SHORT COMMUNICATION

Factors Influencing Post-Operative Hyperglycaemia in Type 2 Diabetes Mellitus Patients Managed Without Intra-Operative Insulin

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Summary

Surgery induces a 'stress' state leading to post-operative hyperglycaemia. To investigate this effect on patients with Type 2 Diabetes Mellitus, we reviewed the records of 50 diabetic patients who underwent surgery without intra-operative insulin. Demographic features together with pre-operative and post-operative blood glucose readings were noted. 27.3% of patients with well controlled pre-operative blood glucose levels developed post-operative hyperglycaemia. In contrast, 84.6% of patients with poorly controlled levels developed the same. Poor control of blood glucose and duration of operation were the only significant predictors of post-operative hyperglycaemia.

Key Words: Pre-operative, Diabetes Mellitus, Clinical Practice Guidelines

The prevalence of Diabetes Mellitus (DM) in adults worldwide was estimated to be 4.0% in 1995. Type 2 Diabetes Mellitus make up about 90% of all adult DM patients. These patients have an estimated 50% chance of having a surgical procedure during their lifetime.

Surgery induces a trauma-like 'stress' state leading to post-operative hyperglycaemia, and is more frequent and more severe in diabetics than in non-diabetics [1]. Hyperglycaemia evoked by surgery, especially in diabetic patients, is associated with an increased risk of infection.

The basic aim of peri-operative blood glucose management is to keep glucose levels high enough to prevent hypoglycaemia, and low enough to prevent ketosis and hyperosmolar non-ketotic diabetic coma[2]. To achieve this aim, it is advised that except for patients with good glycaemic control on oral medication or diet presenting for minor operations, all diabetic patients should receive insulin intra-operatively.

This study was carried out to determine the factors associated with post-operative hyperglycaemia in Type 2 DM patients who were not given insulin intra-operatively. Results of the study could be used to aid the review of clinical practice guidelines for peri-operative management of DM.

Materials and Methods

This study was conducted at the general surgical, urology, orthopaedics, ophthalmology, ENT and gynaecology wards of Hospital Kuala Lumpur, Malaysia. Medical records of all patients who underwent elective surgery over an eight-week period were reviewed. Patients diagnosed as having Type 2 Diabetes Mellitus and who were not given oral hypoglycaemic agents or insulin on the day of operation were included in the study.

Relevant information collected included the patient's age, gender, weight, height, duration of diabetes, type

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and duration of surgery, type of anaesthesia and diabetic management. Blood glucose levels were either measured in the laboratory, or by the bedside using a "Glucometer" (MediSense® Optium™, Abbot Laboratories). Capillary whole blood was used for the glucometer readings, and the following formula was used to convert capillary whole blood to venous plasma values:

[Venous Plasma Glucose Value] = [Capillary Whole Blood Glucose Value] x 1.15 x 0.93
1.15 being the conversion factor for whole blood to plasma values
0.93 being the conversion factor for capillary to venous values
Random blood sugar (RBS) levels were measured on the afternoon before operation. Fasting blood sugar (FBS) levels were measured on the morning of operation. Patients were classified as well-controlled if:

i. RBS was less than 11 mmol l^{-1} (laboratory) or 10.3 mmol l^{-1} (Glucometer), and
ii. FBS was less than 8 mmol l^{-1} (laboratory) or 7.5 mmol l^{-1} (Glucometer).

Post-operative hyperglycaemia was recorded if at least one blood glucose level during the first 24 hours after surgery was more than 11 mmol l^{-1} (laboratory) or 10.3 mmol l^{-1} (Glucometer).

Data was analysed using the Statistical Package for Social Science (SPSS) 10.0.1 standard version. Student's t-test, Fisher's exact test, General Linear Model (GLM) analysis and logistic regression were used as appropriate. A value of $p < 0.05$ was considered significant.

Results

A total of 864 patients were admitted for surgery during the study period. Of this number, 50 patients fulfilled the inclusion criteria. Demographic data and peri-operative plasma glucose values are shown in Table I. Patients who were well controlled did not differ from patients who were not well controlled in terms of age, gender, body mass index (BMI) and duration of diabetes.

