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RESEARCH ARTICLE

ROLE OF GLYCATED HEMOGLOBIN (HbA_1c) ON SEVERITY OF ISCHEMIC STROKE IN PATIENTS WITH (TYPE1AND 2) DIABETES MELLITUS

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Abstract

Diabetes mellitus is a metabolic disorder that can interact with atherosclerosis in ischemic strokes to initiate, activate and propagate vascular events. Glycated hemoglobin (HbA1c) has emerged as a useful biochemical marker reflecting the average glycemic control over the last 3 months, its prognostic value in the acute neurological conditions such as stroke is still not well-established. To study the effect of glycemic status (HbA1c) on severity of acute ischemic stroke in patients with diabetes (type1 and 2) at admission. This was a prospective cross sectional, hospital-based study done at Aden public and private hospitals for a period of thirteen months (January 2020 to February 2021). We evaluated 75 diabetic patients with acute ischemic stroke which was confirmed by brain computed tomography (CT scan). All subjects had blood hemoglobin A1c (HbA1c) measured at admission. They were classified into two groups according to the level of HbA1c: good glycemic control group ((GGC)) HbA1c<7.0% and poor glycemic control group((PGC)) (HbA1c ≥7). Neurological impairment was evaluated by using the National Institutes of Health Stroke Scale (NIHSS). A higher percentage of patients (84%) with acute ischemic stroke had elevated HbA1C levels (≥7), High percentage of patients in PGC (66.7%) as well as who were in GGC (75%) had moderate to severe stroke (NIHSS >8). The association between stroke severity and HbA1C levels on admission was statistically not significant (P value> 0.05). We found that HbA1c cannot be used for predication of severity in diabetic patients with ischemic stroke. Our results provide evidence that although chronic hyperglycemia increases risk of stroke, it is not associated with increased stroke severity.

Keywords: Hemoglobin A1c, Severity, Ischemic stroke, Diabetes mellitus.

1. Introduction

Diabetes mellitus (DM) is one of the most common systemic diseases, it is a worldwide health problem that affects millions of people from all racial and ethnic groups [1]. Diabetes is a major risk factor for cardiovascular disease (CVD), including stroke which is a major healthcare issue in both developing and developed countries with deleterious effects at individual, family and societal levels. The prognosis also differ from normal stroke population as diabetes is associated with an increased risk of subsequent strokes, greater functional disability, longer in-hospital stay, [2,3] higher risk of developing cognitive decline and stroke-related dementia [4,5]. Furthermore, hyperglycemia increases the mortality due to stroke by 3.3% in non-diabetic patients and is associated with worse neurological disabilities [3].

Definition:

Diabetes mellitus (DM) is defined as “a group of metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both (6).

Etiological classification of DM:

The vast majority of cases of diabetes fall into two broad etiopathogenetic categories as type 1 and type 2.

1. **Type 1 diabetes (T1DM)** is characterized by loss of the insulin-producing beta cells of the pancreatic islets, leading to insulin deficiency.
2. **Type 2 diabetes** (T2DM) is characterized by insulin resistance which may be combined with relatively

reduced insulin secretion [7], It is the most common type of DM [8].

3. Gestational diabetes mellitus (GDM).
4. Other specific types of DM: such as diseases of the exocrine pancreas, immune-mediated diabetes, endocrinopathies, drug-or chemical-induced…etc. [6].

Diagnosis of DM:

Diabetes mellitus is diagnosed with a test for the glucose level in the blood by demonstrating any one of the following [9]:

1. Fasting plasma glucose level ≥ 7.0 mmol/L (126 mg/dL).
2. Plasma glucose ≥ 11.1 mmol/L (200 mg/dL) two hours after a 75-gram oral glucose load as in a glucose tolerance test (OGTT).
3. classic symptoms of hyperglycemia or hyperglycemic crisis, and a random plasma glucose 200 mg/dL (11.1 mmol/L).
4. Glycated hemoglobin (HbA1C) ≥ 48 mmol/mol (≥ 6.5 DCCT %) [10].

