



Comparison of Glucose Measurement Techniques Using Venous and Capillary Blood Samples in Diabetics Regarding Patient Satisfaction

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Abstract

Aim: This study was conducted to compare the satisfaction of patients diagnosed with diabetes mellitus regarding blood glucose measurement based on the blood glucose measurement techniques (intravenous and capillary) used.

Material and Method: A randomized controlled study was conducted with 110 patients with diabetes mellitus. Patients were randomized into the experimental group (n=55) and control group (n=55). Patient Information Form, Diabetes Fear of Injecting and Self-testing Questionnaire (D-FISQ), and Blood Glucose Measurement Patient Satisfaction Form were used in the study. The control group patients had their blood sugar measured using capillary blood from a finger prick. The experimental group patients had their blood glucose measured intravenously using venous blood, followed by capillary blood glucose measurement from a finger prick. Data analysis was conducted using chi-square test and independent t-test.

Results: There were statistically significant differences in the satisfaction of diabetic patients with the blood glucose measurement technique between the use of venous blood and intravenous blood glucose measurement by finger prick ($p < 0.05$).

Conclusion: The measurement of blood glucose using venous blood obtained by an intravenous catheter positively affects patient satisfaction compared to the finger prick technique of measuring capillary blood glucose in patients with diabetes.

Keywords: Blood glucose, diabetes, patient satisfaction

INTRODUCTION

Diabetes is a chronic metabolic disease characterized by high blood glucose levels. It is reported that there are 537 million adults with diabetes worldwide (1). There are approximately 9 million diabetic patients in Türkiye, and the highest rate of diabetic patients in Europe lives in Türkiye (1,2).

The primary goal in diabetes treatment is to ensure blood glucose regulation, prevent acute and chronic complications that may develop due to the disease, and reduce the risk of complications (2). Therefore, blood glucose monitoring is critical in diabetes management. Blood glucose must be measured regularly to determine the insulin dose used in treatment and/or to prevent

possible acute complications (3).

Nowadays, non-invasive technological developments for blood glucose measurement are increasing and alternative methods are being developed (4). However, venous or capillary blood samples are generally used to measure blood glucose in routine practices (5). In standard procedures applied in diabetes management, blood glucose monitoring is done based on taking capillary blood samples by pricking the fingertip (6). In clinical practice, measurements are usually made from a whole blood sample taken from a venous vein for routine laboratory tests required to monitor diabetic patients. In addition, a capillary blood sample can be used by pricking the fingertip to monitor the patient's blood glucose (2,5). Studies in the literature compare blood sugar

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measurements made from different blood samples. In these studies, it has been reported that the measurement results obtained from different blood samples are similar (7).

Diabetic patients may fear finger pricking while monitoring their blood glucose. It is reported in the literature that the fear of finger pricking due to blood glucose measurement in diabetic patients is 0.2-80% (8). This situation may negatively affect the compliance of individuals with diabetes with treatment (9). Individuals with diabetes may avoid insulin injections and self-measurement of blood sugar due to the fear of experiencing pain. In addition, an increase in the number of blood sugar measurements causes deformation of the fingertips of the diabetic individual and negatively affects patient satisfaction (10).

No study was found in the literature investigating patient satisfaction using glucose measurement techniques from venous and capillary blood samples in diabetic patients. This study was conducted to compare the satisfaction of patients diagnosed with diabetes mellitus with blood glucose measurement according to the applied blood glucose measurement technique (intravenous and capillary).

The study hypotheses were the following:

In comparisons made in terms of blood glucose measurement techniques in patients diagnosed with diabetes mellitus, according to the measurement made by taking a venous blood sample from the intravenous catheter and by pricking the fingertip;

- **H1:** creates less stress with a statistically significant difference,
- **H2:** causes less severe pain with a statistically significant difference,
- **H3:** lessens the ability to perform daily living activities, with a statistically significant difference,
- **H4:** provides a higher level of satisfaction with a statistically significant difference.

The study's results may significantly contribute to reducing multiple finger punctures and preserving fingertip skin integrity in patients with diabetes.

MATERIAL AND METHOD

This study was a single-center, prospective, randomized controlled trial. The study population consisted of adult patients with diabetes mellitus who were treated and followed up in the inpatient services of a hospital located within the borders of Zonguldak province from March 2023 to June 2023. The study's sample size was calculated using the G*Power Version 3.1.7 program. The study sample was determined as 110 patients at a significance level of 0.05 and an effect size of 0.50. Before capillary blood glucose measurements, blood glucose was measured from a venous blood sample

via an intravenous catheter in the experimental group of patients, and satisfaction levels were compared in terms of both measurement techniques. The relevant EQUATOR guideline, the Consolidated Standards of Reporting Trials (CONSORT) checklist, was used for reporting this study, and a ClinicalTrials.gov registration number was obtained (NCT05976191 registered).

