Carnitine Palmitoyltransferase I Deficiency

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Carnitine palmitoyltransferase I (CPT I) deficiency is a condition that prevents the body from using certain fats for energy, particularly during periods without food (fasting). The severity of this condition varies among affected individuals.

genetic conditions

1. Introduction

Signs and symptoms of CPT I deficiency often appear during early childhood. Affected individuals usually have low blood sugar (hypoglycemia) and a low level of ketones, which are produced during the breakdown of fats and used for energy. Together these signs are called hypoketotic hypoglycemia. People with CPT I deficiency can also have an enlarged liver (hepatomegaly), liver malfunction, and elevated levels of carnitine in the blood. Carnitine, a natural substance acquired mostly through the diet, is used by cells to process fats and produce energy. Individuals with CPT I deficiency are at risk for nervous system damage, liver failure, seizures, coma, and sudden death.

Problems related to CPT I deficiency can be triggered by periods of fasting or by illnesses such as viral infections. This disorder is sometimes mistaken for Reye syndrome, a severe disorder that may develop in children while they appear to be recovering from viral infections such as chicken pox or flu. Most cases of Reye syndrome are associated with the use of aspirin during these viral infections.

2. Frequency

CPT I deficiency is a rare disorder; fewer than 50 affected individuals have been identified. This disorder may be more common in the Hutterite and Inuit populations.

3. Causes

Mutations in the *CPT1A* gene cause CPT I deficiency. This gene provides instructions for making an enzyme called carnitine palmitoyltransferase 1A, which is found in the liver. Carnitine palmitoyltransferase 1A is essential for fatty acid oxidation, which is the multistep process that breaks down (metabolizes) fats and converts them into energy. Fatty acid oxidation takes place within mitochondria, which are the energy-producing centers in cells. A group of fats called long-chain fatty acids cannot enter mitochondria unless they are attached to carnitine. Carnitine palmitoyltransferase 1A connects carnitine to long-chain fatty acids so they can enter mitochondria and be used to

produce energy. During periods of fasting, long-chain fatty acids are an important energy source for the liver and other tissues.

Mutations in the *CPT1A* gene severely reduce or eliminate the activity of carnitine palmitoyltransferase 1A. Without enough of this enzyme, carnitine is not attached to long-chain fatty acids. As a result, these fatty acids cannot enter mitochondria and be converted into energy. Reduced energy production can lead to some of the features of CPT I deficiency, such as hypoketotic hypoglycemia. Fatty acids may also build up in cells and damage the liver, heart, and brain. This abnormal buildup causes the other signs and symptoms of the disorder.

3.1. The Gene Associated with Carnitine Palmitoyltransferase I Deficiency

- CPT1A

4. Inheritance

This condition is inherited in an autosomal recessive pattern, which means both copies of the gene in each cell have mutations. The parents of an individual with an autosomal recessive condition each carry one copy of the mutated gene, but they typically do not show signs and symptoms of the condition.

5. Other Names for This Condition

- carnitine palmitoyltransferase IA deficiency
- CPT 1A deficiency
- CPT deficiency, hepatic, type I
- CPT I deficiency
- liver form of carnitine palmitoyltransferase deficiency

References

1. Akkaoui M, Cohen I, Esnous C, Lenoir V, Sournac M, Girard J, Prip-Buus C.Modulation of the hepatic malonyl-CoA-carnitine palmitoyltransferase 1Apartnership creates a metabolic switch allowing oxidation of de novo fatty acids.Biochem J. 2009 May 27;420(3):429-38. doi: 10.1042/BJ20081932.
2. Bennett MJ, Boriack RL, Narayan S, Rutledge SL, Raff ML. Novel mutations inCPT 1A define molecular heterogeneity of hepatic carnitine palmitoyltransferase Ideficiency. Mol Genet Metab. 2004 May;82(1):59-63.
3. Dykema DM. Carnitine palmitoyltransferase-1A deficiency: a look at classic andarctic variants. Adv Neonatal Care. 2012 Feb;12(1):23-7. doi:10.1097/ANC.0b013e318242df6d.

4. Gobin S, Thuillier L, Jogl G, Faye A, Tong L, Chi M, Bonnefont JP, Girard J,Prip-Buus C. Functional and structural basis of carnitine palmitoyltransferase 1Adeficiency. J Biol Chem. 2003 Dec 12;278(50):50428-34.
5. Greenberg CR, Dilling LA, Thompson GR, Seargeant LE, Haworth JC, Phillips S,Chan A, Vallance HD, Waters PJ, Sinclair G, Lillquist Y, Wanders RJ, Olpin SE.The paradox of the carnitine palmitoyltransferase type Ia P479L variant inCanadian Aboriginal populations. Mol Genet Metab. 2009 Apr;96(4):201-7. doi:10.1016/j.ymgme.2008.12.018.
6. Longo N, Amat di San Filippo C, Pasquali M. Disorders of carnitine transportand the carnitine cycle. Am J Med Genet C Semin Med Genet. 2006 May15;142C(2):77-85. Review.
7. Olpin SE, Allen J, Bonham JR, Clark S, Clayton PT, Calvin J, Downing M, IvesK, Jones S, Manning NJ, Pollitt RJ, Standing SJ, Tanner MS. Features of carnitinepalmitoyltransferase type I deficiency. J Inherit Metab Dis. 2001Feb;24(1):35-42.
8. Rajakumar C, Ban MR, Cao H, Young TK, Bjerregaard P, Hegele RA. Carnitinepalmitoyltransferase IA polymorphism P479L is common in Greenland Inuit and isassociated with elevated plasma apolipoprotein A-I. J Lipid Res. 2009Jun;50(6):1223-8. doi: 10.1194/jlr.P900001-JLR200.