

INSULIN PUMP THERAPY WITH CONTINUOUS GLUCOSE MONITORING IMPROVES METABOLIC CONTROL IN BRITTLE TYPE 1 DIABETES

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Abstract: *Aim:* to evaluate the combination of insulin pump therapy and continuous glucose monitoring in outcome on metabolic control in patients with brittle type 1 diabetes.

Materials and methods: Insulin pump therapy was initiated in eleven brittle type 1 diabetics with poor metabolic control (mean HbA1c = 9.6%). Metabolic control was evaluated with CGMS and HbA1c in the following 6 months.

Results: Glycated haemoglobin showed a reduction in 1.4% in the 6 months following initialisation of pump therapy. Physical activity, various foods and insulin were tested with CGMS. There were no severe hypoglycaemia and occasional post-prandial hyperglycaemia, where patients and their family learned the practical issues of carbohydrate counting. During the next 6 months on pump therapy, the patients successfully managed their diabetes.

Conclusions: Insulin pump therapy can be initiated and used effectively in brittle type 1 diabetics to improve metabolic control and quality of life. When diabetes and pump management are appropriately individualized, this kind of therapy can help type 1 diabetics to achieve and to sustain metabolic control. Lifestyle flexibility, quality-of-life improvement, and independence can be maintained throughout young adulthood.

Key words: type 1 diabetes, insulin pump, continuous glucose monitoring

Introduction

Insulin pump therapy or Continuous subcutaneous Insulin Infusion (CSII) was introduced 20 years ago [1]. The first published results were unsatisfactory, where CSII was used in children and adolescents [2]. New technology used in medicine, in the field of diabetes has led to a better quality of insulin pump in the last 10 years. A lot of studies were published, indicating that CSII was a promising alternative to multiple daily insulin injections (MDI) in children and adolescents with type 1 diabetes. A study published in 1999 showed that CSII was associated with a lower risk of hypoglycaemia, lower haemoglobin A1C levels [3]. Other published studies showed that better metabolic control can be achieved using insulin pump therapy in children and adolescents [4, 5, 6]. The Continuous Glucose Monitoring System (CGMS) can help to achieve and improve metabolic control as a result of a balanced diet, physical activity and correct insulin [6]. In the last several years, rapid acting insulin analogues have been introduced, where a combination of new insulin and pump technology has convinced clinicians and parents that CSII can offer better quality-of-life and better metabolic control [7].

Insulin pump therapy can achieve near normal glycaemia, minimize the risks of severe hypoglycaemia and excessive weight gain, and prevent or delay microvascular complications in brittle type 1 diabetics. CSII in combination with a continuous glucose monitoring system can help type 1 diabetics to achieve their goals in the management of diabetes. Unpredictable physical activity and different styles of eating can be managed more easily with CSII than MDI. The use of CSII in Macedonia is at a very low level. A presentation of the first eleven patients on CSII with brittle type 1 diabetes is given.

Aim

The aims of our study were:

- To implement and explain the importance of CSII in brittle type 1 diabetics
- To set and evaluate CGMS in patients with CSII
- To evaluate the metabolic control in patients with CSII and CGMS

Materials and methods

The study was performed at Endocrinology Clinic in Skopje in the period January 2005 – December 2006. Eleven patients (6 male, 5 female), aged

15.9 ± 4.1 years with brittle type 1 diabetes were included in the study. The mean duration of diabetes was 4.3 ± 2.6 years. All patients had poor metabolic control (mean HbA1c = 9.6 ± 0.9% of two results in the last six months). Patients were without diabetic complications.

Table 1 – Табела 1

Total daily insulin and other parameters before and after CSII
Вкупен инсулин и други параметри пред и по зарочнување со CSII

Mean TDD of Insulin with MDI (U)	72 ± 14.5
Mean reduced TDD by 30% (U)	48 ± 4.6
Basal rate (U)	24 ± 2.3
Bolus rate (U)	31 ± 8.7
Correction factor (mmol/L)	1.8 ± 0.4
Insulin to carbohydrate ratio (gr)	8.7 ± 4.1

A 5-day training course on insulin pump therapy was given to the patients with the hope that it would help provide better metabolic control with a better quality of life. The patients learned how to use pump therapy in every-day activities. A special issue was given on advanced carbohydrate counting, where they learned how to count the carbohydrate grams and how much insulin they should bolus them. The patients were positively surprised that with an insulin pump they could eat what and when they wanted. The most important thing for young adults was that they could sleep much longer in the mornings.

