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Simultaneous Teamwork May Improve Hypoglycemia Rates in Patients with Type 1 Diabetes Using an Insulin Pump

İnsülin Pompası Kullanan Tip 1 Diyabetli Hastaların Hipoglisemi Düzeylerinin İyileştirilmesinde Eş Zamanlı Ekip Çalışmasının Önemi

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Abstract

Objective: Simultaneous teamwork is an advanced collaboration subtype that includes the patient's evaluation by the team members (including physician, nurse and dietician) together in the same session. Our study aimed to investigate the effect of a simultaneous teamwork approach on metabolic and clinical outcomes of patients with Type 1 diabetes using an insulin pump. **Material and Methods:** This retrospective study included 49 previous insulin pump users with Type 1 diabetes who participated in a simultaneous teamwork protocol. Metabolic and clinical parameters were collected before and after the teamwork approach. A separate analysis of 16 patients in whom insulin pump was initiated with simultaneous teamwork and pregnancy data from 9 patients were also reported. **Results:** Simultaneous teamwork resulted in a significant reduction in the frequency of hypoglycemic episodes in previous insulin pump users with Type 1 diabetes. Hemoglobin A1c decreased, but the difference was statistically insignificant. Simultaneous teamwork was also efficient on patients initiated an insulin pump and for pregnancy follow-up in 2 separate subsets of patients with Type 1 diabetes. **Conclusion:** The simultaneous teamwork approach is a practical method to manage Type 1 diabetes in insulin pump users with the potential to reduce the frequency of hypoglycemic episodes.

Keywords: Teamwork; simultaneous teamwork; Type 1 diabetes; insulin pump; continuous subcutaneous insulin infusion

Özet

Amaç: Eş zamanlı ekip çalışması, hastalara ilişkin bulguların doktor, hemşire ve diyetisyenden oluşan bir ekip tarafından aynı oturumda birlikte değerlendirildiği bir işbirliği tipi olarak tanımlanabilir. Araştırmamızın amacı, eş zamanlı ekip çalışmasının tip 1 diyabet tanılı hastaların metabolik ve klinik sonuçlarına olan etkilerini irdelemektir. **Gereç ve Yöntemler:** Bu geriye dönük (retrospektif) araştırmada, önceden insülin pompası kullanmakta olan ve ekip çalışması protokolüne katılan Tip 1 diyabet tanılı 49 hasta yer almıştır. İlk aşamada, ekip çalışması öncesini ve sonrasını içeren metabolik ve klinik parametrelere ilişkin veriler toplanmış; daha sonra eş zamanlı ekip çalışması ile insülin pompası takılan 16 hastaya ve yine aynı yöntemle gebelik takipleri yapılan 9 hastaya ilişkin veriler analiz edilmiştir. **Bulgular:** Eş zamanlı ekip çalışmasında yer alan önceden insülin pompası kullanan Tip 1 diyabet tanılı hastalarda, hipoglisemik atak sıklığı bakımından belirgin bir azalmanın söz konusu olduğu görülmüştür. Hemoglobin A1c değerlerinde ise istatistiksel olarak önemli olmamakla birlikte, düşme eğiliminin olduğu gözlenmiştir. Ayrıca eş zamanlı ekip çalışmasının; insülin pompası kullanımına yeni başlayan tip 1 diyabet tanılı hastaları ve tip 1 diyabet tanılı gebe hastaları kapsayan 2 ayrı hasta alt grubunun takibinde de etkili olduğu belirlenmiştir. **Sonuç:** Eş zamanlı ekip çalışması yaklaşımının insülin pompası kullanan Tip 1 diyabet tanılı hastaların tedavisinde, başta hipoglisemi atak sıklığı olmak üzere, pratik ve etkili bir yöntem olabileceği belirlenmiştir.

Anahtar kelimeler: Ekip çalışması; eş zamanlı ekip çalışması; Tip 1 diyabet; insülin pompası; sürekli cilt altı insülin infüzyon tedavisi

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Introduction

Type 1 diabetes is a chronic disease that needs to be managed over a lifetime. The transition from childhood to adulthood and management in different stages of adulthood are significant in Type 1 diabetes patients (1,2). Successful management of Type 1 diabetes involves correctly balancing insulin dosing and glycemic control and recognizing individual lifestyle and education needs (3). In this instance, patient-centered education is crucial, and teamwork is at the core of this approach. Patients are suggested to be evaluated for the need for diabetes self-management support and education at diagnosis and annually afterward and also when new complicating factors arise and in transition periods (4).

