

Facts About **Myotonic Muscular Dystrophy**

MDA[®] Muscular
Dystrophy
Association
Fighting Muscle Disease

Dear Friends:

Myotonic muscular dystrophy (MMD) has been a part of my family's life for many years. The symptoms for my siblings and me began in our 30s, and we believe the disease goes back at least two generations before us. Some of my nieces and nephews also are affected.

Like many of you, we were surprised to learn that such a wide range of symptoms — muscle weakness, involuntary clenching of hands and jaw, swallowing problems, eye problems, heart disorders, extreme fatigue and other difficulties — could be caused by a form of muscular dystrophy. With correct information about our disorder, we're able to monitor and protect our health to a great degree.

This pamphlet has been prepared to give you the basic knowledge about MMD that you'll need to make your life enjoyable and productive. With this information, you or your children can be prepared for changes to come and armed to minimize many effects of the disease.

By understanding how the disease affects me in different ways, I've been able to stay active while avoiding more physically demanding activities. I take pains to keep my stress level to a minimum and make sure I get plenty of sleep, because I've learned that stress and fatigue will exacerbate my symptoms rapidly. A pacemaker corrects the heart problems caused by my MMD.

I find that, with these precautions and forms of assistance, there's little I can't do in my personal life with my husband and extended family.

My sister and brothers have had to make similar adjustments to the effects of MMD. My nieces and nephews showed symptoms in childhood, and they've received expert medical guidance from the begin-

ning for symptoms that include learning disabilities.

From this booklet you'll learn some encouraging things about MMD: There are treatments and interventions for most of the symptoms and difficulties that arise with the disease. And MDA's research program is constantly making strides toward better treatments and a cure. "MDA Is Here to Help You," on page 14, introduces MDA's many services.

In the meantime, it's good to know that people with disabilities have more opportunities than ever before to develop and use their abilities, as well as legal rights to equal employment opportunity and access to public places. Federal law guarantees children with physical and cognitive disabilities a public education with whatever supports they need.

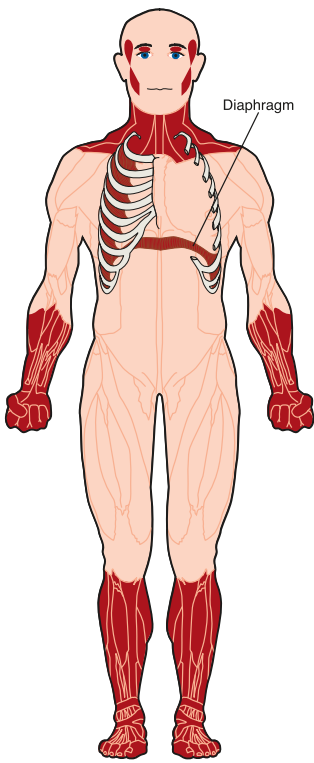
My family's greatest ally in living with MMD is MDA. So, as you face the challenges ahead, please remember: You're not alone.



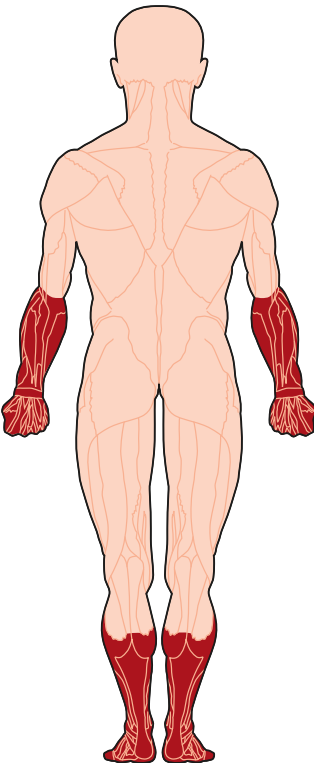
Denise Balon
New Port Richey, Florida



Denise Balon



Weakness and wasting of voluntary muscles in the face, neck and lower arms and legs are common in myotonic muscular dystrophy. Muscles between the ribs and those of the diaphragm, which moves up and down to allow inhalation and exhalation of air, also can be weakened.



