Original Article

Peri operative diabetic management using subcutaneous regular insulin as sliding scale and alberti regimen of glucose insulin potassium infusion - comparative study

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Abstract

Background *The management of diabetic patient during the peri-operative period can be a problem to the anaesthesiologist. Many of worker have used short acting regular insulin using sliding scale which starts before operation and continue in post operatively. Alberti and Thomas proposed a simple regimen using a cotinuous intravenous infusion of an glucose insulin potassium (GIK) solution which is administered during the prei-operative period.*

Objectives *The aim of the study is to observe the rise of blood sugar in diabetic patients per and post operatively and to detrermine the more acceptable method of controlling blood sugar amongst two predetermined methods.*

Methods *A total of 80 patients of ASA II & III were randomly selected. They were divided into the following groups.* ***Group A****. forty patients were randomly allocated to the treatment of thrice daily subcutaneous injections of short acting regular insulin by sliding scale.* ***Group B****. Forty patients were randomly allocated to continuous glucose insulin potassium treatment (GIK). Pre-operative blood glucose was controlled with thrice daily subcutaneous injection of short acting regular insulin.*

Result *The two groups were comparable in demographic data. The blood glucose of group A was raised at mid operation, after 8 hours, 16 hours and 24 hours of operation more than the group B and it were statistically significant. Serum potassium level of the two group did not show any significant difference. The study showed that group B can produce satisfactory blood sugar and serum potassium control than group A. It is safe, simple and less expensive and can be apply in any situation.*

Conclusion *Due to the large number of diabetic patients undergoing surgery and probable complications associated with diabetes, careful perioperave evaluations and management are required in these patients. To select an appropriate interventional strategy depends on the patient, the associated diabetic complications and type of surgery. Chronic diabetic complications can influence surgery and anesthetic conditions. Hence, appropriate risk stratification, optimal blood glucose and suitable interventional strategy are necessary. Glucose insulin potassium infusion can minimize metabolic disturbances during surgery.*

Key words *Alberti Regimen, Sliding Scale, Regular Insulin.*

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Introduction

Blood glucose levels increase during operation in both diabetic and non-diabetic patients. Surgery accompanies by high mortality and morbidity rates in diabetic patient Blood glucose control in diabetic patients during the peri-operative period can be problem to the anaesthesiologist. Many authors have described different regimens for the management of these groups of patients. But Alberti and Thomas found many of the

recommended techniques which are complicated and open to error. Alberti and Thomas proposed a simple regimen using a continuous intravenous infusion of glucose insulin potassium (GIK) solution which is administered during the peri-operative period at constant rate of 100 ml/hrs[1]. For diabetic patients regular insulin is given in various methods. Many of workers have used subcutaneous injection of regular insulin using sliding scale which starts before operation and is continued in post operatively. As this disease affects numerous systems diabetic patients require to be approached systemically and carefully[2].

Perioperative assessments can help us to find the high risk diabetic patients and the patients need extra- management. Some diabetic patients need to improve blood glycemic control before surgery. A simple protocol can help anaesthesiologist to develop a safe perioperative management[3]. Diabetic patients constitute 12.4%-25% of the hospitalized patients. According to the fact that a significant hyperglycemia can influence surgical outcome, studies suggest a good pre-operation glycemic control to prepare a better outcome and an accelerated wound healing. On the other hand, avoiding hypoglycemia is very important in the patients undergoing surgery[4].

Aim of the study is to compare blood glucose control in peri-operative period by two predetermined methods. As far as blood sugar measurement is concerned we have used both conventional laboratory method and with glucometer.

Materials and Methods

This prospective study was performed at Border Guard Hospital Peelkhana, Dhaka from Jun 2009 to Dec 2011. After departmental approval and obtaining written informed consent from the patients, 80 patients were divided into 2 groups. All patients were selected from weekly operating lists.

Blood glucose level was estimated by glucometer and laboratory method. Serum potassium level was also measured. Blood glucose level was controlled by soluble insulin pre-operatively. Free flowing venous blood was taken before operation (designated time F), at approximate mid-time of operation (designated time 0 hrs.), then 8 hourly for 24 hours.

The object of this study was to compare peri-operative blood glucose control using two different methods.

