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Fasting during the holy month of Ramadan among older children and adolescents with type 1 diabetes in Kuwait

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Abstract

Objective: To evaluate the safety of fasting during the holy month of Ramadan among children and adolescent with type 1 diabetes (T1D).

Methods: A retrospective cohort study of 50 children and adolescents with T1D whose mean age was 12.7 ± 2.1 years was conducted. Twenty-seven patients (54%) were on multiple daily injections (MDI) insulin regimen and 23 (46%) were on insulin pump therapy. Before fasting for Ramadan, children and their families were evaluated and educated about diabetes management during Ramadan. Hemoglobin A_{1c} (HbA_{1c}), weight, number of days fasted, hypoglycemia and hyperglycemia episodes, and emergency hospital visits were collected and analyzed after completing the month. Participants were compared according to the insulin treatment regimen and their glycemic control level before Ramadan.

Results: The children were able to fast 20 ± 9.9 days of Ramadan, and the most common cause for breaking the fast was mild hypoglycemia (7.8% among all cases). There was no significant difference between the two insulin regimen groups in breaking fast days, frequency of hypo- or hyperglycemia, weight and HbA_{1c} changes post Ramadan. Patients with HbA_{1c} $\leq 8.5\%$ were able to fast more days during Ramadan with significantly less-frequent hypoglycemic attacks as compared to patients

with HbA_{1c} > 8.5 (1.2 ± 1.5 vs. 3.3 ± 2.9 days of hypoglycemia, $p = 0.01$, respectively).

Conclusions: Fasting for children with T1D above the age of 10 years is feasible and safe in both pump and non-pump users, and well-controlled patients are less likely to develop complications. Education of the families and their children before Ramadan, along with intensive monitoring of fasting children during the month are crucial.

Keywords: adolescence; children; fasting; Kuwait; Ramadan; type 1 diabetes mellitus.

Introduction

The holy month of Ramadan is the ninth month of the Islamic lunar calendar. Fasting during Ramadan is one of the five pillars of Islam and is obligatory for all healthy adults and adolescents after puberty [1]. The practice of fasting involves abstaining from eating, drinking and use of oral medications from sunrise to sunset [2]. Thus, the fasting period varies according to the geographical location and season, and can last up to 18 h or more during the summer in the Middle Eastern region and even longer outside the Middle East [3].

For healthy individuals, fasting should not be associated with harmful effects. However, Islam exempts younger children and unhealthy individuals from fasting as it may be difficult [1]. Although exempted, a significant number of Muslims with diabetes insist on fasting despite the advice of their healthcare providers and the permission given by Islam to avoid fasting if it adversely affects health and safety. They feel psychologically and spiritually inclined to fast along with other Muslims creating a challenge for themselves and their healthcare providers [4].

During Ramadan, Muslims usually consume two main meals, Iftar and Sohour. Iftar is the main meal and is taken at sunset when the individual breaks the fast. Traditionally, such a meal is high in caloric content specifically from carbohydrates. Another lighter meal, Sohour, is taken before sunrise and is usually low in caloric content. Moreover, small snacks may be taken between

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the two main meals [4–6]. Such changes in meal schedule, content and lifestyle produce two contrasting metabolic environments within the same day. This may influence the control of diabetes leading to acute complications like hypoglycemia or hyperglycemia during fasting [5]. Moreover, fasting is known to accelerate ketosis and to increase the risk of diabetic ketoacidosis (DKA) [4–6]. For such reasons, fasting during Ramadan has been uniformly discouraged by medical professionals for people with poorly controlled type 1 diabetes (T1D) [6]. However, some physicians believe that fasting is safe for people with diabetes who are in good glycemic control including adolescents and older children [7, 8].

Careful medical evaluation and customized individual education of children/adolescents with T1D and their caregivers are crucial before they decide to fast [9, 10]. They must be educated about frequent self-monitoring of blood glucose (BG), how to maintain a balanced healthy diet and a normal level of activity, and how to avoid excessive activities during the fasting hours [6, 9–11]. Basal/bolus insulin, the preferred regimen, is modified to accommodate the change in meal time with a reduction of basal insulin by 10–20%. It is recommended to cover both Iftar and Sohour with pre-Ramadan lunch and dinner bolus doses, respectively, and to give small boluses for snacks in between as needed [6, 7, 12, 13].

Despite the increasing body of literature on fasting in adults with type 2 diabetes (T2D), there is paucity of evidence on the safety and metabolic effects of fasting during Ramadan in older children and adolescents with T1D [14, 15]. Thus, educating and managing younger patients with diabetes while fasting remain a great challenge. We have, therefore, conducted this retrospective study to evaluate the safety of fasting during the holy month of Ramadan in older children and adolescents with T1D who are either receiving multiple daily injections (MDI) of insulin or using insulin pump therapy.