MMD symptoms also can begin in children past infancy but not yet adolescents. Generally, the earlier MMD begins, the more severe the disease symptoms.

What Is Myotonic Muscular Dystrophy?

Myotonic muscular dystrophy (MMD) is a form of muscular dystrophy that affects muscles and many other organs in the body. Unlike some forms of muscular dystrophy, MMD often doesn't become a problem until adulthood and usually allows people to walk and be fairly independent throughout their lives.

The infant form of MMD is more severe. It can occur in babies born to parents who have the adult form, even if the parents have very mild cases.

The word *myotonic* is the adjective for the word *myotonia*, an inability to relax muscles at will. Most commonly, myotonia makes it difficult to relax the fingers after a firm hand grip. People with adult-onset myotonic dystrophy may simply adjust to this problem, and not realize that slow muscle relaxation is abnormal.

The term *muscular dystrophy* means progressive muscle degeneration, with weakness and shrinkage of the muscle tissue. This muscle wasting generally presents much more of a problem to people with MMD than does the myotonia. Muscle pain also can occur in MMD.

Myotonic muscular dystrophy often is known simply as *myotonic dystrophy* and occasionally is called *Steinert disease*, after the doctor who originally described the disorder in 1909. It's also called by its Greek name *dystrophia myotonica*, and therefore sometimes is abbreviated "DM" rather than "MMD."

Myotonia isn't a feature of any other form of muscular dystrophy (although it occurs in other kinds of muscle diseases, where it can be severe). When a person suspected of having muscular dystrophy has myotonia, the diagnosis is likely to be MMD.

MMD varies greatly in severity, even within the same family. Not everyone

has all the symptoms and not everyone has them to the same degree. For some people, symptoms are fairly mild even in middle age, while for others, the weakness and wasting are severely limiting to daily activities. For still others, the effects are somewhere in between.

There is, however, a distinct difference between the type that affects newborn infants — *congenital MMD* — and the type that begins in adolescence or adulthood — *adult-onset MMD*.

Infants with congenital MMD have severe muscle weakness, including weakening of the muscles that control breathing and swallowing. These problems can be life-threatening and need intensive care. Myotonia isn't part of the picture in infants with MMD but may occur in later life.

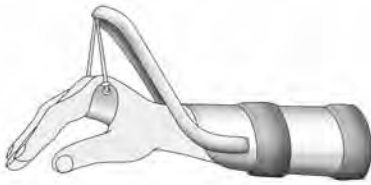
What causes myotonic muscular dystrophy?

Myotonic muscular dystrophy is caused when a portion of either of two genes is larger than it should be. See "Does It Run in the Family?" (page 12) to learn what scientists understand about how these genetic flaws cause MMD.

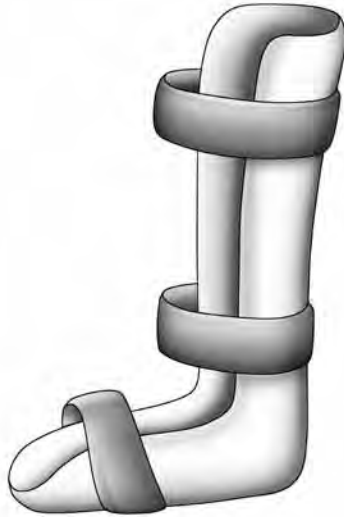
The *chromosome 19* form of the disease, called *type 1 MMD (MMD1 or DM1)*, is the most common, and most of this booklet describes that form.

Type 2 MMD (MMD2 or DM2), arising from an abnormality on chromosome 3, is less common, generally less severe, but not as well understood as the chromosome 19 form.

Most of the information in this booklet is derived from studies of people with type 1 MMD.



A wrist support can hold the hand in a good position for using a keyboard, writing or drawing.