Role of HbA1c in diabetes mellitus

Glycated hemoglobin (HbA1c) is a result of the nonenzymatic attachment of a hexose molecule to the N-terminal amino acid of the hemoglobin molecule. The American Diabetes Association (ADA) validates its use in 2010 as a diagnostic criterion for diabetes. Diagnostic Standard for HbA1C in Diabetes [11]:

HbA1C	Diagnosis
<5.7%	Normal
5.7-6.4%	Prediabetes.
≥ 6.4%	Diabetes

HbA1c target in DM treatment:

Hemoglobin A1c (HbA1c) has direct relationship with mean glycemia because erythrocytes are continuously glycated during their 120–day lifespan. The International Diabetes Federation and the American College of Endocrinology recommend HbA1c values below 48 mmol/mol (6.5 DCCT %), while the American Diabetes Association recommends HbA1c be below 53 mmol/mol (7.0 DCCT %) for most patients who have higher risk of hypoglycemia [12].

HbA1c and ischemic stroke:

Diabetes is considered a risk factor for ischemic stroke, patients with DM are at 1.5–3 times the risk of stroke compared with the general population[13]an estimated prevalence of DM is 21%-44.4% among patients who experience acute ischemic stroke [14]. HbA1c has been shown to be a biochemical marker and a good predictor of vascular disruption is patients with diabetes [15,16], It has also been shown to be well associated with diabetic complications [15–17]. However, its prognostic value in the acute neurological conditions such as stroke is still not well-substantiated. The current understanding is not enough to inform the guidelines.

While intensive blood sugar control has been shown to reduce small blood vessel complications such as retinopathy and nephropathy, it has not been shown to reduce large blood vessel complications such as stroke [18,19]. In Prospective Diabetes Study (UKPDS) 3867 individuals with newly diagnosed type 2 diabetes were followed for 10 years, with "intensive" treatment plan which was shown to lower HbA1c by 0.9%, this improved glycemic control led to fewer microvascular endpoints but did not impact macrovascular events [20]. There are numerous studies of HbA1c effect on microvascular complications of DM but only few studies on its effect in stroke clinical picture, impact on the severity and prognostic value in diabetic patients with stroke. For example, studies from India [21,22] conduct to explain the effect of glycemic status at admission on severity and outcome of acute Ischemic stroke in patients with diabetes conclude that glycemic control has significant association on severity and outcome of ischemic stroke patients with diabetes and they stated that estimation of HbA1c levels at the time of admission might be a predictor of the severity of neurological impairment in patients with acute ischemic stroke and diabetes mellitus. Same findings were found by studies from Arabic countries (Sudan [23] and Egypt [24]). while other studies (China [25] and Korea [26] conclude that no association was detected between HbA1c with stroke severity.

The aim of this study was to elucidate the association between glycemic control status, defined by HbA1c on admission and the severity of acute ischemic stroke among Yemeni patients with Diabetes Mellitus.

2. Objectives

To Study the effect of glycemic status (HbA1c) at admission on severity of acute ischemic stroke in patients with diabetes mellitus (type 1 and type 2).

2.1. Specific objectives:

1. To describe the sociodemographic characteristics of patients (age, gender and educational level).
2. To study the clinical profile of ischemic stroke in diabetic patients (clinical picture, NIHSS score of stroke severity).
3. To identify risk factors associated with stroke (hypertension and DM).
4. To study the glycemic status of patients at admission by measuring HbA1c and compare between poor and good glycemic control groups in correlation to stroke severity.

3. Patients and Methods

This was a prospective cross sectional, hospital-based study was done at Aden public and private hospitals (Al-Gamhoria, Al-Buraihi, Saber, Al-Naqeeb, Al-Waly and Aden German) for a period of thirteen mounts (January 2020 to February 2021). We evaluated 75 diabetic patients with acute ischemic stroke which was confirmed by brain computed tomography (CT scan). All patients had blood hemoglobin A1c (HbA1c) measured at admission. They were classified into two groups according to the level of HbA1c: good glycemic control group ((GGC)) HbA1c<7.0% and poor glycemic control group ((PGC))(HbA1c ≥7). Neurological impairment was evaluated by using the National Institutes of Health Stroke Scale (NIHSS).

3.1. Study population:

All known diabetic patients admitted to the hospital with new onset ischemic stroke diagnosed clinically and confirmed by brain CT scan.

Inclusion criteria:

- Diabetic patients of both sexes more than 18 years old with ischemic stroke.

Exclusion criteria:

- Any prior neurological disability from previous stroke or other diseases.
- Persons with diabetes other than type 1 and 2 (gestational diabetes).
- Hemorrhagic stroke and stroke due to other causes such as space occupying lesions, cerebral venous thrombosis…. etc.
- Severally ill patients (cancer, cirrhosis, heart failure).
- Presence of medical conditions that may affect the level of HbA1c.
- Negative (CT) scan of brain both on admission and on follow-up.

