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Management of diabetic patient's undergoing major surgery using glucose insulin potassium infusion

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ORIGINAL ARTICLE

ANAESTHETIC MANAGEMENT OF DIABETIC PATIENTS UNDERGOING MAJOR SURGERY USING GLUCOSE INSULIN POTASSIUM INFUSION A STUDY OF THIRTY CASES.

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ABSTRACT

Thirty diabetic patients undergoing major elective surgery were studied to assess the effectiveness of a regimen of glucose - insulin - potassium infusion at the Aga Khan University Hospital, Karachi. Out of the 30 patients studied, 25 were non insulin dependent and 5 insulin dependent. During surgery 24 out of 30 patients (80%) had acceptable glycaemic control i.e. mean blood glucose levels in the range of 90-216 mg/100 ml with neither clinical nor biochemical evidence of hypoglycemia or hyperglycaemia. Post operatively, the mean blood glucose level on the day of operation was acceptable in 19 patients (63.33%).

During this study, no patient had clinical or biochemical hypoglycemia, neither was there any incidence of serious morbidity or mortality attributable to problems with diabetic control. Glucose insulin potassium infusion was found to be satisfactory for managing diabetics during major surgery.(JCPSP 1993;3(2):44-49)

KEY WORDS : Diabetes mellitus, anaesthetic management, glucose insulin potassium infusion.

INTRODUCTION

Now that infections and infestations are well under control due to better sanitation, effective protective inoculations and potent antibiotics, metabolic and degenerative diseases are the problems that the anaesthesiologists have to face, one such disease is diabetes mellitus. It has been estimated that 50% of diabetics will need an operation at some time during their life[1]. Diabetic patients undergoing surgery are at a higher risk of developing complications if the control of diabetes is poor.

The advent of insulin revolutionized the treatment of diabetic patients undergoing surgery, a revolution that was extended by the discovery of antibiotics. Inspite of all these improvements in the management of diabetic patient, surgery carries a significant mortality and morbidity even in good centres[2,3]. The major causes of morbidity and mortality in diabetic patients were and still are infection[4,5] and myocardial disease[6]. It is obvious that problems may arise during and after surgery in diabetics and that these problems are exacerbated by poor control of diabetes. A recent retrospective study suggests, however, that if diabetes is well controlled, postoperative morbidity is not increased by diabetes[7]. There is obviously a need for a logical straightforward set of guidelines for the management of diabetes in patients undergoing major surgery. At present there are a multitude of recommended regimens[8-12]. One such regimen is the use of glucose insulin potassium infusion. This study was designed to see whether glucose insulin potassium infusion (GIK) provides adequate diabetic control during surgery or not and to see whether it reduces mortality and morbidity in diabetic patient under going major surgery.

MATERIAL AND METHODS

Thirty diabetic patients of ASA I & II scheduled for major elective surgery were studied. Five of these patients were insulin-dependent and the rest were non-insulin-dependent. Major surgery was defined as operations lasting for more than one hour which are likely to interfere with diet and normal diabetic management e.g. cholecystectomy, major vascular reconstruction and bowel resection. These patients were admitted forty-eight hours before surgery for stabilization of their blood glucose level and they were placed on soluble insulin according to sliding scale based on blood glucose estimations. These patients were scheduled first on the operating list. If they were on the afternoon list, then a light breakfast was given at 6 a.m.

All patients received Tab.diazepam 0.15mg/kg two hours before surgery with sips of water. Morning dose of Insulin was omitted and fasting blood sugar and serum potassium done two hours preoperatively. Depending on these results glucose insulin potassium infusion was started one hour preoperatively. Dose of insulin and potassium was according to the GIK regimen as given in Table 1.

Anaesthesia was induced with thiopentone sodium 5 mg/ kg body weight and endotracheal intubation carried out after giving suxamethonium 1.5 mg/kg body weight. Anaesthesia was main-

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TABLE I

GLUCOSE INSULIN POTASSIUM DRIP REGIMEN

1. Use a separate drip for glucose-insulin-potassium infusion.
2. Flush the given set with 25ml of glucose-insulin-potassium solution before starting the infusion.

