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Research Article

Assessment of serum glucose potassium ratio as a predictor for mortality of acute ischemic stroke

Akut iskemik inme mortalitesinin bir belirleyicisi olarak serum glukoz potasyum oranının değerlendirilmesi

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Abstract

Aim: The study aims to demonstrate the effect of changes in serum glucose/potassium ratio (GPR) which were performed in patients with acute ischemic stroke (AIS) and patient management is performed more quickly and effectively.

Material and Methods: The hemogram and biochemical parameters of patients undergoing mechanical thrombectomy (MT) for AIS have been retrospectively reviewed. Patients were divided into two groups non-survivors and survivors. The GPR was calculated, and their ability to predict mortality was statistically evaluated between the groups.

Results: A total of 173 patients, of which 131 in the survivor group and 42 in the non-survivor group, were examined. In the non-survivor group Glucose and GPR were statistically higher than the survivor group ($p<0.05$). Moreover, the sensitivity and specificity of the serum GPR were found to be 97.6% and 50.4%, respectively.

Conclusion: These findings suggest that GPR could serve as a useful parameter for predicting mortality in AIS patients undergoing mechanical thrombectomy.

Keywords: glucose-potassium ratio, acute ischemic stroke, mortality, mechanical thrombectomy

ÖZ

Amaç: Bu çalışma, akut iskemik inme (AIS) hastalarında yapılan serum glukoz/potasyum oranındaki (GPR) değişikliklerin hasta yönetiminin daha hızlı ve etkin bir şekilde yapılmasına etkisini göstermeyi amaçlamaktadır.

Gereç ve Yöntemler: AIS nedeniyle mekanik trombektomi uygulanan hastaların hematolojik ve biyokimyasal parametreleri retrospektif olarak incelendi. Hastalar non-survivor (yaşamayanlar) ve survivor (yaşayanlar) olmak üzere iki gruba ayrıldı. GPR hesaplandı ve mortaliteyi tahmin etme yetenekleri gruplar arasında istatistiksel olarak değerlendirildi.

Bulgular: Survivor grupta 131 ve non-survivor grupta 42 olmak üzere toplam 173 hasta analiz edildi. Non-survivor grubunda glukoz ve GPR, survivor grubuna göre istatistiksel olarak anlamlı şekilde yüksekti ($p<0.05$). Ayrıca, serum GPR'nin duyarlılığı ve özgüllüğü sırasıyla %97.6 ve %50.4 olarak bulundu.

Sonuç: Bu bulgular, mekanik trombektomi uygulanan AIS hastalarında mortaliteyi tahmin etmek için GPR'nin kullanışlı bir parametre olarak hizmet edebileceğini öne sürmektedir.

Anahtar Kelimeler: glukoz-potasyum oranı, akut iskemik inme, mortalite, mekanik trombektomi

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Introduction

Over 13.7 million people have a stroke annually, one in six people will experience one at some point in their lifetime, and 5.8 million people die as a result (1). In the past, the first line of treatment for acute ischemic stroke (AIS) was intravenous thrombolytic therapy. Mechanical thrombectomy (MT) for large vessel occlusions (LVO) was shown to be superior to other medical treatments in recent randomized trials (2-4). Younger age, a low baseline National Institutes of Health Stroke Scale (NIHSS) score, rapid onset of symptoms and rapid reperfusion, and a favorable baseline AlberStroke Programme Early CT Score (ASPECT) were all found to be predictive of a positive clinical outcome in recent studies (5, 6). Clinical outcomes are adversely affected by increased thrombectomy passes, intracerebral hemorrhage, and diabetes mellitus (5).

Due to an increase in catecholamines during stressful or traumatic situations, potassium levels fall, and glucose levels rise. According to the literature, patients who have subarachnoid hemorrhage, pulmonary embolism, traumatic brain injury, or blunt abdominal trauma can quickly and accurately predict their morbidity and mortality using hyperglycemia or the glucose-potassium ratio (GPR), which is calculated as glucose divided by potassium. Numerous studies demonstrate the relationship between rising blood glucose levels and critical illness and trauma-related mortality and morbidity. Comparing isolated GPR to glucose and potassium levels, isolated GPR has a better ability to predict mortality and morbidity (7-11).

In this study, the adequacy of the GPR, which is an easy and simple parameter that can be used in the clinic in predicting the mortality of patients undergoing mechanical thrombectomy for AIS, was evaluated.

