Severe Infantile Transaldolase deficiency: A case report

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Abstract

Transaldolase TALDO deficiency is a rare autosomal recessive disorder of the pentose phosphate pathway. It has variable presentations with poor outcome when present early in life. We present a young Saudi infant with a fatal early presentation of TALD deficiency.

Introduction

Transaldolase TALDO is an enzyme required in pentose phosphate pathway (PPP). It is an alternative route for glucose oxidation. It links the pentose phosphate pathway to glycolysis. The end products are D-ribose 5-phosphate and Nicotinamide adenine dinucleotidephosphate NADPH. In the absence of TALDO, toxic intermediate products may accumulate and lead to variety of clinical features. TALDO deficiency is a rare autosomal recessive disorder with main presentations: an early onset severe form that can be fatal and a late onset presentation which comprises a slowly progressive less severe form of the disease. The diagnosis can be made by special tests in urine and plasma or by enzymatic assay. However, the diagnosis nowadays is usually confirmed by DNA analysis of the TALDO1 gene. No effective treatment is available so far.

The Case

This is a four months old girl who was born at term by normal spontaneous vaginal delivery to a 39 years old mother. The parents are second degree cousins. They have had another five healthy children. The pregnancy was uneventful. The birth weight was 2.1 kg (-2.4 SD), length 48 cm (-0.5 SD) and head circumference 31 cm (-2.8 SD). The patient was admitted on the second day of life to NICU for six days because of indirect hyperbilirubenaemia (total bilirubin 158 normal 5.1–20.5 mmol/L). In the absence of TALDO, toxic intermediate products may accumulate and lead to variety of clinical features. TALDO deficiency is a rare autosomal recessive disorder with main presentations: an early onset severe form that can be fatal and a late onset presentation which comprises a slowly progressive less severe form of the disease. The diagnosis can be made by special tests in urine and plasma or by enzymatic assay. However, the diagnosis nowadays is usually confirmed by DNA analysis of the TALDO1 gene. No effective treatment is available so far.

The patient was discharged in a stable condition. He was seen after one week where the repeated CBC was normal and the platelet count was 200. At the age of four months the patient presented with abdominal distension that started according to the parents at the age of one moth and was gradually increasing. There was no history of vomiting, diarrhea or constipation, fever, skin rash or decreased activity. The baby was on breast feeding with acceptable intake. The physical examination revealed normal vital signs with subtle dysmorphic features (low set ears and depressed nasal bridge). The skin examination was unremarkable. The liver enzymes were mildly elevated. ALT 135 (normal 3–30 U/L) and AST 81 (normal 2–40 U/L) while the serum bilirubin was initially 95 mmol/L with direct fraction of 50 mmol/L. Later on the serum bilirubin increased gradually till reached 539 mmol/L with direct fraction of 355 mmol/L. Alkaline phosphatase 1107 (normal 110–400 U/L), albumin 13 (normal 30–46 g/L) and GGT 77 (normal 12–55 U/L). Urine analysis was negative for protein and others. The coagulation...
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Discussion

Pentose pathway is an alternative route for glucose oxidation. The end products of the pathway are D-ribose 5-phosphate and Nicotinamide adenine dinucleotide phosphate NADPH. Trans ketolase and transaldolase, are essential enzymes required to link the pentose phosphate pathway to glycolysis in a reversible fashion. These two enzymes convert pentose 5-phosphate into glycolytic intermediates [1,2]. By conversion of the carbon structure among different sugars, it enables the production of fructose-6-phosphate and erythrose-4-phosphate from glyceraldehyde-3-phosphate and sedoheptulose-7-phosphate. Intermediate toxic metabolites such as ribitol, D-arabitol and erythritol may accumulate In the absence of transaldolase [3], TALDO deficiency is a rare autosomal recessive inborn error of the pentose phosphate pathway first described in 2001 [1].

To date, has been diagnosed in 41 patients worldwide. The largest number of these patient where interestingly Saudis (12 patients) [4-8]. Two main presentations of TALDO has been recognized so far: an early onset presentation (prenatal or neonatal disease) which is the severe form, in most of the cases rapidly fatal, and a late onset presentation (early or late infantile form) with slowly progressive and milder form of the disease. The liver dysfunction begins in early fetal life in both presentations. In the early onset presentation, liver involvement usually present in the form of coagulopathy, transaminitis, hyпо albuminemia, and skin changes in newborns. Progressive liver failure is the main factor in the reduced lifespan. In patients with later onset disease, liver dysfunction is milder and progresses more slowly. Renal tubular dysfunction may occur and usually present with low molecular weight proteinuria [8]. The mechanism of liver and kidney involvement in TALDO is most likely secondary to the toxic accumulation of sugars and polyols (sedoheptulose-7-phosphate, ribose-5-phosphate, ribulose-5-phosphate, xylulose-5-phosphate and C5-polyols: D-ribitol; D-arabitol; and D-xylitol) on the hepatocytes and kidney tubules [2,9,10]. The concentrations of these toxic metabolites are notably the highest in the first weeks of life. Polyol concentrations seem to decrease with age. The other clinical features are summarized in table 1.

Our patient represented the severe neonatal type of TALDO deficiency. The interesting feature is the huge splenomegaly which was more impressive than hepatomegaly. In most of the reported cases the hepatomegaly was more impressive. The diagnosis of TALDO deficiency is challenging. As the clinical presentation varies, the diagnosis usually is confirmed by DNA analysis of the TALDO1 gene. Abnormal polyols and/ or sugars (erythritol, arabitol, ribitol, sedoheptitol, perseitol,

### Table 1: Clinical features of Transaldolase deficiency. Williams M, et al. J Inherit Metab Dis. 2019 [8].

| APCEI Score | 0 | 1 | 2 | 3 | 4 | 5 |
|-------------|---|---|---|---|---|---|
| Accumulation of polyols (in the urine) | | | | | | |
| Reaction | | | | | | |
| Rejected | | | | | | |
| Opposed | | | | | | |
| Full polyester | | | | | | |
| Partial polyester | | | | | | |
| None | | | | | | |
| In addition | | | | | | |
| C-1 carbon (no polyols) | | | | | | |
| Acidosis | | | | | | |
| +a 60-80 mmHg | | | | | | |
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Sedoheptulose, mannoheptulose, and sedoheptulose-7P) can be detected in urine. Erythritol, arabitol, and ribitol may be mildly elevated in the plasma and cerebrospinal fluid. Previously erythronic acid has been labeled as a biomarker in TALDO-D. Aminoaciduria is not uncommon but usually not specific and of the form commonly seen with liver dysfunction (high glutamine, methionine, and ethanolamine). Enzymatic analysis of TALDO enzyme can be measured and usually showed lower level than control. Most patients are homozygous for a mutation in TALDO1 in keeping with the high frequency of consanguinity. Missense mutations, in frame deletions, and frameshift mutations have been detected [8]. No effective treatment for TALDO deficiency is available up to date. Liver transplantation has a potential risk of disease recurrence. N-acetylcysteine, decreasing oxidative stress with antioxidants (e.g., vitamins C or E), and reducing polyols or sugar-P accumulation by using specific inhibitors of the PPP were suggested [11]. Only N-acetylcysteine is shown to work on and the response was specifically reported after challenging with acetaminophen [4,5,7]. In conclusion, TALDO deficiency is a rare in born error of metabolism of the pentose phosphate pathway with multisystem variable presentations that should be considered in any pediatric patient with unexplained hepatosplenomegaly or hepatic failure. However, no effective treatment is available so far.

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