Hyperglycemia in Acute Cerebral Infarction

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Objective: *Report the results of hyperglycemia in the patients with acute cerebral infarction.*
Material and Method: *A retrospective review of 231 patients who presented with the syndrome of acute cerebral infarction at Ratchaburi Hospital from January 1,2000 to December 31,2004. Patients data, diagnosis, blood glucose, and underlying disease were collected from medical records (n = 231).*
Results: *Hyperglycemia is defined as the blood glucose level of more than 140 mg/dl. Odd ratio for 1 year mortality was calculated using multivariable Cox regression models. Admission hyperglycemia was present in 43.7 % of patients with acute cerebral infarction. 61 % of these patients received oral hypoglycemic drugs during their hospital admission. Hyperglycemic patients had a longer hospital stay than normoglycemics (6.91 vs 4.60, p < 0.001) and increased risk for death at 1 year (odd ratio = 1.004, p < 0.01).*
Conclusion: *Hyperglycemia can predict mortality of acute cerebral infarction.*

Keywords: *Hyperglycemia, Predict, Acute cerebral infarction*

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Hyperglycemia has been reported to augment acute ischemic brain injury in human and animal models[1-7]. Possible mechanisms of this effect include increased brain tissue acidosis, increased blood-brain barrier permeability, and increased hemorrhagic transformation of the infarction. Whether acute hyperglycemia independently affects patient outcomes or whether this effect primarily reflects the effects of increased infarct severity or poor glycemic controlled is debated. Although some studies have not found an effect of acute hyperglycemia on subsequent acute cerebral infarct outcomes[6,8], many of these studies have been limited by small sample size, lack of control for other important clinical factors, and a relatively short patient follow-up period. Furthermore, even hyperglycemia is accepted as adversely affecting the acute cerebral infarction outcome. But its treatment is not effective. The aim of the present study was to report the results of hyperglycemia in the patients with acute cerebral infarction.

Material and Method

The author reviewed the medical records of the patients (14 years of age or older) who presented with acute cerebral infarction and were admitted to Ratchaburi Hospital. The diagnostic criteria for diagnosis of acute cerebral infarction consisted of history taking, complete physical and neurological examinations, complete routine laboratory investigations and CT-scan of the brain. All patients' data were collected between January 1,2000 and December 31,2004.

Patients were classified as hyperglycemic on admission with acute cerebral infarct if admitting blood glucose was $\geq$ 140 mg/dl. Comparison of the patients with and without admission hyperglycemia was analyzed with Chi-square test and unpaired t test where appropriate. Multivariable modeling of time to death associated with admission hyperglycemia was analyzed with Cox regression models. Independent variables included patients' characteristics,underlying disease at time of acute cerebral infarction, and admission hyperglycemia. All analyses were done using SPSS package. A p-value of < 0.05 was considered significant.

Results

231 patients had acute cerebral infarction (Table 1). Age range was 39 to 86 years with a mean age of 64.61 in the normoglycemic group and 62.82 in the hyperglycemic group, 121 cases were women. Hyperglycemia was found in 101 cases(43.72%). Only 6.92%

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of the normoglycemic patients had diabetes mellitus. A blood glucose average of 4.53 was obtained in patients with hyperglycemia. Hyperglycemic patient had mean blood glucose of 210.81 mg/dl during their hospital stay. The management of hyperglycemia is shown in Table 2.

The correlation of mortality and the patients' blood glucose level is shown in Table 3. One year life survival analysis by patient characteristics with odd ratio (95%CI) and five year survival curve with admission blood glucose < 140 mg/dl were presented in Table 4 and Fig. 1 respectively.

Discussion

Acute cerebral infarction with hyperglycemia on admission had significantly increased risk of death

Table 1. Patient characteristics (n = 231)

Patient characteristic	BS < 140 mg/dL, n = 130 (%)	BS ≥ 140 mg/dL, n = 101 (%)	p-value*
Men, n (%)	79 (60.8)	31 (30.7)	<0.001
Women, n (%)	51 (39.2)	70 (69.3)	<0.001
Underlying conditions			
Hypertension	92 (70.8)	42 (41.6)	<0.001
Diabetes mellitus	9 (6.9)	76 (75.3)	<0.001
Dyslipidaemia	61 (46.9%)	56 (55.5)	0.125
Coronary artery disease	25 (19.2)	21 (20.8)	0.447
Age (X ± SD)	64.61±9.1	62.82±6.23	0.003
Serum glucose (X ± SD)	102.06±14.35	210.81±35.93	<0.001
Number fingerstick BG (X ± SD)	1.26±9	4.5±2.8	<0.001
Length of hospital stay (X ± SD)	4.6±3.1	6.9±4.1	<0.001