Material and Methods

Study Design and Eligibility Criteria

This retrospective study was conducted at the Department of Anesthesiology intensive care unit at our hospital between 2021 March and 2023 March. Ethical approval was obtained from the Ethics Committee of KTO Karatay University (E-41901325-200-62861) on 23 June 2023. This study was carried out according to the Declaration of Helsinki or ethical rules.

The inclusion criteria are patients aged≥ 19 years undergoing mechanical thrombectomy for acute ischemic stroke. Patients with a history of diabetes mellitus or admission serum glucose level >200 mg/dL, a disease/or drug use that could induce hyperkalemia or hypokalemia, history causing hypokalemia, chronic disease history, acute renal failure, chronic renal failure, nephrological pathology, malignancy history, liver cirrhosis, age of <19 years will be excluded from the study.

The patients analyzed in the study were grouped into the survivor group and the non-survivor group.

Medical and Demographic History

On hospital admission, age, sex, and laboratory parameters were recorded: hemoglobin, hematocrit, platelet, white blood cell count (WBC), Alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), blood urea nitrogen [BUN], serum creatinine, sodium, K, Glucose. In addition, GPR will be calculated using the following formulas:

GPR = glucose level/potassium level.

Outcome Measures

The primary outcome is the role of GPR in predicting mortality. The secondary outcome is GPR cut-off value for acute ischemic stroke.

Statistical Analyses

All statistical analyses will be performed using the IBM Statistical Package for the Social Sciences Statistics for Windows version 23.0 software (IBM, Armonk, NY, USA). Continuous data are reported as mean±standard deviation. The comparison of quantitative variables between the two groups was performed using the Mann–Whitney U test. Correlations between categorical variables will be evaluated using the Chi-square test. Receiver operating characteristics (ROC) analysis will be performed for the GPR and glucose for predicting mortality of acute ischemic stroke. The area under the ROC curve (AUC), cut-off values, sensitivity, specificity, positive predictive value, and negative predictive values will be calculated in order to evaluate the performance of the GPR and glucose. The level of statistical significance is set at $p<0.05$.

Results

Patient characteristics of the 358 stroke patients hospitalized during the study period and 165 with diagnosed as not meeting inclusion criteria and 20 with missing data cases were excluded. Thus, we included and analyzed data for 173 patients (83 males, 90 females; mean age, 69.8 years; range 26-97 years) (Fig 1).

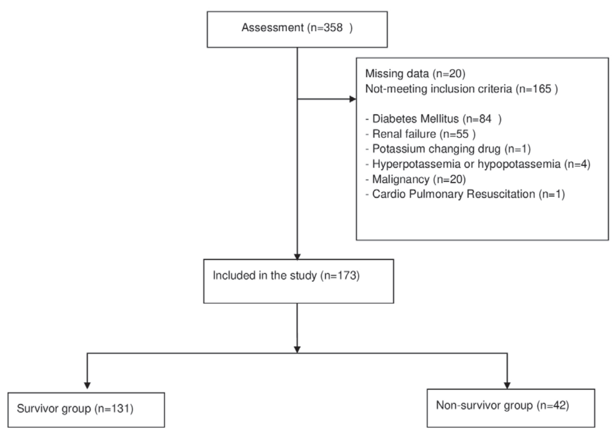

Figure 1. Consort diagram

The group stroke was defined as a survivor (group S) or non-survivor (group N) after admission to the intensive care unit. The mean patient age was 68.9 and 72.6 years, respectively, and the difference was not significant (P = 0.097). For the gender rate between groups, there were no statistical differences (p=0.077). Patients' mortality was recorded at 24.2% (n=42). Patient demographic data and laboratory parameters were compared between group S and group N (Table 1).

