

Effect of Ketones on the Onset of Local Anesthesia among Diabetic Patients in the Kingdom of Saudi Arabia

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ABSTRACT

Aim: To evaluate the effect of blood ketones on the onset of local anesthetic (LA) effect among diabetic patients in Abha, Kingdom of Saudi Arabia.

Materials and methods: A convenient sample of 34 subjects was taken for the study. All those who were suffering from diabetes mellitus (types I or II), aged 40 to 70 years, having vital maxillary anterior teeth and who were willing to participate, were enrolled for the study. Moreover, 15 nondiabetic (healthy) patients who had visited the Department of Restorative Dental Sciences for undergoing endodontic treatment of maxillary anterior teeth were also included in the study. The subjects were checked for blood glucose level and blood ketone values. All the participants were given infiltration in maxillary central incisor teeth using 2% lidocaine with epinephrine for all the participants. The onset of the effect of LA was checked using thermal test (cold Endo Ice) and Electron Pulp tester (EPT).

Results: The average blood ketone value among the controlled type I and controlled and uncontrolled type II was found to be 0.1 mmol/L, while it was 0.2 mmol/L among the subjects with uncontrolled type I diabetes.

Conclusion: The onset of LA effect was found to be within 3 minutes in all cases except those with type I uncontrolled diabetes wherein it was found to be 4 minutes. The difference was not found to be statistically significant.

Clinical significance: Due to long-term hyperglycemic condition in diabetic patients, their body cells are unable to get energy from carbohydrates due to lack of insulin and it thus results in the utilization of the body fats as source of energy, producing ketones as by-product. Hence, knowing the effect of ketones, if any, on the onset of LA would be quite beneficial.

Keywords: Blood glucose, Diabetes, Ketones, Local anesthesia.

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INTRODUCTION

Silink,¹ previous president of the International Diabetes Foundation (2003–2006), very aptly said: “Diabetes is understood by few and ignored by many.”

Diabetes mellitus is a metabolic disorder of the body wherein pancreas is either unable to produce insulin or the insulin produced by it is ineffective, thus giving rise to two types of diabetes, types I and II, respectively.² Type II diabetes mellitus is more common, involving over 90% of all diabetic patients. Prevalence of diabetes worldwide has been predicted to be as high as 54% by the year 2025 against as low a figure as only 4% in 1995.³ Such an alarming rise in diabetes calls for our proportionally optimal attention toward it and the associated ailments/problems.

Very serious complications, such as damage to target organs as well as microvascular abnormalities causing oral manifestations have been observed as to be related to long-term uncontrolled diabetes mellitus due to hyperglycemia.⁴ Hence, diabetic people are more prone to dental and periodontal problems which the dentists are often confronted with while treating such patients. As of now, the epidemic spread of diabetes makes it most necessary for dentists to be acquainted with its knowledge and the ways of providing, to the diabetic patients, the competent professional dental care with none of the hurdles in ensuring their treatment.

Due to long-term hyperglycemic condition in diabetic patients, their body cells are unable to get energy from carbohydrates due to lack of insulin and it thus results in the utilization of the body fats as source of energy. This, in turn, gives rise to production of ketones as a by-product of breakdown of fats, which consequentially creates toxic situation by affecting their blood pH values called ketoacidosis.⁵

This scenario leads to plan a study so as to evaluate the effect of ketones on the onset of LA effect among diabetic patients in Abha, Kingdom of Saudi Arabia.

MATERIALS AND METHODS

An analytical study was conducted among diabetic patients to assess the effect of ketones on the onset of anesthetic effect after infiltration with LA agent in Abha, Kingdom of Saudi Arabia. Prior to the commencement of study, ethical approval was taken from Scientific

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Research Committee, College of Dentistry, King Khalid University, Abha. A convenient sample of 34 subjects was taken for the study. All those who were suffering from diabetes mellitus (types I or II), aged 40 to 70 years, having vital maxillary anterior teeth and who were willing to participate were enrolled for the study. The patients had visited the Department of Restorative Dental Sciences for undergoing endodontic treatment of maxillary anterior teeth. All those diabetic patients having other medical problems, such as hypertension and hypothyroidism were excluded from the study so as to avoid the effect of other systemic problems on the outcome of the study. Moreover, 15 healthy patients who were free from diabetes or any other systemic diseases also participated in the study, making a total sample of 34 subjects [diabetic (19) and nondiabetic (15)].

