

Review

# Diabetes and Ramadan: Review of the literature

B. Benaji<sup>a,\*</sup>, N. Mounib<sup>b</sup>, R. Roky<sup>a</sup>, N. Aadil<sup>a</sup>, I.E. Houti<sup>a</sup>,  
S. Moussamih<sup>a</sup>, S. Maliki<sup>c</sup>, B. Gressier<sup>d</sup>, H. El Ghomari<sup>e</sup>

<sup>a</sup> *Research Group in Pharmacological Sciences, Hassan II – Ain Chok University,  
KM 8 Route D'El Jadida BP: 5366 Maarif – Casablanca, Morocco*

<sup>b</sup> *Department of Biology, Faculty of Sciences, 19 Rue Tarik Ibnou Ziad – BP: 9167 Mers Sultan, Casablanca, Morocco*

<sup>c</sup> *Department of English, Faculty of Letters, Ain Chok, Quartier AL Inara, BP: 8507 Ain Chok, Casablanca, Morocco*

<sup>d</sup> *Department of Pharmacology, Pharmacokinetic and Clinical Pharmacy – Faculty of Pharmacy of Lille,  
3, rue du Professeur Laguesse 59006 Lille, Cedex, France*

<sup>e</sup> *Department of Endocrinology, Diabetology and Nutrition, C.H.U. Ibn Rochd Hospital,  
Hassan II – Ain Chok University, Casablanca, Morocco*

Received 18 February 2005; received in revised form 16 August 2005; accepted 7 October 2005

Available online 2 May 2006

## Abstract

During the month of Ramadan, Muslims fast every day from dawn to sunset. In the healthy subject, this fasting does not have any harmful consequences on health. However, it can induce several complications for patients with diabetes. The aim of this review twofold: first, it seeks to give some clues about methodological aspect of research during Ramadan and to show the impact of various diabetes monitoring and treatment, including biochemical and clinical parameters, diet and caloric intake, drug intake when fasting. Second, it intends to determine whether or not Ramadan fasting induces complications in patients with types 1 and 2 diabetes and ultimately to elaborate some advice as to the management of fasting patients.

Several studies have shown that Ramadan fasting did not alter biochemical parameters in patients with type 2 diabetes. However, other studies have shown that there is either an increase or a decrease in biochemical parameters during Ramadan.

Ramadan fasting would be acceptable for patients with well-balanced type 2 diabetes who are conscious of their disease and compliant with their diet and drug intake.

If patients with type 1 diabetes wish to fast, it is necessary to advise them to undertake control of their glycaemia several times a day. Patients with type 1 diabetes who will fast during Ramadan may be better managed with fast absorption insulin.

© 2006 Elsevier Ireland Ltd. All rights reserved.

**Keywords:** Islamic fasting; Diet; Body weight; Biochemical parameters; Physical activity; Hypoglycaemic drug; Insulin; Therapeutic schedule

## Contents

1. Introduction . . . . .	118
1.1. Studies search and selection methods . . . . .	118
1.2. Studies on diabetes and Ramadan: methodological characteristics (Table 1) . . . . .	118
1.3. Diabetes patients' diet and body weight during Ramadan . . . . .	119
1.4. Ramadan fasting: effects on glycaemia and biochemical parameters in patients with diabetes . . . . .	120

\* Corresponding author. Tel.: +212 6145 6045; fax: +212 2294 5220.

E-mail address: [benajib2003@yahoo.fr](mailto:benajib2003@yahoo.fr) (B. Benaji).

1.5.	Physical activity during the month of Ramadan . . . . .	121
1.6.	Prescription of anti-diabetic drug during the month of Ramadan . . . . .	122
1.6.1.	Patients on oral hypoglycaemic drugs . . . . .	122
1.6.2.	Patients on insulin treatment . . . . .	122
1.7.	Role of physicians in the protection of the health of patients with diabetes . . . . .	123
2.	Conclusion . . . . .	123
	References . . . . .	123

## 1. Introduction

Ramadan fasting is one of the five pillars of Islam observed by over one billion Muslim adults worldwide. During this month, Muslims refrain from food, water and oral drug intake. Ramadan fasting could not induce any harmful effect in young healthy subjects [1]. However, it can induce several complications in patients with diabetes. Islamic rules allow such patients not to fast, although they usually insist on so doing. A recent multi-centric large survey concerning patients with diabetes revealed that 78.7% with type 2 diabetes and 42.8% of patients with type 1 diabetes have fasted for at least 15 days [2]. Physicians, therefore, have to handle situations where patients with diabetes insist on fasting, and to answer several questions about the health complications fasting may have on their patients.

Is the risk of glycaemia imbalance higher in patients with diabetes fasting during Ramadan? What is the impact of fasting on angiopathic complications? If type 2 (non-insulin-dependent diabetes) patients fasted, what would be the advised diet? If type 1 (insulin-dependent diabetes) patients did not refrain from fasting, what should their physicians do? What is the best therapeutic schedule to propose to patients with diabetes? Finally, what medical and religious arguments are there to convince patients with diabetes not to fast? The objective of this bibliographical review is to answer these questions and clarify some of the issues related to them.

After a thorough investigation, it appears that there exist only two review articles on diabetes and Ramadan. The first one [3], published in 1987, made use of only four references on Ramadan and diabetes. The second [4], published in 1997, made use of only five references on Ramadan and diabetes.

### 1.1. Studies search and selection methods

Studies referred to in this paper were derived from Medline, using the key words “Ramadan, fasting and diabetes”. The search period was between 1979 and 2005. Moreover, proceedings from the following meetings were hand searched: (1)-First International Congress

on Ramadan and Health, Casablanca, Morocco, 1994; (2) Second International Congress on Ramadan and Health, Istanbul, Turkey, 1997; (3) Congress of the Diabetes Mellitus during the Holy Month of Ramadan, Cairo, Egypt, 1997; (4) First Congress of Endocrinology and Metabolic Diseases, Beirut, Lebanon, 1999; (5) Congress on Health and Ramadan, Tehran, Iran, 2001.