Group - A

Forty subjects (Table-1) were randomly allocated to this group. Pre-operative blood glucose control was attained with thrice daily injections of short acting soluble insulin. On the morning of operation, short acting soluble insulin was given subcutaneously according to sliding scale as followed Border Guard Hospital Peelkhana Dhaka. The same method was followed in the postoperative period for next 24 hours.

The sliding scale method based on the blood glucose level. Insulin was given by the following way :

Table I *Patients of Group A*

RBS (mmol)	Insulin dose (IU) S/C route
6-8	02
8-10	04
10-12	06
12-14	08
14-16	10
16-18	12
18-20	14
20-22	16

Sl	Name of operation	No
1.	Dissectomy for PLID L_4 & L_5	4
2.	Excision of fibro adenoma of breast	8
3.	Open cholecystectomy	8
4.	Vaginal hysterectomy	8
5.	Abdominal hysterectomy	12

Group - B

Forty patients (Table-II) were randomly allocated to continuous glucose insulin potassium treatment (GIK). Pre-operative blood glucose controlled was attained with thrice daily injection of short acting insulin.

Table II *Patients with GIK infusion*

Sl	Name of operation	No
1.	Abdominal hysterectomy	20
2.	Inguinal herniorrhaphy	4
3.	Dissectomy for PLID $L_{3/4}$	4
4.	Repair of incissional hernia	4
5.	Open cholecystectomy	4
6.	Sub-total thyroidectomy.	4

An infusion (GIK) containing 500 ml 5 % D/A, 10 mmol/1 of potassium chloride to which 10 units of soluble insulin was started 30 min before induction of anaesthesia. Subsequent dose of insulin was adjusted according to blood glucose levels as indicated in Alberti's regimen as given below. The infusion was continued for 24 hours [5]:

Blood glucose (mmol/L)	Insulin dose (U)
<4	No insulin
4-6	5
6-10	10
10-20	15
>20	20

Results

Observation of the present study was analysed in the light of comparison among two groups. Each group having **n**=40, all results are expressed as SD and compared by students 'T' testvalues were considered significant if P<0.05.

Table-III *Demographic data of the study*

Group	Age in years Mean (S.D.)	Body weight in kg Mean (S.D.)	Sex M:F
*A	43.8 (±7.46)	55 (±5.2)	1:9
**B	50 (±11.2)	53 (±4.9)	3:7

* P > 0.05

** P > 0.05

Demographic data of Table-3 were statistically not significant and Duration of anaesthesia in Table-4 were also statistically no significant :

Table IV *Duration of Anaesthesia*

Group Mean	Mean (min)	S.D.
*A	87	±53.75
**B	84.5	±36.5
*	P > 0.05	
**	P > 0.05	

Group - A (Table-V)

Plasma glucose level rise during surgery from 8.87 (±3.37) mmol/l to 17.9 (±8.31) mmol/l by laboratory method and 17.4 (±2.69) mmol/l by glucometer. The concentration elevated mainly at 8 hours (p<0.02) and at 16 hours (p<0.01) post operatively. Reached peak at 16 hrs. 17.9 (±8.31) mmol/l by laboratory method and 17.4 (±2.69) mmol/l by glucometer method and came down to lowest level at 24 hrs. Post operatively 9.31 (±4.67) mmol/l by laboratory method and 8.84 (±3.73) mmol/l by glucose method.

There was no significant change of serum potassium level from pre-operative value to post operative (Table-6).

Table V *Blood glucose level*
Group - A

Group-A	Time hrs.	Lab. Method mmol/l	Glucometer mmol/l
	0	13.63 (±7.44)	11.17 (±2.86)
	8	17.57 (±9.02)**	17.0 (±2.75)
	16	17.9 (±8.31)***	17.4 (±2.69)
	24	9.31 (±4.67)	8.84 (±3.73)
	F	8.87 (±3.37)	8.84 (±3.73)

** P 0.02
*** P 0.01

Table VI *Serum potassium Level*
Group-A (N = 40)

Time. hrs.	Value (mmol/I)
0	4.26 (±0.29)
8	3.64 (±.38)
16	3.82 (±.35)
24	4.13 (±.34)
F	3.75 (± .29)

Group-B (with GIK infusion, diabetic) (Table-VII)

Plasma glucose concentration started to rise slowly, than Group A. Blood glucose level rose peak level at 8 hours 9.23 (±2.20) mmol/l by laboratory method and 9.09 (±2.15) mmol/l by glucometer method.