The subjects were checked for blood glucose level using Accu-Chek Active Glucometer with glucose test strips, and they were examined for blood ketone values using ketone test strips (Glucometer). Glucometer is a valuable and reliable tool for easy measurement of blood glucose levels. There are many different types of blood glucose meters, but the same basic principles of use apply in all the different types. The machine is put in service by using the test strips which are inserted into it, the coding is checked, and a small drop of blood (achieved using a lancet device) is applied on the spot of the strip indicated at its end. Within seconds the blood glucose level in mmol/L (or mg/dL) is displayed. Its accuracy has been validated by various previous researchers in their studies.⁶⁻⁸

All the participants (diabetic as well as healthy) were given infiltration in maxillary central incisor teeth by two dentists. The LA agent used was 2% lidocaine with epinephrine for all the participants. The onset of the effect of LA was checked using thermal test (Cold Endo Ice) and EPT.

The examiners were calibrated in the Department of Restorative Dental Sciences, College of Dentistry, King Khalid University before the beginning of the study. The intra- and interexaminer reliability was checked using Kappa statistics wherein the agreement between the examiners and examinations was found to be acceptable.

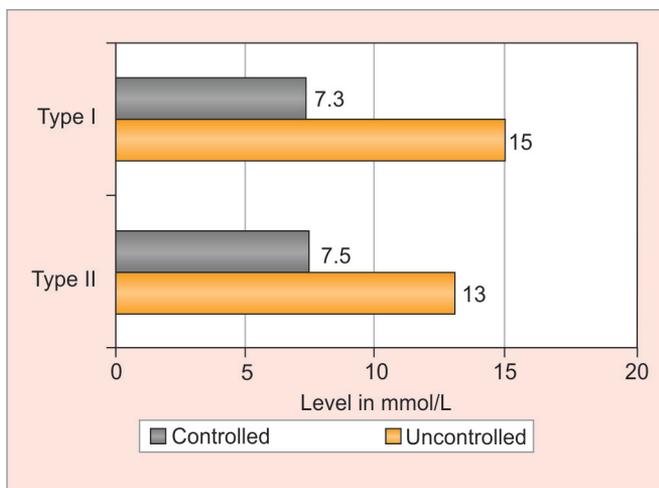
The patients were enquired about age, the type of diabetes, duration of diabetes, medications, and any other systemic diseases, and their responses were recorded on a recording pro forma. Data were entered into Microsoft Excel sheet and subjected to statistical analysis using Statistical Package for the Social Sciences version 19.

RESULTS

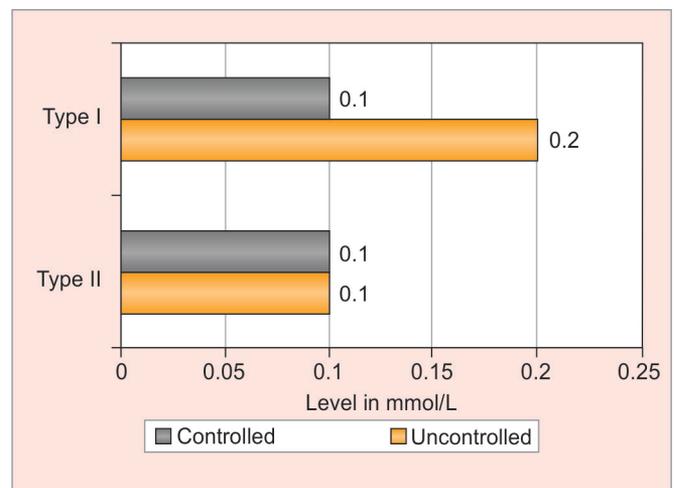
Out of the total 34 subjects, 15 were healthy (nondiabetic) and 19 were diabetic. Out of total 19 diabetic patients, 7 (36.84%) subjects had type I diabetes and the remaining 12 (63.15%) subjects had type II diabetes. Among the subjects suffering from type I diabetes, 6 (85.71%) subjects had uncontrolled diabetes and only 1 (14.28%) subject had controlled diabetes (Table 1). The average glucose value among the subjects having controlled type I diabetes was found to be 7.3 mmol/L and it was 15 mmol/L among those with uncontrolled type I diabetes, while it was 7.7 mmol/L among subjects with controlled type II diabetes and 13 mmol/L among those having uncontrolled type II diabetes (Graph 1). The average blood ketone value among the controlled type I and controlled and uncontrolled type II was found to be 0.1 mmol/L, while it was 0.2 mmol/L among the subjects with uncontrolled type I diabetes (Graph 2).