Inclusion criteria comprised reports of data from original studies, including data from the control period before or after Ramadan and data from the period of Ramadan. Articles reporting data from the periods before and after Ramadan only were excluded. Exclusion criteria also comprised review articles, case studies, letters to editors and studies in children and pregnant women. For drug intake schedule during Ramadan, reports of points of view were included.

### 1.2. Studies on diabetes and Ramadan: methodological characteristics (Table 1)

Most papers on Ramadan and diabetes report survey data and only few controlled clinical assays were carried out on this subject. Results showed discrepancies that could be explained in terms of protocol differences. In fact, the non-fasting control, the choice of the experimental day during Ramadan and the timing of blood sampling were not always comparable. Other explanations could be related to the difference in nutritional customs and habits, as well as climate specificity and seasonal occurrence of Ramadan. It is important to note in this connection that Ramadan is a lunar month, and each year it occurs 11 days earlier. Each 9 years, Ramadan occurs in a different season; the length and temperature of fasting days also change. Fasting duration was not always cited in the protocol of these studies.

It should also be noted that more work using more appropriate research methods is still needed on Ramadan fasting so that we can assess the physio-pathological changes. In other words, the methodological research protocol on Ramadan fasting should include control periods before and after Ramadan, and during each week of Ramadan as well. During such periods, special attention should be given to biochemical and clinical control

Table 1  
Methodological characteristics of the studies on diabetes and Ramadan

First author and year	Country	Patients, N (T2/T1)	Weeks of the study	Parameters
Al-Fayez (1988)	S. Arabia	11 (5/6)	BR, R1, R4, AR	Glc, HbA1c, Creat, renogram
Al-Hader (1994)	Jordan	23 (0/23)	BR, R4	HbA1c, Frc, TG, Chol, UA
Athar (1994)	USA	6 (6/0)	BR, R4	BW, Glc, HbA1c, TG, Chol, UA, BP
Bagraiçik (1994)	Turkey	21 (21/0)	BR, R1, R4, AR	Glc, Frc, insulin, Cpp
Barber (1979)	UK	30 (0/30)	NP	Carbohydrates intake, hospital admission
Belkhader (1993)	Morocco	591 (591/0)	BR, R1, R4, AR	HbA1c, Frc, Hypog F
Beshyah (1988)	UK	15 (NP)	BR, R2, R4	BW, Glc, Frc, Chol, TG, Hypog F
Bouguerra (1997)	Tunisia	26 (26/0)	BR, R3, AR	BW, Glc, HbA1c, Frc, BP, TG, Chol, LDL, HDL, Kcal
Chamakhi (1991)	Tunisia	51 (40/11)	BR, R4, AR	BW, HbA1c, Frc, Creat, TG, Chol, UA, Hypog F, Kcal
Chandalia (1987)	India	13 (13/0)	BR, R4	Diet, Glc, HbA1c
Elati (1997)	Tunisia	8 (8/0)	BR, R4	Glc, Glycerol, TG, FFA, Ins, Cpp
Forghani (2001)	Iran	20 (20/0)	BR, R	BW, BMI, HbA1c, UA, Kcal intake
Gaaloul (1999)	Tunisia	25 (25/0)	BR, R4, AR	BW, BP, Glc, HbA1c, Frc, Chol, LDL, HDL, Kcal
Glimepiride (No author) (2005)	Multicentric	332(332/0)	BR, R4, AR	Glc, HbA1c
Gustaviani (2004)	Indonesia	24 (24/0)	BR, R1, R4, AR	Frc, BHA
Kadiri (1997)	Morocco	120 (100/20)	BR, AR	Kcal intake
Kadiri (1999)	Morocco	24 (22/2)	BR, R1, R2, R3, R4, AR	BW, BMI, Glc, diet
Kadiri (2001)	Morocco	64 (0/64)	BR, R1, R2, R4	Insulin effect on Glc
Katibi (2001)		33 (33/0)	BR, R, AR	Glc
Khatib (1997)	Jordan	46 (46/0)	BR, R2, R4	BW, Glc, HbA1c, Frc, Chol, TG, HDL, Kcal intake
Latif (1993)	Jordan	43 (43/0)	BR, R2, R4, AR	BW, Glc, TG, Tchol, HDL, LDL
Mafouzy (1990)	Malaysia	22 (22/0)	BR, R	BW, Glc, Fruc, Tchol, nutrient intake
Mafouzy (2002)	Malaysia	235 (235/0)	BR, R	Drug effect, Fruc, HbA1c, Hypog F
Mattoo (2003)	Multicentric	151 (151/0)	R2, R4	Ins lispro effect on Glc, Hypog F
Salti (2004)	Multicentric	12 243 (11173/1070)	AR	BW, BMI, physical activity, diet, Hypog, hyperg F
Sari (2004)	Turkey	22 (22/0)	BR, R, AR	BW, BHA, Glc, Fruc, HbA1c, Chol, LDL, HDL, TG
Sulimani (1991)	S. Arabia	47	BR, AR	BW, HbA1c, glycated proteins
Uysal (1998)	Turkey	41	BR, R4, AR	BW, BMI, HbA1c, Chol, HDL, TG
Yarahmadi (2003)	Iran	57	BR, R2, R4	BW, HbA1c, Chol, glycated proteins

*Abbreviations:* Number of patients (N), type 2 (T2), type 1 (T1), before Ramadan (BR), first week of Ramadan (R1), second week of Ramadan (R2), third week of Ramadan (R3), fourth week of Ramadan (R4), after Ramadan (AR), HbA1c (glycosylated haemoglobin), glucose (Glc), total cholesterol (Chol), HDL-cholesterol (HDL), LDL-cholesterol (LDL), triglyceride (TG), creatinine (Creat), uric acid (UA), blood pressure (BP), C peptide (Cpe), hypoglycaemic frequency (Hypog F), hyperglycaemic frequency (Hyperg F), beta-hydroxybutyric acid (BHA) body mass index (BMI).

as well as to dietary habits, food composition, food value caloric control, weight changes and the importance of schedule during circadian periods. It is recommended that these factors be taken into consideration and that any intervening variable should be under control.