That is subsequent post operative levels for diabetic patients were lower in the glucose insulin potassium infusion treated subject. The peak level marked at 8 hours after operation (p.0.05). There was also no significant difference between the serum potassium level pre and post operatively (Table-VIII)

Table VII *Blood glucose level*

Group - B

Group – B N = 40	Time hrs.	Labo. method mmol/l	Glucometer mmol/l
	0	7.53 (±2.96)	7.36 (±2.5)
	8	9.23 (±2.20)	9.07 (±2.15)
	16	8.94 (±2.99)	8.69 (±2.36)
	24	6.69 (±2.01)	6.69 (±1.9)
	F	7.2 (±2)	6.69 (±1.9)

* $p < 0.05$

Discussion

Diabetes mellitus (DM) is becoming a pandemic worldwide. The highest percentages of increases in disease prevalence are likely to be in developing nations. WHO listed 10 countries to have the highest numbers of people with diabetes in 2000 and 2030. According to this report, Bangladesh has 3.2 million of diabetic subjects in 2000 and the number is expected to increase to a staggering 11.1 million by 2030 placing her among the top 10 countries with diabetes[6]. Diabetes offers a serious bar to any kind of operation and injuries involving open wounds, haemorrhage or damage to the blood vessels are exceedingly grave in subjects. The management goal is to optimize metabolic control through close monitoring, adequate fluid and caloric repletion, and judicious use of insulin. Patients with diabetes undergo surgical procedures at a higher rate than do nondiabetic people[7].

The stress response may precipitate diabetic crises (diabetic ketoacidosis, hyperglycemic hyperosmolar syndrome [HHS]) during surgery or postoperatively, with negative prognostic consequences. The invariant features of the metabolic stress response include release of the catabolic hormones epinephrine, norepinephrine, cortisol, glucagons, and growth hormone and inhibition of insulin secretion and action. These anti-insulin effects of the metabolic stress response essentially reverse the physiological anabolic and anti-catabolic actions of insulin.. The neuroendocrine response to the stress of general anesthesia and surgery leads to activation of potent counterregulatory hormones[7,8].

Sliding scale regular insulin (SSI) in the management of patients with diabetes was the standard practice as early as 1934 and was also used in the hyperglycemic emergency diabetic ketoacidosis. SSI is widely used in health institutions because it is easy and convenient, but it has the disadvantage of not delivering insulin in a physiologic manner, thereby leading to fluctuations in glycemic levels. The usual regimen of sliding scale subcutaneous insulin for perioperative glycemic control may be a less preferable method because it can have unreliable absorption and lead to erratic blood glucose levels [9].

There is no internationally recommended sliding scale, none for any one country or state, none for the same individual during a life time. The insulin regimen should be periodically evaluated and changed to meet the needs of the patient. As per Gill and Mac Farlane sliding scale is illogical in that it responds to hyperglycemia after it has happened, rather then preventing it and sliding scale depends on the clearly inaccurate assumption. That insulin sensitivity is uniform among all patients[10].

In a sliding scale system, insulin administration is based on the preprandial blood glucose reading and/ or the expected caloric or carbohydrate intake. The wide fluctuations and excessive spikes in blood glucose levels associated with sliding scale management may cause reactive oxidative stress a trigger for vascular damage, especially in patients with type 2 diabetes .A premeal blood glucose level is not an accurate predictor of the insulin needed at that time,it is simply a reflection of the insulin previously administered. Insulin given in response

to the current blood glucose, then, may compound a prior dosing error, leading to serious drops or spikes in blood sugar. Pharmacodynamically, short-acting insulin lasts 6 to 8 hours. It should be given every 6 hours, in 4 equal doses, without ever skipping a dose[11,12].

Retrospective and prospective cohort studies, have concluded that SSI should be discouraged because it has not been shown to be an effective means of achieving much-needed optimal glycemic control in hospitalized patients[13]. However, the issue of SSI has never been settled because of the lack of data on prospective, randomized, controlled studies. Subcutaneous insulin injection can be fraught with problems, however. Unpredictable absorption, a difficulty under normal circumstances, may be worse because of changes in tissue perfusion that occur in the perioperative period and may be of particular concern in obese patients [14].

