

# Effects Of Insulin Pump And Subcutaneous Insulin Infusion Therapy On Glycemic Control In Brittle Diabetics

## *Brittle Diyabetlilerde İnsülin Pompası (IP) ile Subkutan İnsülin İnfüzyon Tedavisinin Glisemik Kontrolde Etkisi*

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### Abstract

**Objective:** A type of type I diabetes mellitus characterized by any kind of serious unstable conditions in glycemia requiring recurrent and/or long term hospitalization by altering the quality of life is defined as Brittle (unstable) diabetes who are admitted to hospital due to frequently recurring ketoacidosis, hypoglycemia and/or hyperglycemia. Brittle diabetes is the most difficult group of patients for the patients as well as diabetes team (physician, diabetes training nurse and dietician). Glycemic control can't be achieved easily despite intensive insulin therapy.

**Materials and Methods:** The present study included 30 patients including 22 women and 8 men who were admitted to our clinic with brittle diabetes. Initially, doses of insulin pump were adjusted based on protocol for switching from multiple intensive insulin therapy to insulin pump. The patients were re-evaluated for glycemic control 3 months after discharge from the hospital.

**Results:** Prior to insertion of insulin pump (IP), mean of fasting blood glucose was 237.66±69.51 mg/dl, mean fed blood glucose concentration 282.70±82.61 mg/dl, mean HbA1c level 8.74±0.29%, total insulin dose 45.13±10.75 U/day. Three months after initiation of continuous subcutaneous insulin infusion therapy, mean fasting blood glucose concentration was 93.63±23.25 mg/dl, mean post-prandial blood glucose concentration was 116.20±28.34 mg/dl, mean HbA1c was 6.34±0.81% (p<0.001), and total insulin dose was 38±16.45 U/day (p <0.005).

**Conclusions:** As our findings, the best option in the treatment of brittle diabetes which is unresponsive to multiple doses of insulin and makes a trouble for both the patient and the physician in achieving glycemic control is subcutaneous continuous insulin infusion despite its high cost. *Turk Jem 2007; 11: 89-92*

**Key words:** Insulin pump, glycemic control, brittle diabetics

### Özet

**Amaç:** Tip 1 diyabetin, yaşantıyı kesintiye uğratarak tekrar tekrar ve/veya uzun süreli hastaneye yatmayı gerektiren, glisemideki her çeşit ciddi kararsız durum ile karakterize şekli Brittle (kararsız) Diyabet olarak tanımlanmaktadır. Bu hastalar sıklıkla tekrarlayan ketoasidoz, hipoglisemi ve/veya hiperglisemi sebebiyle hastaneye yatmaktadır. Brittle diyabet, hastaların olduğu kadar diyabet ekibi (hekim-diyabet eğitim hemşiresi-diyetisyen) içinde en zor hasta grubudur. İntensif insülin tedavisine rağmen glisemik kontrol kolaylıkla sağlanamamaktadır.

**Gereç ve Yöntem:** Kliniğimize yatırılarak Brittle Diyabet tanısı almış yaş ortalaması 31.23±9.97 yıl, diyabet süreleri ortalama 8.66±7.95 yıl, vücut kitle indeksi ortalaması 22.76±2.47 kg/m<sup>2</sup> olan 22 kadın/8 erkek, toplam 30 Tip 1 diyabetli çalışmaya alındı. Hastaların tümü yatış öncesi multipl doz intensif insülin tedavisi almaktaydı ve diyabet merkezimizce takip edilmekteydi. Hastalara eğitimleri tamamlanarak portabl eksternal insülin pompası uygulandı. İnsülin pompa uygulamasından ortalama 7 gün sonra taburcu edildi. Hastalar hastane çıkışlarından 3 ay sonra glisemik açıdan tekrar değerlendirildi.

**Bulgular:** Hastaların IP uygulama öncesi açlık kan şekeri ortalaması 237.66±69.51 mg/dl, tokluk kan şekeri ortalaması 282.70±82.61 mg/dl, HbA1c %8.74±0.29, total insülin dozları 45.13±10.75 ünite/gün iken, insülin pompası ile sürekli subkutan insülin infüzyon tedavisi başladıktan 3 ay sonraki değerler sırası ile 93.63±23.25mg/dl (p<0.001), 116.20±28.34 mg/dl (p<0.001), %6.34±0.81(p<0.001), 38±16.45 ünite/gün (p <0.005) saptanmıştır.

