

CORRELATION BETWEEN MICROALBUMINURIA AND SEVERITY OF ACUTE ISCHEMIC STROKE: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute ischemic stroke remains a major contributor to mortality and long-term neurological disability worldwide. Identification of inexpensive and readily available biomarkers that reflect disease severity may facilitate early risk stratification and optimize clinical management. Microalbuminuria, a marker of generalized endothelial dysfunction and vascular injury, has emerged as a potential predictor of adverse cardiovascular and cerebrovascular outcomes. **Methods:** This hospital-based observational study was designed to evaluate the relationship between microalbuminuria and the severity of acute ischemic stroke among adult patients presenting to a tertiary care teaching hospital. Eligible patients underwent clinical evaluation, laboratory investigations including urine albumin-creatinine ratio assessment, and neurological examination using the National Institutes of Health Stroke Scale. Demographic characteristics, vascular risk factors, and relevant clinical variables were documented. Statistical analyses included descriptive methods and appropriate inferential tests to assess associations between urinary albumin excretion and stroke severity while accounting for potential confounding variables. **Result:** Patients with elevated urinary albumin excretion demonstrated a tendency toward more severe neurological impairment at presentation. Increasing levels of microalbuminuria were associated with higher stroke severity scores and a greater burden of conventional vascular risk factors, supporting its potential role as an indicator of widespread endothelial dysfunction in acute ischemic stroke. **Conclusion:** Measurement of microalbuminuria may provide clinically useful prognostic information in patients with acute ischemic stroke. As a simple and widely accessible laboratory parameter, it has the potential to complement conventional clinical assessment and contribute to early risk stratification in routine practice. Further multicentre studies with larger populations are warranted to validate these findings and determine their implications for patient management.

Keywords: Acute ischemic stroke, Microalbuminuria, Urine albumin-creatinine ratio, National Institutes of Health Stroke Scale, Endothelial dysfunction, Cerebrovascular disease, Biomarkers, Prognosis.

INTRODUCTION

Stroke is one of the leading causes of death and long-term disability worldwide, with acute ischemic stroke accounting for nearly 80–85% of all cerebrovascular events. Despite substantial advances in acute stroke care, early identification of patients at risk of severe neurological deficits remains an important clinical challenge. Biomarkers that are inexpensive, rapidly measurable, and reflective of

the underlying vascular pathology may improve risk stratification and facilitate timely therapeutic interventions.^[1]

Microalbuminuria, defined as moderately increased urinary albumin excretion, is increasingly recognized as a marker of generalized endothelial dysfunction rather than merely an indicator of early renal injury. Endothelial damage contributes to increased vascular permeability, chronic inflammation, oxidative stress, and accelerated

atherosclerosis, all of which play critical roles in the development and progression of ischemic stroke. Consequently, microalbuminuria has gained attention as a potential surrogate marker of systemic vascular injury and adverse cerebrovascular outcomes.^[2,3]

Several clinical studies have demonstrated a significant association between microalbuminuria and stroke severity. Pavuluri et al. reported that microalbuminuria independently predicted early neurological deterioration in patients with acute ischemic stroke and was associated with worse clinical outcomes.^[4] Huang et al. further showed that elevated urinary microalbumin levels were predictive of early neurological deterioration across different etiological subtypes of ischemic stroke, suggesting its utility as an early prognostic biomarker.^[5] Earlier observational studies by Gaurav et al. and Słowik et al. similarly demonstrated that patients with microalbuminuria had significantly higher NIHSS scores and more severe neurological deficits than those without elevated urinary albumin excretion.^[6,7]

Evidence from systematic reviews also supports the clinical relevance of albuminuria in cerebrovascular disease. Li et al. observed that microalbuminuria is common among patients with acute ischemic stroke and is associated with poor neurological outcomes and increased vascular risk.^[8] In addition, recent reviews on biomarkers in acute ischemic stroke have emphasized the potential value of urinary biomarkers, including microalbuminuria, for improving prognostic assessment when used alongside conventional clinical evaluation.^[9]

The biological basis of this association is likely multifactorial. Generalized endothelial dysfunction may simultaneously affect cerebral and renal microvasculature, resulting in disruption of the blood–brain barrier, impaired autoregulation, increased vascular permeability, and glomerular albumin leakage. Thus, urinary albumin excretion may serve as an indirect marker of widespread vascular injury and microangiopathy, predisposing patients to larger infarct burden and more severe neurological impairment.^[2,4,8]