An ankle-foot orthosis (AFO) can keep the foot from flopping down and causing falls.



A long, thin face with hollow temples, drooping eyelids and, in men, balding in the front, is typical in myotonic dystrophy.

What happens in adult-onset MMD?

When MMD begins in the teen years or during adulthood, it can be a slowly progressive condition resulting in a modest amount of disability. However, for others the condition can have a major effect on daily life, mobility and employment.

A confusing aspect of MMD for people with the condition and their doctors is that many different parts of the body can be affected. The following paragraphs discuss different problems that can occur, although many people with the disease only have some of them. Most of the problems can be lessened with treatment.

Limb muscles

Weakness of the voluntary muscles usually is the most noticeable symptom for people with adult-onset MMD.

The *distal muscles* — those farthest from the center of the body — usually are the first, and sometimes the only, limb muscles affected in MMD1. Areas of the limbs affected may include the forearms, hands, lower legs and feet. Over time, these muscles get smaller, so the lower legs and arms may appear thinner than the upper legs and arms.

People with MMD often notice that their grip is weak and that they have trouble using their wrist or hand muscles. At the same time, the muscles that pick up the foot when walking weaken, so the foot flops down, leading to tripping and falling. This is called *foot drop*.

Some people can compensate for weak foot muscles by picking up the foot from the knee and walking with a “marching” step. Eventually, though, many people with MMD find that a cane or walker is helpful to compensate for foot and leg weakness.

A lower leg brace, called an *ankle-foot orthosis* or *AFO*, may be needed. A few people with MMD use a wheelchair or a power scooter for convenience when covering long distances.

Various devices that hold the hand in a good position for using a keyboard or writing or drawing can help compensate for weak wrist and hand muscles.

Head, neck and face muscles

The muscles of the neck, jaw and parts of the head and face may weaken, especially in MMD1. Weakness and loss of bulk in these muscles leads to a characteristic appearance doctors and experienced family members recognize as MMD. In men, early balding in the front part of the scalp is very common, adding to the distinct appearance of MMD.

Eyelids may droop (called *ptosis*, but the “p” is silent). The chewing muscles can be affected, which makes the temples appear hollow and the face look thin.

Severe ptosis can be troubling. It may be hard to hold the eyes open for reading, watching television or driving. Special glasses with “eyelid crutches” can hold the eyes open. You can’t buy these off the shelf, but a skilled optician can make them for you. Surgery can be done, but weakness often comes back, making it necessary to repeat the operation.

Weak neck muscles can make it hard to sit up quickly or lift one’s head straight up off a bed or couch. The stronger trunk muscles have to be used for these actions.

Muscle weakness generally has a somewhat different pattern in MMD2. Facial weakness is much less common than in MMD1, while weakness of the upper part of the leg (thigh) occurs early in the disease. In type 1, thigh weakness, if it occurs, comes later in the disease.

Breathing and swallowing muscles

Respiratory muscles can become weak in MMD1, affecting lung function and depriving the body of needed oxygen. Weakness of the diaphragm and other breathing muscles can lead to problems getting enough oxygen when a person is asleep, even if they don't have any symptoms of breathing difficulty while awake.

Respiratory problems are further aggravated, many experts believe, by an abnormality in the brain's breathing control center. This abnormality also can lead to a condition known as *sleep apnea*, in which people stop breathing for several seconds or even a minute many times a night while asleep.

A good way to treat respiratory muscle weakness is to pump air into the lungs during the night with a small, portable "breathing booster" known as a *bilevel positive airway pressure device* (also called BiPAP, a registered trademark of the Respironics company). It's usually used with a face mask that easily can be taken on and off. This kind of breathing assistance also can be used during the day, although usually that's not necessary. (CPAP or *continuous positive airway pressure* devices are not as useful for people whose respiratory problems are caused by weak breathing muscles.)

Cough assist machines and techniques can help people clear out secretions, especially when a person with MMD1 has a cold or chest infection. The MDA clinic doctor, respiratory therapist or a specialist called a *pulmonologist* can advise about these techniques and machines and how to use them.