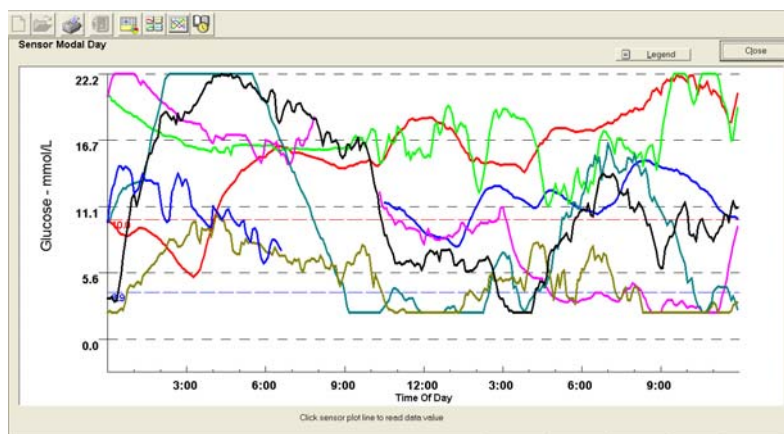


Figure 1 – CGMS in brittle type 1 diabetic on multiple daily injections
Слика 1 – CGMS кај пациент со нестабилен дијабетес на интензивирани
инсулинска терапија

The total daily dose (TDD) of insulin with MDI was reduced by an average of 30%. The CSII was started at a basal rate of mean 1.1 IE of ultra

rapid insulin per hour, with a correction factor of mean 1.8 (one insulin unit reduces glycaemia by 1.8 mmol/L) and the insulin to carbohydrate ratio of mean 8.7 (8.7 gr of carbohydrate – one insulin unit). A Medtronic Minimed 508 insulin pump was used with a Quick Infusion set.

In a period of one month after the initialisation of the insulin pump, CGMS was performed on all patients. CGMS showed 824 ± 42 measurements of glycaemias over a 3-day period. Evaluation of insulin, carbohydrate counting and physical activity was performed. The basal rate, correction factor and insulin-to-carbohydrate ratio were changed depending on the results of CGMS. The HbA1c decreased to $8.2 \pm 0.4\%$ in the first 3 months and to 7.1 ± 0.6 in the next 3 months. The HbA1c from $9.6 \pm 0.9\%$ with MDI was reduced to $7.65 \pm 0.3\%$ in the first 6 months of initialisation of CSII.

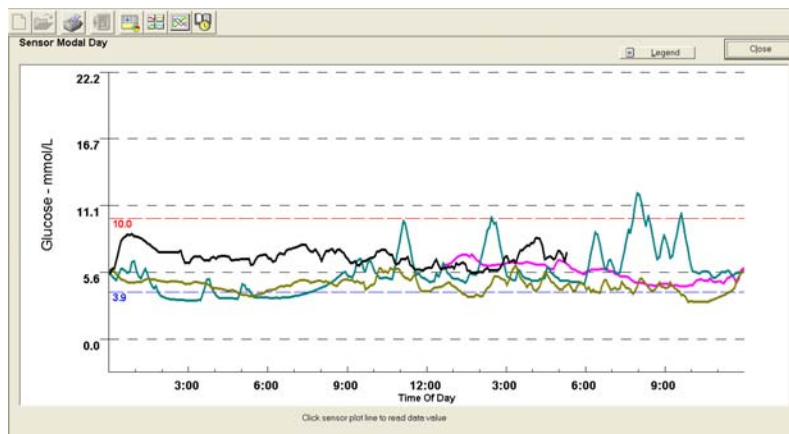


Figure 2 – CGMS in brittle type 1 diabetic after 6 months on insulin pump therapy

Слика 2 – CGMS кај пациент со нестабилен дијабетес, шест месеци
по зарочнување со инсулинска румра

All patients achieved satisfactory metabolic control with insulin pump therapy, where preprandial and postprandial glycaemic values were normal. The parents were very pleased and felt that this was the best treatment for their children. The patients with consultation from the diabetes team learned how to adjust the pump to accommodate very intense physical activity and avoid either hypo- or hyperglycaemia during or after physical activity.

