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Blood Glucose Measurement: Is Serum Equal to Plasma?

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In 2002, the National Academy of Clinical Biochemistry (NACB) published "Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus" [1]. Measurement of plasma glucose was the only diagnostic criterion for diabetes. Glycemic control was monitored by measuring glucose using patients' plasma or blood glucose with meters and laboratory analysis of glycosylated hemoglobin (HbA1c). Ten years later, these recommendations were updated by a multidisciplinary guideline team including clinical, laboratory, and evidence-based guideline methodology experts [2]. The guidelines were reviewed by the joint evidence-based Laboratory Medicine Committee of the American Association for Clinical Chemistry and the NACB, and the guidelines were accepted after revision by the Professional Practice Committee and approved by the Executive Committee of the American Diabetes Association (ADA). In addition to measurement of venous plasma glucose, HbA1c concentration in blood can also be used for the diagnosis of diabetes mellitus.

When glucose is used to diagnose diabetes, the guideline recommends it to be measured in venous plasma in an accredited laboratory. Sample tube should be placed immediately in an ice-water slurry to minimize glycolysis, and the plasma should be separated from the cells within 30 minutes, otherwise a tube containing a rapidly effective glycolysis inhibitor like citrate buffer should be used. Samples for fasting plasma glucose (FPG) analysis should be drawn in the morning rather than in the daytime because of diurnal variation in FPG, which is higher in the morning than in the afternoon [3]. The concentration of glucose decreases due to glycolysis by erythrocyte, white blood cells, and platelet, which degrades glucose at a rate of 5% to 7% per hour [4]. On occasion, it needs to be transported from the site where it was sampled to a remote laboratory facility for glucose measurement, due to which the blood glucose values can appear to be lower than the actual value and lead to false diagnosis, especially for those who are near the cut-off value.

The method used for blood processing can also influence blood glucose levels. Plasma glucose values are about 11% higher than those of whole blood when the hematocrit is normal. Postprandial capillary blood glucose levels are higher than venous blood glucose levels by up to 20%, probably due to glucose consumption in tissues [5]. With regards to the differences in blood glucose level between plasma and serum, some studies reported that plasma glucose is higher than serum glucose whereas other studies found no difference. Nonetheless, measurement of glucose in serum is not recommended for the diagnosis of diabetes [6,7], while plasma allows samples to be centrifuged promptly without waiting for the blood to clot.

In this regards, Kang et al. [8] attempted to compare fasting serum glucose with FPG in real-life clinical situations and also examined an ordinary time delay in sample processing for a month. Serum samples were centrifuged within 1 hour and glucose was measured within 2 hours, while plasma samples were immediately centrifuged and glucose was measured within 15 minutes. Among 1,254 participants, mean glucose concentrations for plasma and serum were 119.4±9.9 and

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108.5±6.5 mg/dL, respectively. When using plasma glucose rather than serum, 20.9% had newly diagnosed with diabetes. Moreover, among the participants who were normoglycemic (n=169) according to their fasting serum glucose levels, 105 and 24 participants were newly diagnosed with impaired fasting glucose and diabetes, respectively. Apart from these results, the time delay from blood sampling to glycemic test in ordinary health examination of the National Health Insurance Corporation was 78±52 minutes.

Screening test for diabetes in asymptomatic people was previously shown to be controversial, but it is now well-established for those who at risk of diabetes and Korean Diabetes Association also recommends screening tests for people at risk. However, every hospital and/or health examination institute has different environment, and the method for glucose measurement may also be different. Time delay as well as different methods of blood processing may lead false missed diagnosis of hyperglycemic status in health screening, especially for those who have glucose levels near the cutoffs value for diagnosis.

In conclusion, although the differences in plasma and serum glucose is not yet clearly revealed, measurement of glucose in plasma allows samples to be centrifuged promptly without waiting for the blood to clot, and values can be measured immediately to avoid glycolysis. Each hospital as well as health screening center should establish an accurate and same diagnostic method to facilitate a quick diagnosis of diabetes and manage people with diabetes efficiently.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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