

Blood glucose testing at alternative sites in adolescents with type 1 diabetes

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Article points

1. Young people report that fingerprick blood glucose testing is less painful than alternative testing sites.
2. The upper arm and hypothenar sites were the most popular alternative testing sites.
3. Alternative sites provide reasonably reliable blood glucose results except in times of hypoglycaemia.

Key words

- Young people
- Blood glucose monitoring
- Alternative test sites

Intense pain of pricking the fingertip and inadequate or excessive blood extraction due to the frequent use of a one site may cause difficulties in accurately measuring blood glucose levels in young people with diabetes. Moreover, pain and aching in fingertips when touching surfaces, difficulty in holding a pen, a feeling of pins and needles and the emergence of calluses have been noted as common problems caused by long-term use of a single test site, such as a fingertip (Ellison et al, 2001; McGarraugh et al, 2001; Greenhalgh et al, 2002; Holstein et al, 2002; Jungheim and Koschinsky, 2002; Lock et al, 2002). It is suggested that such problems could be overcome by introducing alternative sites for blood glucose testing and help children with type 1 diabetes to cope with their condition (Lucidarme et al, 2005). This article looks at the effectiveness of using alternative sites for blood glucose testing in young people with type 1 diabetes in terms of pain reduction and the accuracy of test results.

Diabetes is considered one of the most common chronic childhood illnesses. In the authors' opinion, treatment of childhood type 1 diabetes should involve a care plan designed in cooperation with the young person, and their parents based upon the specific needs of the

person with diabetes, maintaining glycaemic control, optimising conditions for healthy development and psychosocial support (Çavusoglu, 2002).

'Self monitoring of blood glucose plays a vital role in the treatment plan of children with diabetes mellitus. Regular self blood

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glucose monitoring enables the appropriate changes to be made in the treatment and management of the child's diabetes to meet individual goals and needs' (Greenhalgh et al, 2002). Therefore, diabetes education is the most vital component of a diabetes treatment (Çavusoglu, 2002).

Despite the fact that blood glucose measurements can be an important part of a diabetes management strategy, a series of difficulties have been reported in relation to the frequency of measurement and recurrent use of fingerprick tests (Ellison et al, 2001; McGarraugh et al, 2001; Greenhalgh et al, 2002; Holstein et al, 2002; Jungheim and Koschinsky, 2002; Lock et al, 2002). However, for alternative sites to be useful in young people with diabetes, it must be verified that differences in circulatory physiology of the off-finger test sites do not lead to significantly different blood glucose results.

Design and methods

The study aimed to investigate whether or not sites other than the fingertip were less painful for blood glucose testing in young people and if using a different site affected the reliability of results. The study design was submitted to the Board of Ethics at Ege University Nursing School and Ege University School of Medicine Hospital for ethical approval. It was also authorised by the Pediatric Endocrinology Clinic.

The study comprised 53 young people selected at random from those with type 1 diabetes aged 12–18 years who were treated at the Pediatric Endocrinology Clinic at Ege University School of Medicine Hospital in Izmir, Turkey, between 1 September 2005 and 1 June 2006. The adolescents with diabetes and their parents were given information about the study – all gave written consent to participate.

A 23-point questionnaire collected data on the sociodemographic characteristics of each participant as well as the management strategy being employed – for example, use of insulin pens, frequency of injections and

frequency of self monitoring of blood glucose (SMBG). Also recorded were any problems encountered during SMBG and whether or not the individual would consent to use alternative sites for blood tests.

The participants were invited to have any questions about alternative site testing answered by the medical staff. Over one day, SMBG samples were taken (morning fasting, morning non fasting and afternoon fasting) from a capillary site (finger) first and then from an alternative site chosen by the participant from a selection (see *Figure 1*).

Participants were given a chart to complete with their SMBG results, information about SMBG procedures in alternate sites and a pain scale. The Wong-Baker Pain Faces Rating Scale, a pain scale used for measuring pain intensity in young people aged 3–18 years, was utilised to evaluate the pain levels after blood drawing for glucose monitoring (*Figure 2*; Wong and Baker, 1988). Following the SMBG, the adolescents in our study were asked to choose a face in the scale that best expressed their feelings, which translated to a pain scale score.

The study data were coded with SPSS 10 and evaluated after cumulative figures, percentage distribution, chi-square distribution and regression analyses were conducted.

Results

The average age of the participants was 15 ± 1.91 years. A diabetes duration of >7 years was found in 54.7% of the female participants and 43.7% of the males. In total, 52.8% of the adolescents were taking

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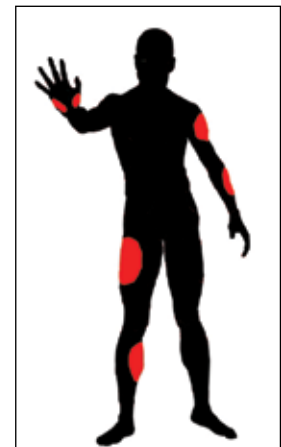


Figure 1. Diagram of alternative testing sites offered to trial participants.

