of ischemic stroke was 46.9% in 50–69% carotid stenosis and only 25% in <50% carotid stenosis in the study done by Rajesh and Richa.[13] Some of the above studies were correlated with our findings, and a few studies did not agree, so there might be a few other risk factors contributing to the development of the ischemic stroke.

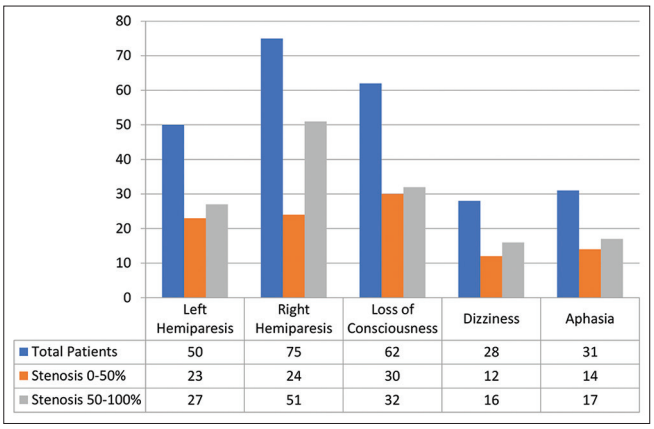

Figure 1: Severity of carotid stenosis with presenting symptoms

In this study, brain neuro-imaging findings were lacunar infarcts, 42 (33.6%) were the most common findings, followed by equally normal findings and MCA infarcts 27 (21.6%), ACA infarcts 17 (13.6%), and posterior circulation infarcts 12 (9.6%). Lacunar infarcts were similarly common CT findings in ischemic infarct patients in a previous study.[14] Among the stroke patients, neuro-imaging study normal and lacunar infarct 13 (36%) were the two equal common CT findings, according to Fernandes et al.[15]

This study also demonstrated the neuro-imaging in carotid Doppler study stenosis >50% and <50% patients' status. Lacunar infarct was the most common finding in 24 (30.8%) and 18 (38.3%) CT findings in carotid artery stenosis >50% and <50%, respectively, and the least common finding was PCA infarct 9 (11.5%) and 3 (6.4%), respectively. Seventy-five percent of patients with <50% stenosis had lacunar infarcts in CT findings. According to the Rajesh study,[13] Lacunar infarct 41 (34.2%) was the most common CT brain findings, and PCA infarct 12 (10%) was the least common CT finding in ischemic stroke patients, in a study done by Gyawali et al.[3] The above study's findings were correlated with our findings.

In this study of the evaluation of clinical profiles, right hemiparesis 75 (60%) patients were more than left hemiparesis 50 (40%); out of right hemiparesis, 51 (68%) had carotid stenosis >50%; and in a left hemiparesis, a similar finding was that 27 (54%) had >50% carotid stenosis. In this study, 62 (49.6%) were found loss of conscious and out of them, 32 (51.6%) had >50% carotid stenosis, 28 (22.4%) with dizziness, 16 (57.14%) had >50% carotid stenosis, and 31 (24.8%) with aphasia. Out of them, 17 (54.83%) had carotid stenosis >50%. These above

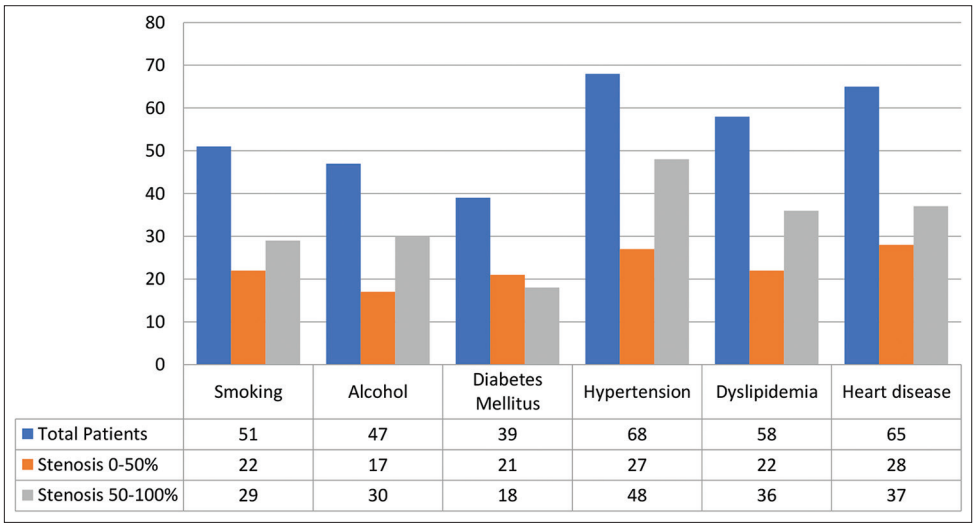

Figure 2: Presentation of stroke risk factors with the severity of carotid stenosis

clinical profiles were similar to findings from previous studies done by Gyawali et al.,[3] Bollipo et al.,[11] Fernandes et al.,[15] and Pathak et al.[16]

In the risk factor evaluation in this study, 68 (54.4%) were hypertensive patients, out of whom 48 (70.58%) had significant stenosis. Fernandes et al.,[15] studied found 19 (38%) patients were hypertensive, out of which 4 (21%) had significant stenosis. According to Das et al., hypertension was the common risk factor in both group stenosis (>50%) patients and <50% carotid stenosis.

In our study, of the 125 patients, 65 (52%) had heart disease and showed the strongest positive correlation with carotid artery stenosis, out of which 37 (56.92%) had >50% stenosis. Das et al.,[9] studied 157 patients with ischemic stroke, out of whom 19.70% had heart disease, 35.70% had >50% stenosis, and 18.20% had 0–50% carotid stenosis[9] Garg et al.,[12] study also found heart disease showed the maximum positive correlation with carotid stenosis in ischemic stroke.

In this study, 58 (46.4%) patients had dyslipidemia, of which 36 (62.06%) had >50% stenosis and 22 (37.93%) had <50 carotid stenosis. A study conducted by Gyawali et al.,[3] observed dyslipidemia (51.7%) in stroke patients with carotid stenosis.

In our study, risk factors like smoking, alcohol, and diabetes mellitus were found in 51 (40.8%), 47 (37.6%), and 39 (31.2%) of patients, respectively, out of which 29 (56.86%), 30 (63.82%), and 18 (46.15%) had >50% carotid stenosis. Fernandes et al.,[15] study found 20 (40%) with a history of smoking and 8 (16%) patients had diabetes mellitus. Out of them, 6 (30%) had significant stenosis in smoking patients, and 3 (37%) had significant stenosis in diabetes mellitus.

Limitations of study

In this study, we were not able measured type of plaque, not able to covered all the clinical features and risk factors.

CONCLUSION

In this study, 125 ischemic stroke patients were enrolled. In the carotid Doppler study, high prevalence was associated with >50% stenosis as compared with <50% stenosis.

In CT imagining study, lacunar infarct found most common followed by normal and MCA infarct with least common was PCA infarct.

Right-sided hemiparesis was more common than left-sided hemiparesis in our study patients. The next common clinical features were loss of conscious, aphasia, and dizziness.

In the conventional risk factors, HTN was the most common, followed by heart disease, dyslipidemia, smoking, alcohol, and diabetes mellitus.

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Authors Contribution:
TP- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **JK-** Data collection and statistical analysis and interpretation; **SP-** Editing, coordination and manuscript revision; **HG-** Data collection and statistical analysis and interpretation; **BP-** Data collection and statistical analysis and interpretation.

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