Clinical Diagnosis

PLA2G6-associated neurodegeneration (PLAN) is an inherited group of diseases that includes three different phenotypes; classic infantile neuroaxonal dystrophy (INAD), atypical neuroaxonal dystrophy (NAD), and PLA2G6-related dystonia–parkinsonism. Infantile neuroaxonal dystrophy (INAD) is a progressive neurodegenerative disorder that was diagnosed by clinical findings prior to discovery of the causative gene, PLA2G6, in 2006. For classic INAD, the most common clinical features are onset before 3 years of age, clinical evidence for CNS involvement, psychomotor regression, progression, and histopathologic evidence of dystrophic axons (spheroid bodies). The strongest corroborative features include cerebellar atrophy (seen in most cases), optic atrophy, and axial hypotonia leading to spasticity and rigidity. In about half of cases abnormal iron accumulation will be detected in the globus pallidus on T2-weighted MRI. Atypical NAD has a later onset, typically during early childhood to adolescence, and slower progression. Features include speech delay, autistic features, gait changes and dystonia. PLA2G6-related dystonia–parkinsonism occurs in late adolescence to early adulthood. Common features include parkinsonism, dystonia, and neuropsychiatric changes. For a complete review of PLAN, please refer to the listing on www.genereviews.org.

Inheritance

PLAN is inherited in an autosomal recessive fashion, meaning that both parents of an affected child are obligate carriers of mutations in the PLA2G6 gene. The recurrence risk for a couple with an affected child is 1 in 4 (25%) for any future pregnancy, and each healthy sibling of an affected child has a 2 in 3 (66%) chance of being a carrier.

Molecular Genetic Testing

PLA2G6 is the only known gene associated with PLAN. Clinical uses for testing include confirmation of the diagnosis, carrier testing for others such as parents or siblings, and prenatal diagnosis to determine whether a developing fetus is affected. Pre-implantation genetic diagnosis uses in vitro fertilization techniques with molecular genetic testing to predict which embryos will be affected before transferring them into the mother. PGD will be possible for families with identifiable mutations, and the OHSU Knight Diagnostic Laboratories can provide input to PGD centers as needed for these cases.

Testing is done by DNA sequencing of the coding region (17 exons) and splice sites to determine the presence of disease-causing mutations and/or benign single nucleotide polymorphisms. Testing detects approximately 85% of mutations in individuals with a clinical diagnosis of INAD. For the entire population of individuals positive for PLA2G6 mutations, approximately 10% have only one mutation identified. If the clinical findings are consistent with PLAN, then it is assumed that a second mutation is present that cannot be detected by current testing methodologies.
Testing Strategy for a Proband

Discovery of the \textit{PLA2G6} gene has altered the testing strategy. When INAD or atypical NAD are suspected, we recommend an ophthalmological examination and brain MRI because cerebellar atrophy and optic atrophy are strong corroborative features. If suspicion remains high, mutation scanning of \textit{PLA2G6} is recommended as the next step instead of a nerve biopsy. If no mutations are found but the evolving phenotype remains most consistent with INAD, then a biopsy to assess for spheroid bodies could be considered.

Genetically Related (Allelic) Disorders

Individuals with Karak syndrome, Schindler disease, and neurodegeneration with brain iron accumulation (NBIA) were found to be in the phenotypic spectrum of PLAN, and are no longer considered to be clinically distinct.

Specimen Requirements:

- **Blood:** ACD (solution A or B) tubes, 5 mL for adults and children, 2-3 mL for infants. Requisition form must accompany specimen, including ethnicity, clinical and family history information. Turnaround time is approximately 3 weeks.

- **CPT codes:**
  - 83891, 83898x17, 83904x17, 83912

- **Cost:**
  - Full gene sequencing costs approximately $2050.00 (please contact lab for exact amount). Testing additional family members for known mutations is done for a reduced charge.

Patient resources:

- **International PLAN Research Registry**
  
- **Oregon Health & Science University**
  
- **NBIA Disorders Association**
  
- **Portland, OR**
  
- **503-494-4344**
  
- **www.NBIAdiseases.org**
  
- **El Cajon, CA**
  
- **619-588-2315**

- **International Dystrophie Neuro Axonale Infantile Association**

- **Paris, France**

- **http://asso.orpha.net/DNAI/**

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