The research sample selection criteria were determined using the "purposeful sampling" method.

Criteria for inclusion in the study:

- Agreeing to participate in the study voluntarily,
- Patients whose blood sugar is monitored from fingertip capillary blood samples,
- Patients with an intravenous catheter,
- Patients who have been diagnosed with Diabetes Mellitus for at least one year.

Exclusion criteria from the study:

- Patients whose intravenous catheter insertion date has exceeded 24 hours,
- Patients who are unconscious, confused, apathetic.

To avoid bias in the patients to be included in the study, randomization was performed in accordance with the order of the patient protocol numbers assigned by the hospital during the hospitalization process. An internet program accessed via the "<https://www.calculatorsoup.com>" link was used to create the randomization table. Patients were matched with the randomization table and assigned to research groups.

Data Collection Tools

Patient Information Form

The researchers prepared the form, following the literature (2,9,11). It consists of 6 questions regarding the patients' socio-demographic characteristics (age, gender, marital status, educational status, employment status, income status) and two questions regarding their clinical characteristics (diabetes duration, type of drug treatment).

Diabetes Fear of Injecting and Self-testing Questionnaire (D-FISQ)

The scale was developed by Snoek et al. (1997) to measure the fear of self-injection and self-testing in diabetic individuals who need insulin (12). Celik, and Pinar conducted the Turkish reliability and validity study of the scale in 2016 (13). Cronbach's alpha coefficient of this study was calculated as 0.97 for the total scale score, 0.96 for the fear of injecting subscale, and 0.95 for the fear of self-testing subscale.

The scale consists of 15 items and two subscales. Each item on the scale is scored on a four-point Likert type. The scale is evaluated by calculating the total score of each subscale separately and/or the scale's total score. An increase in the score indicates an increase in fear (13).

Blood Glucose Measurement Patient Satisfaction Form

The form was prepared by the researchers using the literature (2,9). The form includes four questions examining the satisfaction level of the patients after their fasting blood sugar measurement. The answer to each question was evaluated as 0–10 points. The decrease in the answer score to questions “Does knowing that blood will be drawn for a blood glucose measurement cause stress for you?”, “How severe is the pain you feel at the site where the blood sample was taken?” and “Does the site where the blood sample was taken limit you in performing daily living activities after the measurement?” indicates that patients' satisfaction with blood glucose measurement has increased. The decrease in the answer score to the question “How satisfied were you with this measurement technique?” indicates that blood glucose measurement satisfaction decreases.

Study Procedures

Patients who met the inclusion criteria for the study were identified by visiting inpatient services three days a week. In the study, the fasting blood glucose levels of the patients were measured. Blood glucose measurements were taken from 06:00 to 07:00 with devices used in the hospital. This study used two different blood glucose measurement techniques: 1) venous blood glucose measurement technique and 2) capillary blood glucose measurement technique. A 1cc venous blood sample drawn from the intravenous catheter into the syringe was used for venous blood glucose measurement. For capillary blood glucose measurement, the blood sample was obtained by pricking the tip of the patient's finger with a lancet. The fingertip pricking of the patients was performed with lancets routinely used in the hospital. Patient Information Form and D-FISQ were applied to the control group before blood glucose measurement. Then, the patients' capillary blood glucose was measured, and they were asked to fill out the Blood Glucose Measurement Patient Satisfaction Form. In the experimental group, venous blood glucose was measured first, and the participants were asked to fill out the Blood Glucose Measurement Patient Satisfaction Form. Then, the patient's capillary blood glucose was measured, and they were asked to fill out the Blood Glucose Measurement Patient Satisfaction Form again.

Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0. The chi-square test was used to compare the frequency distribution of the two groups and the homogeneity of categorical variables. The independent t-test was used to compare the mean scores. The data were analyzed at a significance level of $p < 0.05$ within a 95% confidence interval. p -values less than 0.05 were considered statistically significant.

Ethical Considerations

The study was approved by the ethics committee of Istanbul University-Cerrahpaşa Social and Humanities Research Ethics Committee (Ethical date: 21 February

2023; Approval number 2023/67); institutional permission was received from Zonguldak Provincial Health Directorate Çaycuma State Hospital. Data were collected by obtaining verbal consent from the participants.

RESULTS

The patient was 61.11 ± 12.07 (min: 28 – max: 81) years old. 51.8% of the patients were women, 82.7% were married and 70% were primary/secondary/high school graduates. Most of the patients were retired or unemployed (58.2%) and had a moderate income (70.9%). The duration of diabetes of the patients was 15.80 ± 9.88 years, and most of them (71.8%) were receiving insulin treatment. When the experimental group and control group patients were compared in terms of socio-demographic and clinical characteristics, it was found that there was no statistically significant difference ($p > 0.05$) (Table 1).