Blood sugar	Soluble Insulin	Potassium	Glucose infusion	Rate of infusion
<90mg/100 ml	5 units	10mmols	500ml 10%	100ml/hr
90-180mg/100ml	10 units	10mmols	500ml 10%	100ml/hr
180-360mg/100ml	15 units	10mmols	500ml 10%	100ml/hr
>360mg/100ml	20 units	10mmols	500ml 10%	100ml/hr

3. Estimate blood sugar and potassium as below :

BLOOD SUGAR
- one hour after starting drip
- every hour during surgery
- 4-hourly post-operatively

SERUM POTASSIUM
- 4 hourly intra-operatively
- 8 hourly post-operatively

4. Manage as given below:

- If blood sugar < 60mg/100ml, stop G.I.K. Regime and give 25ml of 50% glucose & check blood sugar after 15 minutes
- If serum potassium is less than 3 mmol/L add 20 mmols of potassium to 500ml 10% D/W
- If serum potassium > 5mmol/L stop potassium

tained with nitrous oxide and oxygen in a ratio of 70:30 supplemented with halothane 0.5%. Muscle relaxation was obtained with pancuronium 0.1 mg/kg body weight and analgesia by pethidine 0.8 mg/kg body weight. The neuromuscular blockade was reversed with neostigmine and atropine.

The glucose insulin potassium infusion was delivered through an IVAC pump at a rate of 100mls/hour and continued throughout surgery. During this period blood glucose was monitored hourly with glucometer using glucostix and serum potassium checked 4 hourly. The blood sugar was also sent to the laboratory every 2 hours (The laboratory result of glucose compared favourably with the glucometer). The insulin content of infusion was changed every hour depending on the results of blood glucose. The maintenance fluid used was normal saline administered through a separate cannula and blood replacement was done whenever needed.

Post-operatively, in all these patients the glucose insulin potassium infusion was continued till the patient started oral feeding. During this period blood sugar was checked 4 hourly and serum potassium 8 hourly. When patient had resume oral feeding, blood sugar was checked before each main meal and then subcutaneous insulin was given according to sliding scale and insulin dependent diabetic patients were brought to original preoperative insulin regimen in 2-3 days. In the insulin-independent diabetic patients, when the postoperative insulin requirement becomes less then 20 units per day, then their diabetes was controlled by diet or oral hypoglycemic drugs depending on the treatment on which they were prior to surgery.

RESULTS

The demographic detail of the patients and the surgical procedure performed on them is given in Table II.

Glycaemic control

Fasting blood glucose on the day of operation was acceptable in all the patients (Table III). Preoperative fasting blood glucose in the optimal range (90-180 mg/100 ml) was achieved in 25 out of 30 patients (83.33%).

TABLE II

DETAILS OF PATIENTS AND SURGICAL PROCEDURE

S.no	AGE (yrs)	SEX	WEIGHT (kg)	ASSOCIATED PROBLEMS	TYPE OF DIABETES	SURGICAL PROCEDURE
1	60	F	86.0	Hypertension	NIDDM*	Cholecystectomy
2	55	M	86.0	-	NIDDM	Pyelolithotomy
3	55	F	61.5	Hypertension	NIDDM	Cholecystectomy
4	50	M	86.5	1st Degree Heart Block	NIDDM	Cholecystectomy
5	60	M	75.0	-	NIDDM	Thoracotomy
6	35	M	50.5	-	NIDDM	Splenectomy
7	68	M	87.5	-	NIDDM	Nephrectomy
8	55	M	50.0	-	NIDDM	Hemicolectomy
9	45	F	55.0	Hypertension	IDDM**	Abd. Hysterectomy
10	65	M	75.0	-	NIDDM	Total Hip Replacement
11	58	M	78.0	Right Bundle Branch Block	NIDDM	Cholecystectomy
12	70	M	65.0	-	NIDDM	Total Hip Replacement
13	62	M	73.0	-	NIDDM	Nephrectomy
14	43	F	51.8	-	NIDDM	Exploratory Laparotomy
15	54	F	80.0	-	NIDDM	Cholecystectomy
16	60	F	70.0	-	NIDDM	Cholecystectomy
17	58	F	67.0	Ischaemic Heart Disease	NIDDM	Modified Radical Mastectomy
18	51	F	81.6	-	NIDDM	Incisional Hernia Repair
19	48	F	65.0	-	NIDDM	Cholecystectomy
20	53	F	60.0	Hypertension	NIDDM	Exploratory Laparotomy
21	60	M	50.0	Hypertension	NIDDM	Internal Fixation # Shaft Femur
22	38	M	54.0	-	IDDM	Thoracotomy
23	51	F	62.5	-	NIDDM	Cholecystectomy
24	65	M	64.0	Peripheral Vascular Disease	NIDDM	Femoro Popliteal Grafting
25	48	M	70.0	-	NIDDM	Exploratory Laparotomy
26	40	M	53.0	-	NIDDM	Cholecystectomy
27	50	F	65.0	Hypertension	NIDDM	Cholecystectomy
28	68	F	60.0	-	NIDDM	Exploratory Laparotomy
29	52	M	83.6	-	NIDDM	Cholecystecctomy
30	50	F	80.0	Hypertension	NIDDM	Cholecystectomy