Table 1. Comparison of demographic data and laboratory parameters according to the mortality status

Variables	Survivor (n = 131)	Non-survivor (n = 42)	p Value
Age(years)	68.9±12.4	72.6 ± 11.6	0.097
Gender (Male/Female)	69/62	15/27	0.054
Hemoglobin (g/dL)	13.6 ±1.9	13.6 ± 1.8	0.750
Htc (%)	41.7 ± 5.07	42 ± 4.7	0.277
Platelet (×103/mm3)	270 ± 69	269 ± 96	0.192
WBC (x103 /mm3)	16.4 ± 2.4	12.4 ± 4.5	0.741
ALT (U/L)	17.5±12.8	16.2 ±8.6	0.541
AST (U/L)	21.6 ± 9.1	23.9 ± 11.4	0.187
GGT (U/L)	29.7 ± 33.6	37.3 ± 48	0.346
BUN (mg/dL)	16.1 ± 4.6	17.3 ± 6	0.242
Creatinine (mg/dL)	0.8 ± 0.1	0.8 ± 0.1	0.191
Sodium (mmol/L)	139.3 ± 2 .7	139.4 ± 2.9	0.874
Potassium (mmol/L)	4.2 ± 0.4	4.2 ± 0.5	0.592
Glucose (mg/dL)	116 ± 18	160 ± 22	*0.001
GPR	27.6 ± 5.5	38.4 ± 7.3	*0.001
Mortality rate (%24.2)	-	-	

Htc: Hematocrit; WBC: white blood cell; ALT: alanine aminotransferase; AST: aspartate aminotransferase; GGT: gamma-glutamyl transferase; BUN: blood urea nitrogen; GPR: glucose/potassium *p value < 0.05

We compared the GPR as a primary outcome at admission between the two groups. Median GPR at admission in the S and N groups were 27.2 (range, 15.5-45.1) and 37.6 (range, 27.2-62.1) points, respectively. The GPR was significantly correlated with the mortality rate at admission (95% confidence interval (CI): 0.851–0.949; p < 0.001).

Table 2 presented the ROC curve analysis of GPR and glucose in discriminating mortal patients among all the studied patients.

For all studied patients, the AUC for GPR was measured as 0.900, and 27.2 as a cut-off value had 97.6% sensitivity and 50.4% specificity. For glucose, the AUC was measured as 0.947, and 117.5 mg/dL as a cut-off value had 97.6% sensitivity and 47.3% specificity (Figure 2) for mortality compared between the two groups.

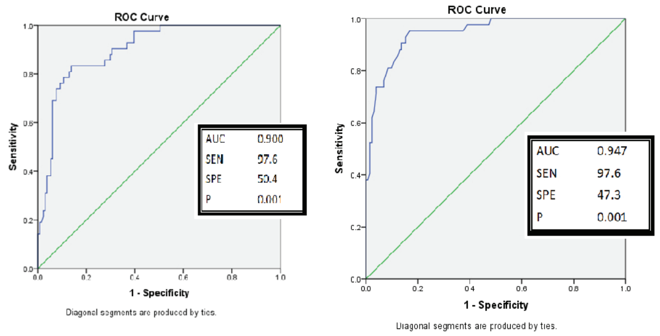

Figure 2. ROC analyses of GPR and glucose. (a) ROC curve analysis of GPR in predicting mortality. (b) ROC curve analysis of glucose in predicting mortality.

Table 2. ROC curve analysis of GPR and glucose in predicting mortality

	AUC	Cut-off value	SEN	SPE
Glucose	0.947	117.5	0.976	0.473
GPR	0.900	27.2	0.976	0.504

Discussion

This study investigated the predictive role of GPR for mortality in patients with AIS. The plasma GPR was significantly higher in non-survivors and was a predictor of mortality. Therefore, the plasma GPR was useful for predicting mortality in these AIS patients.

Intravenous thrombolytic therapy used to be the first line of treatment for acute ischemic stroke (AIS). Recent randomized trials for AIS have demonstrated that mechanical thrombectomy (MT) is superior to alternative medicinal therapies (3,4). Additionally, our hospital is the center where mechanical thrombectomy therapy has been performed successfully for many years. For this reason, the other hospitals utilize the first step of therapy as Intravenous thrombolytic therapy, and then they transfer these patients to our center. Thus, we only included the mechanical thrombectomy patients for AIS in our study.

A meta-analysis found that having excellent collaterals prior to endovascular therapy was related to better clinical results (12). Wufuer et al. demonstrated in another meta-analysis that good collaterals may contribute to positive 3-month clinical outcomes and a low mortality risk (13). Predictive favorable clinical outcomes were reduced National Institutes of Health Stroke Scale (NIHSS) scores observed at the onset of symptoms. Furthermore, it was observed that a high National Institutes of Health Stroke Scale (NIHSS) score upon admission served as an indicator of unfavorable clinical outcomes (14).