Respiratory muscle weakness does not appear to be a feature of MMD2.

Swallowing muscles, if weakened, can lead to choking or "swallowing the wrong way," with food or liquid going down the trachea (windpipe) to the lungs instead

of down the esophagus to the stomach. (Inhaling food or body secretions into the lungs is called *aspiration*.) Swallowing is partly voluntary and partly involuntary, and both sets of muscles can be affected.

Vomiting can be very dangerous for a person with MMD whose swallowing muscles are weak. A head-down position is crucial to prevent inhaling the vomit — a possibly fatal problem.

A swallowing specialist can help people learn to swallow more safely and, if needed, how to change the consistencies of foods and liquids so they can be swallowed more easily. It's important to watch for swallowing problems, such as a tendency to choke on food or drinks, and mention them to the doctor.

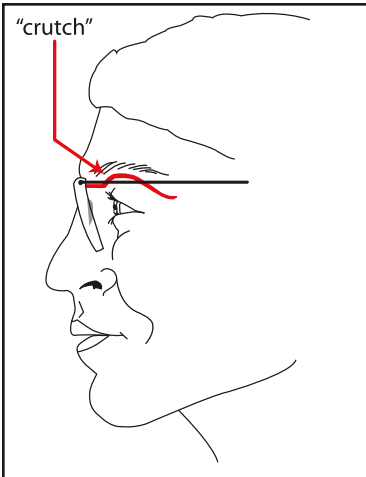
If swallowing difficulties are extreme (more common in congenital MMD1 than in adults with MMD), a feeding tube can be inserted into the stomach to aid nutrition and prevent aspiration of food and drink. It later can be removed if the problem resolves itself.

Myotonia

Myotonia of voluntary muscles can make it hard for someone with MMD1 or MMD2 to relax the grip, especially in cold temperatures. Door handles, cups, handwriting and using hand tools may pose a problem, although some people never notice it. Myotonia also can affect the muscles of the tongue and jaw, causing difficulty with speech and chewing.

Myotonia typically is not very bothersome in MMD1, but if it becomes troublesome, drugs, such as mexiletine (Mexitil), can be used to treat it.

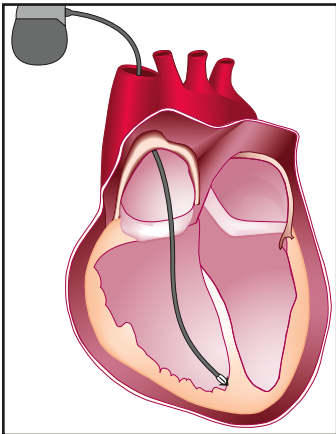
Myotonia can be uncomfortable and even cause pain, although people with MMD also can have muscle pain that isn't connected to the myotonia.



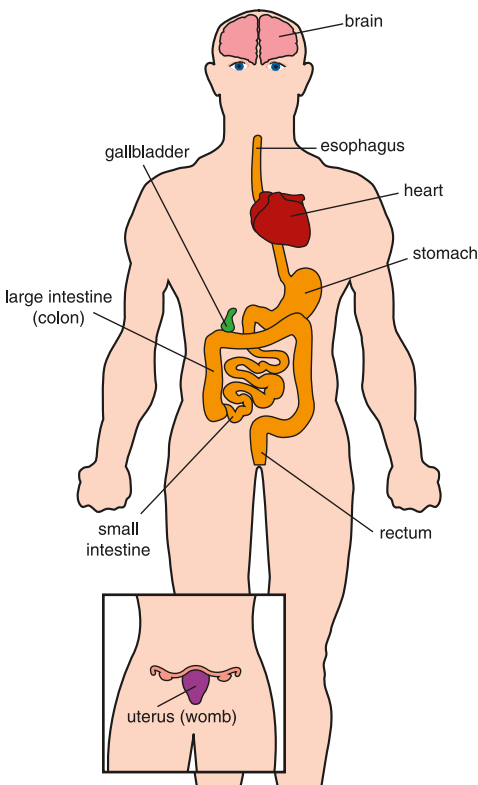
Special glasses with "crutches" to hold skin away from the eyes can help when muscles in this area are weak.



