

Fasting in Ramadan with an insulin pump

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Abstract

A good majority of subjects with diabetes on insulin therapies observe fasting during Ramadan. The challenge for the physician and the patient is to manage diabetes without an interruption to fasting by avoiding hypoglycaemia and simultaneously ensuring that blood glucose remain at acceptable safe levels. Insulin Pumps differ from syringes and insulin pens in that it offers a variable basal rate, different type of boluses and associated calculators. The technological advances that pumps offer, help educated subjects pre-programme a reduced basal rate throughout the day. Pumps ensure avoidance of hypoglycaemia and hyperglycaemia and preserve quality of life and enhance confidence in patients during fasting. Due to multiple benefits, insulin pumps are considered the best delivery systems for insulin during the holy month of Ramadan, despite the prerequisites for its optimal output and cost concerns.

Keywords: Diabetic Ketoacidosis, Fasting, Hypoglycaemia, Infusion Pumps, External, Quality of life.

Introduction

Persistently elevated glucose levels are known to produce micro vascular complications of diabetes and insulin, as a time tested therapy will have unlimited potential in lowering the glucose levels. Treatment of diabetes with insulin though an absolute necessity, is often delayed due to the inherent fear of hypoglycaemia. Subjects with near normal HbA1c levels on insulin injections should be vigilant enough to have meals at the right time and plan their physical activity to match the physiology of insulin action to avoid hypoglycaemia.

The Quran specifically exempts the sick from fasting (Holy Quran, Al-Bakarah, 183-185), especially if fasting might lead to harmful consequences. Patients with diabetes fall under this category because diabetes may place them at increased risk for various complications which include hypoglycaemia, hyperglycaemia, diabetic ketoacidosis, dehydration and thrombosis.¹ Approximately 43% of patients with type 1 diabetes (T1DM) and 79% of patients with type 2 diabetes (T2DM) fast during Ramadan.²

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Insulin pump offers one of the best strategies to deliver insulin to safely observe fasting during the holy month of Ramadan, avoiding the necessity of needle pricks. All patients with T1DM and a good majority with T2DM are on insulin injections. Commonly, insulin is delivered either via syringes or insulin pen devices. Once injection is delivered, it is impossible to alter the dose or halt its absorption. In contrast, insulin pump therapy is an alternate insulin delivery strategy where complete cessation of insulin delivery is possible in addition to programming the device for a reduced basal insulin delivery during the hours of fasting proportionate to the bodily requirements, thereby mitigating the risk of hypoglycaemia and ensuring suppression of hepatic glucose output.

Insulin Pump Therapy

Insulin pump is a small computerized, external, battery powered device about the size of a pager that delivers insulin into the sub-cutaneous tissue 24 hours a day using a preset programme. It consists of the main pump unit which holds an insulin reservoir. The reservoir is attached to a long, thin piece of tubing with a needle or cannula at one end. The tubing, cannula housing, cannula and adhesive are together termed the infusion set. The reservoir stores insulin for 2-3 days and usually holds 300 units of insulin. The server device facilitates the infusion set insertion. Insulin pump therapy is also referred to as Continuous Subcutaneous Insulin Infusion (CSII) therapy. Pumps are not fully automatic but must be programmed to release small doses of insulin continuously (basal), or a bolus dose close to mealtime to control the spike in blood glucose after a meal. Insulin pump may be set to deliver miniscule amounts on insulin, as low as 0.025 units.

Thus insulin pump mimics the insulin delivery of a healthy

Table-1: Selecting Insulin for Insulin pumps.

Properties	Insulin Lispro	Insulin Glulisine	Insulin Aspart
Rate of Occlusion	15.7%	40.9%	9.2%
Rate of Absorption	similar	similar	similar
Clinical efficacy	similar	similar	similar
Onset of action	faster	faster#	faster
Hypoglycaemia	less	less	less

*Insulin Aspart has least occlusion rates with greatest chemical and physical stability.³

#Onset of action is faster compared to insulin aspart but this advantage lasts only for 1 hour.

Table-2: Medtronic Insulin Pumps and Features.

Properties	Paradigm 715	Paradigm 722	Paradigm Veo	640G System
Variable Basal Rate	Present	Present	Present	Present
Minimum Basal Rate	0.05 U/hr	0.05 U/hr	0.025 U/hr	0.025 U/hr
Real Time Sensing	Real time display of glucose data not possible (can wirelessly connect to some blood glucose meters)	Real time display of glucose data possible (hypoglycaemia and hyperglycaemia trend alarms present)	In addition to real time display of glucose data, low glucose suspend feature present	Real time display of glucose data with greater performance and comfort. In addition, predictive low suspend feature present
Bolus Wizard Calculator	Present	Present	Present	Present
Bolus Option	Available	Available	Available	Available

Table-3: Merits & Demerits of Using Insulin Pump during Ramadan Fasting.

Merits	Demerits
Total avoidance of hypoglycaemia, hyperglycaemia and diabetes related emergencies	The device and accessories are very expensive
Variable basal rate and different types of bolus insulin delivery possible	Basic education and excellent technological learning skills absolutely essential
Continuous display of sugar values without finger pricks	Separate sensor deployment necessary along with Real time or Veo pump
Almost physiological delivery of insulin -both basal and bolus from the same rapid acting formulation	Patient need to have the device externally attached to the body all the time
Offers flexibility in lifestyles with probably no interruption to Ramadan fasting	Subjects need to get accustomed to the device for several months for trouble free use during Ramadan

human pancreas and is considered the most physiological method of insulin delivery currently available. Only rapid acting insulin can be used in pumps. It more closely mimics the endogenous insulin than regular human insulin and the tendency for hypoglycaemia is significantly less. Insulin aspart is the most widely used and the preferred rapid acting analogue in pumps since the occlusion rate is the least.³

Basal Rates

Insulin pump may be set to deliver as high as 48 different basal rates a day to avoid high and low blood sugars. They can be manually turned off, decreased or increased for unexpected change in blood sugar levels. The basal rate accounts for between 35-50% of a patient's Total Daily Dose of insulin.