The best method of providing insulin during surgery is debatable. Few data clearly demonstrate the superiority of one regimen over another. Any regimen should (1) maintain good glycemic control to avoid hyperglycemia and hypoglycemia; (2) prevent other metabolic disturbances; (3) be relatively easy to understand; and (4) be applicable to a variety of situations (operating room, recovery room, and general medical and surgical wards)[15].

In 1979, the British Journal of Anaesthesia published an article by Alberti and Thomas in which they introduced the i.v. infusion of a premixed bag of glucose insulin potassium for the metabolic management of diabetic patients in the perioperative period. Intravenous infusion of insulin, glucose, and potassium is now standard therapy and has replaced subcutaneous insulin therapy for the perioperative management of diabetes, especially in type 1 diabetic patients and patients with type 2 diabetes undergoing major procedures. Several reports have emphasized the advantages of the insulin infusion regimen over subcutaneous delivery[1,16].

The combined GIK infusion is efficient, safe, and effective in many patients but does not permit selective adjustment of insulin delivery without changing the bag.. Adequate glucose should be provided to prevent catabolism, starvation ketosis, and insulin-induced hypoglycemia. The physiological amount of glucose required to prevent catabolism in an average nondiabetic adult is 120 g/day (or 5 g/h). This can be given as 5 or 10% dextrose. An infusion rate of 100 ml/h with 5% dextrose delivers 5 g/h glucose. Intravenous insulin infusion offers advantages because of the more predictable absorption rates and ability to rapidly titrate insulin delivery up or down to maintain proper glycemic control[1,17].

The goal is to maintain blood glucose levels within a target range 120 to 180 mg per dL . Alberti and co-workers represents a substantial improvement in the management of diabetic patients undergoing major surgery. However, this method does not allow rapid and independent modification of the respective amounts of glucose and insulin being infused, thus possibly delaying correction of impending hypoglycemia or increasing hyperglycemia. Problem with this method is the inability to independently adjust the insulin and glucose delivery rates as may be required. A new concentration of solution must be prepared if the ratio of insulin to glucose has to be changed[18,19].

Historically, the debate regarding perioperative insulin therapy for patients with diabetes has revolved around SC vs. IV administration the occurrence of hypoglycemia than hyperglycemia. In the past 2 decades, most authors have come to support the IV route of insulin administration because it avoids the less predictable absorption of SC insulin that is exacerbated by the fluid shifts that are common in patients during the perioperative period[20,21,22].

Regardless of whether separate or combined infusions are given, close monitoring is required to avoid catastrophe during these infusion regimens. Although the separate infusions offer greater flexibility, they lack the inherent safety of the combined regimen. Alberti and Thomas emphasized that during starvation in type 1 diabetics, the restraining effects of basal insulin on catabolism are lost and that catabolism 'runs riot' when catabolic hormone secretion increased during surgery.. The recommendations for type 1 diabetic patients were to use the Alberti regimen in all patients undergoing surgery and to continue the infusion until the patient was eating[23,24,25].

There is a need for a simple but effective method for insulin delivery during the prei-operative

period. Adsorption of insulin to plastic does occur this was not a significant clinical problem, hypoglycemia did not occur. The results show that infusion of GIK in diabetic patient patients improved control of plasma glucose during and after the infusion period compared to sliding scale method. The 24 hours glucose, insulin and potassium infusions resulted in reasonable control of the blood glucose. The need to make changes in the insulin dose was based on laboratory and Glucometer analysis. We also attempted to be meticulous in our study for estimating the blood glucose levels with Glucometer by visual estimation. This also showed no significant difference from the conventional laboratory method to measure the blood glucose. Our study also showed no sigificant difference in the serum potassium level in both groups. By GIK tends to give us most smoother post operative period as the level rises concern, although we can not give any cause for this our limited study, but nevertheless, it allows one to continue further study in this particular area.

Conclusion

It should be emphasized that successful peri operative management of diabetic patients is a big challenge and requires a simple protocol. It was noticed that glucose insulin potassium group (GIK) had a relatively smother peri operative diabetic control, although the study of the serum potassium level did not show any significant difference, neither there was any difference of estimation of blood glucose level between the glucometer and laboratory method in our study.

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