Comparison of haemoglobin A1c level in insulin pump versus multi daily injections users for type one diabetes mellitus

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Abstract

Background: Saudi Arabia has the 3rd highest rate of type one diabetes in the world.

Objectives: To compare HbA1c, lipid profile and acute complications in Continuous Subcutaneous Insulin Infusion (CSII) with multiple daily injections (MDI) users for type one diabetes (T1DM) in Taif city, Saudi Arabia.

Settings and Design: Sampling was done for all patients with T1DM and managed either by MDI or CSII.

Methods: We recruited all results from May 2015 to January 2018 comparing HbA1c, lipid profile and acute complications. Data collection was done through electronic files. Data was analysed by the Statistical Package of Social Sciences (SPSS). The independent sample 't' test was used to compare continuous variables. Chi-square test was used to compare categorical variables.

Results: Of 214 patients, 137 on MDI and 77 on pump were recruited. All HbA1c readings were significantly higher in MDI users (p<0.05). Acute complications were higher in pump users (7.8% and 18.2%) compared to MDI users (2.9% and 6.6%) for each hypoglycaemia and DKA respectively. The occurrence of hypoglycaemia and DKA in MDI and pump users were found to be statistically insignificant, (p=0.155 and p=0.134) and (p=0.790 and p=0.721) respectively.

Conclusions: In patients with T1DM, HbA1c was significantly higher in MDI users, conversely, DKA was significantly higher in pump users. Hypoglycemia showed a significant relation to age in MDI group. Lipid profile was statistically insignificant.

Key words: Comparison, haemoglobin, insulin, pump, injections, diabetes

Introduction

Insulin pump or Continuous Subcutaneous Insulin Infusion (CSII) aims to lower the risk of acute complications (1). Insulin pump works according to blood glucose status of the patient and predicted variations of the meals. Pump users can adjust their basal and bolus doses more accurately, which is needed for better compliance (1). The suitable selection of an insulin pump is important to meet the requirements and circumstances of every patient (physiologically and financially) (2). The aim of the study was to compare (CSII) and (MDI) concerning HbA1c, lipids profile, and complications including DKA and hypoglycemia in type-1 diabetes.

Subjects and Methods

Study design and setting: The study was conducted retrospectively at diabetes and endocrinology center, King Abdul-Aziz Specialist Hospital in Taif, Saudi Arabia.

Sampling and study instrument: Data were recruited from electronic files and were eligible if their ages were from 1-40 years , and were on either insulin pump or multiple daily insulin injection regimens, and on a stable insulin regimen for at least one month prior involving either use of an insulin pump or multiple daily injections consisting of insulin glargine and insulin lispro or insulin as part or any new or other type of insulin.

Inclusion criteria: Patients with normal thyroid function, not on other medications or anti-inflammatory agents, steroids before, during, or after the study were involved in the study. Also, with no recent history of infectious, inflammatory, or immune diseases. Insulin pump patients were using MINIMED PARADIGM® 515/715, 515/722, and veo 754 INSULIN PUMPs.

Exclusion criteria: Patients were excluded if they had any heart disease, liver disease, kidney disease, high blood pressure, rheumatic disease, stroke, tuberculosis TB, epilepsy, HIV, an active infection, and tumour (cancer) history or if they were terminally or mentally ill; and if they were currently using glucocorticoid or beta-blockers or had any recent surgery.

After applying the exclusion criteria, the total number of patients was 214, 137 on MDI and 77 on the insulin pump.

Ethical approval: Research Ethics Center at King Abdul-Aziz Specialist Hospital (KAASH) approved the study. Since there was no contact with the patients (electronic files) and the data was anonymous, consent was not needed.

Statistical analysis

Data of this research were entered and analysed using the Statistical Package of Social Sciences (SPSS) Ver 23. The independent sample 't' test was used to compare the values of MDI and Insulin Pump group based on the normality of data. A significance value, $P<0.05$, was considered as statistically significant. Pearson Chi-square test was used as a statistical test for finding an association between categorical variables in the study.