### 1.3. Diabetes patients' diet and body weight during Ramadan

The aim of diet in patients with diabetes is to improve the stability of glycaemia and to reduce the risk of atherogenic complications. In several studies, the

daily caloric and carbohydrates intake is said to decrease during Ramadan in type 2 [5–7] and type 1 patients [8]. Studies in type 2 patients report that the decrease in carbohydrate intake is compensated for with an increase in fat intake without any change in the daily caloric intake [8]. However, an engorging after the breaking fast meal is usually observed. Indeed, it was reported in healthy subjects that 65% of the daily caloric intake was observed after this single meal [9].

Regarding body mass index (BMI) and body weight, several reports have shown that body weight does not change during the fasting period [10–16]. Other studies

have report a reduction in mean body weight during Ramadan [6,8,17–20]. Fasting patients with diabetes could be advised to spread the daily caloric allowance over the non-fasting period. Diurnal fasting during Ramadan is counterbalanced by compensatory changes during the night, which preserves normal body weight [21]. The problem of strict adherence to diet by patients with diabetes and their failure to loose weight is well known. Several studies have demonstrated the benefit of experimental supplemented fasting on the metabolic control of diabetes [22,23]. Ramadan fasting could be considered as an ideal hypo-caloric diet for the obese type 2 patients.

It is important to note that during Ramadan there is a major change in dietary patterns. People may fast from dawn to sunset, but they take substantial quantities of sugary fluids (juice and carbonated drinks) together with fried foods and carbohydrate rich meals during non-fasting hours. Sweet foods, moreover, are specially prepared for Ramadan. These traditionally rich foods associated with Ramadan may present a risk of hyperglycaemia and weight gain for Muslim diabetic patients [24].

A dietary plan, based on metabolic, nutritional and lifestyle requirements, should be individually developed which will replace and define the caloric prescription. These nutritional recommendations account for the fact that a single diet does not appropriately treat all types of diabetes. Also, the nutritional content should be established according to the socioeconomic conditions (i.e., the patients' living standard, purchasing power, level of education and the like). Yet, proteins should represent 10–20% of the daily calories needed, the remaining 80–90% being divided between fat and carbohydrates. The diet should be low in saturated fats and carbohydrates and high in vegetables and mono and polyunsaturated lipids. Less than 10% of the latter corresponds to saturated fats. The distribution of calories from fat and carbohydrate varies from one individual to another depending on the nutrition evaluation and objectives of treatment [25,26]. During regimen adjustment, strict attention to diet control and daily activities is essential for successful Ramadan fasting. The benefits of Ramadan fasting will only occur in patients who maintain their appropriate diets [27].

#### *1.4. Ramadan fasting: effects on glycaemia and biochemical parameters in patients with diabetes*

The risk of hypoglycaemia could increase during Ramadan because of daytime fasting. Effectively, a decrease in fasting glucose [10,19] and an increase in

the frequency of severe hypoglycaemia during Ramadan have been reported [2] in a population including both types 1 and 2 patients. However, in type 2 patients, Ramadan fasting has been reported not to alter glycaemia [5–7,14,16,18,20,28–34]. When blood samples are taken at 4 h interval, results show no significant changes in the circadian rhythm of blood glucose in eight obese type 2 women [20]. However, blood glucose decreases in the afternoon (at 15:00 h) and increases in the evening and in the morning (at 21:00 and at 08:00 h) during this month, in normal weight type 2 patients [17,35]. This last result confirms what has been shown in healthy subjects [36].

Several studies have shown that serum HbA1c values [5,7,11,12,14,16,17,34,37,38], fructosamine [14,16,34,39] do not change during Ramadan fasting. In some cases, fructosamine and HbA1c levels decrease during this month [6,11,40]. Fasting plasma insulin and C-peptide levels do not change either [35]. According to a recent study, these two variables are reported not to change in women but to decrease in men [34]. When bloods samples are taken at 4 h interval, the results show that plasma insulin level and C-peptide increase at 08:00 h and decrease later in the day [20]. Insulin resistance decrease in both genders during Ramadan, but this change is significant only in men [34]. Uric acid increases during this month [15,38]. The same result is observed in healthy subjects [39–43].

Regarding the effect of Ramadan fasting on lipid metabolism, some studies have shown that Ramadan fasting does not alter triglyceride and total LDL- and HDL-cholesterol levels [20,30,33]. However, several studies have reported a decrease in triglycerides [16,17,19,27,38] and an increase in total cholesterol [34] HDL [16,19,27,44] and LDL [7,34]. The changes in triglyceride and total HDL-cholesterol levels in Ramadan confirm those obtained in healthy subjects, except for the LDL results which are said to decrease in these latter [45,46]. The responsiveness of the platelet aggregators decrease at the end of Ramadan, thus showing an eventual decrease of thrombosis in type 2 patients [47]. Only one study has considered the biochemical variations in 11 insulin-treated patients during Ramadan. The results have reported an increase in glycaemia, fructosamine and total cholesterol, and a decrease in HbA1c [8].

