Lactate dehydrogenase deficiency

Lactate dehydrogenase deficiency is a condition that affects how the body breaks down sugar to use as energy in cells, primarily muscle cells.

There are two types of this condition: lactate dehydrogenase-A deficiency (sometimes called glycogen storage disease XI) and lactate dehydrogenase-B deficiency.

People with lactate dehydrogenase-A deficiency experience fatigue, muscle pain, and cramps during exercise (exercise intolerance). In some people with lactate dehydrogenase-A deficiency, high-intensity exercise or other strenuous activity leads to the breakdown of muscle tissue (rhabdomyolysis). The destruction of muscle tissue releases a protein called myoglobin, which is processed by the kidneys and released in the urine (myoglobinuria). Myoglobin causes the urine to be red or brown. This protein can also damage the kidneys, in some cases leading to life-threatening kidney failure. Some people with lactate dehydrogenase-A deficiency develop skin rashes. The severity of the signs and symptoms among individuals with lactate dehydrogenase-A deficiency varies greatly.

People with lactate dehydrogenase-B deficiency typically do not have any signs or symptoms of the condition. They do not have difficulty with physical activity or any specific physical features related to the condition. Affected individuals are usually discovered only when routine blood tests reveal reduced lactate dehydrogenase activity.

Frequency

Lactate dehydrogenase deficiency is a rare disorder. In Japan, this condition affects 1 in 1 million individuals; the prevalence of lactate dehydrogenase deficiency in other countries is unknown.

Causes

Mutations in the \textit{LDHA} gene cause lactate dehydrogenase-A deficiency, and mutations in the \textit{LDHB} gene cause lactate dehydrogenase-B deficiency. These genes provide instructions for making the lactate dehydrogenase-A and lactate dehydrogenase-B pieces (subunits) of the lactate dehydrogenase enzyme. This enzyme is found throughout the body and is important for creating energy for cells. There are five different forms of this enzyme, each made up of four protein subunits. Various combinations of the lactate dehydrogenase-A and lactate dehydrogenase-B subunits make up the different forms of the enzyme.

The version of lactate dehydrogenase made of four lactate dehydrogenase-A subunits is found primarily in skeletal muscles, which are muscles used for movement. Skeletal
muscles need large amounts of energy during high-intensity physical activity when
the body's oxygen intake is not sufficient for the amount of energy required (anaerobic
exercise). During anaerobic exercise, the lactate dehydrogenase enzyme is involved
in the breakdown of sugar stored in the muscles (in the form of glycogen) to create
additional energy. During the final stage of glycogen breakdown, lactate dehydrogenase
converts a molecule called pyruvate to a similar molecule called lactate.

Mutations in the LDHA gene result in the production of an abnormal lactate
dehydrogenase-A subunit that cannot attach (bind) to other subunits to form the lactate
dehydrogenase enzyme. A lack of functional subunit reduces the amount of enzyme
that is formed, mostly affecting skeletal muscles. As a result, glycogen is not broken
down efficiently, leading to decreased energy in muscle cells. When muscle cells do
not get sufficient energy during exercise or strenuous activity, the muscles become
weak and muscle tissue can break down, as experienced by people with lactate
dehydrogenase-A deficiency.

The version of lactate dehydrogenase made of four lactate dehydrogenase-B subunits
is found primarily in heart (cardiac) muscle. In cardiac muscle, lactate dehydrogenase
converts lactate to pyruvate, which can participate in other chemical reactions to
create energy. LDHB gene mutations lead to the production of an abnormal lactate
dehydrogenase-B subunit that cannot form the lactate dehydrogenase enzyme. Even
though lactate dehydrogenase activity is decreased in the cardiac muscle of people with
lactate dehydrogenase-B deficiency, they do not appear to have any signs or symptoms
related to their condition. It is unclear why this type of enzyme deficiency does not
cause any health problems.

**Inheritance Pattern**

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.

**Other Names for This Condition**

- deficiency of lactate dehydrogenase
- lactate dehydrogenase subunit deficiencies
- LDH deficiency
Diagnosis & Management

Genetic Testing Information

- What is genetic testing? https://primer/testing/genetictesting

Research Studies from ClinicalTrials.gov

- ClinicalTrials.gov https://clinicaltrials.gov/ct2/results?cond=%22lactate+dehydrogenase+deficiency %22

Other Diagnosis and Management Resources


Additional Information & Resources

Health Information from MedlinePlus

- Encyclopedia: Lactate Dehydrogenase Test https://medlineplus.gov/ency/article/003471.htm
- Health Topic: Carbohydrate Metabolism Disorders https://medlineplus.gov/carbohydratemetabolismdisorders.html
Genetic and Rare Diseases Information Center

- Lactate dehydrogenase A deficiency
  https://rarediseases.info.nih.gov/diseases/3160/lactate-dehydrogenase-a-deficiency
- Lactate dehydrogenase B deficiency
  https://rarediseases.info.nih.gov/diseases/3161/lactate-dehydrogenase-b-deficiency
- Lactate dehydrogenase deficiency
  https://rarediseases.info.nih.gov/diseases/3159/lactate-dehydrogenase-deficiency

Educational Resources

- Johns Hopkins Medicine: End Stage Renal Disease (What is Renal Failure?)
  https://www.hopkinsmedicine.org/healthlibrary/conditions/adult/kidney_and_urinary_system_disorders/end_stage_renal_disease_esrd_85,P01474
- Kennedy Krieger Institute: Metabolic Myopathies
  https://www.kennedykrieger.org/patient-care/conditions/metabolic-myopathies
- KidsHealth from Nemours: Blood Test: Lactate Dehydrogenase (LDH)
- MalaCards: lactate dehydrogenase deficiency
  https://www.malacards.org/card/lactate_dehydrogenase_deficiency
- Orphanet: Glycogen storage disease due to lactate dehydrogenase deficiency
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=2364
- Washington University, St. Louis: Neuromuscular Disease Center: Lactate Dehydrogenase A Deficiency
  https://neuromuscular.wustl.edu/msys/glycogen.html#ldh

Patient Support and Advocacy Resources

- Muscular Dystrophy Association
  https://www.mda.org/disease/metabolic-myopathies/types/lactate-dehydrogenase-deficiency

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28%28lactate+dehydrogenase+deficiency%5BTIAB%5D%29+OR+%28lactate+dehydrogenase+subunit+deficiency%5BTIAB%5D%29+OR+%28lactate+dehydrogenase+A+deficiency%5BTIAB%5D%29%29+AND+english%5Blang%5D+AND+human%5Bmh%5D
Catalog of Genes and Diseases from OMIM

- GLYCOGEN STORAGE DISEASE XI
  http://omim.org/entry/612933

- LACTATE DEHYDROGENASE B DEFICIENCY
  http://omim.org/entry/614128

Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/7603529

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/22127970

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/2620460

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/7630349

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/8044998

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