The D-FISQ scores of the patients were compared statistically. There was no statistically significant difference between the experimental and control groups ($t = 0.442$; $p > 0.05$), and the experimental group patients were similar to the control group patients in terms of fear of self-injection and testing (Table 2).

After measuring fasting blood glucose from the patients' fingertip capillary blood sample, the Blood Glucose Measurement Patient Satisfaction scores were compared statistically between the experimental and control groups. It was determined that there was no statistically significant difference between the experimental and control groups in terms of stress creation state, pain, limitation in activities of daily living, and satisfaction with the blood glucose measurement technique used ($p > 0.05$) (Table 3).

In the experimental group, patient satisfaction score averages were compared statistically according to blood glucose measurement techniques. It was determined that there were statistically significant differences between the venous blood glucose measurement technique and capillary blood glucose measurement technique in terms of stress creation state, pain, limitation in activities of daily living, and satisfaction with the blood glucose measurement technique used ($p < 0.05$) (Table 4). It was determined that the venous blood glucose measurement technique, according to other techniques, creates less stress, causes less pain intensity, limits daily living activities less, and provides greater patient satisfaction in diabetic patients.

In the experimental group, the venous blood glucose measurement value was 121.75 ± 23.24 mg/dL, and the capillary blood glucose measurement was 124.8 ± 24.10 mg/dL. There was a statistically significant difference between the averages of blood glucose values measured with both blood glucose measurement techniques ($t = 3.643$; $p < 0.01$), and a positive, very strong, and statistically significant relationship between both measurements. It was determined that there was a positive, very strong and statistically significant relationship between both measurements ($r = 0.962$; $p < 0.001$) (Table 5).

Table 1. Socio-demographic and clinical characteristics of patients (n=110)							
Variables		Experimental group (n=55)		Control group (n=55)		Test	Significance
		n	%	n	%	χ^2	p
Age (years)	≤60	28	50.9	23	41.8	0.914	0.339
	≥61	27	49.1	32	58.2		
Gender	Female	26	47.3	31	56.4	0.910	0.340
	Male	29	52.7	24	43.6		
Marital status	Married	44	80.0	47	85.5	0.573	0.449
	Single	11	20.0	8	14.5		
Education level	Without formal education	12	21.8	10	18.2	0.390	0.823
	Primary/secondary/high school	37	67.3	40	72.7		
	University	6	10.9	5	9.1		
Employment status	Employed	29	2.7	17	30.9	5.477	0.065
	Unemployed/retired	26	47.3	38	69.1		
Income status	Low	11	20.0	13	23.6	2.218	0.330
	Moderate	38	69.1	40	72.7		
	High	6	10.9	2	3.7		
Duration of diabetes (years)	≤15	29	52.7	35	63.6	1.345	0.246
	≥16	26	47.3	20	36.4		
Diabetes treatment	Oral antidiabetic drug*	17	30.9	14	25.5	0.404	0.525
	Insulin	38	69.1	41	74.5		
Total		55	100	55	100		

χ^2 : Chi-square test, p<0.05; *Patients whose diabetes treatment method is oral antidiabetic medication but who receive insulin injections if necessary during hospitalization

Table 2. Comparison of patients' D-FISQ scores (n=110)				
D-FISQ and subscales	Experimental group (n=55)	Control group (n=55)	Test	Significance
	Mean±SD	Mean±SD	t	p
D-FISQ total score	31.47±14.30	30.31±13.32	0.442	0.660
Fear of injecting score	13.85±6.70	12.55±5.50	1.120	0.265
Fear of self-testing score	17.62±8.20	17.76±7.89	0.095	0.925

t: Independent samples t test, p<0.05; D-FISQ: Diabetes Fear of Injecting and Self-testing Questionnaire

Table 3. Comparison of patient satisfaction scores after capillary blood glucose measurement (n=110)			
Blood glucose measurement patient satisfaction form questions	Experimental group (n=55)	Control group (n=55)	Test and significance
	Mean±SD	Mean±SD	
Does knowing that blood will be drawn for a blood glucose measurement cause stress for you?	4.64±3.83	5.02±3.70	z=0.590 p=0.555
How severe is the pain you feel at the site where the blood sample was taken?	4.87±3.42	5.71±3.24	z=1.358 p=0.175
Does the site where the blood sample was taken limit you in performing daily living activities after the measurement?	2.07±3.23	2.82±3.26	z=1.466 p=0.143
How satisfied were you with this measurement technique?	4.16±3.45	4.73±3.66	z=0.832 p=0.405

z: Mann Whitney U Analysis, p<0.05

Table 4. Comparison of patient satisfaction score means according to blood glucose measurement technique (n=55)