Uninterrupted health care is the key in the management of chronic diseases such as Type 1 diabetes. The importance of team and patient-centered approaches have been shown in various studies in subjects with Type 1 and 2 diabetes (5). A patient-centered approach was effective in reducing hemoglobin A1c (HbA1c) levels (6). Also, high-quality structured patient education is critical to motivating patients to achieve better metabolic control (5). A previous study, including patients with Type 1 diabetes using an insulin pump, showed that a short-term retraining program conducted by a diabetes team was efficient in improving the level of knowledge and practice skills (7).

The need for education and adaptation is life-long in patients with diabetes. The use of technology in diabetes management has increased considerably in the past few years and is expected to increase in the following years. Therefore, accessibility and applicability are significant for technology to be beneficial in management (8). However, a previous survey (9) found that a whole diabetes team (physician, nurse, dietician, and psychologist) was available to 53% of pediatric diabetes units but only 23% of adult units, showed a decrease in support in adulthood. Especially, patients with Type 1 diabetes using an insulin pump are likely to suffer from a shortage of support in their adulthood. This study aimed to explore the clinical benefit of the simultaneous teamwork approach in patients with Type 1 diabetes using an insulin pump. A seperate group of patients was initiated with an insulin pump by simultaneous teamwork and their clinical course was observed. Moreover, pregnancy data were collected in a subset of patients with Type 1 diabetes in whom simultaneous teamwork was utilized to follow metabolic control.

Material and Methods

Study Protocol

This retrospective study was conducted at Dokuz Eylül University Hospital, Endocrinology and Metabolism Clinic, from 2010 to 2020. Sixty-seven patients with Type 1 diabetes using an insulin pump were included and analyzed in 3 groups. The first group was composed of 49 insulin pump users with Type 1 diabetes who were studied before and after simultaneous teamwork (cohort 1). The second group composed a group of 16 separate patients in whom insulin pump was initiated by simultaneous teamwork (cohort 2). The third group reported 9 pregnant patients who were followed up with simultaneous teamwork (cohort 3). Cohorts 1 and 2 shared seven pregnant patients. Of note, two pregnant patients were not included in cohorts 1 or 2 because pre-teamwork data were not available in these two cases.

The previous approach was a standard care model where patients with Type 1 diabetes were separately seen at different sessions by the team members, including physicians, diabetes educators/nurses, and dieticians, and additional consultations were conducted as needed (e.g., obstetrician, psychiatrist). The simultaneous team approach started in September 2017, where patients were evaluated by the team members together in the same session.

Ethical Approval

The study followed the ethical standards and adhered to the study protocol of the international agreements (Helsinki Declaration revised in 2013). The Ethics Committee of Dokuz Eylül University Non-Interventional Clinical Trials approved the study (2019/27-30, 11.04.2019).

Data Acquisition

In cohort 1, metabolic parameters and clinical characteristics such as hypoglycemia

frequency and ketosis/ketoacidosis admissions were evaluated before and after the simultaneous teamwork approach. These assessments were performed after the teamwork approach in cohort 2 and during pregnancy in cohort 3. Before the teamwork period covered a period from January 2010 to September 2017, and the after-teamwork period was from January 2018 to January 2020. The period from September 2017 to January 2018 was defined as the transition period, and assessment from this period was excluded.

Data regarding demographic and clinical properties (e.g., age, gender, education status, smoking history, weight, height), clinical history (e.g., Type 1 diabetes diagnosis age, pump initiation age, comorbid disorders, number of endocrinology clinic visits), insulin doses and details of hypoglycemic and hyperglycemic episodes were collected from paper charts and electronic records. HbA1c, lipid profile, and liver and kidney function values were collected retrospectively, and average values were calculated annually.

Hypoglycemia was defined as severe and mild, depending on the patients' ability of self-treatment rather than the nature or intensity of symptoms, treatment, or blood glucose level at the time of hypoglycemia (10). Self-treated episodes were classified as mild, whereas episodes requiring external help were severe (10). For mild hypoglycemia, frequent hypoglycemia was defined as experiencing ≥2 episodes of hypoglycemia/week (10). Diabetes-related micro-and macro-vascular complications were noted. Clinical and biochemical data regarding pregnant women being followed up with simultaneous teamwork were obtained, and the fetuses' health status and birth weight were obtained through records. HbA1c, lipid, alanine aminotransferase (ALT), creatinine, and microalbuminuria (mg/g to creatinine) levels were measured using standardized methods with appropriate quality control and quality assurance procedures.