**Sonuçlar:** Glisemik kontrolü sağlamada hasta ve klinisyen için her zaman sorun yaratan, multipl doz insüline yanıt alınamayan Brittle diyabetin tedavisinde en iyi seçenek, maliyetinin yüksek olmasına rağmen insülin pompası ile subkutan sürekli insülin infüzyonudur. *Turk Jem 2007; 11: 89-92*

**Anahtar kelimeler:** İnsülin pompası, glisemik kontrol, brittle diyabet

## Introduction

A type of type 1 diabetes mellitus characterized by any kind of serious unstable conditions in glycemia requiring recurrent and/or long term hospitalization by altering the quality of life is defined as Brittle (unstable) diabetes [1]. These patients are admitted to hospital due to frequently recurring ketoacidosis, hypoglycemia and/or hyperglycemia. Brittle diabetes is the most difficult group of patients for the patients as well as diabetes team (physician, diabetes training nurse and dietician). Glycemic control can't be achieved easily despite intensive insulin therapy [2]. This type of diabetes which frequently occurs in the second or third decades of life presents predominantly in three ways. These presentations exhibit recurring ketoacidosis in 59% of the patients, recurrent hypoglycemia in 17% and mixed clinical picture in 24% [3]. Brittle diabetes is constitutes a serious problem for both the patients and the physicians, is made stable by insulin infusion applied through insulin pump (IP).

## Materials and Methods

The present study included a total of 30 patients including 22 women and 8 men who were admitted to our clinic with brittle diabetes between 2001 and 2003 and whose mean age was  $31.23 \pm 9.97$  years, mean duration of diabetes was  $8.66 \pm 7.95$  years and mean body-mass index (BMI) was  $22.76 \pm 2.47$  kg/m<sup>2</sup>. The present study is prospective. The study has approved by the local ethics committee.

16 patients (53%) had hypo- and hyperglycemia attacks, 2 (7%) frequently recurring diabetic ketoacidosis, 11 (37%) continuous history of hypoglycemia and 1 (3%) patient was pregnant. All patients were on multiple dose intensive insulin therapy prior to admission and were being followed by our diabetes center. The patients in whom good glycemic control couldn't be achieved and diagnosis of brittle diabetes was made were admitted to hospital for 10 days. Their training on insulin pump was completed and then third-generation portable external IP was inserted (Minimed insulin pump to 2 patients and DanaDiabcare insulin pump to 28 patients). Initially, doses of insulin pump were adjusted based on protocol for passing from multiple intensive insulin therapy to insulin pump [4]. The patients were re-evaluated for glycemic control 3 months after discharge from the hospital.

### Statistical evaluation

Compare means T test in SPSS software for windows (version 11.0) was used to compare parametrical data between groups. The values were expressed as mean  $\pm$  1 standard deviation. P values  $< 0.05$  were considered as statistically significant (Table 1).

## Results

Prior to insertion of insulin pump (IP), mean of fasting blood glucose was  $237.66 \pm 69.51$  mg/dl, mean postprandial blood glucose concentration  $282.70 \pm 82.61$  mg/dl, mean HbA1c level  $8.74 \pm 0.29\%$ , total insulin dose  $45.13 \pm 10.75$  U/day whereas these figures were as follows 3 months after initiation of continuous subcutaneous insulin infusion therapy, respectively:  $93.63 \pm 23.25$  mg/dl,  $116.20 \pm 28.34$  mg/dl,  $6.34 \pm 0.81\%$ , and  $38 \pm 16.45$  U/day. Results were summarized below in table 2.

## Discussion

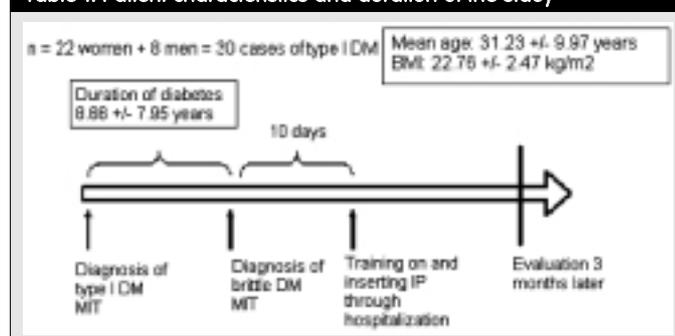
The term of brittle diabetes was used by diabetologists to define the patients with unstable glycemic control appearing as unresponsive to all treatment modalities. Brittle diabetes was described in 1964 by Molnar as "excessive diabetic variability", in 1977 by Tattersall as "it alters the life by hypoglycemic and hyperglycemic attacks regardless of cause", in 1988 by Schade by "alteration of life three times or more weekly or complete abstinence from work due to recurrent attacks of hypoglycemia and hyperglycemia", in 1991 by Tattersall et al. as "being have admitted to hospital at least three times in a period of 2 years due to hypoglycemia or hyperglycemia", in 1996 by Gills et al. as "every kind of seriously unstable condition requiring frequent and/or long-term hospitalization by altering the life" [5].

Methods of insulin therapy may be divided into 2 categories:

- Classical (conventional) insulin therapy.
- Intensive insulin therapy
  - Multiple dose intensive insulin therapy (MIT)
  - Continuous subcutaneous insulin pump (through insulin pump).