* Chi-square test or unpaired t-test

Table 2. Treatment of patients with hyperglycemia (n = 85)

Treatment	n = 85 (%)	Mean serum glucose
No oral Hypoglycemic drugs	15 (17.6)	148-187
Oral Hypoglycemic only	52 (61.2)	195-244
Sliding scale insulin only	8 (9.4)	228-264
Combined oral hypoglycemic and insulin	10 (11.8)	228-278

Table 3. Correlation of the mortality and the patients' blood glucose level (n = 231)

Outcome	Admission BS groups		p-value*
	BS < 140 mg/dL, n = 130 (%)	BS ≥ 140 mg/dL, n = 101 (%)	
Sex			<0.001
Men	79 (60.8)	31 (30.7)	
Women	51 (39.2)	70 (69.3)	
Mortality			0.002
6-month mortality	4 (3.1)	7 (6.93)	
1-year mortality	8 (6.2)	12 (11.88)	
3-year mortality	11 (8.5)	19 (18.81)	
5-year mortality	18 (13.9)	28 (27.72)	

*Chi-square test

Table 4. One-year survival analysis

Variable	Odd ratio	95%CI	p-value
Hyperglycemia	1.004	1.002, 1.007	0.001
Age (per year)	1.061	1.037, 1.086	0.001
Coronary artery disease	1.474	1.061, 2.049	0.021
Hypertension	1.231	1.304, 1.144	0.013
Dyslipidaemia	0.967	0.728, 1.285	0.817
Sex	1.421	1.050, 1.923	0.023

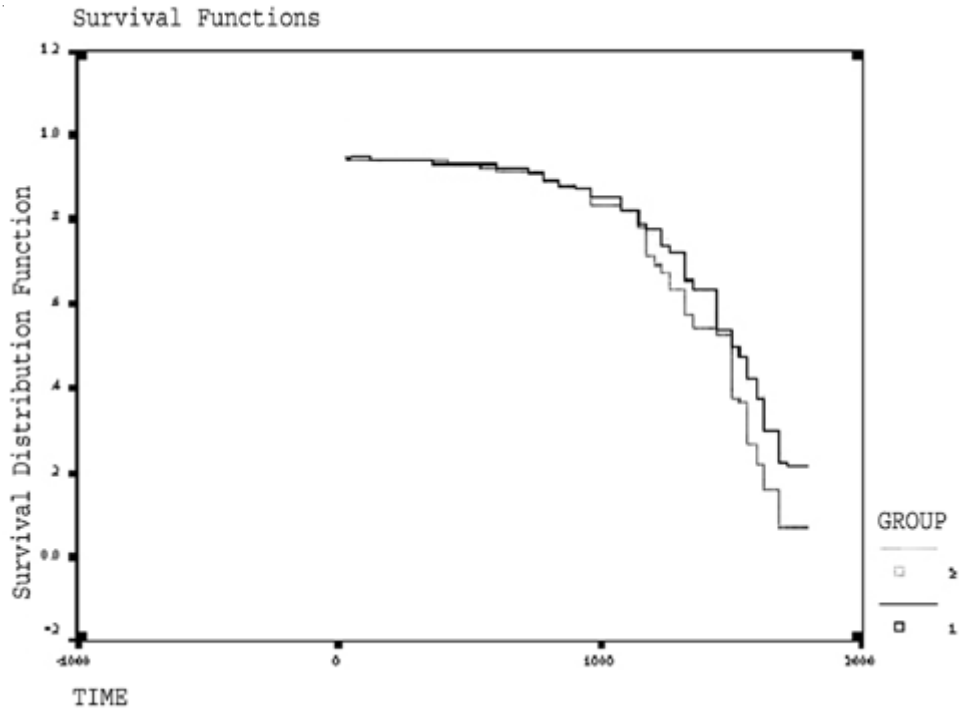

Fig. 1 Five years survival curve. Solid line showed patients with admission blood glucose < 140 mg/dl

when compared with euglycemic patients. The risk affect of hyperglycemia on death was independent. The present study revealed that hyperglycemia had a poor outcome. In the patients with acute cerebral infarction the author found that 17% of hyperglycemic patients received no diabetic treatment during their admission. Queale et al comment that the poor control of diabetic patients leads to detriment[9].