Statistical Analysis

Statistical analyses were performed using IBM SPSS for Mac, Version 20 (IBM Corp. Released 2011, Armonk, NY, USA). Numeric variables were summarized as median (25^{th}-75^{th} percentile), and categorical variables were calculated with cross-table analysis and shown numerically as a percentage. A comparison was made using the Wilcoxon signed-rank test for dependent variables, and categorical variables were compared using the chi-square test. A p-value of <0.05 was considered statistically significant.

Results

The effects of the simultaneous teamwork approach on patients with Type 1 diabetes using an insulin pump (cohort 1)

Cohort 1 comprised 49 patients, and data regarding these patients are summarized in Table 1. The median age was 36 years (from 28-46 years) (39 women; 79.6%). Most patients either had a college degree (actively working) or were current students in a university. The median body mass index was 23.81 kg/m^2. Moreover, 44% of patients had hyperlipidemia and were on statins. Autoimmune thyroid disorder was another common disorder. At the time of diagnosis of Type 1 diabetes, the median age was 15 (9-24) years, suggesting that most patients were diagnosed during adolescence and had received their first diabetes education in pediatric endocrinology clinics. The median age at pump initiation was 27 (19-34) years, with a median duration of pump usage of 10 (6-14) years. In most patients, the pump was initiated at adult endocrinology clinics, and patients had a median of 11 (5-14) years of diabetes when the pump was first initiated. Patients were on an insulin pump for a median of 10 (6-14) years when they were enrolled in the study. Chronic complications of diabetes were observed in 38.8% of patients. Retinopathy was the most common chronic complication followed by nephropathy. The total daily dose of insulin was 47 (33-61.5) units before initiating an insulin pump, while the dose was 35 (30-50) units after initiation. Before initiating insulin pumps, 26 (53.1%) patients experienced an episode of either ketosis or ketoacidosis, while this number reduced to 15 (30.6%) after using an insulin pump. The frequency of ketosis/ketoacidosis per year was 1 (0-1) before using an insulin pump, while after the

Table 1. Demographic data and characteristics of the patients enrolled in this study.

