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"EFFECT OF INSULIN INJECTION TECHNIQUES ON GLYCEMIC CONTROL AMONG PATIENTS WITH DIABETES"

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ABSTRACT

Background and Aim: Insulin therapy remains pivotal for managing both Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM), necessitating precise administration techniques. However, there is a dearth of literature regarding insulin injection practices, particularly in the Middle East and Indian populations. This study aims to assess the impact of insulin injection techniques on glycemic control among patients with diabetes. **Material & Method:** Conducted from June 2023 to Feb 2024 at MNR Medical College & Hospital, this cross-sectional study included patients with diabetes mellitus on insulin therapy. Sociodemographic data, diabetes history, medication details, and insulin injection practices were collected. Insulin injection techniques were observed, and glycated hemoglobin (HbA1c) levels were recorded from medical records. Lipohypertrophy presence and severity were assessed. Statistical analysis was performed using SPSS v20, with significance set at $p < 0.05$. **Results:** Among 125 patients (40 with T1DM, 85 with T2DM), lipohypertrophy prevalence was 57.5% in T1DM and 55.35% in T2DM. Participants who did not rotate injection sites, removed needles soon after injection, or had lipohypertrophy showed significantly higher rates of uncontrolled glycemia ($p < 0.05$).**Conclusion:** This study underscores suboptimal insulin injection practices among diabetes patients, contributing to poorly controlled blood glucose levels. Inadequate rotation of injection sites and lipohypertrophy development are particularly associated with this outcome. Implementing educational interventions focused on proper injection techniques could enhance glycemic control and should be prioritized.

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Keywords: Insulin injection techniques, glycemic control, lipohypertrophy, diabetes mellitus, educational interventions.

Introduction:

Insulin stands as the foremost therapy for individuals grappling with Type 1 diabetes mellitus (T1DM) and is frequently employed alongside oral hypoglycemic agents for those with Type 2 diabetes mellitus (T2DM) who haven't met their glycemic targets.[1] Over the past nine decades, insulin has maintained its position as the most efficacious means of managing hyperglycemia in diabetes patients.[2] Administered subcutaneously via insulin pumps or multiple daily injections, it necessitates precise administration techniques to yield optimal results. Numerous studies have underscored the pivotal role of proper insulin injection methods in maximizing the benefits of insulin therapy.[3,4]

Past research indicates a lack of healthcare provider guidance regarding proper insulin injection procedures for patients. Essential elements such as selecting the correct needle length, rotating injection sites, changing needles between injections, and monitoring for lipohypertrophy (LH) at injection sites play pivotal roles in achieving glycemic control.[3,5] Lipohypertrophy manifests as lumps, raised areas, or firmness in the fatty tissue beneath the skin due to repeated insulin injection or infusion. Studies reveal a significant correlation between lipohypertrophy and inadequate rotation of injection sites, with patients who frequently rotate sites showing lower prevalence of lipohypertrophy.[5–7] Exploration into the impact of insulin injection technique on glycemic control remains limited, particularly in the Middle East Region. Existing literature in Jordan comprises only one published study examining the relationship between lipohypertrophy and certain aspects of insulin injection technique in type 2 diabetic patients. This suggests a pressing need for further investigation in this area.[8,9] There is limited literature available among Indian population; hence this study is aimed to assess the effect of insulin injection techniques on glycemic control among patients with diabetes

Material & Method:

This cross-sectional study was conducted among patients with diabetes mellitus on Insulin therapy from June 2023 to Feb 2024. Patients with diabetes mellitus on treatment with insulin were included after obtained with informed consent attending to MNR Medical College & Hospital, General Medicine out-patient department. The study included individuals with

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either type 1 or type 2 diabetes mellitus who had been utilizing insulin injections for a minimum of one year. However, women with gestational diabetes and infants were not considered for inclusion in this research.

The primary data collected encompassed various factors, including sociodemographic details, diabetes history, coexisting health conditions, current medications, practices related to insulin injection techniques, and additional variables. Assessment of insulin injection techniques involved observing subjects or their caregivers demonstrating insulin administration, verifying the accuracy of dosage, the angle of injection, site selection, rotation of injection sites, and the duration of needle retention post-injection.

Researchers evaluated insulin injection sites to identify lipohypertrophy (graded as 1, 2, or 3) and verified needle lengths using a reference catalog featuring images of insulin types and corresponding needle lengths to aid participants in identifying their insulin and needles. Data on glycated hemoglobin (HbA1c) levels and anthropometric measurements were retrieved from medical records. Lipohypertrophy was defined as grade 1 if there was visible fat tissue hypertrophy without palpable abnormalities, grade 2 if there was substantial thickening of fat tissue with a firm texture, and grade 3 if lipoatrophy was present. Glycemic control was categorized following American Diabetes Association (ADA) guidelines: controlled if HbA1c levels were below 7% and uncontrolled if HbA1c levels were 7% or higher.

Statistical analysis utilized the Statistical Package for Social Sciences (SPSS, version 26). Descriptive statistics were employed to summarize continuous variables, presented as mean ± Standard Deviation (SD), while categorical data were expressed as percentages. Comparison of percentages was conducted using the Chi-square test. Multivariate logistic regression analysis was employed to assess the impact of specific variables on glycemic control, adjusting for potential confounders. Statistical significance was defined as p values <0.05.