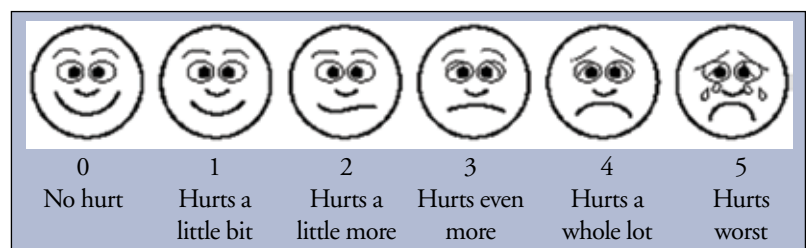


Figure 2. The Wong-Baker Pain Faces Rating Scale.

Table 1. Proportion of 53 participants with type 1 diabetes who experienced specific testing site problems with fingerprick testing.

Problem	n	%
Inadequate blood extraction from fingertip	31	58.5
Feeling of intense pain when pricking the fingertip	17	32.1
Difficulty in measuring because of excessive blood extraction	16	30.2
Pain and aching in fingertips when touching surfaces	12	22.6
Feeling of pins and needles	12	22.6
Weakness in fingers	10	18.9
Coldness in fingertips	8	15.1
Difficulty in holding a pen	3	5.7

Table 2. Preferences for the primary alternative blood glucose test site N=53.

Site	n	%
Forearm	16	30.2
Hypothenar	14	26.4
Thenar	11	20.8
Upper arm	10	18.9
Calf	2	3.8
Thigh	0	0

≥4 insulin injections per day and 86.8% reported having problems during fingerprick blood glucose measurements.

An analysis of the problems illustrated that the highest number of complaints involved inadequate blood extraction from fingertips (58.5%; see *Table 1*).

Pain

The participants of the study were asked to choose an alternate site for blood glucose measurement: their first choices are shown in *Table 2*. Preference was shown for upper arm and hypothenar sites.

Evaluating pain from the fingerprick blood glucose tests, it was found that 20 (37.8%) reported pain on testing compared with 31 (58.5%) using a procedure that utilised an alternative site. In a comparison of pain levels, there was no significant difference between the levels of pain experienced when testing at the fingertip site and at an alternative site.

It was noted that participants reported pressure pain during lancing the alternative site. Nevertheless, it was also reported that the adolescents who had problems with fingertip testing still favoured this familiar site over an alternate site.

Accuracy

Blood glucose samples were collected from the young people with diabetes three times a day from both sites and subsequently analysed. The reliance interval was found to be at the lowest in the morning non-fasting glucose test (n=13.293, slope=0.913, R=0.955) and highest in the afternoon non-fasting glucose tests (n=0.597, slope=1.003, R=0.974).

Discussion

In type 1 diabetes, glycaemic control can be maintained through regular SMBG and appropriate action, which together can help prevent complications in the long term (Jungheim and Koschinsky, 2002; Lock et al, 2002). Until recently, the fingertips have been the only practical sampling site for SMBG. As systems for collecting and measuring blood glucose at alternative anatomical sites gain acceptance, the equivalence of glucose concentrations at these sites becomes an important factor in glycaemic self-management (Ellison et al, 2002).

Pain levels of both capillary and the alternate site tests were assessed in the study and it was found that 62.3% of adolescents reported no pain with fingertip blood glucose testing compared with only 41.5% when sampling from an alternate site.

Six sites other than the fingertip are commonly used for blood glucose tests; the participants in our study primarily preferred forearm tests (30.2%) and hypothenar tests (26.4%) of those offered as alternative sites to the fingertips. The authors hypothesise that this can be explained by the practicality of being able to test from such areas in crowded places such as school, peer groups or family meetings.

Lucidarme et al (2005) conducted a study with 29 young people with type 1 diabetes aged 5–17 years old. After 16 days, 66% of participants preferred using an alternative site over using the fingertip. However, during episodes of hypoglycaemia, the results from the alternative site (in this case, the arm) were, on average, -11.5 ± 31 mg/dl different from the fingertip test. Thus, when testing for the

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1. Participants reported pressure pain during the blood drawing from the alternate site.
2. Adolescents who had problems with capillary site tests still favoured a rather familiar site (capillary) over an alternate site.

purpose of detecting hypoglycaemia, it may be preferable to test on the finger. Moreover, Lucidarne and colleagues strongly suggested that the use of alternate sites be confined to daily glucose tracking and that the capillary site tests be given priority especially for the periods of hypoglycaemia.

Conclusion

The proximity of the reliance intervals of the fingerprick and the alternate site tests provided reasonable data underlining the availability of alternate sites for the glucose tests. While more pain was reported with the alternative sites, this was largely due to pressure pain from attempting to extract an adequate volume of blood. Overall, alternative sites provide a useful and reliable alternative for blood glucose monitoring for some individuals, but cannot be recommended for the majority in the long-term, particularly with regards to accuracy during hypoglycaemia. ■

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