	Cohort 1 n=49 n (%), median (25-75 percentile)	Cohort 2 n=16 n (%), median (25-75 percentile)	Cohort 3 n=9 n (%), median (25-75 percentile)
Gender (F/M)	39/10 (79.6/20.4)	8/8 (50/50)	9 (100)
Current age (y)	36 (28-46)	29 (24-34)	31 (25-44)
Occupational status (student/working/not working/retired)	5/40/2/2 (10.2/81.6/4.1/4.1)	4/11/0/1 (25/68.8/0/6.3)	0/7/2/0 (0/77.8/22.2/0)
Education (primary school/high school/university)	4/2/43 (4.1/8.2/87.8)	1/1/14 (6.3/6.3/87.4)	1/1/7 (11.1/11.1/77.8)
Weight (kg)	68 (58-73)	67.5 (62-83.5)	58 (50-77)
Height (m)	1.65 (1.61-1.72)	1.70 (1.66-1.78)	1.65 (1.52-1.73)
BMI (kg/m^2)	23.81 (22.21-25.32)	23.3 (21.9-26.6)	23.7 (19.5-33.3)
Smoker	9 (18.4)	5 (31.3)	2 (22.8)
Comorbid disorders	32 (65.3)	8 (50)	6 (66.7)
• Hyperlipidemia	22 (44.9)	3 (18.8)	4 (44.4)
• Autoimmune thyroid disease	16 (32.7)	4 (25)	3 (33.3)
• Hypertension	6 (12.2)	2 (12.5)	0 (0)
• PCOS	2 (4.1)	0 (0)	0 (0)
• Thyroid cancer	2 (4.1)	0 (0)	0 (0)
• Inflammatory bowel disease	1 (2)	0 (0)	0 (0)
• JRA	1 (2)	0 (0)	0 (0)
• MNG	1 (2)	0 (0)	0 (0)
• Asthma	1 (2)	0 (0)	0 (0)
• Epilepsy	1 (2)	0 (0)	0 (0)
• Renal transplantation	1 (2)	0 (0)	0 (0)
• Hearing loss	0 (0)	1 (6.3)	0 (0)
Marital status (married/single/divorced)	26/21/2 (53.1/42.9/4.1)	8/8/0 (50/50/0)	9/0/0 (100/0/0)
Age at diagnosis (y)	15 (9-24)	18 (18-24)	18 (8-28)
Age at pump initiation (y)	27 (19-34)	30 (24-33)	26 (22-34)
Duration of diabetes before use of a pump (y)	11 (5-14)	10 (2.5-16.5)	10 (3-22)
Duration of pump (y)	10 (6-14)	1 (1-2)	6 (1-14)
Chronic complications (n)	19 (38.8)	7 (43.8)	5 (55.6)
Retinopathy (n)	11 (22.4)	5 (31.3)	2 (22.2)
Nephropathy (n)	7 (14.3)	4 (25)	2 (22.2)
Proteinuria (n)	11 (22.4)	4 (25)	2 (22.2)
Neuropathy (n)	3 (6.3)	3 (18.8)	1 (11.1)
Diabetic gastroparesis (n)	3 (6.1)	0 (0)	0 (0)
Coronary artery disease	1 (2)	0 (0)	0 (0)
Peripheral artery disease	2 (4.1)	0 (0)	0 (0)
CGMS use (n)	26 (53.1)	11 (68.8)	7 (77.8)
Regular visit frequency after simultaneous teamwork (n)			
Visit ≤1/year	5 (10.2)	0 (0)	0 (0)
Visit 2/year	12 (24.5)	2 (12.5)	1 (11.1)
Visit 3/year	15 (30.6)	2 (12.5)	2 (22.2)
Visit ≥4/year	16 (32.7)	12 (75)	6 (66.7)
Discontinuation of insulin pump (n)	1 (2)	1 (6.3)	0 (0)
Pump type (n) Minimed 640G Medtronic, Ireland Paradigm Veo, Medtronic, IrelandDana, IME-DC, Germany	22/26/1 (44.9/53.1/2)	10/6/0 (62.5/37.5/0)	5/4/0 (55.6/44.4/0)

BMI: Body mass index; PCOS: Polycystic ovary syndrome; JRA: Juvenile rheumatoid arthritis; MNG: Multinodular goiter; CGMS: Continuous subcutaneous insulin infusion.

initiation, the frequency was 0 (0-0.1)/year. Forty-two (85.7%) patients experienced mild hypoglycemic episodes before initiating an insulin pump, while after initiating the pump, the number was 36 (73.5%). On the other hand, the patients experiencing severe hypoglycemic episodes before and after the initiation of an insulin pump were 9 (18.4%) and 5 (10.2%), respectively. Among patients with worse control after simultaneous teamwork, worsening metabolic control was generally associated with life stress, newly diagnosed additional disease, breastfeeding, discordance with the insulin pump, and gastroparesis.

The median follow-up periods before and after simultaneous teamwork were 4 (2-6) and 2 (2-3) years, respectively. After the simultaneous teamwork approach, a significant reduction in the frequency of mild hypoglycemic episodes was observed (Table 2). Although there was a tendency toward reduced HbA1c after the simultaneous teamwork approach, the difference was insignificant. An increase in high-density lipoprotein cholesterol (HDL-C), total cholesterol, and low-density lipoprotein cholesterol (LDL-C) levels and a decrease in ALT levels were observed (Table 2).

There was a tendency toward a better HbA1c profile in patients using continuous glucose monitoring system (CGMS) (7.58% ±1.05 vs. 8.29±1.57, p=0.07). Also, patients using 640G had significantly lower HbA1c levels than patients using Veo (7.32±0.69 vs 8.30±1.52, p=0.007). However, CGMS use of the insulin pump model did not affect the frequency of ketoacidosis episodes or hypoglycemia.

Simultaneous teamwork approach for the initiation of an insulin pump in patients with Type 1 diabetes (cohort 2)

The insulin pump was initiated with the simultaneous teamwork approach in 16 patients with Type 1 diabetes. The demographic properties and characteristics of the patients in cohort 2 are summarized in Table 1. The median age was 30 (24-33) years, and the median duration of diabetes was ten years (2.5-16.5). Before the insulin pump initiation, the median follow-up duration was 2.5 (1.25-4) years. The follow-up was one year (1-2) on an insulin pump. Most (68.8%) patients used CGMS to monitor their glucose levels. The most common accompanying disease was autoimmune thyroid disease, hyperlipidemia, and hypertension. In cohort 2, about 18.8% of patients were on statins.