Discussion

Even without having to learn the technology associated with CSII pumps, dealing with type 1 diabetes is stressful for adolescents and parents [8]. Diabetes is a serious illness, which fact should be accepted by the children and

parents. Different nutritional requirements, therapeutic demands, coping with emotional aspects can worsen the metabolic control, where the diabetes team together with the family can help. This study illustrates that when the patients and their family are given the proper training and support in how to use an insulin pump, it can help achieve better metabolic control, with a better quality of life. After switching from MDI to CSII, patients and parents have described an overall improvement in quality of life for themselves and the family as a whole. The improvement was attributed to a newly-found flexibility in managing metabolic control supported by CSII in combination with CGMS [9].

The study reports that using the CSII improved both quality of life and metabolic control. In one study of 6 months' duration, a high level of satisfaction with CSII was achieved, with 95% of families opting to continue with CSII beyond the study period [10]. A longitudinal follow-up study of children with type 1 diabetes who had been on CSII for up to 4 years also demonstrated the benefits of CSII [11]. Willi *et al.* [12] also observed that CSII was especially effective in teenagers with type 1 diabetes, lowering HbA1c levels and reducing the number of episodes of severe nocturnal hypoglycaemia without contributing to excessive weight gain.

Missed mealtime bolus doses have been noted by others [13] to be the major cause of suboptimal glucose control in type 1 diabetes on CSII therapy, especially in teenagers. In adolescents, parents and clinicians need to check the bolus history function of the pump to ensure the child is taking prescribed pre-meal and correction doses. In our study, the patients' desire for independence and to maintain a lifestyle that included demanding physical activities were one of the motivating factors prompting the switch from MDI to CSII therapy. They quickly learned to adjust their insulin doses according to their needs. The review article [15] introduced and described this kind of therapy to Macedonia in 2002. The effort should be made to implement more insulin pumps with brittle type 1 diabetics in Macedonia, because the level of use is not satisfactory. The patients' ability to cope with their diabetes, despite these changing insulin requirements, was exemplary.

Conclusion

An important lesson learned from this study and also from the literature is that CSII is certainly an option for adolescents and brittle type 1 diabetics. Using CGMS in combination with CSII can lead to better metabolic control. Type 1 diabetics and their families have different medical, psychological, and social requirements. Diabetes teams should consider these differences and provide support accordingly to achieve better metabolic control and a better quality of life.

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Re z i m e

**KOMBINIRANA TERAPIJA NA INSULINSKA PUMPA
SO KONTINUIRANO MONITORIRANJE NA GLIKEMIJA
JA PODOBRUVA METABOLNATA KONTROLA
KAJ NESTABILEN TIP 1 DIJABETES****Petrovski G., Dimitrovski ^., Milenkovi} T.***Klinika za endokrinologija, dijabetes i metabolni
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Цел: Да се евалуира исходот од комбинирана терапија на инсулинска пумпа (ИП) со континуирано мониторирање на гликемија (КМГ) кај пациенти со нестабилен дијабетес мелитус тип 1.

Материјали и методи: ИП беше поставена кај единаесет млади пациенти со нестабилен тип 1 дијабетес со лоша гликорегулација (просечен HbA1c = 9.6%). Метаболната контрола беше евалуирана со HbA1c и КМГ во наредните 6 месеци.

Резултати: Во наредните шест месеци од започнување на ИП, беше забележано намалување на HbA1c за 1.4%. КМГ беше направен за да се изврши корекција на физичката активност, исхраната и инсулинот. Кај пациентите не беа забележани тешки хипогликемични епизоди. Во наредните 6 месеци, пациентите самостојно и успешно одржуваа добра гликемиска контрола.

Заклучок: ИП може да се користи и да биде ефикасна кај пациенти со нестабилен дијабетес за подобрување на метаболната контрола, како и за подобрување на квалитетот на животот. Кога третманот на дијабетесот и инсулинската пумпа се адекватно индивидуализирани, овој вид на терапија може да помогне кај пациенти со нестабилен дијабетес при што може да се постигне и одржи добра гликемиска контрола. Предностите се однесуваат во флексибилноста, квалитетот на животот и независност во текот на адолесценцијата.

Клучни зборови: дијабетес мелитус тип 1, инсулинска пумпа, континуирано гликозно мониторирање.

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Просек на TDD на инсулин со MDI (U)	72 ± 14.5
Просечно намалување на TDD за 30% (U)	48 ± 4.6
Базална доза(U)	24 ± 2.3
Болусна доза (U)	31 ± 8.7
Корекциски фактор (mmol/L)	1.8 ± 0.4
Однос на инсулин за јаглени-хидрати (gr)	8.7 ± 4.1