Most of the patients with hyperglycemia either had a prior diagnosis of diabetes mellitus or received this diagnosis during their admission from acute cerebral infarction. Only 10% of the patients with hyperglycemia on admission either had transient hyperglycemia not associated with diabetes mellitus or were diagnosed with diabetes mellitus later during out-patient follow-up. Many studies found that the prevalence of diabetes mellitus in patients with an acute cerebral infarction was significantly increasing, and it should go along with the increased prevalence of diabetes mellitus in the population[10,11].

Some previous studies have reported the difference in outcome of hyperglycemia on mortality after acute cerebral infarct, with some findings having increased short-term mortality[1-2,11-14,15], or increased long term mortality[10], or no effect of acute hyperglycemia on mortality[6-8,16].

Hyperglycemia also has been linked to mortality in acute myocardial infarction[17]. Capes et al showed that hyperglycemia remains an independent risk for mortality even up to 5 years after cerebral infarction[17].

The present study showed that hyperglycemia in acute cerebral infarction is common and it might affect the mortality as early as 6 months after the attack and persist for a longer time, even more than 5 years. The precise mechanism by which hyperglycemia is associated with increased post acute cerebral infarct mortality is unknown even though there is evidence that has confirmed that hyperglycemia can be rapidly and safely treated in acute cerebral infarct with insulin[18]. However, the appropriate management of hyperglycemia in acute cerebral infarction at the present study in hospital is not available.

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ระดับน้ำตาลในเลือดสูงในผู้ป่วยโรคเส้นโลหิตในสมองตีบชนิดเฉียบพลัน

ศุภชัย ไพบูลย์ผล

จากการศึกษาแบบย้อนหลัง ผู้ป่วยซึ่งมีอาการของโรคเส้นโลหิตในสมองตีบแบบเฉียบพลัน วินิจฉัยโดยอาการทางคลินิกและการตรวจเพิ่มเติมโดยทำ CT scan สมองทุกราย ในโรงพยาบาลราชบุรี ระหว่าง วันที่ 1 มกราคม พ.ศ. 2543 ถึง 31 ธันวาคม พ.ศ. 2547 จำนวน 231 ราย ข้อมูลที่ได้จากการรวบรวมบันทึกเวชระเบียนผู้ป่วย ได้แก่ อายุ เพศ ระดับน้ำตาลในเลือด ข้อมูลการรักษาควบคุมระดับน้ำตาลในเลือดระหว่างนอนอยู่โรงพยาบาล ระดับน้ำตาลในเลือดสูงนิยามโดยระดับน้ำตาลในเลือดที่เจาะครั้งแรกที่ผู้ป่วยนอนโรงพยาบาลมากกว่าหรือเท่ากับ 140 มิลลิกรัมต่อ เดซิลิตร ค่า odds ratio อัตราตายที่ 1 ปี คำนวณโดยใช้ multivariate Cox regression model จากการศึกษาพบว่าระดับน้ำตาลสูงมีจำนวนมากถึงร้อยละ 43.7 ในผู้ป่วยโรคเส้นโลหิตสมองตีบแบบเฉียบพลัน ผู้ป่วยกลุ่มน้ำตาลในเลือดสูงเกือบทั้งหมดมีระดับน้ำตาลในเลือดสูงตลอดระยะเวลาที่เข้ารับการรักษาในโรงพยาบาล และพบว่าร้อยละ 61 ได้รับยาลดน้ำตาลในเลือดชนิดรับประทาน ในผู้ป่วยกลุ่มระดับน้ำตาลในเลือดสูงนี้พบว่านอนโรงพยาบาลนานกว่ากลุ่มระดับน้ำตาลในเลือดต่ำ (6.91 vs 4.60, $p < 0.001$) ระดับน้ำตาลในเลือดสูงเพิ่มอัตราเสี่ยงต่อการเสียชีวิตที่ 1 ปี (odds ratio = 1.004, $p < 0.01$) ฉะนั้นระดับน้ำตาลที่สูงในผู้ป่วยเส้นโลหิตในสมองตีบแบบเฉียบพลันสามารถทำนายอัตราการเสียชีวิตผู้ป่วยได้ ในการศึกษานี้พบว่าการควบคุมระดับน้ำตาลในเลือดที่สูงในผู้ป่วยที่นอนอยู่ในโรงพยาบาลควบคุมได้ไม่ค่อยดีนัก