

# Capillary and venous blood glucose readings in emergency care: correlation and methodological considerations

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**Objectives:** To ascertain the reliability of capillary blood glucose readings and their correlation with venous blood glucose levels according to the conditions under which capillary blood is tested.

**Method:** Capillary blood glucose was measured in 100 healthy volunteers (Optium Xceed blood glucose meter) under 5 conditions: A, before the subject had contact with grapes; B, after touching whole grapes for 10 seconds; C, after brief contact with grape juice and after drying the skin; D, after superficial cleaning; and E, after thorough cleaning.

**Results:** The mean (SD) age of the participants was 35.4 (10.2) years and 72% were women. The mean capillary blood glucose levels were 90 mg/dL in condition A, 115 mg/dL in condition B, 401 mg/dL in C, 198 mg/dL in D, and 124 mg/dL in E ( $P < .001$ , all comparisons). The specificity of the test for detecting abnormal glucose levels ( $> 140$  mg/dL) ranged from 99% under condition A to 7% under condition C. Under condition E, 83% of the volunteers would have been considered diabetics according to the capillary blood glucose reading.

**Conclusions:** The correlation between capillary and venous blood glucose levels is good if the capillary blood reading is taken under the proper conditions. The results of the test may change according to various factors if the technique is not applied correctly. Emergency staff should take care to carry out the test properly. [Emergencias 2008;20:332-334]

**Key words:** Blood glucose. Blood glucose self-monitoring. Hypoglycemia.

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## Introduction

A 76-year-old male was recently attended in our emergency department presenting a diminishment in consciousness while picking grapes. He was a hypertensive, diabetic patient who received treatment with enalapril 5 mg/day and insulin NPH 24-0-14 IU. The patient suddenly presented unintelligible speech, automatism of the upper limbs, sweating and somnolence. He was initially attended in the healthcare centre where blood pressure was reported as 120/70 mm Hg, with cardiac frequency of 50 bpm, blood oxygen saturation measured by pulseoxymetry of 94% and capillary glycaemia of 108 mg/dL. The electrocardiogram was normal and the patient was transferred to the emergency department for suspicion of acute vasculocerebral accident. In the emergency department the vital signs were similar; he was in stupor, salivating, occasional eye opening,

median pupils, without speech, withdrawal on pain stimuli and muscular spasms. A new ECG, chest x-ray, blood analysis and coagulation were normal. On clinical worsening of the patient an urgent cranial computerised tomography (CT) was requested. At this time venous glucose was 21 mg/dL. With such a great difference between capillary and venous glucose readings both were repeated and capillary glycaemia of 92 mg/dL and venous glycaemia of 21 mg/dL were verified. It was interpreted that the difference lay in the hypothetical presence of grape juice remains on the fingers of the patient. After meticulous cleaning of the fingers, hypoglycaemia values were obtained with the glucometre using capillary blood, thereby confirming the suspicion. Given the discrepancy between capillary and venous glucose readings the aim of this study was to investigate the correlation between capillary and venous glucose readings in conditions other than standard.

## Methods

One hundred healthy volunteers from different settings of our hospital with no known history of diabetes agreed to participate in the study after providing informed consent. Capillary glycaemia was measured at baseline (greater than or equal to 2 hours postprandial) in different situations. Five capillary glucose readings were performed (discarding the first drop) using a previously calibrated glucometre (Optium Xceed) with punctures in the side of the fingertips in 5 different situations: A) prior to contact with grapes, B) after touching whole grapes for 10 seconds, C) after brief contact (1-2 seconds) with grape juice and air drying thereafter, D) after superficial cleansing with dry cotton, and E) after in depth cleansing with dry cotton. Determination at time A was denominated as baseline condition since this was made after a postprandial period greater than or equal to 2 hours.

We also determined the percentage of patients in whom erroneous interpretation of raised levels of glycaemia was made and who had been falsely diagnosed with altered glucose tolerance (baseline glycaemia > 126 mg/dL).

The Student's t test was used for the comparison of means and *p* values less than 0.05 were considered statistically significant.

## Results

The mean age of the participants was 35.4 years (SD 10.22) and 72% were women. The means of the different determinations of glycaemia in the different conditions of the study are shown in Table 1. The great difference observed between the different readings and the increase in glycaemia by simply touching whole grapes was of note, with these values rising, in some cases, up to 500 mg/dL on contact with grape juice. It is also interesting that in most cases the cleaning of the finger did not completely eliminate the remains of grape glucose even after two meticulous cleansings.