Table 1: Frequency distribution of diabetic subjects according to the control of diabetes

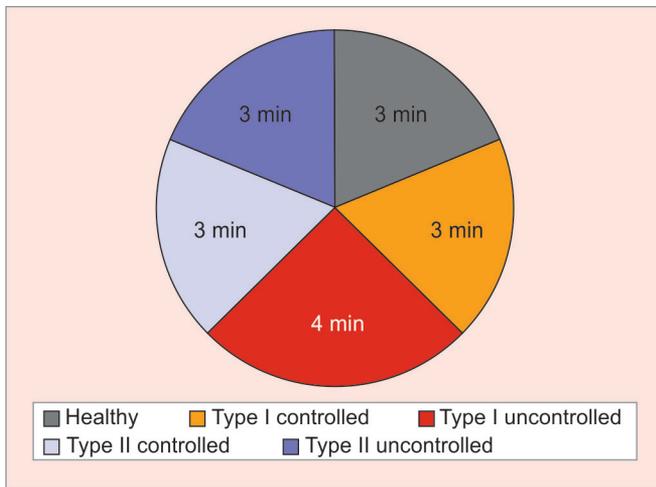
Type I diabetes		Type II diabetes	
Controlled	Uncontrolled	Controlled	Uncontrolled
1	6	2	10



Graph 1: Frequency distribution of subjects according to blood glucose level



Graph 2: Frequency distribution of subjects according to blood ketone values



Graph 3: Frequency distribution of subjects according to onset of anesthetic effect

As far as the onset of anesthesia was concerned, it was found to be 3 minutes in all cases except those with type I uncontrolled diabetes wherein it was found to be 4 minutes. The difference was not found to be statistically significant (Graph 3).

DISCUSSION

Impaired carbohydrate, fat, and protein metabolism has been observed to occur due to relative or absolute insufficiency in insulin production by pancreas among diabetic patients.⁹ The literature reveals a significant association between oral health and diabetes mellitus. In addition to periodontal diseases related to diabetes, various studies conducted earlier depict that periapical lesions are found to be more among patients having uncontrolled diabetes.¹⁰⁻¹³ Dentists often face diabetic patients referred for endodontic treatment, for which the dentists and the specialists (endodontists), while dealing with such patients for their dental problems, are required to be acquainted with in-depth knowledge about diabetes and its consequences as well. Hence, a study, as called for the purpose, was carried out among diabetic and healthy patients so as to evaluate the effect of ketones on the onset of LA.