Different Types of Basal Rates

The basal rate used for a specific situation is called a basal pattern. Multiple basal patterns can be programmed during Ramadan fasting. A patient on insulin pump can use a standard basal pattern, a different pre-programmed basal pattern or a temporary basal rate. The basal pattern used most frequently is called standard basal pattern. Other basal patterns can be pre programmed such as high patterns, low patterns etc.

Temporary basal rate is used to change basal rate insulin delivery for a fixed period when pre-programmed pattern is not used. Once this fixed period is over, pump will

automatically go back to the standard basal rate pattern. Basal insulin delivery can also be suspended in the wake of a severe hypoglycaemia. The basal profiles in pump should be set high or low 3 hours prior to the expected glucose excursions. For example, the day time basal delivery may be reduced by 50% during the month of fasting.

Bolus Types

There is a radical change in the eating pattern during the fasting days. The quantity and content of the meals also varies during the Ramadan month. Insulin pump offers different types of bolus options. The standard bolus is the most frequently used bolus pattern for meals that contain average fat and carbohydrate content and delivers all the insulin over a short period of time. It is also used for correction bolusing. In a square-wave bolus, bolus amount delivers evenly over the period of time it is set for. It is useful when eating small amounts of carbohydrate over an extended period of time. The dual-wave bolus delivers a combination of an immediate standard pre-meal insulin bolus (approximately 3 min) followed by a square-wave bolus that is evenly delivered over several hours. It is primarily used for meals that are both high in carbohydrates and fat, which may delay digestion. In patients with prolonged postprandial hyperglycaemia, dual-wave has been identified to be an effective and potential option to improve glycaemic control. Bolus delivery may be planned before breaking the fast and early morning before the meals so as to avoid both hypoglycaemia and hyperglycaemia during the fasting hours.



Figure-1: Medtronic Paradigm® pump.

Correction Bolus

A correction bolus may be given when glucose is above the upper level of the target range. The pump can be programmed to recommend insulin doses based on current glucose level, anticipated food intake and other factors. Bolus Wizard function in insulin pump also takes into account the active insulin which is the rapid acting insulin which is still present in the circulation from a previously delivered bolus which will prevent the occurrence of low sugars. The altered food habits and change in composition of diet during the fasting month may be intelligently managed by choosing the various bolus functions in the pump.

Insulin Pump Therapy in T1DM and T2DM

Insulin pumps have been an established device in the management of T1DM for more than 4 decades. However, with the recognition of its multiple benefits, pumps have become more popular in T2DM since 9 years.^{4,5}

Insulin pump is probably the only device which can specifically address the Dawn phenomenon in T1DM by increasing the dose of insulin infusion within the pump in the early morning hours. In an observational study among 49 T1DM patients, 61.2% fasted the whole month smoothly, using the insulin pump. Interestingly, no severe hypoglycaemia was reported.⁶ Khalil et al. observed a redistribution of insulin over 24-hour period in relation to changes in the daily lifestyle and eating patterns during fasting.⁷ Other studies also favour the use of pump therapy as an effective and safer option especially in reducing the breaks in fasting due to hypoglycaemia. Compared with those who did not fast during Ramadan, patients with T1DM on insulin pump who fasted showed



Figure-2: MiniMed 640G.

a slight improvement in A1c without increasing the risk of hypoglycaemia.⁸

If the patient is on a real time pump, interstitial sugars will be displayed on the pump screen without making any finger pricks. Moreover, insulin delivery can also be modified at the press of a button without administering injections. The Medtronic Paradigm® Veo pumps with the feature of low glucose suspend stops insulin delivery when a prespecified sensor glucose threshold is reached. The new MiniMed 640G predicts hypoglycaemia before it occurs and suspends insulin delivery to avoid it and resumes insulin delivery once sensor glucose levels recover. These pumps specifically designed to avoid hypoglycaemia may thus prove to be of profound benefit during Ramadan fasting. The Artificial Pancreas where an insulin pump is coupled with real-time Continuous Glucose Monitoring to provide automatic delivery of insulin through sophisticated mathematical algorithms is the next step to closing the loop.⁹

Indications for Insulin Pump Therapy during Ramadan

Some of the important indications for pump therapy in diabetes during Ramadan are as follows:^{10,11}

- ◆ Patients on multiple daily injections with co-morbidities and planning to fast
- ◆ Previous history of Hypoglycaemia during Ramadan fasting

- ◆ History of emergencies - Hypoglycaemia, diabetic ketoacidosis, dehydration etc.
- ◆ Frequent episodes of severe hypoglycaemic episodes
- ◆ Unstable course of diabetes/brittle diabetes
- ◆ Patients with high level of insulin resistance and on high doses of insulin
- ◆ Patients with micro- or macrovascular complications including CAD, CKD
- ◆ Patients with huge glycaemic fluctuations and glycaemic variability
- ◆ Co-morbid illnesses where Hypoglycaemia can be fatal
- ◆ Motivation and learning skills should be adequate for using CS11

Conclusions

Insulin pumps are alternative devices to deliver rapid acting insulin replacing the conventional insulin syringes and insulin pens. Pump therapy during Ramadan should be an intelligent choice preferably in experienced and trained users rather than in first time users. Affordability should never be the sole criterion for pump therapy though cost may be the single most important limiting factor in majority of patients. However, motivation and learning skills are key determinants in selecting candidates for CSII likely to fast during Ramadan.

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