No studies have been carried out to answer the questions of angiopathic complications aggravation in patients with type 2 diabetes during Ramadan. The prevention and treatment of microangiopathic complications rely on HbA1c, blood pressure and cigarette quitting control. The prevention of macroangiopathic

Table 2  
Biochemical changes before, during and after Ramadan compared to the values recommended by the expert committee of the French drug agency

Variables	Studies	Baseline	Ramadan		After Ramadan	Recommended values [44]
			R2	R4		
Hb1Ac (%)	Beshyah88	10.3 ± 2.6	10.1 ± 2.2	11.4 ± 2.4		
	Uysal 98	7.30 ± 1.6	ND	7.55 ± 1.7	7.32 ± 1.7	<6.5
	Bouguerra 97	8.8	ND	8.3	7.4	
	Gaaloul	9.2	ND	10.6	7.1	
TG (mmol/l)	Uysal 98	2.76 ± 2.4	ND	2.71 ± 2.3	2.32 ± 1.79	
TG in female (g/l)	Yarahmadi 03	1.80 ± 1.0	2.03 ± 1.01	2.00 ± 1.04	ND	<1.7 mmol/l (1.5 g/l)
TG in male (g/l)	Yarahmadi 03	2.14 ± 1.22	1.70 ± 0.90	1.80 ± 0.87	ND	
Chol in female (g/l)	Yarahmadi 03	2.42 ± 0.7	2.60 ± 0.7	2.7 ± 0.6	ND	
Chol in male (g/l)	Yarahmadi 03	2.20 ± 0.4	2.30 ± 0.4	2.4 ± 0.4	ND	<5.2 mmol/l (2 g/l)
Chol (mmol/l)	Gaaloul 99	4.24	ND	4.45	ND	
	Uysal 98	5.36 ± 1.21	ND	5.28 ± 1.29	5.28 ± 1.26	
	Mafauzy 90	5.36 ± 1.21	ND	5.81 ± 0.94	ND	
HDL (mmol/l)	Latif 93	0.96 ± 0.28	0.99 ± 0.20	1.08 ± 0.25	1.11 ± 0.33	
	Uysal 98	1.01 ± 0.20	ND	1.11 ± 0.20	1.09 ± 0.20	
HDL in female (g/l)	Yarahmadi 03	0.46 ± 0.11	0.47 ± 0.09	0.50 ± 0.12	ND	>1.2 mmol/l (0.45 g/l)
HDL in male (g/l)	Yarahmadi 03	0.39 ± 0.16	0.47 ± 0.08	0.45 ± 0.10	ND	
HDL (mmol/l)	Gaaloul 99	1.05	ND	1.11	ND	
LDL (mmol/l)	Latif 93	3.28 ± 1.27	2.85 ± 1.14	3.11 ± 1.09	2.75 ± 0.71	
	Uysal 98	3.00 ± 0.85	ND	3.08 ± 0.93	3.08 ± 1.01	
	Gaaloul 99	2.81	ND	2.89	ND	<2.5 mmol/l (1g/l)
LDL in female (g/l)	Yarahmadi 03	1.59 ± 0.56	1.17 ± 0.50	1.87 ± 0.58	ND	
LDL in male (g/l)	Yarahmadi 03	1.35 ± 0.32	1.45 ± 0.35	1.72 ± 0.42	ND	
BMI female (kg/m <sup>2</sup> )	Uysal 98	29.8	28.3	30.4	ND	
BMI male (kg/m <sup>2</sup> )	Yarahmadi 03	26.3	25.1	25	ND	<25 Kg/m <sup>2</sup>
BMI (kg/m <sup>2</sup> )	Uysal 98	30.4 ± 3.0	ND	30.4 ± 4.0	30.5 ± 4.0	
BP in female (mmHg)	Yarahmadi 03	122/83	125/80	118/78	ND	<140/80 mmHg
BP in male (mmHg)	Yarahmadi 03	130/81	126/80	123/79	ND	

The control of the glycosylated haemoglobin (HbA1c) and blood pressure is related to the prevention of the microangiopathic complications. The control of blood pressure, HbA1c, total cholesterol (Chol), HDL-cholesterol (HDL), LDL-cholesterol (LDL), triglyceride (TG) and body mass index (BMI) is related to the prevention of the macroangiopathic complications. *Abbreviation:* not determined multicentric (ND), second week of Ramadan (R2), fourth week of Ramadan (R4).

complications is based on blood pressure, HbA1c, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglyceride, cigarette quitting, BMI and physical activity control. Biochemical changes during Ramadan (Table 2) have been compared to the values recommended [48]. Most of these parameters were not controlled before Ramadan. In these studies, moreover, angiopathic complications before Ramadan were not mentioned. It is difficult to conclude on any aggravation of the angiopathic complications during Ramadan. Consequently, multi-centric studies are needed in order to evaluate the impact of fasting on angiopathic complications. The protocol of these studies should include a baseline period before Ramadan, at least two control periods during Ramadan (one period during the first week of Ramadan and the other during the last week of Ramadan) and one period after Ramadan.

Patients included in these studies must be controlled for the parameters cited above.

### 1.5. Physical activity during the month of Ramadan

Studies interested in physical activities in fasting patients with diabetes are very rare. Many studies have made clear that light to moderate exercise on a regular basis during Ramadan fasting is harmless for patients with type 2 diabetes [49]. Fasting, to be more precise, has proved not to have any interference with tolerance to physical exercising [50]. Theoretically, moderate or intense physical activity should be avoided towards the end of the day, particularly if the month of Ramadan coincides with the summer. However, any activity prescribed by physicians requires clear information as related risks and preventions.

### 1.6. Prescription of anti-diabetic drug during the month of Ramadan

The aim of drug treatment in patients with diabetes is to decrease the frequency of hypoglycaemia and to balance glycaemia. The prescription of anti-diabetics during Ramadan has to take into consideration religious and clinical constraints. The Islamic religion forbids daytime drug intakes [51]. Clinical constraints are related to the optimisation of drug intake.