3.2. Variable definitions:

1) Stroke severity at admission:

Assessment of severity was measured by using National Institutes of Health Stroke Scale (NIHSS) within 72 hours of admission.

National Institutes of Health Stroke Scale (NIHSS): is a neurological examination stroke scale used to evaluate the effect of acute cerebral infarction on the levels of consciousness, language, neglect, visual-field loss, extraocular movement, motor strength, ataxia, dysarthria, and sensory loss [27]. Each item scores a specific ability between a 0 and 4, maximum score is 42, with the minimum score being a zero, higher scores indicating greater severity.

Stroke severity may be stratified on the basis of NIHSS scores as follow: **NIHSS interpretation [27]:**

Description	Score
No stroke	0
Mild stroke	1 – 7
Moderate-stroke	8 – 16
Severe stroke	17 – 20
Very sever stroke	21-42

2) Glycated hemoglobin (HbA1c): based on HbA1c level at admission diabetes patients with acute ischemic stroke were divided in to two groups:

1. Good glycemic control (HbA1c < 7).
2. Poor glycemic control (HbA1c equal or more than 7).

3.3. Statistical analysis:

Data were entered into computer using the Statistical Package for Social Sciences software (SPSS version 24). The results were presented as mean ± standard deviation (SD) for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Categorical variables were compared using Chi-Square test and Fishers exact test.
Quantitative variables were compared using T-Test or One-way analysis of variance (ANOVA) test. Statistical significance was determined as a *P*< 0.05.

4. Results

Table 1. distribution of patients by Socio- demographic characteristics (n=75)

variables			n (%)
Sex	**Male**		**44(58.7)**
	Female		**31 (41.3)**
Male: Female ratio=1.4:1			
Mean age (Min.- Max.)		62,91±9.3 (45-90)	
Male mean age (Min.- Max.)		61.23±7.7 (45-78)	
Female mean age (Min.- Max.)		65.29±10.8 (48-90)	
Education	**M No. (%)**	**F No. (%)**	**Total**
Illiterate	21(28)	26(34.7)	47(62.7)
Primary school	6(8)	1(1.3)	7(9.3)
Secondary school	13(17.3)	1(1.3)	14 (18.7)
University	4(5.3)	3(4)	7(9.3)

Table 1: show that male constitute 44(58.7%) of study population and 31 (41,3%) were females, with a male to female ratio is 1.4:1 showing male preponderance. Patient's age ranged from 45 to 90 years with a mean of **62,91**±9.3 and median 63 years. Female were older than male. Almost more than half of participant were illiterate (62,7%).

Table 2: Depicts the clinical presentation of patients with acute ischemic stroke. The most common presentation was focal neurological deficits (97.3%). According to NIHSS classification, almost half (49.3%) of study population had moderate stroke severity, 32% had mild severity and18.7 % had severe stroke.

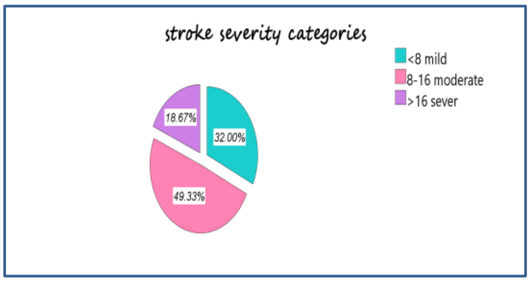

Fig 1. percentage of studied pt. in stroke severity categories

Table 2. Clinical presentation of acute ischemic stroke and Stroke severity (NIHSS)

Clinical presentation	No. (%)			
Focal neurological deficits	73(97.3)			
Cranial nerve involvement	70(93.3)			
Language problem	27(36)			
Altered Sensorium	12(16)			
Stroke severity (NIHSS)	**Mild (< 8)**	**Moderate (8-16)**	**Severe (16-20)**	**Very severe (21-42)**
No. (%)	24(32)	37(49.3)	14(18.7)	0
NIHSS mean=11.35±5.5	Min.-Max =2-20			

Table 3: distribution of patients by socio-demographic characteristics and stroke severity (n=75)