A significantly higher proportion of patients presenting for major operation were well controlled (Fisher's test, $p = 0.045$). However, the incidence of post-operative hyperglycaemia did not differ significantly between patients who had major or minor operations (Fisher's test, $p = 0.77$).

Analysis using the GLM revealed that the covariates that were significantly correlated with the post-operative blood sugar level were FBS ($F = 9.68$, $p < 0.01$) and duration of operation ($F = 4.65$, $p = 0.04$). However, in the absence of an FBS, RBS was a good predictor of the post-operative sugar level ($F = 11.5$, $p < 0.01$).

Stepwise logistic regression revealed a fasting blood glucose beyond normal limits and operation duration of more than 3 hours were significant predictors of post-operative hyperglycaemia (Table II).

Table I: Demographic data, and peri-operative management and plasma glucose levels. Continuous data are expressed as mean (SD).

	Plasma glucose well controlled	Plasma glucose not well controlled	All patients
Total number of patients	22	26	50#
Age (years)	58.1 (11.8)	55.1 (12.0)	56.7 (11.7)
BMI (kg m^{-2})	22.9 (5.2)	24.1 (4.4)	23.4 (4.9)
Sex (male / female)	15 / 7	12 / 14	27 / 23
Duration of illness (years)	5.1 (4.5)	7.6 (6.0)	6.6 (5.4)
Duration of operation (hours)	2.2 (1.7)	2.0 (1.3)	2.1 (1.5)
Random blood glucose* (mmol l^{-1})	7.1 (2.0)	11.1 (5.5)	9.2 (4.6)
Fasting blood glucose* (mmol l^{-1})	6.1 (1.6)	11.3 (3.3)	8.9 (3.7)
Highest post-operative glucose level* (mmol l^{-1})	9.5 (4.1)	15.1 (4.7)	12.6 (5.2)
Post-operative hyperglycaemia (yes / no)	6 / 16	22 / 4	30 / 20
No. of post-op blood samples	2.3 (2.8)	4.8 (4.3)	3.1 (3.7)

includes 2 patients with incomplete blood sugar data
* capillary whole blood sugar levels converted to plasma venous levels

Table II: Independent variables that influenced the incidence of post-operative hyperglycaemia. The model managed to predict the outcome correctly in 82.6% of the cases.

Predictor variable	β (SE)	Wald statistic	Odds ratio (95% CI)
Constant	- 4.16 (1.18)	12.34	
Fasting blood glucose beyond normal limits	3.20 (0.88)	13.11	24.5 (4.3 – 138.6)
Duration of operation more than 3 hours	2.53 (1.03)	6.05	12.5 (1.7 – 93.5)

Discussion

Our findings with regards to glycaemic control and operation duration are similar to those reported by previous investigators[3,4]. However, a previous study found that major surgery caused a greater increase in plasma glucose levels in the first 2 hours of surgery when compared to minor surgery[5]. In contrast, we found the incidence of post-operative hyperglycaemia was independent of the severity class of the operation.

In order to set cut-off limits for easy identification of diabetic patients at risk of post-operative hyperglycaemia, we converted continuous variables to dichotomous variables and subjected them to logistic regression. The results suggest that active intervention, such as an insulin infusion, is required in Type 2 DM patients with a fasting venous plasma glucose of more than 8 mmol l^{-1} on the morning of operation. The same is also necessary if the procedure lasts for more than 3 hours.

Our results support the recommendations of the Malaysian Consensus on the Management of Non-Insulin Dependent Diabetes Mellitus. According to the Consensus Statement, only well-controlled patients should be allowed to undergo elective surgery, and patients having major operations should be given an insulin infusion. Postponing an operation based on a high RBS on the day before surgery is justified if high post-operative blood sugar levels need to be avoided. However, an FBS on the morning of the operation would be a better indicator.

Duration of operation is another predictor of the risk of post-operative hyperglycaemia. Unfortunately, it is difficult to predict the duration of operation. Assuming major operations will take a longer duration, it is appropriate to start a glucose-insulin-potassium infusion for patients undergoing such procedures.

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