In countries such as India, where stroke continues to impose a substantial healthcare burden, identifying low-cost biomarkers that can be readily incorporated into routine clinical practice is of considerable importance. Measurement of the urine albumin-to-creatinine ratio is simple, inexpensive, and widely available, making it an attractive adjunct for bedside prognostication. However, evidence regarding its relationship with stroke severity remains heterogeneous, and further observational studies are required to strengthen the existing literature. Therefore, the present study was undertaken to evaluate the correlation between microalbuminuria and the severity of acute ischemic stroke and to explore its potential utility as a practical prognostic marker in routine clinical care.

MATERIALS AND METHODS

The present study was conducted as a hospital-based observational study in the Department of General Medicine, Trichy SRM Medical College Hospital and Research Centre. Adult patients presenting with acute ischemic stroke were considered for enrolment after clinical assessment and confirmation of eligibility. The study population included patients of either sex aged 40–65 years who presented with acute ischemic stroke. Patients with known renal disease, urinary tract infection, malignancy, eclampsia or preeclampsia, rheumatic heart disease, or cardiomyopathy were excluded, as these conditions could independently influence urinary albumin excretion or confound the interpretation of microalbuminuria.

A total sample size of 120 patients was planned. The sample size was derived using the single proportion formula: where Z_{α} was taken as 1.96 at 95% confidence level, p represented the expected prevalence of microalbuminuria among patients with acute ischemic stroke based on previous literature, $q = 1 - p$, and d represented the allowable absolute precision. After adjustment for feasibility and anticipated data completeness, the final sample size was fixed at 120 participants. Patients fulfilling the inclusion criteria were recruited by consecutive sampling. After obtaining informed consent, demographic details, presenting complaints, vascular risk factors, relevant past history, personal habits, and clinical examination findings were recorded using a structured study proforma. Stroke severity was assessed using the National Institutes of Health Stroke Scale, a validated neurological scoring system that evaluates consciousness, gaze, visual fields, facial palsy, motor function, limb ataxia, sensory loss, language, dysarthria, and neglect. Urine albumin-creatinine ratio was measured using a spot urine sample. Microalbuminuria was defined as urine albumin-creatinine ratio between 30 and 300 mg/g.

The primary study variable was microalbuminuria, assessed using urine albumin-creatinine ratio. The primary outcome variable was severity of acute ischemic stroke as measured by NIHSS score. Other variables included age, sex, body mass index, blood pressure, diabetes mellitus, systemic hypertension, coronary artery disease, smoking, alcohol use, and relevant clinical features at presentation.

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26. Continuous variables were summarized using mean and standard deviation for normally distributed data and median with interquartile range for skewed data. Categorical variables were expressed as frequency and percentage. Normality of continuous variables was assessed using appropriate statistical tests. Comparison of continuous variables between groups was performed using the independent samples *t*-test for normally distributed data and Mann–Whitney *U*

test for non-normally distributed data. Associations between categorical variables were assessed using the chi-square test or Fisher's exact test, as appropriate. Correlation between urine albumin-creatinine ratio and NIHSS score was evaluated using Pearson or Spearman correlation depending on data distribution. Univariate and multivariate logistic regression analyses were planned to identify factors independently associated with stroke severity after adjusting for age, diabetes mellitus, hypertension, smoking, alcohol use, and other relevant vascular risk factors. A two-sided p value of less than 0.05 was considered statistically significant.

The study was conducted after approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants or legally acceptable representatives before enrolment.

Confidentiality of patient information was maintained throughout the study, and all data were used only for academic and research purposes.

RESULTS

A total of 120 patients diagnosed with acute ischemic stroke were included in the study. The demographic profile, vascular risk factors, urinary albumin excretion, and neurological severity were evaluated to determine the relationship between microalbuminuria and stroke severity. The findings demonstrated that patients with higher urinary albumin excretion tended to present with more severe neurological deficits as assessed by the National Institutes of Health Stroke Scale (NIHSS).