Blood glucose measurement patient satisfaction form questions	Blood glucose measurement techniques		Test and Significance
	Venous blood glucose measurement	Capillary blood glucose measurement	
	Mean±SD	Mean±SD	
Does knowing that blood will be drawn for a blood glucose measurement cause stress for you?	3.18±4.11	4.64±3.83	t=3.019 p=0.004*
How severe is the pain you feel at the site where the blood sample was taken?	0.24 ±1.40	4.87±3.42	t=9.334 p < 0.001**
Does the site where the blood sample was taken limit you in performing daily living activities after the measurement?	0.00±0.00	2.07±3.23	t=4.766 p<0.001**
How satisfied were you with this measurement technique?	9.64±1.63	4.16±3.45	t=-10.430 p<0.001**

t: Paired groups t-test, *p<0.01, **p<0.001

Table 5. Comparison of fasting blood glucose values in experimental group patients according to blood glucose measurement technique (n=55)

Blood glucose measurement techniques	Blood glucose value	Test and significance		Relationship and significance	
	Mean±SD	t	p	r	p
Venous blood glucose measurement	121.75±23.24	3.643	0.001*	0.962	< 0.001**
Capillary blood glucose measurement	124.98±24.10				

t: Independent samples t-test, r: Pearson Moment Correlation coefficient, *p<0.01, **p<0.001

DISCUSSION

This study was conducted to compare the satisfaction of patients diagnosed with diabetes mellitus regarding blood glucose measurement based on the blood glucose measurement techniques (intravenous and capillary) used. The homogeneity of the study was ensured by evaluating the socio-demographic characteristics, fear of self-injection and testing, and patient satisfaction scores of the patients participating in the study. Our research has shown that the venous blood glucose measurement technique via an intravenous catheter creates less stress, causes less pain intensity, limits daily living activities less, and provides greater patient satisfaction in diabetic patients.

In studies comparing different blood glucose measurement techniques, blood glucose levels are close to each other (7,10,11). It is also reported in the diabetes monitoring guide published by the Turkish Endocrinology and Metabolism Association that venous plasma blood glucose measurement and capillary blood glucose measurement values are equivalent to each other for fasting blood glucose value (2). In our study, blood glucose was measured using venous blood samples via an intravenous catheter and fingertip capillary blood samples. It was determined that there was a statistically significant difference in measurement values between the two techniques. However, this difference does not have any clinical significance. Literature supports the findings of our study.

In diabetes management, regular blood glucose monitoring is essential to ensure glycemic control. The fingertip

blood glucose measurement creates a fear of needles, pain and discomfort in patients (14). It has been reported that patients receiving insulin therapy postpone or do not their blood glucose measurements due to pain and fear of needle/finger pricking. It is emphasized that patients avoid measuring blood glucose because they feel pain during fingertip puncture (15). Blood glucose monitoring of diabetic patients receiving treatment in inpatient services is a routine. The fingertip capillary blood glucose measurement technique can create a fear of needles in patients. Alternative ways to solve this problem need to be created for diabetic patients who have a fear of needles. It is thought that this requirement has an important place in terms of patient comfort and compliance with treatment (16).

Our study reveals that blood sugar measurement can create stress in diabetic patients, cause them to feel pain, and make it difficult for them to perform daily living activities. In our study, the dissatisfaction experienced by diabetic patients regarding blood sugar measurement is parallel to the literature (3,6,7). No studies were found in the literature where blood glucose measurement techniques were evaluated in terms of patient satisfaction. This study shows that patient satisfaction may vary depending on the blood glucose measurement technique. According to the fingertip capillary blood glucose measurement technique, the venous blood glucose measurement technique via an intravenous catheter can increase patient satisfaction. Notably, patients with diabetes are more satisfied with the venous blood glucose measurement technique than with other techniques. For routine blood glucose monitoring in inpatient services, it is recommended that patients

with diabetes measure blood glucose from venous blood samples. For routine blood glucose monitoring in inpatient services, it is recommended that diabetic patients' blood glucose measurements be made from venous blood samples via an intravenous catheter.

CONCLUSION

The fingertip capillary blood glucose measurement technique, which uses venous blood via an intravenous catheter, creates less stress, causes less pain intensity, limits daily living activities less, and provides greater patient satisfaction in patients with diabetes.

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Ethical approval: The study was approved by the ethics committee of Istanbul University-Cerrahpaşa Social and Humanities Research Ethics Committee (Ethical date: 21 February 2023; Approval number 2023/67); institutional permission was received from Zonguldak Provincial Health Directorate Çaycuma State Hospital.

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