Table 3 shows the data comparison before and after insulin pump administration. A

Table 2. Comparison of data of patients using an insulin pump before and after the simultaneous teamwork approach.

Parameter	Before simultaneous teamwork, n (%), median (25-75 percentile)	After simultaneous teamwork, n (%), median (25-75 percentile)	p value
Total episodes of ketosis/ketoacidosis (n)	15 (30.6)	8 (16.3)	0.152
Any episode of mild hypoglycemia (n)	32 (65.3)	18 (36.7)	**0.008**
Mild hypoglycemia (n) ≥2/week	18 (36.7)	6 (12.2)	**0.009**
Severe hypoglycemia(n)	6 (12.2)	1 (2)	0.111
Average HbA1c (%)	7.65 (7.20-8.55)	7.54 (7.2-8.2)	0.724
Average TG (mg/dL)	80.9 (67-106.3)	77.15 (56.4-105.6)	0.498
Average TC (mg/dL)	193.5 (168-215.7)	206 (176.8-226)	**0.001**
Average HDL-C (mg/dL)	60 (52.8-68)	66.3 (56.3-69.8)	**0.001**
Average LDL-C (mg/dL)	115.7 (99-131.2)	120.9 (101.5-143.5)	**0.005**
Average ALT (IU/L)	15.5 (13-19.2)	14.4 (11.5-18.7)	**0.034**
Average Cr (mg/dL)	0.7 (0.61-0.76)	0.64 (0.6-0.75)	0.170

HbA1c: Hemoglobin A1c; TG: Triglycerides; TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; ALT: Alanine aminotransferase; Cr: Creatinine.

Table 3. Comparison of data of patients before and after insulin pump administration in whom the insulin pump was administered with the simultaneous teamwork approach.

Parameter	Before insulin pump n (%), median (25-75 percentile)	After insulin pump n (%), median (25-75 percentile)	p value
Weight (kg)	65 (61.5-78.5)	67.5 (62-83.5)	**0.014**
TDDI (units)	40 (30.5-51)	35.5 (30-54)	0.819
Ketosis/ketoacidosis (n)	7 (43.8)	3 (18.8)	0.252
Mild hypoglycemia (n)	14 (87.5)	10 (62.5)	0.220
Severe hypoglycemia	3 (18.8)	1 (6.3)	0.600
Average HbA1c (%)	7.82 (7.62-8.5)	7.75 (7.34-8.43)	0.148
Average TG (mg/dL)	86.59 (64.67-136.7)	82 (64.04-106.54)	0.638
Average TC (mg/dL)	187.74 (147-206.53)	197 (168.93-201.54)	0.778
Average HDL-C (mg/dL)	52.25 (45-67.45)	62.95 (49.41-68.3)	**0.011**
Average LDL-C (mg/dL)	100.08 (79.7-126.9)	106.04 (93.55-115)	0.875
Average ALT (IU/L)	15 (14-18.5)	19.58 (15.04-23.67)	0.347
Average Cr (mg/dL)	0.68 (0.64-0.81)	0.77 (0.64-0.84)	0.695

TDDI: A total daily dose of insulin; HbA1c: Hemoglobin A1c; TG: Triglycerides; TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; ALT: Alanine aminotransferase; Cr: Creatinine.

significant weight gain was observed after initiating an insulin pump in these patients (Table 3). Although numeric improvements were observed in the frequency of ketosis and hypoglycemic episodes, these differences were statistically insignificant. HbA1c levels decreased after insulin pump administration, but the difference was minimal and statistically insignificant. An increase in HDL-C levels was observed after insulin pump administration (Table 3). HbA1c levels and the frequency of hypoglycemia and ketoacidosis episodes were not different between CGMS users and non-users and among users of different insulin pump models in cohort 2.