Materials and methods

Objectives

The objective of this study was to examine the safety and metabolic consequences of Ramadan fasting among children and adolescents with T1D on MDI regimen or insulin pump therapy.

Study design

This was a retrospective cohort study of older children and adolescents with T1D who voluntarily wanted to fast during Ramadan in the

summer (the total fasting time was ~15.3 h/day) at the Endocrinology and Diabetes Unit in the main teaching hospital in Kuwait (Mubarak Al Kabeer Hospital). The unit provides care for about 500 children and adolescents with T1D, out of which more than 100 are on insulin pump. The study protocol was reviewed and approved by the Ethics Committee at The Ministry of Health in Kuwait. The study was conducted in accordance with the Declaration of Helsinki. All data were abstracted from the medical records of the children/adolescents with T1D anonymously, and there was no identification of the identity of any participant.

Study protocol

One to two months prior to the fasting period, children/adolescents with T1D are usually screened and evaluated individually to assess the safety of fasting. According to our unit's protocol, children wishing to fast are permitted to do so if they are older than 10 years of age, had T1D for over a year, and are willing to do frequent BG measurements. Our protocol does not permit fasting for children with the following conditions: sustained poor glycemic control (hemoglobin A_{1c} [HbA_{1c}] > 8.5%, 69.4 mmol/mol), history of DKA within 3 months prior to Ramadan, frequent hypoglycemia, hypoglycemic unawareness, diabetes-related complications or comorbidities, and those who are unwilling to undertake frequent BG monitoring.

Intensive education and written instructions are provided by specialized diabetes educators, dieticians and physicians regarding home glucose monitoring, insulin adjustments, dietary plan, changes in physical activity and when to break the fast. Moreover, insulin doses are usually modified as necessary to accommodate the fasting and individual changes in eating pattern and lifestyle.

Data collection

A standardized data collection form was created to obtain information from the medical records of the identified patients including demographic data (age and gender), duration of diabetes, insulin regimens, weight and HbA_{1c} prior to fasting during the holy month of Ramadan.

Outcome variables

The collected data included the number of completed fasting days (from sunrise to sunset) and the number of incomplete fasting days (stopping the fast at any time after sunrise and before sunset). The number of mild hypoglycemic episodes (BG < 3.9 mmol/L, patient is aware and treats the hypoglycemia orally) [9, 10, 16], severe hypoglycemic episodes (having altered mental status and/or requiring parental therapy with glucagon, IV glucose or a need for hospitalization) [9, 10, 16], and hyperglycemic episodes (BG > 16.7 mmol/L) [9, 10, 16], DKA or emergency room visit were also collected and analyzed. The changes in HbA_{1c} post Ramadan were observed. HbA_{1c} was measured using the TOSOH G8 HPLC analyzer (Tosoh, Darmstadt, Germany) which utilizes the gold-standard ion exchange method of HbA_{1c} measurement, and the values were reported using both SI (International Federation of Clinical Chemistry [IFCC]) and National Glycohemoglobin Standardization Program (NGSP)/Diabetes Control

and Complications Trial (DCCT) units. Weights were assessed using pre-calibrated scales in kilograms and were retrieved from medical reports.

Data analysis

Descriptive statistics of the numeric and categorical variables using mean \pm standard deviation (SD) or frequency and percentages were conducted. The t-test and the chi-square (χ^2) test were used to compare the differences between the numeric and categorical variables, respectively. A p-value of less than 0.05 was considered statistically significant. All data entry and analysis were performed using the Statistical Package for Social Sciences (SPSS Inc. Released 2007, SPSS for Windows, Version 16.0, Chicago, IL, USA).

Results

Clinical characteristics of the study population

The present study included 50 children and adolescents with T1D who fasted for Ramadan (22 males, 28 females). The mean age of the study population was 12.7 ± 2.1 years, and the mean duration of diabetes mellitus (DM) was 4.16 ± 2.9 years. Twenty-seven (54%) of the children were on MDI insulin and 23 (46%) were on insulin pump therapy. The baseline characteristics of the study population are summarized in Table 1. There were no significant differences in gender, weight and HbA_{1c} before Ramadan between children/adolescents who were on MDI insulin and those on insulin pump therapy.

