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Patient Perceptions of Different Lancing Sites for Self-Monitoring of Blood Glucose: A Comparison of Fingertip Site with Palm Site Using the OneTouch® Ultra® Blood Glucose Monitoring System

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Abstract

Background:

Alternate-site testing (AST) for self-monitoring of blood glucose leads to improved glycemic control for treatment of diabetes mellitus. The aim of this randomized, open-label, two-period, crossover study was to compare the comfort of two different lancing sites, fingertip and palm sites, for AST in diabetes patients.

Methods:

Patients injected insulin four times a day. Self-monitoring of blood glucose was carried out more than thrice daily with fingertip measurements for at least three months using apparatuses except the OneTouch® Ultra® Blood Glucose Monitoring System (OneTouch) before examination. The comfort of two lancing sites using OneTouch were compared. In two randomized groups that used one fingertip lancing site for one week followed by the alternate lancing site for another week, patients completed 11-item questionnaires assessing usability of the site before and after each week. Each item was scored on a visual analogue scale from –100 (most negative) to +100 (most positive).

Results:

Most patients desired to continue AST, which was insignificantly different between the two lancing sites (fingertip and palm AST) in 43 diabetes patients aged 57.3 ± 13.8 years, body mass index of 23.1 ± 2.5 kg/m^2, diabetes duration of 19.6 ± 9.7 years, and hemoglobin A1c of 7.4 ± 1.1%. However, patients were less ($p < .01$) satisfied with using the palm lancing site as compared to the fingertip lancing site because of difficulties in inserting the needle, drawing blood samples, and applying enough blood into the test strip.

Conclusions:

These results suggest that patients desire to use the palm for AST, but more technological advances in AST of a palm site is required to reduce patient discomfort.

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Abbreviations: (AST) alternate-site testing, (BMI) body mass index, (CSII) continuous subcutaneous insulin infusion, (FBGT) fingertip blood glucose testing, (HbA1c) hemoglobin A1c, (IDDM) insulin-dependent diabetes mellitus, (OneTouch) OneTouch® Ultra® Blood Glucose Monitoring System, (PBGT) palm blood glucose testing, (SMBG) self-monitoring of blood glucose

Keywords: alternate-site blood glucose testing, fingertip site, palm site, self-monitoring of blood glucose

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Introduction

Self-monitoring of blood glucose (SMBG) is an essential component of intensive management of diabetes. Traditionally, fingertip capillary blood has been used for such monitoring. With technological advances in SMBG devices, the requirement of smaller blood samples and the capillary action of the strip itself, SMBG can now be performed at other sites such as the palm, forearm, or thigh. As a result, increasing numbers of patients are considering alternate-site testing (AST) of blood glucose to increase the frequency of testing while limiting potential pain associated with fingertip testing.[1]

Many researchers have reported clinically relevant differences in fingertip and forearm blood glucose values when measured during times of rapid blood glucose changes.[2–5] On the other hand, studies have demonstrated that blood glucose readings by fingertip blood glucose testing (FBGT) and palm blood glucose testing (PBGT) were similar and were within clinically acceptable ranges at all time points during times of rapid blood glucose changes, i.e., fasting, 1 and 2 h postmeals, and immediately after exercise.[1,6]

However, it is unknown whether self-reported levels of satisfaction associated with ASTs by FBGT and PBGT using available apparatus are the same or not.

The aim of this study was to compare the comfort of two different lancing sites (fingertip and palm sites) for AST using the OneTouch® Ultra® Blood Glucose Monitoring System (LifeScan, Inc., Tokyo, Japan) as the available apparatus.[6] In this randomized, crossover study of insulin-treated patients, we assessed each lancing site with regard to the patient's perceptions of pain, preference, and usability when both FBGT and PBGT were performed using OneTouch.

Research Design and Methods

Study Design

This randomized, open-label, two-period, crossover study compared the comfort of FBGT and PBGT using a drop of capillary blood after lancing in diabetes patients who were injecting insulin. The clinical usability of different lancing sites for AST using an available apparatus was evaluated by using a questionnaire.