#### 1.6.1. Patients on oral hypoglycaemic drugs

Several studies have concluded that Ramadan fasting does not affect glycaemia in balanced type 2 patients treated with OHA drugs and diet [5,27,34], or treated with OHA drugs alone [6,7,14,20,29,52]. No hypoglycemic episodes have occurred during Ramadan in these patients [5,6,20]. However, some studies have reported hyperglycaemic episodes in patients who reduce arbitrarily their drug dosage, or even stop it completely [18,53,54].

In most of these studies, two doses of OHA drug are used during Ramadan, one dose at the sunset meal and the second one at the sunrise meal [6,20]. Only one study has compared the efficiency of two doses during Ramadan: this study includes two groups. The dose given to the first represents 100% of that given in usual times, whereas that given to the second group represents only 75% of that used in usual times [12]. These doses are taken twice daily, and the morning dose is reduced in the group of patients to whom only 75% of the usual dose is given. The results of this study appear to show that hypoglycaemic events are more frequent in the full dose group [12]. It could, thus, be recommended that type 2 patients reduce their morning OHA doses [12], especially in the elderly. Other studies have compared the efficiency of two different treatments during Ramadan repaglinide and glibenclamide, using two daily doses. During Ramadan, type 2 Muslim patients using prandial repaglinide, show a tendency toward better glycaemic control and a lower hypoglycaemia frequency than patients using glibenclamide [55]. Repaglinide, on the other hand, compared to sulfonylurea (glimpiride, gliclazide) can reduce hypoglycaemia frequency [16]. It is important to stress that ADO intake should be carried out during the main meals, and doses adapted to the results of biological and clinical controls.

#### 1.6.2. Patients on insulin treatment

Lispro insulin treatment has also been compared to human insulin in two studies involving type 2 patients. The first one involves 70 patients [56] while the second

involves 151 patients [57]. Lispro insulin is injected immediately before the two allowed meals (at sunrise and sunset) and regular human insulin 30 min before. Results appear to show that lispro insulin treatment gives a better control of postprandial blood glucose after the breakfasting meal [56,57] and a decrease in hypoglycaemia the frequency during daytime [56].

Only one study is available on drug prescription in type 1 patients during Ramadan. The effects of lispro insulin and regular human insulin on blood glucose control and hypoglycaemia frequency have been compared in type 1 patients observing the fast during Ramadan. Lispro insulin or regular human insulin are given twice daily. Results show that glycaemic control, measured through postprandial glycaemic excursions, is improved and hypoglycaemia reduced with lispro insulin compared to regular human insulin [58].

Based on their clinician experience, several authors have suggested the two following therapeutic schedules, depending on the patients' drug regimen before Ramadan. Two injections are advised in the first scheme, and three injections in the second. The first scheme concerns the administration of two doses during Ramadan, one just before the evening meal and a smaller dose before the morning meal [59]. The second, concerns two injections of short acting insulin, used before the breakfasting and the sunrise meals, and an intermediate acting insulin in the late evening [59–61]. In these three articles, the advised therapeutic schedules are not based on controlled clinical assays but only on the authors' points of view.

A single injection is reported to be sufficient; and it is better to use it in the evening during the first meal or in the Sohur [53]. However, in case of complications, such as unstable diabetes, hypoglycaemia antecedent,

Table 3

Criteria allowing and forbidding fasting in patients with diabetes according to the consensus of Casablanca, 1995 [62]

Criteria allowing fasting	Criteria against fasting
Non insulino-dependent diabetes with:	–Insulino-treated diabetes
–Obesity or normal weight	–Unbalanced non-insulino-dependent diabetes
–Sensitive to diet	–Diabetes with degenerative complications
–Under biguanides	–Diabetes and pregnancy
–Under sulfamides	–Gestational diabetes
–Stables and well balanced	–Diabetes and lactation
–Exempt from any:	–Established diabetes in the elderly whatever the type
• Inter current illness	–Instable diabetes
• Degenerative complication	

Table 4  
Clinical and para-clinical measures to be taken into account before, during and after Ramadan

Pre-Ramadan consideration (2 month before)	Ramadan consideration	After Ramadan consideration
–Metabolic control evaluation <sup>a</sup>	In the middle and the end of Ramadan should be to check:	An evaluation is needed:
–Clinical control and physical exam	–Metabolic control evaluation <sup>a</sup>	–Degenerative complications check up
–Adaptation of diet protocol for Ramadan fasting depending on patients' socio-economic standard	–Clinical control and physical exam <sup>b</sup>	–Clinical and biochemical check up
–Drug regimen adaptation	–Adherence to diet and drug intake	–Diabetes' balance
–Degenerative complications check up		–Monthly weight, blood pressure, HbA1c and renal function evaluation every six months
–Suitable physical activity		
–Awareness of deshydration alarming symptoms,		
–Hypoglycaemia or hyperglycemias and other possible complications.		
–Patients' psychological state		

<sup>a</sup> Metabolic control evaluation include: blood glucose, urine acetone (for type 1), HbA1c, cholesterol (Total, HDL, LDL), triglycerides, microalbuminuria, creatinine.

<sup>b</sup> Clinical control and physical exam: weight, blood pressure, deep control for high risk patients.

ketoacidosis, cardiovascular pathology or any associated infection, the fast should be proscribed [53,60].

### 1.7. Role of physicians in the protection of the health of patients with diabetes

Practitioners have to make patients with diabetes aware of their responsibility in the success of their treatment. While the authoritarian attitude is undesirable, it is necessary to be persuasive and never hesitate to use and remind patients of religious arguments, using the Holy Quran and Hadith. In addition, physicians must prepare their patients with diabetes before the beginning of Ramadan. The first step is to make it clear that them not fasting does not necessarily involve transgressing divine laws.