Completion of fasting

Thirteen children/adolescents discontinued the fasting during the first week of Ramadan: two children developed non-fasting-related DKA (one because of pump failure and the other because of pneumonia), three children travelled abroad and eight children because of poor adherence to our fasting protocol. All these children/adolescents were excluded from the final analysis. The remaining 37 children/adolescents were able to fast for 20 ± 9.9 days of the month with seven (18.9%) patients fasting for the whole month of Ramadan. Of the total eligible fasting days (29 days), 13.1% of these days were not fasted. The most common cause of breaking the fast was mild hypoglycemia (60% of unfasted days i.e. 7.8% of all cases) followed by hyperglycemia (28.7% of unfasted days i.e. 3.8% of all cases). None of the patients developed severe hypoglycemia or DKA related to fasting.

Insulin regimen

Two groups of patients were analyzed; group 1 patients were on MDI insulin (one daily injection of long-acting insulin glargine and short-acting insulin injections given before meals) and group 2 patients were on insulin pump therapy. The subgroup outcome comparisons are shown in Table 1. No significant statistical differences were observed between the two groups in terms of the frequency of hypoglycemic episodes or days not fasted, changes in HbA_{1c} and weight. However, three patients on insulin pump therapy suspended the pump during fasting

Table 1: Comparison between participants on MDI and insulin pump therapy at baseline and after fasting for Ramadan.

| Baseline characteristics | Total (n=50) | MDI (n=27) | Pump (n=23) | p-Value |
|---|---------------------------------|---------------------------------|---------------------------------|-------------|
| Age | 12.7 \pm 2.1 | 12.2 \pm 2.1 | 13.4 \pm 2.2 | 0.07 |
| Gender (male) | 22 (44.0) | 14 (28.0) | 8 (16.0) | 0.23 |
| HbA _{1c} \leq 8.5% (69.4) | 31 (62.0) | 17 (63.0) | 14 (60.9) | 0.89 |
| HbA _{1c} before Ramadan (%) (mmol/mol) | 8.6 \pm 1.4 (70.0 \pm 15.7) | 8.3 \pm 1.5 (67.2 \pm 16.2) | 8.9 \pm 1.3 (73.3 \pm 14.7) | 0.17 |
| Weight before Ramadan | 52.9 \pm 14.4 | 52.3 \pm 15.0 | 53.6 \pm 13.7 | 0.74 |
| Duration of diabetes | 4.16 \pm 2.9 | 3.21 \pm 2.3 | 5.28 \pm 3.1 | 0.01 |
| Fasting during Ramadan | Total (n=37) | MDI (n=17) | Pump (n=20) | |
| Gender (males) | 15 (40.5) | 8 (47.1) | 7 (35.0) | 0.5 |
| Completed the month | 7 (18.9) | 2 (5.0) | 5 (13.5) | 0.85 |
| Days of hypoglycemia | 2.1 \pm 2.4 | 2.2 \pm 2.9 | 2.1 \pm 2.0 | 0.8 |
| Days of hyperglycemia | 1.1 \pm 2.0 | 1.1 \pm 1.9 | 1.1 \pm 2.1 | 0.9 |
| Days of completing fasting | 20.0 \pm 9.9 | 25.0 \pm 3.2 | 25.7 \pm 2.7 | 0.5 |
| HbA _{1c} after Ramadan (%) (mmol/mol) | 8.7 \pm 1.3 (71.6 \pm 14.6) | 8.5 \pm 1.4 (69.6 \pm 15.2) | 8.9 \pm 1.3 (74.1 \pm 14.3) | 0.4 |
| Weight after Ramadan | 53.5 \pm 13.5 | 52.8 \pm 13.4 | 54.1 \pm 13.9 | 0.8 |

HbA_{1c}, hemoglobin A_{1c}; MDI, multiple daily injections. Data are displayed as mean \pm standard deviation or as frequency (percentage). Bold value indicate significant p-value \leq 0.05.

hours for 1–2 h to avoid significant hypoglycemia, which helped them continue their fast.

The data of the children/adolescents with $\text{HbA}_{1c} > 8.5\%$ (69.4 mmol/mol) who insisted on fasting against the advice of their treating pediatrician (16 out of the 37 patients [43.2%]) were compared with the data of children/adolescents with $\text{HbA}_{1c} \leq 8.5\%$ (69.4 mmol/mol) (Table 2). Data suggested that those patients with $\text{HbA}_{1c} \leq 8.5\%$ (69.4 mmol/mol) were able to fast more days during Ramadan (26.2 ± 2.4) as compared to patients with $\text{HbA}_{1c} > 8.5\%$ (69.4 mmol/mol) (24.3 ± 3.2) and this difference was statistically significant ($p = 0.04$). Furthermore, patients with $\text{HbA}_{1c} \leq 8.5\%$ (69.4 mmol/mol) showed less increment in HbA_{1c} values after Ramadan and had less hypoglycemia compared to children with $\text{HbA}_{1c} > 8.5\%$ (69.4 mmol/mol) ($p = 0.01^*$).

