**TTN-related Disorders: TTN Gene Deletion/Duplication**

**Test Code:** DDTNX  
**Turnaround time:** 2 weeks  
**CPT Codes:** 81228 x1

### Condition Description

Titan is an extremely large protein that makes up a large part of cardiac and skeletal muscle sarcomere. Titan is encoded by the TTN gene (2q31.2). Mutations in the TTN gene are associated with different disorders and modes of inheritance.

**Autosomal Dominant:**
- Dilated cardiomyopathy
- Hypertrophic cardiomyopathy
- Hereditary myopathy with early respiratory failure

**Autosomal Recessive:**
- Limb-girdle muscular dystrophy
- Tardive tibial muscular dystrophy
- Early-onset myopathy with fatal cardiomyopathy

**Dilated Cardiomyopathy**
Hereditary dilated cardiomyopathy (DCM) may be inherited in an autosomal dominant, autosomal recessive, or X-linked manner, depending on the gene involved. DCM is characterized by left ventricular enlargement and reduced myocardial contraction force. Typically, DCM presents with one of three features: heart failure, thromboembolic disease, or arrhythmias and/or conduction system disease. Approximately 20-50% of idiopathic dilated cardiomyopathy (those cases not due to acquired causes) are thought to have a genetic cause.

**Hypertrophic Cardiomyopathy**
Hereditary hypertrophic cardiomyopathy (HCM) is characterized by left ventricular hypertrophy in the absence of a predisposing cardiac or cardiovascular condition. The manifestation of HCM is extremely variable, even within the same family, and can range from asymptomatic to progressive heart failure. Other features include syncope, presyncope, shortness of breath, chest pain, orthostasis, and palpitations. The onset of HCM is usually during adolescence or young adulthood; however, it can range from infancy to much later in adult life.

**Hereditary Myopathy with Early Respiratory Failure**
Hereditary myopathy with early respiratory failure (HMERF) is an adult-onset myopathy with early respiratory muscle involvement. In most individuals with HMERF, the respiratory muscles, especially the diaphragm were involved. Additionally, individuals with HMERF have proximal weakness of the upper and lower extremities, the neck flexors were involved and some had foot extensor weakness. Creatine kinase (CK) levels are normal or slightly elevated. The age of onset can range from the second to the fifth decade of life.

**Limb-Girdle Muscular Dystrophy**
Limb-girdle muscular dystrophy (LGMD) is a descriptive term applied to a clinically and genetically heterogeneous group of childhood- or adult-onset muscular dystrophies. LGMD is characterized by weakness and wasting restricted to the limb musculature, proximal greater than distal. Onset, progression, and distribution of the weakness and wasting vary considerably among individuals and genetic subtypes. Serum creatine kinase (CK) levels in individuals with LGMD are usually elevated, and muscle biopsy reveals dystrophic changes. LGMDs are distinct from the much more common X-linked dystrophinopathies, which include Duchenne and Becker muscular dystrophy (DMD/BMD). Currently, there are at least twelve genes that cause LGMDs. Mutations in the TTN gene cause autosomal recessive LGMD 2J.

**Tardive Tibial Muscular Dystrophy**
Tardive tibial muscular dystrophy, also known as Udd distal myopathy, is an autosomal dominant disorder that has slow disease progression. It is characterized by weakness of ankle dorsiflexion and the loss of ability to walk on ones heels after age 35.

**Early-Onset Myopathy with Fatal Cardiomyopathy**
Early-onset myopathy with fatal cardiomyopathy (EOMFC), also known as Salih myopathy, is an autosomal recessive disorder that is characterized by muscle weakness and delayed motor development. The muscle weakness can begin in the neonatal period or in early infancy. As the disease progresses, other systems become involved; moderate joint and neck contractures, scoliosis, and dilated cardiomyopathy. Cognitive development is normal. Two mutations within the TTN gene are needed to cause EOMFC.

### References:
- GeneReviews
- OMIM #188840: TTN gene
- OMIM #604145: DCM 1G
- OMIM #613765: HCM 9
- OMIM #608807: LGMD 2J
- OMIM #611705: Early-onset myopathy with fatal cardiomyopathy
- OMIM #603689: Hereditary myopathy with early respiratory failure
- OMIM #600334: Tardive tibial muscular dystrophy

### Genes

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**Indications**

This test is indicated for:

- Confirmation of a clinical diagnosis of a TTN-related disorder in an individual in whom sequence analysis was negative.
- Carrier testing in adults with a family history of a TTN-related disorder in whom sequence analysis was negative.

**Methodology**

DNA isolated from peripheral blood is hybridized to a CGH array to detect deletions and duplications. The targeted CGH array has overlapping probes which cover the entire genomic region.

Please note that a "backbone" of probes across the entire genome are included on the array for analytical and quality control purposes. Rarely, off-target copy number variants causative of disease may be identified that may or may not be related to the patient's phenotype. Only known pathogenic off-target copy number variants will be reported. Off-target copy number variants of unknown clinical significance will not be reported.

**Detection**

Detection is limited to duplications and deletions. The CGH array will not detect point or intronic mutations. Results of molecular analysis must be interpreted in the context of the patient's clinical and/or biochemical phenotype.

**Specimen Requirements**

Submit only 1 of the following specimen types

* Preferred specimen type: Whole Blood

**Type: Whole Blood**

Specimen Requirements:

In EDTA (purple top) or ACD (yellow top) tube:
- Infants (2 years): 3-5 ml
- Older Children & Adults: 5-10 ml

Specimen Collection and Shipping: Refrigerate until time of shipment. Ship sample within 5 days of collection at room temperature with overnight delivery.

**Type: Saliva**

Specimen Requirements:

Oragene™ Saliva Collection kit (available through EGL) used according to manufacturer instructions.

Specimen Collection and Shipping: Store sample at room temperature. Ship sample within 5 days of collection at room temperature with overnight delivery.

**Special Instructions**

Sequence analysis is required before deletion/duplication analysis by targeted CGH array. If sequencing is performed outside of Emory Genetics Laboratory, please submit a copy of the sequencing report with the test requisition.

**Related Tests**

- A cardiomyopathy next generation sequencing panel is available and includes the TTN gene.
- Custom diagnostic mutation analysis (Test Code: KM or DKMDD) is available to family members if mutations are identified by targeted mutation testing or sequencing analysis.
- Prenatal testing is available only for known familial mutations to individuals who are confirmed carriers of mutations. Please contact the laboratory genetic counselor to discuss appropriate testing prior to collecting a prenatal specimen.