

Short Communication: Continuous Subcutaneous Insulin Infusion in Type 1 Diabetic Saudi Children: Two-Year Follow-up

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Abstract

Objective: To assess the efficacy and effectiveness of continuous subcutaneous insulin infusion (CSII) therapy in type 1 diabetic Saudi children. Methods: CSII was initiated in 10 Saudi children with type 1 diabetes mellitus through insulin pump therapy between October 2002 and April 2003. All children were followed at The Diabetes Clinic at King Faisal Specialist Hospital and Research Center. The patients were initially on conventional insulin therapy (CI) before shifting them to CSII. They were trained on carbohydrates counting and started on continuous basal insulin infusion in addition to meal and high blood glucose correction insulin boluses. Results: The patients included in the study had type 1 diabetes mellitus for a mean duration of 5.9 years + 1. The age of the children ranged from 9 to 18 years (mean 13.5 + 3). They were followed on insulin pump therapy for a mean duration of 25 months + 2. There was a significant reduction in hemoglobin A1c (HbA1c), mean blood glucose level, total insulin requirement, frequency of hypoglycemic episodes and frequency of diabetic ketoacidosis (DKA) events during CSII therapy. HbA1c and blood glucose level reduction was maintained for more than 2 years. All children continued to monitor their blood glucose at least 3 times per day and count carbohydrates and match that with insulin meal boluses. Conclusion: CSII improved the glycemic control in diabetic Saudi children and its metabolic effect on blood glucose control was sustained for more than 2 years. Medical, psychosocial and family support is continuously needed for this modality of insulin therapy to achieve its targeted goal.

Introduction

Since the introduction of CSII in the late 1970s, it has become apparent that the use of insulin pump therapy has many potential benefits for children with type 1 diabetes. Several studies showed that insulin pump therapy improves glycemic control, reduces hypoglycemia and decreases episodes of recurrent DKAs [1,2]. We previously reported that CSII therapy is effective in improving the glycemic control in 14 Saudi children over a oneyear followup [3], however it was thought practically that the positive effect of insulin pump therapy on blood glucose control can not be maintained for several years. Children on insulin pump therapy are required to monitor blood glucose 8 times per day initially and then 5 times a day. They need to evaluate carbohydrates intake and match that with insulin and take extra insulin boluses for high blood glucose correction. These children and their families might be enthusiastic to follow these strict instructions for few months after insulin pump initiation; however they may loose control over time. This study showed CSII could be continued as long as the medical supervision and family support are adequately and continuously provided.

Methods

Ten Saudi children (7 males and 3 females) with type 1 diabetes mellitus were selected and started on 508 Mini-Med© insulin pump therapy. Selection criteria included diabetic children with poor diabetic control (HbA1c above 8.5%) who had recurrent hypoglycemic episodes (more than 2 episodes per month). These patients were willing to monitor blood glucose regularly and willing to evaluate carbohydrates intake. All patients were on CI therapy that included two injections of insulin per day (NPH and regular insulin) before shifting them to CSII.

All patients were trained by a diabetic dietician on carbohydrates counting and food nutrition labels reading. Total daily carbohydrate intake calculated as grams of carbohydrates was distributed into 3 meals and 3 snacks.

Insulin pump therapy using the ultrashort acting lispro (Humalog®) insulin was started as continuous basal insulin infusion and distributed into 2-4 basal insulin infusion rates. The total insulin dose through the CSII was calculated as 80% of the total prepump total insulin dose. Fifty percent of that was given as basal continuous infusion over 24 hours. Additional insulin doses for carbohydrates meals were calculated by dividing 500 by the total insulin units per day. One unit of lispro insulin was required to cover 10 to 30 grams of carbohydrates (meal insulin bolus). Additional insulin doses for high blood glucose correction were calculated by dividing 1700 by the total insulin units per day. One unit of lispro insulin was required to correct 50-100 mg/dl above 150 mg/dl (correction insulin bolus).

All patients were initially instructed to check blood glucose 8 times per day; pre and postmeals, bed time and in the early morning for the first few days of CSII initiation, and then 5 times of blood glucose monitoring were required.

Statistical analyses were performed using the paired comparison T test to evaluate the differences between CSII and CI treatment levels of HbA1c, blood glucose levels, hypoglycemic episodes and total insulin requirement as well as changes in body weight. The tests were two tailed and p value of <0.05 was chosen to indicate significant deviation from the null hypothesis.

Results

All patients had type 1 diabetes mellitus for a mean duration of 5.9 years + 1 (4 to 7 years). The age of the children ranged from 9 to 18 years (mean 13.5 +3). They were followed on insulin pump therapy for a mean duration of 25 months + 2 (24 to 30 months).