Dental treatment procedures are invariably associated with anxiety and fear in most of the cases. Such psychological stress can in turn cause deleterious cardiovascular and metabolic effects. Local anesthesia with vasoconstrictor prevents such problems due to the fact that vasoconstrictor not only promotes longer lasting anesthetic effect but also decreases stress level.^{14,15}

In the present study, lidocaine with epinephrine was used in healthy as well as diabetic patients because it has been considered safe for use in various oral surgical procedures, when used in assessed amounts (5.4 mL) among diabetic patients regardless of whether epinephrine (1:100,000) is included.⁴

In our study, the average glucose value among the subjects having controlled type I diabetes was found to be 7.3 mmol/L, and it was 15 mmol/L among those with uncontrolled type I diabetes, while it was 7.7 mmol/L among subjects with controlled type II diabetes and 13 mmol/L among those having uncontrolled type II diabetes. The American Diabetes Association defines fasting plasma glucose concentrations between 6.1 and 7 mmol/L (5.6–6.1 mmol/L blood glucose) as representing “impaired fasting glycemia.” The World Health Organization also recommends that a diagnosis of diabetes mellitus be made if a random plasma glucose concentration is greater than 11.1 mmol/L and a fasting plasma glucose concentration of greater than 7.0 mmol/L.¹⁶

In the current study, the average blood ketone values among controlled type I and controlled and uncontrolled type II were found to be 0.1 mmol/L, while it was 0.2 mmol/L among the subjects with uncontrolled type I diabetes. Insofar the onset of anesthesia was analyzed, it was found to be 3 minutes in all cases except those with type I uncontrolled diabetes wherein it was found to be 4 minutes. The difference was not found to be statistically significant. Moreover, among healthy subjects, the onset of LA was found to be 3 minutes. The reason probably could be attributed to the fact that blood ketone levels found among subjects was not so high that it could have any impact on the onset of anesthesia, as it is arrived at in a previous study that ketones develop in blood when there might have been a protracted period of high blood sugar (>16 mmol/L) involved.⁵ Reference levels for blood ketones have been quoted as up to 0.27 mmol/L.¹⁷ However, 0.5 mmol/L is more widely accepted as the upper limit of normal.^{17,18} Ketosis occurs at levels >1.0 mmol/L and ketoacidosis at levels >3.0 mmol/L.¹⁹

In the present study, the subjects were diagnosed of having controlled or uncontrolled diabetes by taking their glycated hemoglobin (HbA1c) values. Monitoring the values of HbA1c in long-term diabetic patients depicts their control of blood sugar levels. Hemoglobin, a protein attached to red blood cells, transports the oxygen to all the body parts. In cases of high blood glucose values, some of the glucose molecules get attached to hemoglobin; the process is called glycosylation. The HbA1c is the ratio of glycosylated to unglycosylated hemoglobin, given in percentage. This HbA1c level approximates to the average blood glucose value within the previous 3 months. In patients with poor diabetic control, the HbA1c level is greater than 13%.²⁰

In case the control of their disease is well managed, LAs can be administered without any complications among patients with diabetes (types 1/2).²¹ In addition to painless procedure, the protocol for reduction of stress among diabetic patients is quite important. Anesthetics

with vasoconstrictors are safe to be used among diabetics as long as the dose is kept to a minimum. Careful and minimal use of vasoconstrictors among patients with type 1 diabetes should be employed especially among those with brittle diabetes to prevent vasoconstrictor-enhanced hypoglycemia.²²

LIMITATIONS

- In the present study, we could not evaluate other important factors (such as pH of the tissue and pKa of the drug) affecting the onset of LA.
- The duration and dose of medications was not assessed due to limitation of time.

CONCLUSION

It was concluded that blood ketone level had no significant effect on the onset of LA among diabetic patients.

RECOMMENDATIONS

Further studies need to be carried out among diabetic patients to evaluate the effect of the elevated ketone values on the onset of LA effect involving larger sample size.