Subjects

Eligible patients for inclusion in the study were diagnosed with insulin-dependent diabetes mellitus (IDDM) and had been using insulin therapy by self-injecting four times daily for at least three months. The insulin injection sites used were abdominal. Patients with physical conditions affecting their ability to self-inject, such as low vision, low grip strength, and hand tremor, were excluded. Self-monitoring of blood glucose was carried out three or more times with daily measurements at fingertip for at least three months using available apparatuses before examination. All patients gave written informed consent.

Materials

OneTouch® (Life Scan, Inc., Tokyo, Japan) was used for AST of FBGT and PBGT. It consists of the OneTouch Ultra® meter with LFS Quick Sensor® to read blood glucose, and the OneTouch UltraSoft® and the OneTouch UltraSoft Lancet Needle to obtain a drop of capillary blood safely and easily after lancing.[6]

Methods

Patients were randomized to two groups (groups 1 and 2) that used either FBGT or PBGT using OneTouch for one week, followed by the other site of testing for another week. To assess comfort and usability associated with FBGT and PBGT at the two lancing sites, patients completed a questionnaire before and after each test week. The questionnaire consisted of 11 items divided into five categories:

1. Pain, fear, and difficulty judging from the appearance of the different sites using OneTouch.
   (1) Did you think it may be painful to insert?
   (2) Did you think it may be frightening to insert?
   (3) Did you think it may be difficult to insert?
2. Pain and scarring judged from inserting the lancet needle into the different sites using OneTouch.
   (4) Did you think it was painful when you inserted?
   (5) Did you think it would scar when you inserted?

3. Difficulty of inserting the lancet needle, drawing a blood sample or applying enough blood into test strips obtained from the different sites using OneTouch.

   (6) Did you think it was difficult to insert?

   (7) Did you think it was difficult to draw a blood sample?

   (8) Did you think it was difficult to apply enough blood into the test strip?

4. Marking and stopping bleeding after inserting the lancet needle into the different sites using OneTouch.

   (9) Did you think a mark would remain after inserting the needle?

   (10) Did you feel the bleeding would stop immediately after inserting needle?

5. Overall satisfaction.

   (11) Did you desire to continue SMBG testing at the alternate sites using OneTouch?

Each evaluation was scored on a visual analog scale from –100 (most negative response to the question) to +100 (most positive response to the question); a higher score indicated a closer agreement to the question compared with the SMBG test at the alternate lancing site.

Statistical Analysis

All data are presented as mean ± standard deviation values. Mean values in the two groups were compared using Student's unpaired *t*-test. In addition, to compare the prevalence of female and male and chronic diabetic complications in the two groups, Fischer's exact test was used. The differences in scores between the two different lancing sites were analyzed using a nonlinear mixed effects model.[7] A two-tailed value of $p < .05$ was considered statistically significant.

Results

Forty-three patients with IDDM were recruited for the study: 24 women and 19 men. The age was 57.3 ± 13.8 years (26–81 years), body mass index (BMI) was 23.1 ± 2.5 kg/m^2, duration of diabetes was 19.6 ± 9.7 years, and hemoglobin A1c (HbA1c) level was 7.4 ± 1.1%. Four patients had inactive proliferative retinopathy, 3 had albuminuria, 1 had renal transplantation, 1 had an old cerebral infarction, and 2 had ischemic heart disease (**Table 1**). However, patients had no clinically apparent neuropathy, because they had no symptoms related to neuropathy and had normal Achilles tendon reflex, indicating that there was no disturbance of perception owing to neuropathy in all patients. Also, all presented with no factors influencing the techniques for self-injection of insulin and SMBG. Thirty-six of all patients required four daily insulin injections for more than three months, and another seven patients were treated with continuous subcutaneous insulin infusion (CSII) therapy. Thirty-four of 36 patients with four daily insulin injections used rapid- and long-acting components in pens with replaceable cartridges, while 2 patients used regular- and intermediate-acting components, and the remaining 7 used rapid insulin as CSII therapy. The mean dose was 44.1 ± 18.3 U/day.

Before entering the study, all patients performed more than thrice-daily measurements of SMBG and had never experienced using a palm site for lancing.