Results

A total of 214 patients were involved in the study after the exclusion of 28 patients; 137 were on multiple daily injections, and 77 on an insulin pump. The mean age was 14.2 ± 1.76 in the MDI group and 18.5 ± 6 in the pump group (Figure 1). Females were higher in the insulin pump group (59.7%) compared to the MDI group, which was nearly equal (48.9 males vs. 51.1 females) (Figure 2).

Four HbA1c results were taken retrospectively in an interval of three months for each patient. Mean of first HbA1c results (10.40 ± 1.95 vs 8.88 ± 1.82, $p <0.01$), second (9.99 ± 2.02 vs 8.36 ± 1.68, $p <0.01$), third (10.21 ± 1.74 vs 8.08 ± 1.53, $p <0.01$) and final results (10.40 ± 1.80 vs 8.18 ± 1.39, $p <0.01$) were all significantly higher in MDI users compared to pump users. In addition, lipid profile including HDL (53.2439 ± 15.48 vs 52.0851 ± 13.24, $p = 0.668$), LDL (112.75 ± 44.89 vs 105.27 ± 25.31, $p = 0.301$), Triglyceride (97.27 ± 75.9 vs 88.46 ± 67.8, $p = 0.574$) and cholesterol (180.31 ± 52.6 vs 167.44 ± 32.0, $p = 0.128$) showed no significant difference between MDI versus pump users. (Table 1).

The frequency and percentage of DKA were significantly higher in the insulin pump group compared to the MDI group, 14 patients vs. nine patients, respectively (18.2% vs. 6.6%, p value= 0.008). However, there was no significant difference in the frequency and percentage of hypoglycemia between the two groups, six patients vs. four patients, respectively (7.8% vs. 2.9%, p value= 0.105). (Table 2).

We also studied the relationship between the age and the complications of both DKA and hypoglycaemia in MDI and pumped patients. The results of DKA in relation to age in MDI and pump users were not significant (p value=0.705 vs. p value=0.812) respectively, however, the results of hypoglycemia in relation to duration in MDI and pump users showed a significant relation in MDI group only (p value<0.05 vs. p-value= 0.295), respectively (Table 3).