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REFERENCES

1. Silink M. Turning points in the fight against diabetes. *Diabetes Voice* 2008;52:2.
2. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2010 Jan;33(Suppl 1):S62-S69.
3. Nirmala SV, Saikrishna D. Dental care and treatment of children with diabetes mellitus—an overview. *J Pediatr Neonatal Care* 2016 Feb;4(2):00134.
4. Santos-Paul MA, Neves IL, Neves RS, Ramires JA. Local anesthesia with epinephrine is safe and effective for oral surgery in patients with type 2 diabetes mellitus and coronary disease: a prospective randomized study. *Clinics (Sao Paulo)* 2015 Mar;70(3):185-189.
5. Wray L. The diabetic patient and dental treatment: an update. *Br Dent J* 2011 Sep;211(5):209-215.
6. Rheney CC, Kirk JK. Performance of three blood glucose meters. *Ann Pharmacother* 2000 Mar;34(3):317-321.
7. Marsh PA, Monami M, Mannucci E, et al. Glucose monitoring self-testing: evaluation of five last generation different devices performance. *Critical Care Med (18th Int. Diabetes Fed Congress)*, 2003.
8. Tate PF, Clements CA, Walters JE. Accuracy of home blood glucose monitors. *Diabetes Care* 1992 Apr;15(4):536-538.
9. Negrato CA, Tarzia O. Buccal alterations in diabetes mellitus. *Diabetol Metab Syndr* 2010 Jan;2:3.
10. Bender IB, Bender AB. Diabetes mellitus and the dental pulp. *J Endod* 2003 Jun;29(6):383-389.
11. Britto LR, Katz J, Guelmann M, Heft M. Periradicular radiographic assessment in diabetic and control individuals. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003 Oct;96(4):449-452.
12. Garber SE, Shabahang S, Escher AP, Torabinejad M. The effect of hyperglycemia on pulpal healing in rats. *J Endod* 2009 Jan;35(1):60-62.
13. Segura-Egea JJ, Castellanos-Cosano L, Machuca G, Lopez-Lopez J, Martin-Gonzalez J, Velasco-Ortega E, Sanchez-Dominguez B, Lopez-Frias FJ. Diabetes mellitus, periapical inflammation and endodontic treatment outcome. *Med Oral Patol Oral Cir Bucal* 2012 Mar;17(2):e356-e361.
14. Mariano RC, Santana SE, Coura GS. Comparative analysis of anesthetic effect of lidocaine 2% and prilocaine 3%. *BCI* 2000 Jul-Sep;7(27):15-19.
15. Meral G, Tasar F, Sayin F, Saysel M, Kir S, Karabulut E. Effects of lidocaine with and without epinephrine on plasma epinephrine and lidocaine concentrations and hemodynamic values during third molar surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005 Aug;100(2):e25-e30.
16. McAnulty GR, Robertshaw HJ, Hall GM. Anaesthetic management of patients with diabetes mellitus. *Br J Anaesth* 2000 Jul;85(1):80-90.
17. VanItallie TB, Nufert TH. Ketones: metabolism's ugly duckling. *Nutr Rev* 2003 Oct;61(10):327-341.
18. Chiu RW, Ho CS, Tong SF, Ng KF, Lam CW. Evaluation of a new handheld biosensor for point-of-care testing of whole blood beta-hydroxybutyrate concentration. *Hong Kong Med J* 2002 Jun;8(3):172-176.
19. Fukao T, Song XQ, Mitchell GA, Yamaguchi S, Sukegawa K, Orii T, Kondo N. Enzymes of ketone body utilization in human tissues: protein and messenger RNA levels of succinyl-coenzyme A (CoA):3-ketoacid CoA transferase and mitochondrial and cytosolic acetoacetyl-CoA thiolases. *Pediatr Res* 1997 Oct;42(4):498-502.
20. Scully, C.; Epstein, J.; Wiesenfeld, D. *The Oxford handbook of dental patient care*. 2nd ed. Oxford: Oxford University Press; 2005.
21. Perusse R, Goulet JP, Turcotte JY. Contraindications to vasoconstrictors in dentistry: Part II, hyperthyroidism, diabetes, sulfite sensitivity, cortico-dependent asthma, and pheochromocytoma. *Oral Surg Oral Med Oral Pathol* 1992 Nov;74(5):687-691.
22. Little, JW.; Falace, DA.; Miller, CS.; Rhodus, NL. *Dental management of the medically compromised patient*. 5th ed. St. Louis (MO): Mosby; 1997.