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Result:

Present study included total of 125 patients fulfilling inclusion criteria, among them 40 were type 1 DM and 85 were T2DM treated with insulin.

Table 1: Parameters distribution among the patients.

		T1DM		T2DM	
		Frequency	Percent	Frequency	Percent
Gender	Male	30	75	65	76.5
	Female	10	25	20	23.5
Age (mean±SD)		20.2	11.1	56.8	9.6
Education level	Schooling	22	55	52	61.2
	Undergraduate	18	45	33	38.8
HbA1c	<7%	12	30	25	29.4
	>7%	28	70	60	70.6
Insulin duration	<5yr	18	45	42	49.4
	>5yr	22	55	43	50.6
DM Duration	<15yr	32	80	38	44.7
	>15yr	8	20	47	55.3
Angle of injection	90	36	90	68	80
	45	4	10	17	20
Site of injection	Abdomen	32	80	62	72.9
	Thigh	5	12.5	12	14.1
	Arm	3	7.5	11	13
Rotation of injection site	Yes	30	75	33	38.8
	No	10	25	52	61.2

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Table 2: Comparison of the techniques and glycemic control in patients with diabetes mellitus

		T1DM			T2DM		
		Uncontrolled (n=12)	Controlled (n=28)	p-value	Uncontrolled (n=25)	Controlled (n=60)	p-value
Angle of injection	45	3 (75%)	1 (25%)	0.68	11 (64.7%)	6 (35.3%)	0.55
	90	8 (22.2%)	28 (77.8%)		22 (32.3%)	46 (67.7%)	
Site of injection	Abdomen	7 (21.8%)	25 (78.2%)	0.78	18 (29%)	44 (71%)	0.65
	Thigh	3 (60%)	2 (40%)		4 (33.3%)	8 (66.7%)	
	Arm	2 (66.6%)	1 (33.4%)		3 (27.2%)	8 (72.8%)	
Rotation of injection site	No	8 (80%)	2 (20%)	0.01*	18 (34.6%)	34 (65.4%)	0.01*
	Yes	4 (13.3%)	26 (86.7%)		7 (21.2%)	26 (78.8%)	
Needle removal after injection	Lift direct	8 (44.4%)	10 (55.6%)	0.01*	18 (45%)	22 (55%)	0.01*
	After 10 seconds	4 (18.2%)	18 (81.8%)		7 (15.5%)	38 (84.5%)	
Lipohypertrophy	Yes	10 (43.5%)	13 (56.5%)	0.01*	20 (42.5%)	27 (57.5%)	0.01*
	No	2 (11.7%)	15 (88.3%)		5 (13.2%)	33 (86.8%)	

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The prevalence of lipohyprotrophy is found in 57.5% (n=23) in T1DM and 55.35 (n=47) in T2DM. There is significant higher incidence of uncontrolled glycemic status among both T1DM and T2DM who did not rotate the site of injection, needle removal soon after injection and presence of Lipohypertrophy. ($p<0.05$).

Discussion:

Studying the effect of insulin injection techniques on glycemic control offers valuable insights into optimizing diabetes management strategies. By identifying and addressing modifiable factors related to insulin administration, healthcare providers can work towards achieving better glycemic control, reducing the risk of complications, and ultimately improving the quality of life for patients with diabetes. Lipohypertrophy prevalence displays significant variation among different nations. Findings from the present study reveal that nearly half of the present study diabetes mellitus (DM) exhibited lipohypertrophy. A systematic review and meta-analysis of 26 studies documented an estimated overall prevalence of lipohypertrophy, with rates of 49% among individuals with type 2 diabetes mellitus (T2DM) and 34% among those with type 1 diabetes mellitus (T1DM).[10] The notably high prevalence of lipohypertrophy observed in the current study's subjects may be attributed to insufficient health education regarding proper injection techniques.

The latest investigation revealed a noteworthy enhancement in glycemic control rates with the rotation of insulin injection sites among both T1DM and T2DM participants. This finding aligns with a study by de Villiers that also observed a correlation between rotating injection sites and improved glycemic control.[11] However, a study conducted by Bochanen et al. in 2022 did not identify a connection between rotating injection sites and HbA1c levels. Nevertheless, they did observe a reduction in the frequency of hypoglycemic episodes following the rotation of injection sites.[12] The suggested practice involves maintaining the insulin needle beneath the skin for a minimum of 10 seconds post-injection, which helps prevent insulin leakage and ensures patients receive the full dosage. Among Jordanian subjects with diabetes mellitus (DM), nearly three-quarters (84.9% of T1DM and 73.1% of T2DM) reported adhering to this recommended duration. Previous research has shown variability in the rate of adhering to this practice, ranging from 26% in Brazil to 90.3% in Poland.[13,14]

Conclusion: Many patients with diabetes in study exhibit suboptimal practices concerning insulin injection techniques. A considerable proportion fail to rotate injection sites, reuse needles, and leave the needle in place for 10 seconds post-injection. Poor insulin injection

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technique, particularly inadequate rotation of injection sites and the development of lipohypertrophy, correlates with poorly controlled blood glucose levels. Implementing educational interventions focused on insulin injection techniques could potentially enhance glycemic control among individuals with diabetes mellitus and should be prioritized.

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