Table 1. Baseline demographic and clinical characteristics of the study participants

Variable	Value
Sample size	120
Mean age (years)	56.8 ± 8.4
Male sex	72 (60.0%)
Female sex	48 (40.0%)
Hypertension	68 (56.7%)
Diabetes mellitus	46 (38.3%)
Current smokers	39 (32.5%)
Alcohol consumption	42 (35.0%)
Mean BMI (kg/m ²)	25.3 ± 3.4

The study population predominantly consisted of middle-aged and older adults with a slight male predominance. Conventional vascular risk factors,

particularly hypertension and diabetes mellitus, were frequently observed among patients presenting with acute ischemic stroke.

Table 2: Distribution of study participants according to urine albumin-creatinine ratio category

UACR category	Number (%)
30–99 mg/g	44 (36.7%)
100–199 mg/g	41 (34.2%)
200–300 mg/g	35 (29.1%)
Total	120 (100.0%)

Most participants demonstrated urinary albumin-creatinine ratio values within the lower and intermediate microalbuminuria ranges, while nearly

one-third exhibited values approaching the upper limit of the defined microalbuminuria spectrum.

Table 3. Distribution according to NIHSS severity category

NIHSS severity	Number (%)
Mild	38 (31.7%)
Moderate	49 (40.8%)
Severe	33 (27.5%)
Total	120 (100.0%)

Moderate neurological impairment constituted the largest proportion of the study cohort, followed by mild and severe stroke presentations.

Table 4: Association between urine albumin-creatinine ratio and stroke severity

UACR category	Mild	Moderate	Severe	p value
30–99 mg/g	22	17	5	
100–199 mg/g	12	20	9	
200–300 mg/g	4	12	19	<0.001

A progressive increase in neurological severity was observed with increasing urinary albumin excretion. Patients in the highest urine albumin-creatinine ratio

category were more likely to have severe NIHSS scores, whereas those with lower urinary albumin levels predominantly had mild neurological deficits.

Table 5: Correlation between urinary albumin excretion and NIHSS score

Variable	Correlation coefficient (r)	p value
UACR vs NIHSS score	0.58	<0.001

Correlation analysis demonstrated a moderate positive relationship between urinary albumin-creatinine ratio and NIHSS score, indicating that increasing microalbuminuria was associated with greater neurological impairment.

The findings suggest that urinary albumin excretion demonstrates a significant positive association with the clinical severity of acute ischemic stroke. Individuals with higher urine albumin-creatinine ratios consistently exhibited more severe neurological deficits and higher NIHSS scores at presentation. These observations support the hypothesis that microalbuminuria reflects systemic endothelial dysfunction and may serve as a practical biomarker for identifying patients at greater risk of severe acute ischemic stroke.

DISCUSSION

The present study evaluated the relationship between microalbuminuria and the severity of acute ischemic stroke and demonstrated a significant positive association between increasing urinary albumin excretion and greater neurological impairment. Patients with higher urine albumin-creatinine ratios were more likely to present with elevated NIHSS scores, suggesting that microalbuminuria may serve as a readily available biomarker reflecting the extent of cerebrovascular injury and systemic endothelial dysfunction. These findings support the growing body of evidence that renal microvascular abnormalities and cerebral vascular disease share common pathophysiological mechanisms.

The observed association between microalbuminuria and stroke severity is biologically plausible. Endothelial dysfunction results in disruption of vascular integrity, increased capillary permeability, inflammatory activation, and enhanced oxidative stress, ultimately leading to albumin leakage through the glomerular filtration barrier. Similar vascular alterations within cerebral circulation may contribute to impaired autoregulation, blood-brain barrier dysfunction, and progression of ischemic injury. Consequently, elevated urinary albumin excretion may represent a systemic manifestation of widespread vascular damage rather than an isolated renal abnormality.^[2,3]

The findings of the present study are consistent with those reported by Pavuluri et al., who demonstrated that patients with microalbuminuria experienced more severe neurological deficits and an increased likelihood of early neurological deterioration following acute ischemic stroke.^[4] Their observations suggested that urinary albumin excretion could provide clinically meaningful prognostic information during the early phase of stroke management.

Comparable results have also been reported by Huang et al., who found that elevated urinary microalbumin levels were independently associated with early neurological worsening across different etiological subtypes of ischemic stroke.^[5] Their work emphasized that microalbuminuria may reflect ongoing vascular injury irrespective of stroke mechanism and may therefore have broad applicability as a prognostic marker.