Discussion

Few studies were performed to assess the feasibility of fasting during the holy month of Ramadan for children/adolescents with diabetes. The current study provides evidence that supports the safety of fasting during Ramadan in children and adolescents with T1D, especially among those with $\text{HbA}_{1c} \leq 8.5\%$ (69.4 mmol/mol). However, the main concern is for those with $\text{HbA}_{1c} > 8.5\%$ (69.4 mmol/mol) as they may suffer from recurrent hypoglycemia.

Most of the available evidence on fasting during the holy month of Ramadan has been published mainly on adults [13, 17, 18]. The current study examined younger participants with a mean age of 12.7 ± 2.1 years compared to a mean age of 15 ± 4 years reported from the United Arab Emirates (UAE) [19] and an age range between 15 and 19 years from Saudi Arabia and Lebanon [20, 21]. This younger age of participants reflects the current feasibility of fasting for young children with more availability of insulin regimens and advanced insulin pump technology.

Patients in our study were able to fast for 86.8% of the days of Ramadan (20 ± 9.9 days). This finding is consistent with other reports by Kaplan et al. [19] and Musleh et al. [22], which showed that patients were able to fast 85% and 79.9% of the total days eligible for fasting, respectively. Other studies had reported successful completion of the days of fasting, as 11 out of 12 Saudi children and 60.6% of 33 Indian patients completed fasting during Ramadan [14, 23]. El-Hawary et al. showed that 52.8% of 53 Egyptian patients completed the fasting during the month of Ramadan [24]. More recently, Deeb et al. showed that 26% of the subjects fasted for the whole month [25]; they explained that completion of fasting during Ramadan was achieved by utilizing well-structured education program before Ramadan and close follow-up during the month. In all these studies, including the current study, Ramadan was during the summer vacation and was out of the school season. Therefore, families and their children were more

Table 2: Comparison between participants with different levels of HbA_{1c} at baseline and after fasting for Ramadan.

| | $\text{HbA}_{1c} > 8.5\%$ (69.4 mmol/mol) (n=21) | $\text{HbA}_{1c} \leq 8.5\%$ (69.4 mmol/mol) (n=16) | p-Value |
|--|---|--|---------------------------|
| Age | 12.5 ± 2.2 | 13.4 ± 2.2 | 0.2 |
| Gender (males) | 9 (42.9) | 6 (37.5) | 0.7 |
| Duration of diabetes | 4.0 ± 3.6 | 5.0 ± 2.3 | 0.3 |
| Insulin use | | | |
| MDI | 10 (47.6) | 7 (43.8) | 0.9 |
| Pump | 11 (52.4) | 9 (56.2) | |
| Weight before Ramadan | 54.8 ± 15.6 | 52.8 ± 12.1 | 0.7 |
| HbA_{1c} before Ramadan (%) (mmol/mol) | 7.9 ± 0.8 (62.3 ± 8.9) | 9.9 ± 0.8 (84.8 ± 9.2) | < 0.01^a |
| Fasting during Ramadan | | | |
| Days of hypoglycemia | 1.2 ± 1.5 | 3.3 ± 2.9 | 0.01^a |
| Days of hyperglycemia | 1.2 ± 2.1 | 1.0 ± 1.9 | 0.7 |
| Days of completing fasting | 26.2 ± 2.4 | 24.3 ± 3.2 | 0.04^a |
| Weight after Ramadan | 55.1 ± 15.8 | 51.3 ± 9.6 | 0.4 |
| HbA_{1c} after Ramadan (%) (mmol/mol) | 7.9 ± 1.29 (63.78 ± 12.9) | 9.7 ± 0.9 (82.3 ± 9.3) | < 0.01^a |

HbA_{1c} , hemoglobin A_{1c} ; MDI, multiple daily injections. ^aBold values indicate p-value ≤ 0.05 . Data are displayed as mean \pm standard deviation or as frequency (percentage).

comfortable for indoor fasting with closer supervision and less risks of dehydration and complications.

Similar to other reports, mild hypoglycemia was the most common reason to break the fast with the mean days of hypoglycemia (2.1 ± 2.4) leading to break the fast in 7.8% of the cases. However, the frequency of hypoglycemia was quite variable in different studies. For example, only 10% of Indian patients had mild hypoglycemia compared to 15% and 33.3% in the UAE and Kuwait, respectively [7, 19, 23]. Another study in the UAE reported that 29.1% of causes of breaking the fast were hypoglycemia episodes, whilst 51.5% were attributed to non-diabetes-related reasons [22]. The less frequent hypoglycemia in the current study echoed the level of education prior to Ramadan in which our educator team stressed on breaking the fast with any episode of even mild hypoglycemia regardless of the severity or symptoms. Clear instruction that Islamic rules do not forbid repeated blood testing or administration of insulin were emphasized for all participants. Continuous and close follow-up of our regulations were maintained during the whole month.

