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ORIGINAL ARTICLE

Evaluation of a Minimally Invasive System for Measuring Glucose Area under the Curve during Oral Glucose Tolerance Tests: Usefulness of Sweat Monitoring for Precise Measurement

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Abstract

Aims:

We developed a system for measuring glucose area under the curve (AUC) using minimally invasive interstitial fluid extraction technology (MIET). Sweat contamination during interstitial fluid glucose (IG) extraction affects the accuracy of glucose AUC measurement, because this technology uses extracted sodium ion levels as an internal standard. Therefore, we developed a sweat monitoring patch to reduce this effect and investigated its efficacy in volunteers undergoing oral glucose tolerance tests (OGTTs).

Materials and Methods:

Fifty diabetes mellitus inpatients and 10 healthy subjects undergoing the 75 g OGTT were included. Two sites on the forearm were pretreated with microneedle arrays, then hydrogels for interstitial fluid extraction were placed on the treated sites. Simultaneously, hydrogels for sweat monitoring were placed on untreated sites near the treated sites. Plasma glucose (PG) levels were measured every 30 min for 2 h to calculate reference AUC values. Using MIET, IG AUC was calculated from extracted glucose and sodium ion levels after attachment of the hydrogel for 2 h.

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Abbreviations: (ADA) American Diabetes Association, (AUC) area under the curve, (CGM) continuous glucose monitoring, (DM) diabetes mellitus, (FPG) fasting plasma glucose, (IDF) International Diabetes Federation, (IG) interstitial fluid glucose, (IRI) immunoreactive insulin, (ISF) interstitial fluid, (MIET) minimally invasive interstitial fluid extraction technology, (OGTT) oral glucose tolerance test, (PG) plasma glucose, (SMBG) self-monitoring of blood glucose

Keywords: glucose area under the curve, glucose monitoring, glycemic excursion, interstitial fluid glucose, sweat monitoring

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Abstract cont.

Results:

Good correlation between IG AUC measurements using MIET and reference AUCs measured using PG levels was confirmed over a wide AUC range (202–610 mg/h/dl) after correction for the sweat-induced error detected by the hydrogel patches on the nonpretreated skin. Strong correlation between IG AUC and peak glucose levels indicates that glucose spikes can be easily detected by this system.

Conclusion:

We confirmed the effectiveness of a sweat monitoring patch for precise AUC measurement using MIET. This novel, easy-to-use system has potential for glucose excursion evaluation in daily clinical practice.

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