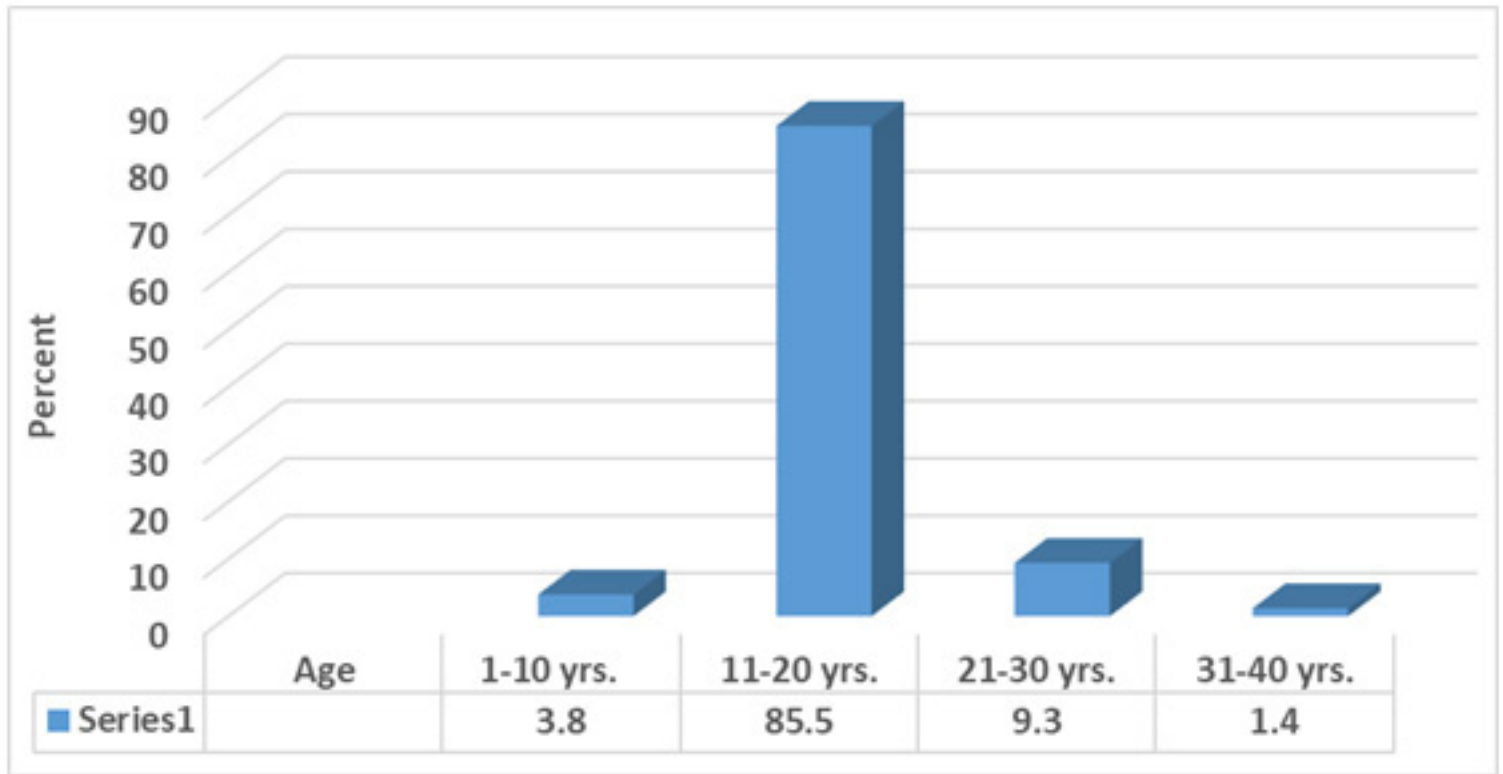**Figure 1: Distribution of the studied patients according to their age groups**

	Age	1-10 yrs.	11-20 yrs.	21-30 yrs.	31-40 yrs.
Series1		3.8	85.5	9.3	1.4

Figure 2: Gender in both MDI and insulin pump groups

(Gender)

MDI

48.9% (67)

51.1% (70)

Pump
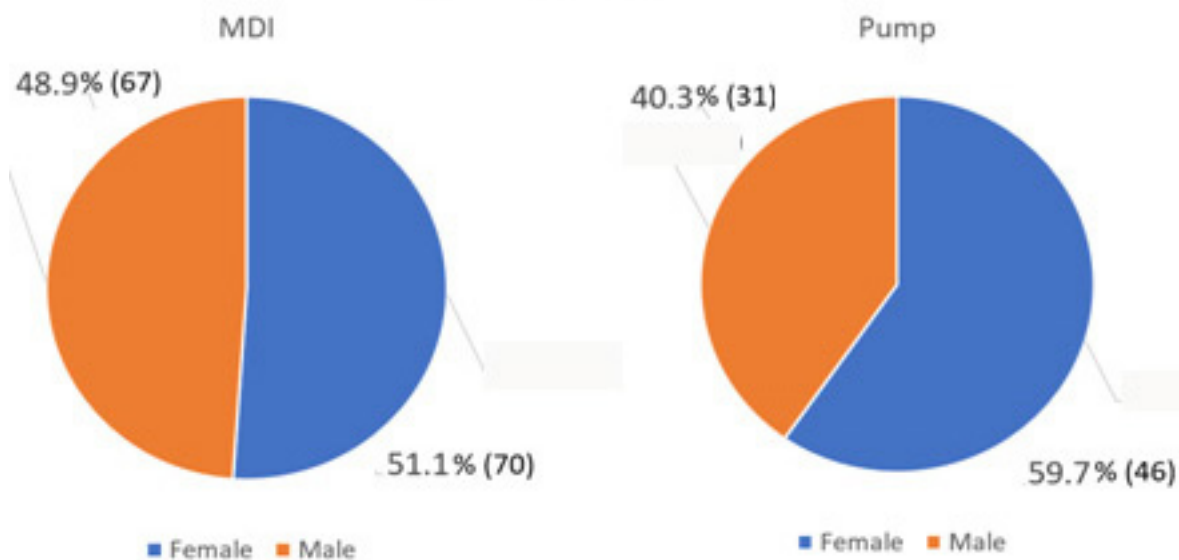
40.3% (31)