Simultaneous teamwork approach in pregnant patients with Type 1 diabetes on an insulin pump (cohort 3)

A few pregnancies (n=9) were followed up using the simultaneous teamwork approach, and the patients' caharacteristics are summarized in Table 1 as cohort 3. Overall, these pregnancies went well without any major complications. All pregnant patients labored healthy babies with no maternal and fetal complications, and the median birth weight of the babies was 3.45 kg (2.4-4.6). The median HbA1c value was 6.57% (4.60-7.60%) during pregnancy.

Discussion

Our study showed promising results regarding the improvement of diabetes by simultaneous teamwork. To the best of our knowledge, this is the first study in Turkey that investigated the effects of such an integrated multidisciplinary approach in managing patients with Type 1 diabetes using an insulin pump.

The effects of the simultaneous teamwork approach in 49 patients using an insulin pump were analyzed and followed-up by our team before and after the simultaneous teamwork approach. HbA1c levels before and after such teamwork approach were compared, a slight reduction was observed (from 7.65% to 7.54%) after the simultaneous teamwork approach; however, it was insignificant. Also, although there was a reduction in ketosis/ketoacidosis episodes and severe hypoglycemic episodes after the simultaneous teamwork approach, the results were not statistically significant. In contrast, the most significant effect of this type of approach was on hypoglycemia episodes. Hypoglycemia is the most frequent acute complication of Type 1 diabetes. In a study assessing the prevalence of hypoglycemia in patients with Type 1 diabetes, many patients were found to experience hypoglycemic

episodes in their daily lives differing in severities (11). Severe hypoglycemia is associated with significant mortality and morbidity; however, mild hypoglycemia is often neglected. Mild episodes of hypoglycemia are also associated with significant harmful effects and increase the risk of cognitive impairment, cardiac arrhythmias, neurologic abnormalities, cognitive deficits, impaired awareness of hypoglycemia, and hypoglycemia-associated autonomic failure with a negative impact on social functions (10). Hypoglycemia unawareness in Type 1 diabetes is associated with diminished response to mild hypoglycemic episodes causing a futile cycle (12). Therefore, attention should be given to mild hypoglycemic episodes in addition to other diabetic complications. The simultaneous teamwork approach showed significant benefits when mild hypoglycemic episodes were considered.

There may be several mechanisms underlying the beneficial effects of the simultaneous teamwork approach on mild episodes of hypoglycemia. This team approach emphasized the importance of hypoglycemia, educated about the preventive measures, and increased the awareness of hypoglycemia by noticing the symptoms and frequent measurements of blood glucose levels. Encouraging the use of CGMS and facilitating the integration of diabetes technology into daily life by this approach may also impact the reduction of hypoglycemic episodes. Early integration of diabetes technology, especially adding CGMS to management strategies, is associated with tight glycemic control and optimized quality of life in newly diagnosed young patients with Type 1 diabetes (13). CGMS can effectively diagnose impaired hypoglycemia awareness in the pediatric population, and structured education was shown to improve impaired hypoglycemia awareness and glycemic variability (14). Also, for adolescents, younger adults, and older adults with Type 1 diabetes, CGMS decreases hypoglycemic episodes (15,16). We observed a better HbA1c profile among patients using CGMS, and improved pump technology was associated with better glycemic control. These observations suggest that integrating newer technologies into daily life may help improve clinical outcomes among insulin pump users.

Another significant point of our study is that the decrease in hypoglycemia frequency did not accompany an increase in HbA1c levels, and therefore, this approach was promising in providing better glycemic control. Most of the patients tend to visit the clinic at least thrice a year with the accessibility of the team members at each follow-up visit. An environment where it is discussed how to achieve better together with the patient may have enabled the patient and our team to notice the previously overlooked or ignored problems. Also, this type of approach may positively affect the emotional distress of the patients, which is frequent in this population. However, these preliminary results are insufficient, and further studies are needed. Although there was a slight improvement in HbA1c levels, the median HbA1c levels were still above the targets despite careful monitoring showing the need for the generation of further strategies.

Both insulin pump administration to patients on multiple daily dose regimens and simultaneous teamwork approach improved HDL levels. Previous studies showed that insulin pump administration had beneficial effects on the lipid profiles of the patients, especially HDL levels (17). In our study, the HDL profiles of our patients improved toward a possible better cardiovascular outcome. The median LDL-C level of the patients included in our study was higher than the accepted cut-off value of 100 mg/dL for predicting cardiovascular risk in patients with Type 2 diabetes. However, although LDL-C is a significant predictor of cardiovascular risk, the cut-off of 100 mg/dL is not applicable for patients with Type 1 diabetes in predicting cardiovascular risk (18). There were also statistically significant changes in other lipid profile parameters and ALT levels; however, the differences were considered clinically insignificant.