It has been shown that intensive insulin therapy provides better glycemic control than conventional insulin therapy in both types 1 and type 2 diabetics. With strict control of blood glucose level nephropathy reduced by 56%, neuropathy by 60% and retinopa-

**Table 1. Patient characteristics and duration of the study**



**Table 2. Results of glycemic control prior to and following treatment with IP**

Intensive Insulin Therapy through IP	Fasting blood glucose (mg/dl)	Postprandial blood glucose (mg/dl)	HbA1c (%)	Total insulin (U/day)
Prior to IP	237	282	8.74	45
Following IP	93	116	6.34	38
p=	0.001	0.001	0.001	0.005

thy by 76% and progress in retinopathy decreased by 39% for each 0.9% reduction in the level of HbA1c in DCCT study on type 1 diabetics. While HbA1c levels reached 8.9% in those diabetic patients receiving conventional insulin therapy, this figure has been 7.1% in those patients receiving intensive insulin therapy [6]. Does this make a difference between two different types of intensive insulin therapy? It should be acknowledged that the method mimicking pancreatic secretion physiology in the best was applications of insulin pump. In regard to applications of insulin pump (IP), basal secretion of insulin can be adjusted hourly and a separate dose of insulin can be adjusted for each meal. The individual may inject extra bolus insulin if required (Figure 1).

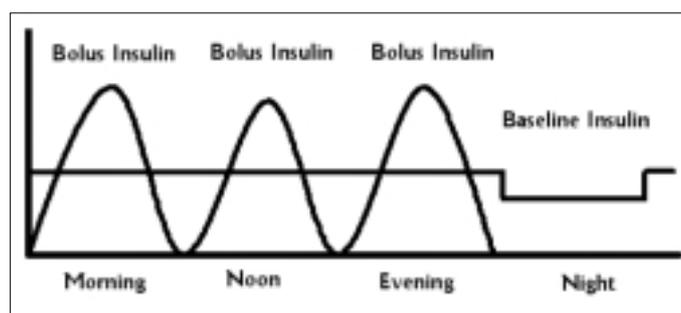
Furthermore, the number of required injections for MIT (4 – 5 times daily) reduces to 1 with insertion of catheter replaced once in 3 days in IP. This means that 12 to 15 injections in 3 days in MIT method is substituted by one injection in IP method [7-11].

60% of members of American Diabetes Association preferred application of insulin pump in a survey on their preference on MIT or IP in treatment of type 1 diabetes. This is because IP mimics physiological insulin secretion as well as causes least complication rates, least pain, least weight gain with the lowest possible insulin doses, least severe hypoglycemia attacks and best quality of life compared to the other treatment modalities [12-16].

In a study by Justen et al. 106 type 1 diabetic patients using IP were followed for averagely 26 months; type 1 diabetics using MIT matched for age and duration of diabetes were also included in the study as control subjects. HbA1c value was 7.1% in the IP group and 7.6% in the group of MIT ( $p < 0.0001$ ). Frequency of serious hypoglycemia was 4 folds higher in IP group [17].

Results of some studies comparing IP and MIT were given in table 3 below

Treatment of brittle diabetes also shows problems and hesitance. Some of the follow-up studies found that most of brittle diabetes cases improved in time. At the end of a study in which 33 patients with serious recurrent diabetic ketoacidosis were followed for 10



**Figure 1.** Continuous subcutaneous insulin infusion through insulin pump

years reported that 90% of the cases were not brittle but 5 patients died during the study period and the remaining patients had higher rates of complications than control group. Hence, waiting increases both morbidity and mortality [21]. Available treatment options of refractory brittle diabetes include intravenous, intraperitoneal, continuous subcutaneous insulin infusion, pancreatic transplantation and psychological supply [22].

Mean levels of fasting and postprandial blood glucose were far from treatment goals and HbA1c level was  $8.74 \pm 2.29\%$  in 30 patients with type 1 diabetes who were diagnosed as having brittle diabetes upon admission in our clinic with mean age of  $31.23 \pm 9.97$  years and mean duration of diabetes of  $8.66 \pm 7.95$  years. It was observed in glycemic controls 3 months later in the patients receiving continuous subcutaneous insulin infusion following training on insulin pump that treatment goals were met. Statistically significant improvement was found in fasting and postprandial blood glucose levels and HbA1c values in the period following IP compared to the period prior to IP ( $p < 0.001$ ). Total required insulin dose was  $45.13 \pm 10.75$  U/day prior to IP and  $38 \pm 16.45$  following IP. This decrease of 16% in insulin requirement was statistically significant. Glycemic goals were achieved by less insulin doses with IP.

The best option in the treatment of brittle diabetes which is unresponsive to multiple doses of insulin and makes a trouble for both the patient and the physician in achieving glycemic control is subcutaneous continuous insulin infusion despite its high cost.

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**Table 3.** IP or MIT in type I diabetes?

	Number of the patients	Duration of IP (years)	HbA1c % (MIT)	HbA1c % (IP)
DCCT[6]	124	6.5	7.0	6.8
Knight[18]	63	2	10.9	9.8
Bode[19]	55	3.1	7.7	7.4
Boland[20]	25	1	8.3	7.5

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