*NIDDM : non insulin dependent diabetes mellitus

**IDDM : insulin dependent diabetes mellitus

TABLE III

	PRE-OPERATIVE		POST-OPERATIVE		
S.No	BLOOD SUGAR (mg/100ml)	SERUM POTASSIUM (mmol/L)	MEAN BLOOD SUGAR (mg/100ml) intra operative	post operative	SERUM POTASSIUM (mmol/L)
1	121	4.1	198.3	196.2	3.5
2	154	4.5	203.0	213.2	4.0
3	160	3.5	233.0	224.5	4.2
4	112	3.8	185.3	190.5	3.3
5	199	3.3	185.0	125.7	3.8
6	150	4.4	196.3	197.5	4.1
7	174	3.5	200.0	250.0	3.8
8	143	4.0	213.0	155.7	4.3
9	175	3.5	225.0	280.0	3.8
10	160	4.5	215.0	202.0	4.3
11	157	4.1	203.3	210.7	4.6
12	166	5.3	273.3	254.2	5.1
13	114	3.9	171.0	218.7	3.5
14	165	4.4	210.0	202.0	4.3
15	169	5.3	191.6	199.0	5.1
16	152	3.3	203.3	189.7	3.5
17	198	3.9	220.0	231.5	3.5
18	152	3.1	206.6	168.5	3.8
19	180	4.3	171.3	198.7	3.6
20	161	4.4	211.6	193.2	4.1
21	122	3.4	217.6	217.7	3.7
22	154	4.1	179.6	237.5	3.5
23	185	4.3	206.6	228.7	3.8
24	187	4.8	211.6	211.2	3.6
25	219	4.7	251.6	198.7	4.5
26	175	4.5	195.0	268.7	4.5
27	187	4.2	193.3	175.0	4.0
28	110	4.3	144.0	167.5	3.8
29	135	4.1	154.0	188.7	3.9
30	165	4.5	211.6	220.0	4.0

Acceptable glycaemia control intraoperatively and postoperatively was defined as mean blood glucose levels in the range of 90-216mg/100ml with neither clinical nor biochemical hypoglycaemia (blood glucose less than 54mg%). During the operation 24 out of the 30 patients (80%) had acceptable glycaemic control. Postoperatively in 19 patients (63.33%) the mean blood glucose on the day of operation was acceptable (Table III).

During this study, no patient had clinical or biochemical hypoglycaemia, neither was there any incidence of serious hyperglycaemia or ketoacidosis. There was no serious morbidity or mortality attributable to problems with diabetic control.

SERUM POTASSIUM CHANGES

The serum potassium on the pre- and first post-operative day is shown is Table III. On the Ist postoperative day, 6 patients had serum potassium ranging between 3-3.5 mmol/L but none had less then 3.0. Two patients had slightly elevated postoperative potassium concentration (5.1 mmol/L in both instances) but in these patients the preoperative values were comparatively high (5.3 mmol/L).

DISCUSSION

The metabolic changes which occur after major surgery have been widely described in literature[13]. The primary aim of metabolic management in a diabetic patient undergoing major surgery is the avoidance of excess morbidity and mortality attributable to diabetes. Normoglycaemia is not necessary[14]. The objective is to achieve a level of glycaemic control which carries the least risk of hypoglycaemia, in the intra- and early postoperative period. It is reasonable to aim for a glucose level of 90-216 mg/100 ml on the day of surgery[15], especially as a recent study in patients undergoing major vascular surgery has shown that diabetic patients with blood glucose concentrations in this range had a morbidity and mortality identical to that of non-diabetic patients[16].

When glucose insulin potassium infusion was used intraoperatively, mean blood glucose values were acceptable at all times, and overall adequate control was achieved in 80% of cases. Bowen et al[8] observed hypoglycaemia in 2 of 27 patients managed with GIK and they recommended that blood glucose level should never be allowed to fall below 90mg% because of the obvious hazards of hypoglycaemia.

In view of the association of hyperglycaemia with high and hypoglycaemia with low insulin requirements, it would be useful if the insulin requirement in the GIK could be accurately predicted prior to operation. Patients undergoing major surgery are more likely to have high insulin requirements, but it is preferable to monitor blood glucose hourly and regulate the insulin dose accordingly.

Accurate blood glucose monitoring is performed by using glucostix and glucometer. Results from the laboratory are usually delayed and costly for the patient. It is demonstrated in this study that an acceptable standard of blood glucose monitoring can be achieved with glucometer. Direct comparison of results using GIK infusion with those using other regimens is difficult, and indeed there have been few assessments in a routine clinical setting. The use of fractional doses of intermediate acting insulin on the day of operation is illogical, difficult to use in practice, and frequently associated with poor control[9]. Two acceptable alternatives other than GIK are available. Anderson[10] suggested giving twice daily short and intermediate acting insulin on the day of surgery and substituting the normal carbohydrate intake by intravenous glucose. The problems with this regimen are that it is more complex, that it depends on adequate subcutaneous perfusion and the patient is vulnerable to interruption of the glucose infusion.