Insulin pumps were administrated with the simultaneous team-work approach to 16 patietns diagnosed with diabetes, and their metabolic and glycemic parameters were compared before and after insulin pump initiation. These patients gained some weight after initiating an insulin pump ($p<0.05$). Weight gain after administration of insulin

pump was also shown in previous studies and was associated with an increased total daily dose of insulin. However, our patients gained weight independent of the total daily insulin dose as their total daily doses of insulin decreased after initiating an insulin pump. In their study, Boucher-Berry et al. (19) tied weight gain after insulin pump use to increased basal insulin dose and lower bolus to basal doses on insulin. Melidonis et al. (20) showed a significant reduction in basal insulin doses of patients, especially after 2 years of insulin pump use. As we could only reach the total daily insulin doses of the patients, the role of basal insulin and bolus to basal ratio of insulin on this weight gain is difficult to interpret. Besides, our median follow-up time was 1 year, and possible effects on decreased doses may occur in the following years. In addition, our study did not assess physical activity that may cause weight changes. Also, the presence of pregnant patients in cohorts 1 and 2 made weight assessments and interpretation challenging. Although there was a slight reduction in the median HbA1c values of our patients from 7.82% to 7.75% after insulin pump administration, the difference was statistically insignificant. In a 3-year prospective study conducted by Melidonis et al. (20), 79 patients were included, and there was a significant decrease in mean HbA1c levels (from 9.6% to 7.2%) at the end of the first year of the insulin pump. As our patients had better glycemic control profiles during the initiation of an insulin pump, the decrease was not apparent. The improvements in ketosis/ketoacidosis and severe and mild hypoglycemic episodes were not statistically significant primarily due to the small sample size.

The median HbA1c value of the pregnant patients was 6.57%, and none experienced pregnancy-and birth-related complications; the median birth weight of the babies was 3.45 kg. The pregnancy of patients with Type 1 diabetes is a challenging period in their lifetime. As Type 1 diabetes in pregnancy increases the risk of maternal preeclampsia, difficulties during delivery, and adverse neonatal outcomes, tight glycemic control is vital (21,22). Pregnancy outcomes were similar in patients with Type 1 diabetes using multiple-dose injections and insulin pumps (23). Preconception counseling and pre-pregnancy care are significant concepts, including education and discussion with the women at reproductive age about pregnancy and contraception and preparing diabetic women for pregnancy. The multidisciplinary team approach is recommended in every stage of pregnancy, including preconception and postpartum periods, to provide the coherence of the care (22).

Study Limitations

The limitations of our study include the retrospective pattern of our study, lack of a control group, and missing data such as basal and bolus insulin doses of the patients. There were variations in the follow-up periods and frequency of laboratory testing. Therefore, each value was calculated as average yearly and used in statistical analysis. The relatively small sample size was another limitation of our study.

Conclusion

In conclusion, all strategies being developed address better integration of the technologies into daily life, and a simultaneous teamwork approach seems to facilitate this integration. Our results suggest that the simultaneous teamwork approach is a practical and beneficial method for patients with Type 1 diabetes using an insulin pump, with especially beneficial effects on mild hypoglycemic episodes. However, more efforts are needed to demonstrate its benefits on glycemic and metabolic control.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Barış Akıncı, Fırat Bayraktar; Design: Barış Akıncı, Fırat Bayraktar, Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli; Control/Supervision: Barış Akıncı, Fırat Bayraktar; Data Collection and/or Processing: Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli, Aysun Belgin Bektaş, Özgül Vatansever, Nalan Aydın, Simge Yılmaz Kavcar, Canan Değirmenci; Analysis and/or Interpretation: Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli, Barış Akıncı; Literature Review: Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli, Aysun Belgin Bektaş; Writing the Article: Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli; Critical Review: Başak Özgen Saydam, Süleyman Cem Adıyaman, Barış Akıncı, Fırat Bayraktar; Materials: Başak Özgen Saydam, Süleyman Cem Adıyaman, Berfu Yeşilli, Aysun Belgin Bektaş, Özgül Vatansever, Nalan Aydın, Simge Yılmaz Kavcar, Canan Değirmenci.

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