The present observations are further supported by the study conducted by Gaurav et al., which identified a significant positive correlation between microalbuminuria and NIHSS score among patients with acute ischemic stroke.^[6] Individuals with higher urinary albumin excretion demonstrated more severe neurological impairment, reinforcing the concept that albuminuria mirrors systemic endothelial dysfunction and microvascular disease.

Earlier evidence from Słowik et al. also demonstrated that non-diabetic patients with acute ischemic stroke who exhibited microalbuminuria experienced greater neurological deficits than those without albuminuria.^[7] Despite differences in patient characteristics and study settings, their findings closely align with the current observations and suggest that the association extends beyond traditional metabolic risk factors.

Beyond individual observational studies, broader evidence has highlighted the prognostic significance of albuminuria in cerebrovascular disease. Reviews examining biomarkers in acute ischemic stroke have concluded that urinary biomarkers may complement clinical assessment by identifying patients at increased risk of adverse neurological outcomes.^[8] Similarly, previous work by Ovbiagele proposed that microalbuminuria represents a marker of generalized vascular injury and may provide insight into future cerebrovascular risk as well as disease progression.^[3]

The relationship between microalbuminuria and stroke severity may also be explained by shared risk factors including hypertension, diabetes mellitus, chronic inflammation, and diffuse atherosclerosis. Persistent endothelial injury in these conditions promotes both renal albumin leakage and cerebrovascular pathology. Thus, microalbuminuria should not be viewed solely as a renal marker but rather as an indicator of widespread vascular dysfunction affecting multiple organ systems.

An important strength of the present study is the use of a standardized neurological assessment tool, namely the National Institutes of Health Stroke Scale, together with objective laboratory quantification of urinary albumin excretion. The observational design and inclusion of patients encountered in routine tertiary care practice enhance the clinical applicability of the findings and support the feasibility of incorporating urine albumin-

creatinine ratio measurement into routine evaluation of patients with acute ischemic stroke.

Nevertheless, certain limitations should be acknowledged. The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to broader populations. Single-point measurement of urinary albumin excretion may not fully account for biological variability. In addition, although major confounding conditions affecting albuminuria were excluded, residual confounding from unmeasured vascular and metabolic factors cannot be completely eliminated. Longitudinal studies incorporating functional outcomes and mortality would further clarify the prognostic significance of microalbuminuria over time.

From a clinical perspective, the findings suggest that assessment of urinary albumin excretion could provide valuable supplementary information during the initial evaluation of patients with acute ischemic stroke. Because urine albumin-creatinine ratio testing is inexpensive, non-invasive, and widely available, it may be particularly useful in resource-constrained healthcare settings where access to advanced prognostic biomarkers is limited. Incorporation of this parameter into comprehensive risk assessment models may facilitate early identification of patients requiring closer monitoring and more intensive management strategies.

Future multicentre prospective studies with larger sample sizes should investigate whether serial measurements of urinary albumin excretion improve prognostic accuracy and whether interventions targeting endothelial dysfunction can modify neurological outcomes. Exploration of the relationship between microalbuminuria, infarct volume, neuroimaging characteristics, and long-term functional recovery may also provide additional insight into the biological significance of this readily measurable biomarker.

Overall, the present study adds to the growing evidence supporting an association between microalbuminuria and the severity of acute ischemic stroke. The consistent relationship between increasing urinary albumin excretion and greater neurological impairment suggests that microalbuminuria may serve as a practical and clinically relevant biomarker reflecting systemic vascular injury and disease severity.

CONCLUSION

The present study demonstrates a significant association between microalbuminuria and the severity of acute ischemic stroke, suggesting that increased urinary albumin excretion reflects greater neurological impairment at presentation. As a marker of systemic endothelial dysfunction and widespread vascular injury, microalbuminuria has the potential to serve as a simple, inexpensive, and readily accessible adjunct in the early evaluation of patients with acute ischemic stroke. Incorporation of urine albumin-creatinine ratio assessment into routine clinical practice may improve risk stratification and assist clinicians in identifying individuals who require closer monitoring and more intensive management. Further large-scale multicentre studies are warranted to validate these findings and to determine the prognostic value of microalbuminuria across diverse patient populations and long-term clinical outcomes.

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