Socio-demographic characteristics		Stroke severity n (%)			NIHSS Mean (SD)	*p- value
		Mild n=24	**Moderate n=37**	**Severe n=14**		
Sex	**M**	16(21.3)	18(24)	10 (13.3)	11.27±6	0.212
	F	8(10.7)	19(25.3)	4(5.3)	11.52±5	
Age groups (years)	40-50	6(8)	4(5.3)	1(1.3)	8.36 ±5	##0.044
	51-60	9(12)	9 (12)	6 (8)	11.67±6	
	61-70	8(10.7)	17 (22.7)	4 (5.3)	11.24 ±5	
	>70	1(1.3)	7 (9.3)	3(4)	13.91±4	
Mean Age		59.13±8	65.11±9.5	63.57±9		
Education	Illiterate	10(13.3)	24(32)	13(17.3)	12.91±5	*0.002
	Primary school	6 (8)	1(1.3)	0	5.71±4	
	Secondary school	7 (9.3)	6(8)	1(1.3)	9.0±4	
	University	1(1.3)	6(8)	0	11.14±3	
*Chi-square	# #one-way Anova					

Table 3: The male and female mean of NIHSS were (11.27) and (11.52) respectively. A higher proportion of them (37.3% male and 30.7% female) were having moderate to severe stroke severity. The differences between sex and stroke severity categories were statically not significant (p=0.212). According to the relation between age and stroke severity categories, it was observed that the lowest age mean 59.13 year was seen in mild stroke severity group. The differences between age means and stroke severity categories were statically significant (p=0.044). A higher proportion of the diabetic illiterate patients (32%) were documented with moderate stroke severity, followed by (17.3%) patients in severe stroke category and lowest percentage (13.3%) were in mild severity. The illiterate diabetic patients were documented to have the highest NIHSS mean (12 .91) in comparison with patients who have higher levels of education (primary, secondary and university (NIHSS = 5.71, 9.0 and 11.14 respectively). The differences between the distribution of stroke severity and levels of education were found to be statistically significant (p=0.002).

Table 4. Distribution of patients by risk factors and stroke severity

variables		Stroke severity n(p)			NIHSS Mean	p-value
		Mild n=24	Moderate n=37	Severe n=14		
Hypertension	Yes n=52 (69.3%) (69.3%)	15(20)	28(37.3)	9(12)	11.60 ±5	0.498*
	No n=23 (30.7%)	9(12)	9(12)	5(6.7)	10.78 ±6	
(Diabetes mellitus) Glycemic control	Good con. n=12 (16%)	3(25)	6(50)	3(25)	11.17±5	0.768*
	Poor con. n=63 (84%)	21(33.3)	31(49.2)	11(17.5)	11.38 ±5	
*Chi -square						

Table 5. paraclinical parameter for stroke severity groups

Variables	Stroke severity			p-value
	Mild n=24	**Moderate n=37**	**Severe n=14**	
Fasting Blood Sugar (FBS)	185.64	206.55	206.40	0.663 **
Postprandial glucose (PPG)	237.88	226.27	214.93	0.706*
Glycosylated hemoglobin (HbA1C)	9.5	9.1	8.8	0.592*
*One-way Anova **Kruskal wails test				

Table 4: Shows the relation between stroke severity and risk factors, where 12% had severe stroke, (37.3%) of the hypertensive patients had moderate stroke severity, and 20% had mild stroke severity.
High percentage of both patients who were in good control group and poor glycemic control group had moderate to severe stroke severity 75% and 66.7% respectively. The differences between distribution of stroke severity and risk factors were found to be not significant (p > 0.05).

Table 5: Compares the paraclinical parameters of patients in stroke severity groups, revealing patients in moderate stroke severity group had the highest HbA1c mean (9,3), patients in mild stroke severity group had highest PPG mean (237), Patients in severe stroke group had the highest FBS mean (206) and those in mild severity group had the lowest FBS mean (185). These three paraclinical parameters did not show any statically significant difference with stroke severity categories (p> 0.05).

5. Discussion

Diabetes mellitus is one of the major modifiable and well-established risk factors for stroke which is a major health problem in the Middle East causing sever disability and death, with a fatality rate that is anticipated to double by 2030 [28]. A systematic review in Arab world of the Global Burden of Disease (GBD) in 2019 estimated that 37.5% of ischemic stroke patients were diabetics. Few studies reported more than 50% diabetics among the stroke patients [29]. in Yemen, there are scarce data available about stroke prevalence in diabetic patients. Rasheed et al stated on their study that DM is the second most common risk factor (44.8%) of stroke after hypertension (57.2%) in Yemeni patients [30], on the other hand, Abdul-Rahman et al reported DM as associated risk factor among 24.4% of ischemic stroke patients. [31]

