

Hemoglobin calabria leading to undetectable hemoglobin A1C

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Abstract

More than 12,000 hemoglobin (Hb) variants have been identified and listed on the HbVar database. Reliable detection of these Hb variants is important for planning hemoglobinopathy screening and genetic counseling. Presumptive diagnosis is usually dependent on dedicated Hb analyzers, e.g. high-performance liquid chromatography (HPLC) or capillary electrophoresis (CE) systems specifically developed for Hb fraction separation and quantification. In most cases, simple Hb variants can be easily identified. Rarely, a novel Hb molecule formed by the assembly of different defective globin chains could complicate clinical and laboratory diagnostics and requires DNA testing.

Introduction

Glycated hemoglobin (HbA1c) is the gold standard for evaluating long-term glycemic control in patients with diabetes. HbA1c is proposed as an early diagnostic marker and also is used in long term follow up of Diabetes in guidelines published in 2019 by the American Diabetes Association (ADA) [1-4]. Numerous assays were subsequently developed to measure glycated hemoglobins. The principle of all methods is to separate the glycated and nonglycated forms of hemoglobin. This can be accomplished based on differences in charge (usually by HPLC) or structure (usually immunoassays or boronate affinity chromatography) [5]. The Diabetes Control and Complications Trial's reference method for measurement of HbA1c is cation-exchange HPLC(CE-HPLC). Although CE-HPLC is widely used for the measurement of HbA1c, presence of hemoglobin variants may interfere this test, producing falsely high or low values when the variant hemoglobin or its glycated form cannot be separated from either hemoglobin A or HbA1c [6].

Here we report a case of a variant Hb detected during HbA1c measurement with CE-HPLC in a diabetic patient. This variant Hb was Hemoglobin J-Calabria (c.194G>A (p.Gly65Asp)). We would like to discuss the consequences of Hb variants in interpretation of HbA1c tests.

Case

A 56-year-old woman was referred to internal medicine outpatient clinic for diabetes screening. She was a native of Ankara, the capital of Turkey. She reported a normal physical development and no history of anemia, jaundice, abdominal distension or blood transfusions. Her family history was not significant. General physical and systematic examinations were unremarkable. Complete blood count (CBC), fasting plasma glucose and HbA1c tests ordered. HbA1c was measured

by CE-HPLC method in ARKRAY ADAMS A1c HA-8180V. CBC (complete blood count) results were RBC: $4.8 \times 10^{12}/L$, Hb: 9.8 g/dL, Hct:28.2%, MCV: 58.6 f/L. Fasting glucose was 126 mg/dL. An unusual peak was observed in the labile HbA1c and stable HbA1c was 0.0%. Presence of such a high level of labile HbA1c alerted us for a possible presence of hemoglobinopathy. Then the patient was advised to have a hemoglobin variant analysis with HPCL (Thermo Scientific D10donex Ultimate 3000). HPLC revealed HbA: 11.3%, HbA2: 4.7%, and HbF: 4.3%. A peak of 76.8% unknown hemoglobin. HbA1c level was measured by immunoturbidimetric assay in Dimension RxL Max instrument. HbA1c level was reported as 6.5%. DNA mutation analysis was performed to detect the unusual hemoglobin variant in the department of genetics, University of Health Sciences Dr Sadi Konuk Training and Research Hospital. DNA isolation was achieved by the salt precipitation method and presence of heterozygote Hb J-Calabria variant (c.194G>A (p.Gly65Asp) was detected in our patient.

Discussion

Hb J-Calabria (beta64 (E8) Gly->Asp, also known as J-Bari; J-Cosenza,) is usually detected incidentally. Hematologic parameters are normal in the heterozygote patients. In peripheral smear with cresyl blue, Heinz bodies may be seen. CE-HPLC separates Hb species based on charge differences between HbA1c and other hemoglobins. HPLC shows Hb J-Calibri and HbA separation at alkaline pH; Hb J-Calibri

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moves faster than Hb A. If the Hb substitution causes a change in the net charge of the Hb (as with Hb variants S, C, D, and E), then it may cause interference with methods such as CE-HPLC or electrophoresis [7]. HPLC-based ion-exchange methods for HbA1c have recently been automated, and interferences by Hb species such as HbF and HbS have been minimized. However, several reports have described artificially low or high HbA1c results with hemoglobin variants such as Hb Wayne, Hb Haelen and others when an automated CE-HPLC method is used [8,9]. Hb J-Calibri can be isolated by DEAE-Sephadex chromatography. Although we used DNA sequence analysis to detect Hb-Calibri. In Hb Calibri dna sequence analysis, presumed mutation is on GGC->GAC at codon 64. Hb J-Calabria has increased oxygen affinity; normal cooperativity and Bohr effect. It is mildly unstable.