Poor clinical outcomes were predicted by elevated glucose levels. A post hoc analysis of the Solitaire Flow Restoration With the Intention for Thrombectomy (SWIFT) multicenter randomized trial revealed that a blood glucose level of >140 mg/dL was independently linked to a lower percentage of positive clinical outcomes (15). According to Sanak et al., three months after mechanical thrombectomy for AIS, lower glucose levels may be linked to better functional results (16). The exact pathophysiological mechanism underlying the relationship between post-stroke hyperglycemia and severe neurological deficit or poor outcome in patients with AIS remains unclear. According to some research, post-stroke hyperglycemia may result from a stress response. Catecholamines, glucagon, and corticosteroids are the main hormones that control blood sugar during the hyperglycemic response (17, 18).

Potassium, which is primarily held inside of cells, is transferred by sodium/potassium adenosine triphosphatase pump (Na/K-ATPase) and active cellular absorption through the cell membrane. Catecholamine, B2 adrenergic hormones, and insulin regulate Na/K-ATPase, which can lower the levels of potassium in the blood that is circulating (19). Additionally, as previously noted, increased catecholamine output caused by AIS raises serum glucose levels; hence, insulin secretion increases, and serum potassium enters cells in this situation (20). Theoretically, as has been demonstrated in a number of prior traumatic brain injury investigations, increased serum glucose concentrations may be strongly linked with trauma severity and post-traumatic prognosis. Meanwhile, it's probable that a poor post-traumatic prognosis is linked to an increase in serum glucose and a drop in K concentration (21-23).

The mortality of patients with blood sugar levels 140 and above was shown to be statistically significant compared to those with blood sugar levels under 140 in the Leto et al. (24) study that looked at the relationships between mortality and blood glucose levels at the time of admission for hip fractures. They suggested that in individuals with hip fractures, blood glucose levels might serve as a predictive indication. According to the research done by Yendamuri et al. (25), general trauma patients with blood sugar levels greater than 200 mg/dl had a mortality rate of 34.1%. They argued that the blood glucose level at the time of admission was an independent predictor for hospital mortality in multi-trauma patients. In our study, blood glucose levels were found to be high in the mortal group at the time of admission in AIS patients. This result is similar to the above studies. But the serum GPR better reflects excessive catecholamine levels after AIS than the serum glucose concentration or serum potassium concentration alone. The use of GPR, which is quick and simple to compute and offers accurate prognostic information, has recently grown among trauma patients (10). In patients with serious brain injuries, Zhou et al.(21) investigated the value of serum GPR as a 30-day mortality prediction. The serum GPR may have a bearing on mortality in patients with severe head traumas, the study's findings indicated. Serum GPR was investigated by Fujiki et al. (26) as a clinical risk factor in individuals with aneurysmal subarachnoid hemorrhage. The study's findings revealed that the severe group's serum GPR was statistically and significantly higher than that of the control group (57.9 [22] vs. 42.3 [15.1]; p <0.001). In our study, it was found that GPR in the group mortal significantly higher than alive group. Median GPR at admission in the S and N groups were 27.2 (range, 15.5-45.1) and 37.6 (range, 27.2-62.1) points, respectively. The GPR were significantly correlated with the mortality rate at admission (95% confidence interval (CI): 0.851–0.949; p < 0.001).

According to Jung et al. (27) the plasma GPR's AUC varied from 0.709 to 0.783. The sensitivity and specificity for predicting mortality following an aneurysmal subarachnoid hemorrhage were 90.2 and 51.0%, respectively, with a cut-off value for the GPR of 37.8. In our study, the AUC for GPR was measured as 0.900, and 27.2 as a cut-off value had 97.6% sensitivity and 50.4% specificity. For glucose, the AUC was measured as 0.947, and 117.5 mg/dL as a cut-off value had 97.6% sensitivity and 47.3% specificity for mortality compared between the two groups.

Our study has some limitations. This was a single-center and retrospective study. Another limitation was that glucagon, corticosteroid, and catecholamine hormone levels were not analyzed at the time of presentation.

Conclusion

In summary, we assessed the serum GPR as a predictor for mortality in patients undergoing mechanical thrombectomy for acute ischemic stroke. These results suggest that the serum GPR is a valuable and simple parameter that can be used in the clinic to predict mortality in patients undergoing mechanical thrombectomy for acute ischemic stroke.

Conflict of Interest

No conflict of interest was declared by the authors. In addition, no financial support was received for this study.

Author Contributions

All the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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