59.7% (46)

Female Male

Table 1: HbA1c results in all four quarters of one year, and lipid profile including HDL, LDL, Total cholesterol and triglyceride results of MDI group compared to insulin pump group

Variable	Group	Mean ± SD	t-test	p value
A1c-1	MDI	10.4008±1.95791	5.274	.0001*
	PUMP	8.8818±1.82848		
A1c-2	MDI	9.9919±2.02436	5.409	.000*
	PUMP	8.3646±1.68860		
A1c-3	MDI	10.2171±1.74142	7.794	.000*
	PUMP	8.0879±1.53297		
A1c-4	MDI	10.4052±1.80452	7.013	.000*
	PUMP	8.1857±1.39717		
HDL	MDI	53.2439±15.48281	.431	.668
	PUMP	52.0851±13.24818		
LDL	MDI	112.7512±44.89962	1.039	.301
	PUMP	105.2783±25.31447		
Total cholesterol	MDI	180.3140±52.37315	1.534	.128
	PUMP	167.4468±32.00191		
Triglyceride	MDI	97.2740±75.97665	.564	.574
	PUMP	88.4688±67.87559	.431	.356

Table (2): Comparison between MDI and pump group according to DKA and hypoglycaemia

Variable			DKA		Hypoglycaemia	
			present	absent	present	absent
GROUP	MDI	n (%)	9 (6.6%)	128 (93.4%)	4 (2.9%)	133 (97.1%)
	PUMP	n (%)	14 (18.2%)	63 (81.8%)	6 (7.8%)	71 (92.2%)
Total		n (%)	23 (10.7%)	191 (89.3%)	10 (4.7%)	204 (95.3%)
P value			0.008*		0.105	

Table 3: Relationship between DKA and hypoglycaemia to age

Variable			1-10 yrs.	11-20 yrs.	21-30 yrs.	31-40 yrs.	Total	p-value
DKA	MDI	Present (n)	0	9	-	-	9 (6.6%)	0.705
		Absent (n)	2	126	-	-	128 (93.4%)	
	PUMP	Present (n)	1	9	4	0	14 (18.2%)	0.812
		Absent (n)	4	39	16	4	63 (81.8%)	
Hypoglycaemia	MDI	Present (n)	1	3	-	-	4 (2.9%)	0.000*
		Absent (n)	1	132	-	-	133 (97.1%)	
	PUMP	Present (n)	1	2	3	0	6 (7.8%)	0.295
		Absent (n)	4	46	17	4	71 (92.2%)	

Discussion

Saudi Arabia is ranked as the 3rd country in the world regarding the rate of type 1 diabetes (T1DM) (2), therefore, our aim was to conduct a study comparing HbA1c, lipid profile (HDL, LDL, Triglyceride, cholesterol) and complications including both hypoglycemia and diabetic ketoacidosis specifically in Taif city, Western region (3).

In our study, we found that the mean of HbA1c in pump users group is significantly lower than the mean of the MDI users. Regarding complications, DKA was significantly higher in the pump group compared to the MDI group; however, there was no significant difference in hypoglycemia between the two groups. Also, there is no significant difference regarding the lipid profile between the two groups.