In this study a total of 75 of diabetic patients presented with acute stroke with male predominance over female. The cause of higher stroke prevalence among men could

be possibly explained in relation to higher prevalence of hypertension, ischemic heart disease and smoking which is more common in male than female [32]‚ in addition to the more stressful lifestyles among males who are deemed as ‘‘the head of the family” as opposed to female [33,34]·

The mean age of the study population was (**62.91**±9.3) years which is nearly equal to the mean age reported by Al-Eithan, et al from Saudi Arabia (61.7 ± 14.7) years [35]‚ Shyam et al from Oman (62.2 ± 13.2) years [36] and Abdul-Rahman Salam, et al (59.6) years from Yemen [31]. The stroke related studies from middle east countries, showed that the age of diabetic patients with stroke was within the sixth and the seventh decade, ranging from 59 to 71[37]. Several studies demonstrate the effect of age on stroke incidence and severity, stating that aging is the most robust non-modifiable risk factor for incident stroke which doubles every 10 years after age 55 years. Approximately three-quarters of all strokes occur in persons aged ≥ 65 years, The possible mechanism underlying the effect of age was that arteries naturally became narrower and harder with increasing age due to the change mediated by endothelial dysfunction and impaired cerebral autoregulation [38].

The majority (68%) of diabetic patients were found in moderate to severe stroke categories, with the maximum number of patients between age groups of 61-70 years. The NIHSS score is increasing from pt. in fourth decade from score of 8.36 to 13.91 in seven and eight decades. It was documented that there was significant (P = 0.04) effect of advancing age on severity of stroke as assessed by NIHSS similarly reported by as Al-Eithan et al and Inam [35,39]

According to education level more than half (62.7%) of the studied patients were illiterate, with females showing higher percentage of illiteracy (34.7%) when compare to males (28%). Those who were from the illiterate group having moderate to severe stroke severity comprised 49.3%of them, it was observed that the total percentage of patients categorized in moderate to severe stroke severity was shown to decrease by their higher level of education.

The mean NIHSS score decrease from 12.91 in illiteracy to (5.71 in primary, 9.0 in secondary and 11.14 in university), A significant effect was noticed (P = 0.002) on the level of education with the severity of stroke. This was in agreement with the studies of Anita et al [39] and Megha Luthra, et al [40] who investigated to which extent the

association between low socioeconomic status including (income, occupation and education) and stroke severity and came to a conclusion that low education was associated with an excess risk of a severe stroke compared to mid/high education.

The hypertensive patients in this study were distributed according to the stroke severity categories as (37.3% in moderate severity and 12% in severe category, mean NIHSS score of hypertensives was comparable higher than non-hypertensive patients (11.60 vs. 10.78 respectively. This did not reveal any statical significant differences between hypertension and stroke severity (p=0.48), that was similarly reported by Sivaji et al from India [21] and Omar et al from Sudan [23]. However, hypertension had a significant association with stroke severity in several studies [41,42], which could be explained by the fact that the reason for this discrepancy may be related to small sample size.

The majority of poor glycemic control group (66.7%) had moderate to severe stroke (NIHSS >8) when compared to (75%) in good glycemic control during the period of admission. The stroke severity did not show any statistical significance (p =0.84) values among glycemic control groups of patients which was corresponding to the reports of Sung et al from Korea [26] and Chao Liu from China [25], but not comparable to studies from Sudan [23] and India [22].

Glycemic parameters of fasting blood sugar, random blood sugar and glycosylate hemoglobin (FBS, RBS and HbA1c) were studied in relation with the stroke severity categories that revealed the lowest FBS mean (185) was in mild severity group, moderate to severe groups had same FBS mean (206). The relations between FBS, RBS mean and stroke severity was statically not significant (p>0.05). This was in harmony with the reports of Wen-Yu [43] and Chao Liu from China [25] and Omar [23], in contrast to Tao Yao et al [44] from China and Sunanda et al from India [22].

Glycosylated hemoglobin (HbA1c) of three levels (mild, moderate and severe) stroke categories did not show any wide range of variation as seen (9.5- 8.8- 9.3) respectively, thus showing no statically significant relation between HbA1c means and stroke severity. The results in this study were compatible with studies from USA and China [44] in contrast to other several studies [23,22]. The explanation of these disagreements may be attributable to several reason: First, the number of diabetic patients included in this study was small. Second, some studies revealed that the association between glucose concentration and outcome is a reflection of stress relating to stroke severity, rather than a direct harmful effect of glucose on damaged neurons [45].