Table 1.
Baseline Patient Characteristics by Group[a]

Characteristic	Mean ± standard deviation	
	Group 1 (n = 25)	Group 2 (n = 18)
Age (years)	56.5 ± 15.1	58.4 ± 12.1
Female/male	13/12	11/7
Duration of diabetes (years)	19.6 ± 11.2	19.7 ± 7.2
BMI (kg/m^2)	22.8 ± 2.8	23.6 ± 2.1
Hemoglobin A1c (%)	7.3 ± 1.3	7.5 ± 0.7
Insulin dose (U/day)	42.4 ± 13.4	46.6 ± 23.6
Diabetes complications	6 (24)	5 (28)
Nephropathy and retinopathy	5 (20)	3 (17)
CVD and CHD[b] Duration of SMBG (year) Number of times of SMBG per day Percent desiring to stop SMBG	1 (4) 10.5 ± 3.7 3.7 ± 3.7 12 ± 3.7	2(11) 11.9 ± 3.7 3.2 ± 3.7 11 ± 3.7

[a] Group 1 used the fingertip site for SMBG for the first week and then the palm site for the following week, while group 2 used the palm site for SMBG for the first week and then the fingertip site for the following week. The number in parentheses is the percentage ratio of patients in each group for all subjects. Self-monitoring of blood glucose was carried out more than three times daily with measurements at fingertip sites for at least three months using available apparatuses before examination. There were no significant differences in the values between the two groups.
[b] CVD, cerebral vascular disease; CHD, coronary heart disease.

Twenty-five patients in group 1 used the fingertip lancing site for the first week and then the palm site for the following week. Eighteen patients in group 2 used the palm lancing site for the first week and then the fingertip site for the following week. There were no significant differences in means of age, sex, duration of diabetes, BMI, HbA1c, insulin dose, prevalence of chronic diabetic complications, duration of SMBG, number of times of SMBG per day, and percent of desire to stop SMBG in patients between the two groups (**Table 1**).

In the results, the mean scores for: pain, fear, or scarring judging from the appearance of the different lancing sites or inserting lancet needle; difficulties in inserting the lancet needle, drawing a blood sample, and applying enough blood into test strips; and marking after inserting the lancet needle in the two sites showed negative values for the question, indicating that the OneTouch used in this study is an excellent apparatus and a well-tolerated device for SMBG, as previously reported.[6] When using this apparatus, most patients desired to continue AST in the two lancing sites as shown by the positive scores for the questions, and there was no significant difference between the scores of the two sites (**Table 2**). Furthermore, there were no significant differences between the scores of the two sites for pain and fear judging from the appearance of the lancing sites, and for marking and stopping bleeding after inserting the needle into site (**Table 2**). Meanwhile, the scores for the questionnaire's four items, 3 and 6–8, on difficulties of inserting the needle with and without appearance of lancing sites, of drawing a blood sample from the lancing sites, and of applying enough blood into test strip for patients using the palm site were significantly higher than for patients using the fingertip site, indicating that it was more difficult to insert the lancet needle, draw a blood sample, or apply enough blood into test strips in the palm site than in the fingertip site (**Table 2**).

Discussion

Since many researchers demonstrated clinically relevant differences in fingertip and forearm blood glucose values when measured during times of rapid blood glucose changes,[2–5] this study was designed using FBGT and PBGT, which proved to offer similar blood glucose values at all time points during times of rapid blood glucose changes.[1,6]

The shortcomings of this study are that the design is an open-label method, the number of patients participating

Table 2.
Questionnaire Scores for the Fingertip Test Compared with the Palm Test for Self-Monitoring of Blood Glucose, Evaluated by Visual Analog Scale[a]