The second step is to educate patients, as well as their families to make them see that fasting can be and is most of the time risky. Several international conferences of consensus on "Diabetes and Ramadan" have been organised, and multi-disciplinary experts (specialists, general practitioners, psychiatrists, pharmacists and theologians) established consensus recommendations and some guidelines (Table 3) for the management of fasting patients [17,62,63]. The consensus proscribes fasting for type 1 patients and all insulin-treated patients. For patients wishing to fast, physicians are expected to reinforce clinical and paraclinical surveillance before, during and after Ramadan (Table 4).

In light of the results of this review, the following recommendations should be reviewed given that the

new fast absorption insulin formulation is available. The latter is said to constitute a therapeutic alternative for type 1 patients insofar as it allows a better glycaemia balance and less hypoglycaemic episodes during Ramadan. This alternative, however, concerns only controlled patients without any other diseases.

## 2. Conclusion

It follows from this review that Ramadan fasting is acceptable for well balanced type 2 patients conscious of their disease and compliant with their diet and drug intake. Islamic rules allow patients not to fast. However, if patients with diabetes wish to fast, it is necessary to advise them to undertake glycaemia control several times a day, to prevent hypoglycaemia risks during daytime fasting or hyperglycaemia during the night. Patients with type 1 diabetes who will fast during Ramadan may be better managed with fast absorption insulin.

During Ramadan fasting, and in order to assess the effect of differences related to gender, race, physical activity, food habits, sleep patterns and other important physiologic and pathologic conditions variables, it is recommended that international multi-centric controlled clinical trials be employed.

## References

- [1] R. Roky, I. Houti, S. Moussamih, S. Qotbi, N. Aadil, Physiological and chronobiological changes during Ramadan intermittent fasting, *Ann. Nutr. Metab* 48 (2004) 296–303.