The use of separate insulin and glucose infusion is a possible way of achieving very precise glycaemic control but requires very close monitoring to obtain good results[11] With separate infusions, hypoglycaemia is a danger if technical failure occurs, though it is not known whether this occurs more commonly than with GIK regimen.

This study was carried out on patient admitted for routine surgery, but since this regimen can be employed at any hour of the day or night it may also be suitable for emergency surgical patients.

It is also suggested that insulin glucose potassium infusion be administered through a separate cannula from that used for other infusions required during major surgery and anaesthesia when other fluids may need to be infused very rapidly. There was no incidence of thrombophlebitis during the time of study and the patients tolerated the regimen well. Although an IVAC pump was used to maintain constant infusion of 100ml/hour if it is not available then Soluset infusion set can be easily used in its place.

In summary it is suggested that glucose insulin potassium infusion regimen is suitable for the routine management of diabetic patients undergoing major surgery specially in district hospitals of Pakistan where good laboratory facilities are not available. The regimen cannot however be used in the blind unmonitored manner implied by some authors[17]. The search for a simple, arbitrary, insulin regimen for the management of diabetics undergoing major surgery is a search for a dangerous illusion. Diabetics vary in their response to insulin and in their metabolic response to surgery. The requirements for acceptable metabolic control in the diabetic during major surgery are the use of a logical regimen, the careful and frequent monitoring of blood glucose and prompt and appropriate changes in therapy.

REFERENCES

1. Root HF. Preoperatively care of the diabetic patient. Postgrad Med 1966; 40:439.

2. Shuman CR. Surgery in the Diabetic patients in Diabetes Mellitus: Diagnosis and treatment. Ed. S. S. Fajans & K. E. Sussman. Vol. 3. American Diabetic Association, New York, 1971:217.

3. Wheelock FC, Marble A. Surgery and diabetes In: Joslin's Diabetes mellitus, 11th ed. Ed Marble A, White P, Bradley RF and Krall LP. Philadelphia: Lee and Febiger. 1971:599.

4. Bagdade JD., Nelson KL., Bulger RJ.; Reversible abnormalities in phagocytic function in poorly controlled diabetic patients. Am J Med Sci 1972;263:451.

5. Bybec JD., Rogers DE. The phagocytic activity of polyps obtained from patients with diabetes mellitus. J Lab Clin Med 1964: 64: 1.

6. Solar NG., Pentecost BL., Bennett MA., Fitzerald MG., Lamb P: Malivs J.M. Coronary Care for Myocardial Infarction in Diabetes. Lancet 1974; 1: 475.

7. Hjortrup A., Sorenson C., Dyremose E., Hjortson C., Kehilct H.; Influence of diabetes mellitus on operative risk. British Journal of Surgery 1985; 72: 783-5.

8. Bowen DJ., Daykin AP., Nancekievill ML., Norman J.; Insulin dependent diabetic patients during surgery and labour. Anaesthesia 1984; 39:407-11.

9. Watts LT., Miller J., Davidson MB., Brown J.; Perioperative management of diabetes mellitus Anesthesiology 1981; 55:104-9.

10. Anderson J., Johnston DG.; Subcutaneous insulin and intravenous glucose therapy for surgical diabetes. Diabetologia 1980;19:557 (abstract).

11. Podolsky S.; Management of diabetes in the surgical patient. Med Clin North America 1982; 66:1361-71.

12. Alberti, KGMM., Thomas, D.J.B (1979), The management of diabetes during surgery. British Journal of Anaesthesia, 51,693-710.

13. Allison SP., Tolin PH., Chamberlain MAJ.: Some effects of anaesthesia and surgery on carbohydrate and fat metabolism. B J M 1969; 41:588-93.

14. Dasidoff F.; Medical management surgery. In:Shnaiz JD(Ed). Diabetes Mellitus: problems in management. Addison Weslley, California. 1982:253-68.

15. Shauman CR.; Surgery and Diabetes. In : Ellenberg M, Rifkin H. (Eds). Diabetes Mellitus. 3rd Ed. Medical Examination Publishing, New York. 1983:668-79.

16. Hjortup A., Rasmussen BF., Kehlet H.; Morbidity in diabetic and non-diabetic patients after major vascular surgery. Br. Med J 1983; 287:1107-8.

17. Bowen DJ., Nance Kievill ML., Proctor EA.: Perioperative management of insulin dependent diabetic patients. Use of continuous intravenous infusion of insulin-glucose-potassium solution.