Third, the risk factors were quite different among age and the stroke subtypes (atherothrombotic, cardio-embolic, lacunar infarction). Other literature reviews showed that there were differences based on type of ischemic stroke and aging [46]. In addition, each stroke subtype had specific risk factors that could not be related to other subtype for example HbA1c and low-density lipoprotein is considered the main risk factor for (atherothrombotic infarction); while on the other hand the large cardiac load, (indicated by left atrial dimension) is the main risk for cardio-embolic infarction. Due to lack of funding and available facilities, we could not investigate the type of stroke type in this study. Fourth, the greatest effects of hyperglycemia were more obvious on stroke risk rather than stroke severity. Thus, this effect accumulates early in the course of the DM disease and in the prediabetes stage, rather than late in the course when comorbid cardiovascular risk factors are more likely to be present.

6. Conclusion

In this current study, a significant correlation was detected between stroke severity and advance age particularly those patients more than 70 years. It was also noticed that Illiteracy increased the risk probability to suffer from severe stroke (NIHSS > 8). It was also documented that the advanced education level was associated with lower NIHSS score.

The glycemic control of diabetic patients was very poor, despite the continuous use of antidiabetic treatment. The majority of patients had HbA1c of more than 7, and there was no relation detected between HbA1c and other glycemic parameters with stroke severity. Our results provide probably some evidence that although chronic hyperglycemia increases the risk of stroke, it may not be have likelihood to be associated with increased stroke severity.

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مقالة بحثية

دور الهيموجلوبين التراكمي في تحديد شدة الصدمة الدماغية الحادة عند مرضى السكر

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المُلخّص

داء السكري هو اضطراب التمثيل الغذائي الذي من الممكن ان يتفاعل مع تصلب الشرايين في الصدمات الدماغية الاقفارية لبدء تنشيط ونشر الاضطرابات في الاوعية الدموية. الهيموجلوبين السكري (HbA1c) هو اختبار بيوكيميائي مفيد للدم يعكس متوسط التحكم في نسبة سكر الدم على مدى الأشهر الثلاثة الماضية، ولا تزال قيمته التنبؤية في الحالات العصبية الحادة مثل الصدمة الدماغية قيد الدراسة. دراسة تأثير الهيموجلوبين التراكمي على شدة الصدمة الدماغية الفقارية الحادة عند مرضى السكر. دراسة وصفية مقطعية مستقبلية لحالات الصدمة الوعائية في مرضى السكري التي تم إدخالها للمستشفيات الحكومية والخاصة في محافظة عدن خلال ثلاثة عشر شهرا (يناير 2020 الى فبراير 2021). تم تقييم 75 مريض من مرضى السكري المصابين بالصدمة الدماغية الاقفارية الحادة بواسطة الأشعة المقطعية الدماغية وقياس مستوى الهيموجلوبين التراكمي في الدم لكل المرضى المرقدين، تم تقسيم المرضى تبعا لمستوى السكر التراكمي الى مجموعتين: مستوى السكر التراكمي الجيد (7>) ومستوى السكر الغير جيد (<أو يساوي 7)، تم تقييم الضعف في الوظائف العصبية باستخدام مقياس المعاهد الوطنية للصحة للصدمات الدماغية (NIHSS). مستوى السكر التراكمي عاليا (أكثر أو يساوي 7) عند نسبة كبيرة من المرضى (84%). نسبة كبيرة من المرضى في كلا المجموعتين كانت لديها صدمة دماغية متوسطة الى شديدة الحدة بلغت (75%) في مجموعة مستوى السكر التراكمي الجيد مقابل (66.7%) في مجموعة مستوى السكر التراكمي الغير جيد. في هذه الدراسة لا توجد علاقة ذات دلالة إحصائية لمستوى السكر التراكمي في تحيد شدة الصدمة الوعائية الدماغية الحادة عند مرضى السكري. لا يمكن استخدام السكر التراكمي لتحديد شدة الصدمات الدماغية الاقفارية الحادة عند مرضى السكر، نتائج هذه الدراسة تبين انه على الرغم من أن الارتفاع المزمن في مستوى سكر الدم يزيد من خطر الإصابة بالصدمات الدماغية الا انه لا يرتبط في زيادة شدة حدة الصدمة الدماغية.

الكلمات المفتاحية: السكر التراكمي، شدة، الصدمة الاقفارية، داء السكري.

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