- [2] I. Salti, E. Benard, B. Detournay, M. Bianchi-Biscay, C. Le Brigand, C. Voinet, et al., EPIDIAR study group, A population-based study of diabetes and its characteristics during the fasting month of Ramadan in 13 countries: results of the epidemiology of diabetes and Ramadan 1422/2001 (EPIDIAR) study, *Diabetes Care* 27 (10) (2004) 2306–2311.
- [3] R. Sulimani, F.O. Famuyiwa, M.A. Laajam, Diabetes mellitus and Ramadan fasting: the need for critical appraisal, *Diabet. Med* 5 (1988) 589–591.
- [4] M.A. Omar, A.A. Motala, Fasting in Ramadan and the diabetic patient, *Diabetes Care* 20 (1997) 1925–1926.
- [5] H.B. Chandalia, A. Bhargav, V. Kataria, Dietary pattern during Ramadan fasting and effect on the metabolic control of diabetes, *Practical Diabet.* 4 (1987) 287–290.
- [6] M. Mafauzy, W.B. Mohammed, M.Y. Anum, A. Zulkifli, A.H. Ruhani, A study of fasting diabetic patients during the month of Ramadan, *Med. J. Malaysia* 45 (1990) 14–17.
- [7] R. Bouguerra, C. Ben Slama, A. Belkhadri, H. Jabrane, L. Beltaifa, C. Ben Rayana, et al., Metabolic control and plasma lipoprotein during Ramadan Fasting in non insulin-dependent Diabetes, in: *The Second International Congress on Ramadan and Health, Istanbul, Turkey, 1997*, p. 33 (Abstract).
- [8] S. Chamakhi, B. Ftouhi, N. Ben Rahmoune, S. Ghorbal, F. Ben, Khalifa, Influence of the fast of Ramadan on the balance glycemie to diabetics, *Medicographia* 13 (Suppl. 1) (1991) 27–29.
- [9] M. Gharbi, M. Akrouf, B. Zouai, Contribution des prises alimentaires pendant et en dehors du Ramadan, *East Mediterr. Health J.* 9 (2003) 131–140.
- [10] S.A. Beshyah, N.I. Jowett, A.C. Burden, Effect of Ramadan fasting on metabolic control in diabetes, *Diabet Med* 5 (Suppl. 2) (1988) 32–33.
- [11] R. Sulimani, M. Laajam, O. Al-Atlas, F.O. Famuyiwa, S. Bashi, M. Mekki, et al., The effect of Ramadan fasting on diabetes control in type II diabetic patients, *Nutr. Res.* 11 (1991) 261–264.
- [12] J. Belkhadir, H. El Ghomari, N. Klocker, A. Mikou, M. Naciri, M. Sabri, Muslims with not insulin dependant diabetes fasting during Ramadan. Treatment with glibenclamide, *Br. Med. J.* 307 (1994) 292–295.
- [13] A.R. Uysal, M.F. Erdogan, G. Sahin, N. Kamel, G. Erdogan, The clinical, Metabolic and Hormonal effect of fasting on 41 NIDDM Patients, during the Ramadan, in: *The Second International Congress on Ramadan and Health, Istanbul, Turkey, 1997*, pp. 44–45 (Abstract).
- [14] Ch. Gaaloul, J. Hamzaoui, I. Hadj Ali, J. Jabrane, R. Bouguerra, C. Ben Slama, et al., Diabetes mellitus and Ramadan fasting, in: *The First Congress of Endocrinology and Metabolic Diseases, Beirut, Liban, PST5, 1999* (Abstract).
- [15] B. Forghani, N. Kassaian, M. Zare, A. Noroozi, M. Amini, The effect of Ramadan fasting on serum uric acid, glycosylated hemoglobin and malonyl dialdehyde in type 2 diabetic patient-sdjkdot, in: *The Congress on Health and Ramadan, Tehran, Iran, Iran J. Endocrinol. Metab. (Suppl. Autumn) 2001* 9 (Abstract).
- [16] R. Sari, M.K. Balci, S.H. Akbas, B. Avci, The effects of diet, sulfonyleurea, and Repaglinide therapy on clinical and metabolic parameters in type 2 diabetic patients during Ramadan, *Endocr. Res.* 30 (2) (2004) 169–177.
- [17] S. Athar, M. Habib, Management of stable typical 2 diabetes mellitus (NIDDM) during Islamic fasting in Ramadan, in: *The First International Congress one Health and Ramadan Casablanca, Morocco, 1994*, pp. 203–212 (Abstract).
- [18] Y. Khoghers, M.I. Sulaiman, S.F. Al-Fayez, Ramadan fasting and diabetes safety and state of control, *Ann. Saudi Med.* 7 (Suppl.) (1987) 5–6.
- [19] F.A. Khatib, Effect of fasting in Ramadan on blood glucose and plasma lipids in diabetics with NIDDM, in: *The Second International Congress on Ramadan and Health, Istanbul, Turkey, 1997*, p. 42 (Abstract).
- [20] F.A. Khatib, Y.A. Shafagoj, Metabolic alterations as a result of Ramadan fasting in non-insulin-dependent diabetes mellitus patients in relation to food intake, *Saudi Med. J.* 25 (2004) 1858–1863.
- [21] J. El Ati, C. Beji, L. Beltaifa, J. Danquir, Metabolic adjustments during Ramadan fasting in non-insulin dependent diabetic patients, in: *The Second International Congress on Ramadan and Health, Istanbul, Turkey, 1997*, p. 43 (Abstract).
- [22] S. Genuth, Supplemented fasting in the treatment of obesity and diabetes, *Am. J. Clin. Nutr.* 32 (1970) 2579.
- [23] B. Vessby, M. Boberg, B. Karistrom, Improved metabolic control after supplemented fasting in overweight type 2 diabetic patients, *Acta Med. Scand.* 216 (1984) 67.
- [24] H. Rashed, The fast of Ramadan: no problem for the well; the sick should avoid fasting, *BMJ* 304 (1992) 521–522.
- [25] American Diabetes Association, Nutrition recommendations and principles for people with diabetes mellitus, *ADA Clin. Pract. Recomm.* 23 (Suppl 1) (2000) S43–S46.
- [26] A. Albright, Nutrition management for type 1 diabetes, in: A. Coulston, C. Rock, E. Monsen (Eds.), *Nutrition in the prevention and treatment of diabetes*, Academic Press, San Diego, 2001, pp. 430.
- [27] C. Tang, M. Rolfe, Clinical problems during the fast of Ramadan, *Lancet* 1 (1989) 1396.
- [28] S. Al fayez, Y.A. Khogheer, M.A. Sulaiman, Plasma glucose changes in diabetes during Ramadan fasting, *J. Islamic Med. Assoc.* 20 (1988) 47–49.
- [29] A.H. Latif, M.Y. Gharieba, H.K. Al-Qassab, O.M. Sartawi, Changes in serum lipids and electrolytes in type II diabetes mellitus during Ramadan, *Saudi Med. J.* 14 (1993) 532–535.
- [30] K. Nagati, H. Kamoun, A. Abid, S. Blouza, H. Jamoussi, M. Atallah, et al., Ramadan fasting and diabetes type II, a tunisian multicentric studydkjdot, in: *The First Congress of Endocrinology and Metabolic Diseases, Beirut, Liban, (1999)*, p. 7.
- [31] S. Kalantary, A.R. Raja, B. Heidarnia, Blood sugar changes in NIDDM patients in the Ramadan month, in: *The Congress on Health and Ramadan, Tehran, Iran, Iran J. Endocrinol. Metab. Suppl. (Autumn) vol. 31 2001* (Abstract).
- [32] I.A. Katibi, A.A. Akande, B.J. Bojuwoye, A.B. Okesina, Blood sugar control among fasting Muslims with type 2 diabetes mellitus in Ilorin, Niger J. Med. 10 (2001) 132–134.
- [33] F. Sadr, M. Afshar, S. Sarboluki, Effect of fasting on glucose, lipids, body weight and blood pressure among non-insulin-dependent diabetes Mellitus, in: *The Congress on Health and Ramadan, Tehran, Iran, Iran J. Endocrinol. Metab. Suppl. (Autumn) vol. 18 2001* (Abstract).
- [34] Sh. Yarahmadi, B. Larijani, M.H. Bastanhigh, M. Pajouhi, R. Baradar Jalili, F. Zahedi, et al., Metabolic and clinical effects of Ramadan fasting in patients with type II diabetes, *J. Coll. Physicians Surg. Pak.* 13 (2003) 329–332.
- [35] N. Bagraiçik, V. Yumuk, T. Damci, M. Ozyazar, The effect of fasting on blood glucose fructosamine, insulin and C-peptide levels in Ramadan, in: *The First International Congress on Ramadan and Health, Casablanca, Morocco, 1994*, p. 32 (Abstract).