Preinsulin pump therapy, during the 6 to 12 months prior to insulin pump therapy initiation, the mean HbA1c was 10.1 % + 1.1 (8.8 to 11.5%), the mean blood glucose level was 235 mg/dl + 32.4 (169 to 271 mg/dl), the frequency of hypoglycemic episodes (defined as a blood glucose level of 40 mg/dl or less) ranged from 2 to 5 episodes per month (mean 3.1 +1.1) and the mean daily total insulin requirement was 1.1 units/kg body weight + 0.4 (0.8-2.2). The total numbers of hypoglycemic convulsive and DKA episodes were 3 and 12 episodes respectively in all patients during the 12 months period prior to insulin pump initiation.

Postinsulin therapy, the mean HbA1c was 7.3 % + 0.3 (6.5% to 8%), the mean blood glucose level was 155 mg/dl + 31.4 (111 to 201 mg/dl), the frequency of hypoglycemic episodes ranged from 1-3 per month (mean 1.8 + 0.6) and the mean daily total insulin requirement was 0.9 unit/kg body weight + 0.2 (0.5-1.3). HbA1c level improved significantly during CSII treatment in the study group (p < 0.0001). Mean blood glucose level was significantly lower during CSII compared with CI therapy (p = 0.0005). A significant decrease in the frequency of hypoglycemic episodes (p <0.001) and total insulin requirement (p = 0.0007) was observed in children treated with CSII. There was no significant difference in body mass index pre and post insulin pump therapy. There was no report of hypoglycemic convulsion or coma or diabetic ketoacidosis requiring hospitalizations in children on CSII.

All children were instructed to check blood glucose 8 times per day. Four children continued to check blood glucose 6-8 times per day and the rest were checking blood glucose 3-4 times per day. The mean HbA1c in those who are monitoring blood glucose more frequently was 6.9% (6.5-7.1) compared to 7.6% (7.2-8) in those who were monitoring blood glucose less frequently (p <0.05).

Discussion

A large number of studies suggest that nearnormal glycemic control prevents or delay complications of diabetes, which has led to dramatic increase in CSII or insulin pump use. This article reports our experience with 10 Saudi children on insulin pump therapy which proves that CSII is extremely effective in treating type 1 diabetic Saudi

children and its metabolic effect on blood glucose control may persist if the medical, technical and family support is available.

CSII therapy needs very close medical and family support. Children on insulin pump therapy need to wear the pump all the time, check blood glucose frequently, correct high blood glucose readings with insulin correction boluses, count carbohydrates, match their meals with insulin meal boluses to achieve the targeted goal. Practically speaking these children might be compliant with these instructions and recommendations for few months but they may lose control and become less compliant as time goes on. Children on multiple daily insulin injection therapy (MDI) as an example of intensive insulin therapy which needs frequent monitoring and multiple daily insulin shots initially exhibited improved metabolic control however the level of control was difficult to sustain for 12 months [4]. In this study, we showed that the better metabolic effect of insulin pump therapy was maintained for 2 years and can last for more as long as the medical and psychosocial support is continuously provided.

The effectiveness of intensive insulin therapy including CSII appears to decrease with a decreased frequency of blood glucose selfmonitoring and insulin dose adjustment [5,6]. Our patients were instructed to check their blood sugar at least 8 times per day. The favorable results achieved in this study may have been promoted by high frequency of blood glucose selfmonitoring. Some patients were less compliant with frequent blood glucose monitoring but none of them were checking blood glucose less than 3 times a day. Those who were checking more frequently had a better glycemic control than those who were monitoring blood glucose less frequently.

Hypoglycemia is a serious risk associated with intensive therapy and occurs with both CSII and MDI. Early studies suggested that the risk of hypoglycemia with CSII was greater or similar to that of conventional diabetes management and MDI [7]. More recently, however reports have suggested that severe hypoglycemia may be reduced by CSII as much as 4-fold compared with MDI treatment with no reduction in glycemic control [8,9]. Reduced frequency of hypoglycemia was observed in our patients on insulin pump therapy and none of them developed hypoglycemic coma or convulsion.

Among the possible hazards of CSII is the susceptibility of these patients to rapidly develop attacks of DKA. The risk of DKA can be minimized by frequent selfmonitoring of blood glucose and taking the emergency necessary steps in the event of unexplained hyperglycemia. In our group of patients none developed DKA on CSII, which required hospitalizations. However mild episodes of DKAs were successfully managed by increasing the rate of basal insulin infusion rate.

The present study showed that CSII is effective in improving the metabolic control in Saudi type 1 diabetic children. The results of this local experiment showed that effect of CSII may be maintained if adequate medical and family support is available.

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