Category, item	Fingertip	Palm	*p* value
Pain, fear, and difficulty judged from appearance of the different sites.			
(1) Did you think it may be painful to insert?	–34.0 ± 50.2	–29.0 ± 55.0	.447
(2) Did you think it may be frightening to insert?	–40.0 ± 46.8	–36.0 ± 53.3	.455
(3) Did you think it may be difficult to insert?	–54.0 ± 44.8	–41.0 ± 52.6	.019
Pain and scarring judged from inserting the lancet needle into the different sites.			
(4) Did you think it was painful when you inserted?	–26.0 ± 41.8	–30.0 ± 43.9	.909
(5) Did you think it would scar when you inserted?	–44.0 ± 43.5	–48.0 ± 45.3	.905
Difficulty in inserting the lancet needle, drawing a blood sample, or applying enough blood into test strips obtained from the different sites.			
(6) Did you think it was difficult to insert?	–58.0 ± 37.2	–36.0 ± 54.0	.001
(7) Did you think it was difficult to draw a blood sample?	–51.0 ± 49.3	–10.0 ± 57.6	.001
(8) Did you think it was difficult to apply enough blood into the test strip?	–60.0 ± 34.6	–45.0 ± 50.3	.001
Marking and stopping bleeding after inserting the lancet needle into the different sites.			
(9) Did you think a mark would remain after inserting needle?	–41.0 ± 42.1	–34.0 ± 53.0	.363
(10) Did you think the bleeding would stop immediately after inserting the needle? Overall satisfaction.	58.0 ± 40.3	56.0 ± 37.3	.886
(11) Do you desire to continue SMBG testing at the alternate sites?	32.0 ± 51.4	15.0 ± 61.4	.086

[a] All data are presented as mean ± standard deviation values. Each score for fingertip and palm sites was obtained using a visual analog scale from –100 (most negative response to a question) to +100 (most positive response to a question); a higher score indicates a closer agreement to the question compared with the SMBG test at the alternate site using OneTouch. Two-tailed values of $p < .05$ were defined as statistically significant in comparison with the differences in scores between the two sites using the nonlinear mixed effects model.

is small, and only one apparatus, OneTouch, was used for AST at both fingertip and palm sites. On the other hand, the study's design reflects clinical practice, where patients will be aware of the products used with apparatus used for AST and patients learn that glucose readings at fingertip and palm sites are similar and within the clinically acceptable range at all time points during times of rapid blood glucose changes.[1,6]

Interestingly, most patients desired to continue AST, as shown by the positive scores for the question, "Did you desire to continue SMBG testing at the alternate sites using OneTouch," and there was no difference between fingertip and palm sites in the overall satisfaction score for continuing AST. However, the patients' scores for difficulties of inserting the needle with and without appearance of lancing sites, drawing a blood sample from the lancing sites, and applying enough blood into the test strip were higher for the palm lancing site than the fingertip lancing site.

The perception may be different with changes in demographic and clinical data with diabetes complications. In this study, there were no such differences between the two groups. Further, we evaluated using a crossover comparison study to eliminate individual differences of perception. Therefore, it is unlikely that the significant difference in scores would be due to the different perceptions, owing to demographic and clinical data.

Current research verifies that this apparatus used for SMBG is outstanding for glucose readings by FBGT and PBGT; over two-thirds (70%) of patients using SMBG would use palm testing in the future, and more than half (52.5%) of them would probably test more frequently,[6] which is in line with our findings. Although patients desire palm testing as AST, some comfort levels are different between fingertip and palm lancing sites using OneTouch for AST. In particular, there were more difficulties in inserting the needle, drawing a blood sample, and applying enough blood into the test strip for patients using the palm lancing site than for patients using the fingertip lancing site. This indicates that development of a more technologically advanced SMBG device for palm lancing sites can also help alleviate some discomfort of AST. Reducing difficulties in inserting the needle, drawing a blood sample, and applying enough blood into the test strip at palm site can have important clinical implications, as it might be possible to reduce anxiety for those performing AST.[8]

Conclusions

The present study indicates that patients with diabetes who perform multiple glucose measurements as SMBG prefer using OneTouch for AST. However, patients have more difficulty inserting the needle with and without appearance at lancing site, drawing the blood sample, and applying enough blood into the test strip at the palm lancing site than at the fingertip lancing site.

Even with the use of OneTouch, which plays an important role in reducing discomfort at alternate sites, more technological advances in SMBG devices are needed for AST at palm site, which may consequently allow patients to perform AST without anxiety

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