- [36] L. Iraki, A. Bogdan, F. Hakkou, N. Amrani, A. Abkari, Y. Touitou, Ramadan diet restriction modify the circadian time structure in humans. A study on plasma gastrin, insulin, glucose and calcium and on gastric pH, *J. Clin. Endocrinol. Metab.* 82 (1997) 1261–1273.
- [37] R.A. Sulimani, Management of typical 2 diabetes with oral agent during Ramadan, in: *The congress of the diabetes mellitus during the holy month of Ramadan*, Cairo, Egypt, 1997, p. 8 (Abstract).
- [38] A.F. Al-Hader, A. Niazy, The effects of Ramadan fasting on certain biochemical parameters in normal subjects and in type II diabetic Patients, in: *The First International Congress on Ramadan and Health*, Casablanca, Morocco, 1994, p. 26 (Abstract).
- [39] A. Kadiri, A. Rkiouak, A. Bahtat, Etude du profil clinique et biologique du diabétique jeûneur pendant le Ramadan, in: *The First Congress of Endocrinology and Metabolic Diseases*, Liban. Beirut, PST32, 1999 (Abstract).
- [40] R. Gustaviani, P. Soewondo, G. Semiardji, A.W. Sudoyo, The influence of calorie restriction during the Ramadan fast on serum fructosamine and the formation of beta hydroxybutirate in type 2 diabetes mellitus patients, *Acta Med. Indones* 36 (2004) 136–141.
- [41] M. Al Tufail, A. Haq, S. Al, Sedairy, Effect of Ramadan fasting on biochemical and haematological parameters, *Med. Sci. Res.* 20 (1992) 299–301.
- [42] K.Y. Mustafa, N.A. Mahmoud, K.A. Gumaa, A.M.A. Gader, The effects of fasting in Ramadan: fluid and electrolyte balance, *Br. J. Nutr.* 40 (1992) 583–590.
- [43] M.Z.A. Nomani, M.H. Hallak, I.P. Siddiqui, Effect of Ramadan fasting on Plasma uric acid and body weight in healthy men, *J. Am. Diet. Assoc.* 90 (1990) 1435–1436.
- [44] A.R. Uysal, M.F. Erdogan, G. Sahin, N. Kamel, G. Erdogan, Clinical and metabolic effects of fasting in 41 type 2 diabetic patients during Ramadan, *Diabetes Care* 21 (1998) 2033–2034.
- [45] Y.M. El Arnoaty, W.A. Johnson, Nutritional and biochemical changes during Ramadan fasting, *FASEB J.* 5 (1991) 1665.
- [46] A. Adlouni, N. Ghalim, A. Bensliman, J.M. Lacerf, Fasting during Ramadan induces a Marked in high-density lipoprotein cholesterol and decrease in low-density lipoprotein cholesterol, *Ann. Nutr. Metab.* 41 (1997) 242–249.
- [47] M.O. Ayyildiz, M. Aybak, Z. Bolaman, Effect of Ramadan fasting on platelet aggregation in patient with non insulin dependent Diabetes mellitus, in: *The First International Congress on Ramadan and Health*, Casablanca, Morocco, 1994, p. 30 (Abstract).
- [48] Agence Française de Sécurité Sanitaire des Produits de Santé, Recommandations pour le traitement médicamenteux du diabète de type (2), *La Presse Médicale* 28 (1999) 1527–1533.
- [49] A. Ewis, N.M. Afifi, Ramadan fasting and non-insulin-dependent diabetes mellitus: Effect of regular exercise, in: *The Second International Congress on Ramadan and Health*, Istanbul, Turkey, 1997, p. 76 (Abstract).
- [50] M. Arab, Different aspects of health in Ramadan among normal and diabetic persons, in: *The Second International Congress on Ramadan and Health*, Istanbul, Turkey, 1997, p. 36 (Abstract).
- [51] N. Aadil, I.E. Houti, S. Moussamih, Drug intake during Ramadan, *BMJ* 329 (2004) 778–782.
- [52] Glimpiride in Ramadan (GLIRA) Study Group, The efficacy and safety of glimepiride in the management of type 2 diabetes in Muslim patients during Ramadan, *Diabetes Care* 28 (2005) 421–422.
- [53] S.G. Barber, S. Fairweather, A.D. Wright, M.G. Fitzgerald, J.M. Malins, Muslims, Ramadan, and diabetes mellitus, *Br. Med. J.* 1 (1979) 46–47.
- [54] J.C. Davidson, Muslims, Ramadan and diabetes mellitus, *Br. Med. J.* 2 (1979) 1511–1512.
- [55] M. Mafauzy, Repaglinide versus glibenclamide treatment of Type 2 diabetes during Ramadan fasting, *Diabetes Res. Clin. Pract.* 58 (2002) 45–53.
- [56] J. Akram, V. De Verga, Insulin lispro (Lys(B28), Pro(B29) in the treatment of diabetes during the fasting month of Ramadan. Ramadan Study Group, *Diabet. Med.* 16 (1999) 861–866.
- [57] V. Mattoo, Z. Milicevic, J.K. Malone, M. Schwarzenhofer, A. Ekanagaki, L.K. Levitt, et al., A comparison of insulin lispro Mix25 and human insulin 30/70 in the treatment of type 2 diabetes during Ramadan, *Diabetes Res. Clin. Pract.* 59 (2003) 137–143.
- [58] A. Kadiri, A. Al-Nakhi, S. El-Ghazali, A. Jabbar, M. Al Arouj, J. Akram, et al., Treatment of type 1 diabetes with insulin lispro during Ramadan, *Diabetes Metab.* 27 (2001) 482–486.
- [59] A. Lakhdar, Challenge cups of maintaining good diabetic control in insulin treated patients during Ramadan, in: *The Congress of the Diabetes Mellitus during the Holy Month of Ramadan*, Cairo, Egypt, 1997, p. 12 (Abstract).
- [60] F. Azizi, Blood glucose in health and diabetes during Ramadan, in: *The Second International Congress on Ramadan and Health*, Istanbul, Turkey, 1997, p. 40 (Abstract).
- [61] A. Al Nakhhi, M. Al Arouj, A. Kandari, M. Morad, Multiple insulin injections during fasting Ramadan in IDDM patients, in: *The Second International Congress on Ramadan and Health*, Istanbul, Turkey, 1997, p. 77 (Abstract).
- [62] International Meeting on Diabetes and Ramadan Recommendations, Edition of the Hassan II Foundation for Scientific and Medical Research on Ramadan. Casablanca, Morocco, 1995.
- [63] Management of diabetes mellitus during the holly Month of Ramadan, International Symposium. *Pract. Diab. Inter.* 15 (1998) S1–S23.