In a study conducted in Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia, there was a significant decrease in the frequency of hypoglycemia as well as reduction in the level of HbA1c in pump users (4). The frequency of hypoglycemia among female patients was significantly reduced as well as patients who had a shorter duration of T1DM at six months duration when compared to the baseline (1.50 ± 1.40 versus 2.63 ± 0.92) (p-value <0.05) (5).

Also, a study conducted by Bin-Abbas et al. (2015) found patients who had T1DM for six years as a mean duration (6). The age of the patients ranged from 4-18 years, and the patients were followed on insulin pump therapy for a mean duration of 10 months. They found a significant decrease in HbA1c, frequency of hypoglycemic episodes, and frequency of diabetic ketoacidosis (DKA) events during insulin pump therapy (6). Both previous research (5,6) had almost the same outcome as our research regarding the results of HbA1c. On the other hand, complications results were not the same as our study.

A retrospective study on 326 subjects using pump insulin therapy compared with 328 patients on multiple daily insulin injections regimen, was conducted in Kuwait in 2015 and showed a decrease of HbA1c results in six months to 5 years follow up (p-value<0.001) in insulin pump users compared to the MDI group. These results were unlike the baseline results which showed no significant difference (p=0.741) which is consistent with our study (7).

In addition, pump users group showed a significant decrease in hypoglycaemic episodes (9.7 to 4.1 episode per 100 patients per year, p<0.05). On the other hand, the MDI group showed an increase in hypoglycaemic episodes (7.7 to 19.7 episodes per 100 patients per year, p<0.05), which is different compared to our research (8). There was no significant difference in DKA episodes either at the beginning or at the end of the study between the two groups (p=0.08) in contrast to our study, which showed a significant difference (8).

A meta-analysis was done in London in 2008 on 22 studies. In general, the study showed an overall rate ratio of severe hypoglycaemic episodes of 4.19 in both randomized controlled trials (RCTs) and before/after studies (9).

Glycaemic control was also studied in this research, and it revealed that HbA1c difference was lower in RCTs compared with before/after studies (0.21% vs. 0.72%, p=0.042) (10).

Regarding severe hypoglycaemic episodes, all studied research in this meta-analysis were in favour of insulin pump therapy except two studies, Maniatis et al. (2001) and Sciaffini et al. (2003) which were more in favour of MDI users compared to insulin pump users which is consistent with the results of our research (11,12). In glycaemic control, all studies were in favour of insulin pump users, which is similar to the results of our research, except the study of Kaderman et al. (1999) (13).

A retrospective case-control study during a two year period conducted in Sweden compares 216 patients starting insulin pump with a control group on MDI. The study shows an improvement of HbA1c in insulin pump patients after 6 and 12 months compared with the MDI group. Regarding the complications, DKA was higher in the insulin pump group compared with the MDI group (2.8 vs. 0.5/100 person-yr) and the hypoglycaemic episodes were 3 per 100 persons-year in the insulin pump group versus 6 in the MDI group (p < 0.05). This study shows a similar outcome to our study regarding both HbA1c and DKA; however, it is not consistent with our study regarding hypoglycaemic episodes (11).

In the present study, no significant relationship was found between age and frequency of DKA and hypoglycaemia in both MDI and pump users patients except for hypoglycaemia in MDI group which showed a significant relation (p-value <0.05).

Limitations

Limitations of our study could be the difficulty of generalizing our findings, as the target population didn't cover the whole Saudi population as it was an online survey.

Conclusion

In a patient with T1DM, HbA1c was significantly higher in MDI users compared to pump users. Lipid profile, including HDL, LDL, Triglyceride, and cholesterol was statistically insignificant. However, DKA was significantly higher in pump users; however, there was no significant difference in regard to hypoglycaemia. There was no significant relationship between complications and age except for hypoglycaemia which showed a significant relation.

Acknowledgments

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