Bethlem Myopathy/Ullrich Congenital Muscular Dystrophy: \textit{COL6A2} Gene Deletion/Duplication

\textbf{Condition Description}

The congenital muscular dystrophies are a group of genetically and clinically heterogeneous hereditary myopathies characterized by congenital hypotonia and muscle weakness, contractures, and delayed motor development. Muscle biopsy usually reveals a nonspecific dystrophic pattern. The clinical course is broadly variable and can involve the brain and eyes. Initial testing often includes clinical evaluation, muscle imaging, electromyography, and muscle biopsy, followed by targeted genetic testing.

The collagens are a superfamily of extracellular matrix proteins that play a role in maintaining the integrity of various tissues. Collagen VI forms a microfibrillar network in close association with the basement membrane around muscle cells. Collagen VI is composed of three different peptide chains: alpha1(VI), alpha2(VI), and alpha3(VI). The alpha1(VI) and alpha2(VI) chains are encoded by two genes -- \textit{COL6A1} and \textit{COL6A2} respectively -- situated on chromosome 21q22.3. \textit{COL6A3}, the gene for the alpha3(VI) chain, maps to chromosome 2q37. Mutations in the type VI collagen genes are associated with Bethlem myopathy and Ullrich congenital muscular dystrophy, which are likely different ends of a clinical spectrum. Mutations are identified in approximately 66\% of individuals clinically affected with Bethlem myopathy and approximately 79\% of individuals clinically affected with Ullrich CMD.

\textit{Bethlem Myopathy}

Bethlem myopathy (BM) is an autosomal dominant myopathy with contractures. BM is clinically heterogeneous, although the hallmark of this condition is early contractures of the interphalangeal joints of the fingers, elbows, and ankle joints, together with flexion contractures of the elbow and of the ankles. Other symptoms can include proximal weakness, decreased fetal movements, congenital torticollis, bilateral clubfoot, and keloid formation. IQ and brain development are usually unaffected. Onset may be in the neonatal period, childhood, or adolescence, but most children exhibit weakness or contractures during the first two years of life. Occasionally, spontaneous improvement of muscle weakness and of congenital contractures is noticed in the first decade. The course is slowly progressive, and after the fifth decade more than half of the patients need aids for ambulation, especially outdoors.

\textit{Ullrich Congenital Muscular Dystrophy}

Ullrich congenital muscular dystrophy (UCMD) has a more severe phenotype, in general, than BM. Common symptoms include neonatal muscle weakness, proximal joint contractures, hyperlaxity of the distal joints, failure to thrive, lack of independent ambulation, and severe respiratory impairments by the end of the first decade of life. Other symptoms can include congenital hip dislocation, torticollis, prominent ears and heels, keloid formation, hyperkeratosis, scoliosis, and facial weakness. IQ and brain development are usually unaffected. Respiratory failure can lead to life-threatening infections in the first or second decade of life. UCMD is autosomal recessive in about 40\% of cases, and is now known to be dominant in the other 60\% of cases.

Histopathological findings on muscle biopsy for both conditions are either nonspecific or show dystrophic changes and CK levels are either normal or mildly elevated. Immunofluorescent labeling of collagen VI in fibroblast cultures is a useful diagnostic tool, although double labeling is recommended to verify that the collagen VI protein that is present localizes correctly to the basement membrane. Expression of laminin alpha 2 (merosin) is normal.

For patients with suspected Bethlem myopathy or Ullrich CMD, sequence analysis is recommended as the first step in mutation identification. For patients in whom mutations are not identified by full gene sequencing, deletion/duplication analysis is appropriate.

\textbf{References}

- Bonnemann, Carsten. Personal communication, July 8, 2009.

\textbf{Genes}

\textit{COL6A2}

\textbf{Indications}

This test is indicated for:

- Confirmation of a clinical diagnosis of Bethlem myopathy or Ullrich CMD in an individual in whom sequencing analysis was negative.
- Carrier testing in adults with a family history of autosomal recessive Ullrich CMD in whom sequencing analysis was negative.

\textbf{Methodology}

Disclaimer: This information is confidential and subject to change without notice. It may not be reproduced in whole or part unless authorized in writing by an authorized EGL representative.
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**

Submit copies of diagnostic biochemical test results with the sample, if appropriate. Contact the laboratory if further information is needed.

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**

- Sequence analysis of the COL6A2 is required before deletion/duplication analysis
- Analysis of the COL6A1 and COL6A3 genes is also available.
- Prenatal testing is available to couples who are confirmed carriers of mutations. Please contact the laboratory genetic counselor to discuss appropriate testing prior to collecting a prenatal specimen.