The specificity for the diagnosis of altered glucose tolerance with the capillary glucose test (for values  $\geq$  160 mg/dL) ranged from 99% for situation A (basal glycaemia) and 7% for situation C (after contact with the grape juice) and was 74% for situation E (after in depth cleansing). It is of note that in the case of situation C 83% of the cases would be included for the study of diabetes for presenting random capillary glucose readings greater than or equal to 200 mg/dL after contact

**Table 1.** Results of the glucometre determination in capillary blood in the 100 patients included in the study

Situation	Mean $\pm$ SD	Range	<i>p</i> *
A	90.4 $\pm$ 14.8	52-142	
B	114.7 $\pm$ 54.2	54-446	<i>p</i> < 0.001
C	400.9 $\pm$ 153.1	74-550	<i>p</i> < 0.001
D	198 $\pm$ 107	75-550	<i>p</i> < 0.001
E	123.7 $\pm$ 43.7	73-348	<i>p</i> < 0.001

\*The values of *p* correspond to the analysis of the difference observed between the mean of each situation (from B to E) and the baseline (situation A). (A- Prior to contact with the grapes. B- After touching whole grapes for 10 seconds. C- After brief contact (1-2 seconds) with grape juice followed by air drying. D- After superficial cleaning with dry cotton. E- After in depth cleansing with dry cotton.)

with grape juice (which, with the presence of symptoms, would be a diagnosis of diabetes).

## Discussion

The clinical manifestations which the patient presented and the first analyses led to the suspicion of a neurological process as the cause for the reduction in the level of consciousness and the presence of a normal CT did not allow this aetiology to be excluded. The increasing availability of imaging tests (CT and magnetic resonance) has produced an artificial deviation in the diagnosis of the causes of coma and under-evaluation of findings on examination<sup>1</sup>.

The simplicity of the diagnosis and treatment of severe hypoglycaemia and the serious implications which a delay in treatment may carry led to the decision to determine the reason for the significant difference between the glycaemia tests performed twice in capillary blood and the venous blood carried out by the biochemistry laboratory<sup>2</sup>.

The possibility of the results being altered because the patient was grape harvesting and the remains of grapes on the fingers could provoke a false normalisation in the capillary glycaemias performed represented the assumption that the puncture zone had not been cleansed and the first drop of blood had not been discarded for the sample, in addition to a curious conclusion<sup>3,4</sup>. The importance of meticulous cleansing of the puncture zone is of note to avoid falsification of the values, since the variation in the data obtained is considerable, even after a second cleansing as shown in this study.

This study was performed with the cleaning of the finger by swabbing with dry cotton according to the guidelines of the use of the glucometres which recommend blood withdrawal from a clean, dry and warm area without the use of alcohol or other antiseptics<sup>4</sup>.

Glucometres are widely used for the determination of capillary glycaemia in emergency departments since they have the advantage of providing rapid and punctual information of the glycaemia of a patient<sup>5</sup>. The good correlation between glycaemia measured in capillary and venous blood using the glucometre and the measurement in serum of plasma in the conventional laboratory (greater than 85-87%) is well known, although this varies depending on the glucose concentration and therefore a reduction may be observed in the precision in extreme concentrations<sup>3,4,6</sup>. Other factors which may influence the capillary glucose values measured with the glucometre include variation in haematocrit, hypotension, hypoxia, level of triglycerides and, as described in the present clinical case and the posterior study undertaken, bad application of the technique providing altered results due to the remains of glucose in the puncture zone.

In conclusion, the use of glucometres in normal conditions is accompanied by acceptable precision and is of great utility, but it is important to observe all the conditions of good technical application in the procedure to avoid interpretation errors. This is of maximum importance in emergency patient care since the pressure in providing care in this scenario may occasionally induce poor technique. It is therefore recommended that if capillary glycaemia results do not agree with clinical suspicion, another puncture area should be

used or a vein should be catheterised and a sample taken from the same to repeat the measurement<sup>8</sup>.

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## Correlación entre glucemia capilar y venosa en urgencias: un apunte metodológico

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**Objetivos:** Comprobar la fiabilidad de la glucemia capilar y su correlación con la glucemia venosa según las condiciones en las que se realice.

**Método:** Se determinó la glucemia capilar en 100 en voluntarios sanos (glucómetro Optium Xceed) en cinco condiciones diferentes: A, previo al contacto con uvas; B, tras tocar durante 10 segundos uvas enteras; C, tras contacto breve con el jugo de uva y posterior secado; D, después de limpieza superficial y E, después de limpieza profunda.

**Resultados:** La edad media de los participantes fue de 35,4 años (DE 10,2) y el 72% eran mujeres. Los valores medios de glucemia capilar (mg/dl) en las cinco condiciones descritas fueron 90 para A, 115 para B ( $p < 0,001$ ), 401 para C ( $p < 0,001$ ), 198 para D ( $p < 0,001$ ) y 124 para E ( $p < 0,001$ ). La especificidad para detectar glucemias alteradas ( $> 140$  mg/dl) osciló entre el 99% en la situación A y el 7% en la situación C. En esta última situación, el 83% de los voluntarios serían considerados diabéticos mediante la determinación de la glucemia capilar.

**Conclusiones:** Existe una buena correlación entre glucemia capilar y venosa cuando la primera se realiza en las condiciones adecuadas, aunque puede verse alterada por distintos factores si existe mala mala aplicación de la técnica, por lo que debe insistirse en su correcta realización en urgencias. [*Emergencias* 2008;20:332-334]

**Palabras clave:** Glucemia capilar. Glucemia venosa. Glucómetro. Coma hipoglucémico.