As far as we know, HB Calabria has been reported only in members of a French family and in a Chinese male. In one of these cases it is found in combination with beta-thalassemia [10,11]. We could not find any cases in the literature about the effect of Hb J-Calibri on the false measurement of HbA1c. As far as we know, this is the first case reported of Hb J-Calibri variant in Turkey. Hb J-Calibri does not lead to clinical abnormalities, it also does not affect hematologic parameters. However, in our case microcytic anemia was present. By further investigations it was found that this microcytic anemia was due to iron deficiency so oral iron replacement therapy was started. We think that Hb J-Calibri and other hb variant cases are mostly overlooked. Hb J-Calibri variant should be taken into account for cases that HbA1c levels cannot be evaluated by CE-HPLC method. If the CE-HPLC method is used to measure HbA1c, then careful inspection of chromatograms may identify the presence of aberrant peaks produced by variants. When the HPLC method shows the presence of an uncommon hemoglobin variant, an alternative method to measure HbA1c should be used [12].

References

- Giardine B, Borg J, Viennas E (2014) Updates of the HbVar database of human hemoglobin variants and thalassemia mutations. *Nucl Acids Res* 42: 1063-1069.
- Fucharoen G, Srivorakun H, Singsanan S (2011) Presumptive diagnosis of common haemoglobinopathies in Southeast Asia using a capillary electrophoresis system. *Int J Lab Hematol* 33: 424-433.
- Szuberski J, Oliveira JL, Hoyer JD (2012) A comprehensive analysis of hemoglobin variants by high performance liquid chromatography (HPLC). *Int J Lab Hematol* 34: 594-604.
- American Diabetes Association (2014) Standards of medical care in diabetes. *Diabet Care* 37: S5-S13.
- Little RR, Sacks DB (2009) HbA1c: how do we measure it and what does it mean? *Curr Opin Endocrinol Diabetes Obes* 16: 113-118. [[Crossref](#)]
- Bouzid K, Ahmed HB, Kalai E (2014) Prevalence of hemoglobin variants in a diabetic population at high risk of hemoglobinopathies and optimization of HbA1c monitoring by incorporating HPLC in the laboratory workup. *Libyan J Med* 9: 25768. [[Crossref](#)]
- Little RR, La'ulu SL, Hanson SE, Rohlfling CL, Schmidt RL (2015) Effects of 49 Different Rare Hb Variants on HbA1c Measurement in Eight Methods. *J Diabetes Sci Technol* 9: 849-856. [[Crossref](#)]
- Rodríguez-Capote K, Estey MP, Barakauskas VE, Burton T, Holmes D, et al. (2015) Identification of Hb Wayne and its effects on HbA1c measurement by 5 methods. *Clin Biochem* 48: 1144-1150. [[Crossref](#)]
- Bots M, Stroobants AK, Delzenne B (2015) Two novel haemoglobin variants that affect haemoglobin A1c measurement by ion-exchange chromatography. *Clin Chem Lab Med* 53: 1465-1471.
- Blouquit Y, Thillet J, Beuzard Y, Vernant JP, Dreyfus B (1977) Structural and functional studies of hemoglobin J Calabria: beta64 (E8) Gly leads to Asp. *Biochim Biophys Acta* 492: 426-432. [[Crossref](#)]
- Chen SS, Yang KG, Jia PC, Liang CC, Long GF, et al. (1982) Studies on abnormal hemoglobins in China: structural analysis of a case of Hbj Calabria (author's transl). *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 4: 6-8. [[Crossref](#)]
- KurtoÄŸlu AU, Eren E, Erkal A, KurtoÄŸlu E, Yilmaz N (2017) Hemoglobin J-Iran (HBB c.232C>G): Interference with the assay of HbA1c. *Clin Chim Acta* 465: 80-81. [[Crossref](#)]