One of the major concerns for people with T1D and their caregivers during fasting is the occurrence of severe symptomatic hypoglycemia or DKA. Such association was not demonstrated in our study or in any other studies as none of the children developed life-threatening fasting-related complications. This might be explained by the careful selection of patients who are permitted to fast with well-structured education, supervision and proper insulin regimens [14, 19–23]. However, El-Hawary et al. [24] reported different findings. They demonstrated that four patients out of 53 developed DKA while they were using regular insulin and NPH (neutral protamine Hagedorn) regimen.

The proportion of subjects with insulin pump therapy has significantly increased in all age groups [26]. The use of insulin pump therapy during Ramadan was not adequately addressed in children before, as most of the previous studies were performed on adults with T1D [27–29]. The current study compared the use of MDI insulin with insulin pump therapy during fasting, and the results showed that there were no significant differences in breaking fast days, frequency of hypo- or hyperglycemia, weight, and HbA_{1c} changes post Ramadan between the two groups. Our findings are consistent with results from other studies showing that children and adolescents with diabetes on both regimens can fast safely during Ramadan [21, 22, 30]. A recent study concluded that the use of insulin pump therapy did not show any added benefit regarding the complication rate and diabetes control during Ramadan [25]. However, Alamoudi et al. [31] observed less glycemic variability in

patients on insulin pump compared to those on MDI. Furthermore, another study that used a flash glucose monitor showed that there were insignificant advantages of using insulin pump therapy instead of MDI in terms of breaking fast days and frequency of hypoglycemia [32]. Contrary to our results, a significant reduction in HbA_{1c} in patients on insulin pumps was found in a smaller study (five patients) when compared with conventional insulin therapy (four patients) during Ramadan fasting [20].

There were minimal increments in HbA_{1c} values after fasting in our study (from 8.3 ± 1.4 to $8.7 \pm 1.3\%$). This finding was consistent with previous reports [21–24]. Patients who had poor glycemic control (HbA_{1c} > 8.5% [69.4 mmol/mol]) prior to fasting had significantly higher increments in HbA_{1c} compared to patients with HbA_{1c} ≤ 8.5% (69.4 mmol/mol) ($p < 0.01$). On the other hand, children with uncontrolled diabetes showed more evident improvements in their HbA_{1c} than children with controlled diabetes; this reflects a beneficiary effect of fasting on glycemic control especially among this critical group.

Patients with HbA_{1c} ≤ 8.5% (69.4 mmol/mol) were able to fast for more days during Ramadan with significantly less-frequent hypoglycemic episodes as compared to patients with HbA_{1c} > 8.5% (69.4 mmol/mol). Despite being postulated that tighter control may predispose to more hypoglycemic episodes as observed by Deeb et al. [30], strong evidence supports that poor control is very serious. As demonstrated by Afindi et al., adolescents with poor pre-Ramadan glycemic control have wider fluctuations of BG with longer episodes of hypoglycemia, hyperglycemia and severe hyperglycemia [33]. This is the key finding in our study as it highlights the importance of having a good glycemic control to ensure safe fasting during Ramadan. Individuals with well-controlled T1D are more capable of managing their diet and lifestyle changes during Ramadan. This is in accordance with international protocols used in the management of fasting during Ramadan in adults with diabetes which confirm that poor control of diabetes is considered as one of the main contraindications for fasting [9, 10, 34, 35].

The current study has some limitations. One of these limitations is the retrospective nature of the study. The insignificant differences in the basal characteristics of the studied population could have attenuated the risk of selection bias. Another limitation is the lack of a control group of non-fasting children, which did not permit comparison of glycemic control and complications. Despite these limitations, this study reports the fasting outcomes of children/adolescents with T1D who are using insulin pump. To the best of our knowledge, this is one of the

few studies which could recruit this number of patients. This special population is growing, and many clinicians are dealing with them more often. These clinicians are in need of evidence to help them take proper clinical decisions and medical guidance.

Conclusions

Fasting for children with T1D above the age of 10 years is feasible and safe in both pump and non-pump users, and well-controlled patients are less likely to develop complications. Pre-Ramadan education of the families and their children along with intensive monitoring of fasting children during Ramadan are crucial.

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