The use during the night of a portable ventilator with a face mask can help compensate for weak breathing muscles and faulty breathing control by the brain.



A cardiac pacemaker can return the heartbeat to a normal rhythm.



The digestive tract and uterus (womb) often are affected in type 1 myotonic dystrophy. These organs contain involuntary muscles, which can weaken or develop myotonia (trouble relaxing). Abnormalities in the brain can lead to excessive sleepiness or apathy. The heart (especially the “electrical” part) also can be affected.

Heart problems

The heart can be affected in MMD1 or MMD2. Oddly, since MMD is mostly a muscle disease, it isn’t the muscle part of the heart (which pumps blood) that’s most affected, but rather the part that sets the rate and rhythm of the heartbeat — the heart’s *conduction system*. It’s common in MMD1, especially after many years, to develop a *conduction block*, which is a block in the electricity-like signal that keeps the heart beating at a safe rate. This appears to occur in MMD2 as well, although there aren’t as many studies in this form of the disease.

Fainting, near fainting or dizzy spells are the usual symptoms of conduction block, and these should never be ignored! Such problems can be fatal.

In the early stages, a partial conduction block may cause no symptoms but can be detected by an *electrocardiogram (EKG)*, a painless test of how the heart is beating. The doctor likely will order regular EKGs. Conduction blocks can usually be corrected by a *cardiac pacemaker*, an electronic device that’s surgically inserted near the heart to regulate the heartbeat.

In both forms of MMD, cardiac muscle impairment also can occur, although it isn’t as common as conduction abnormalities.

Not everyone with MMD needs treatment for heart problems, but everyone should be checked for them.

Internal organs

Most of the internal organs in the body are hollow tubes (such as the intestines) or sacs (such as the stomach). The walls of these tubes and sacs contain involuntary muscles that squeeze the organs and move things (food, liquids, a baby during childbirth and so forth) through them.

In MMD1, many of the involuntary muscles that surround the hollow organs can weaken. These include the muscles of the digestive tract, the uterus and the blood vessels. As of 2008, these problems appear to be absent or mild in MMD2.

Abnormal action of the upper digestive tract can impair swallowing. Once food is swallowed, the involuntary muscles of the esophagus should take over and move food into the stomach. However, in MMD1, these can have spasms and weakness, causing a feeling of food getting “stuck” and sometimes leading to inhaling food into the lungs. Care in swallowing, sometimes with the advice of a specialist, may be needed.

The lower digestive tract — large intestine (colon), rectum and anus — also can be affected by weakness and spasm in MMD1. Crampy pain, constipation and diarrhea can occur. Your doctor can advise about setting up a bowel routine and using diet and other treatments to help manage this kind of problem.

Drugs such as metoclopramide (Reglan) help move things along the digestive tract and sometimes are used to treat these problems in MMD1.

The gallbladder — a sac under the liver that squeezes bile into the intestines after meals — can weaken in MMD1. People with MMD probably are more likely than the general population to develop gallstones. Symptoms are difficulty digesting fatty foods and pain in the upper right part of the abdomen. Surgery can be done if necessary.

Fortunately, most people don’t have problems in urinating or holding onto urine in MMD.

There's a wide range in severity of the mental and emotional symptoms of the disease.

Because of weakness and uncoordinated action of the muscle wall of the uterus, women with MMD1 may experience difficulties in childbirth that can be serious for both mother and baby. These may involve excessive bleeding or ineffective labor. Sometimes a Caesarean operation (C-section) is advised, but surgery also can be a problem in MMD (see "Anesthesia," page 8).

A pregnant woman with MMD1 has to be certain that all her doctors, including any who will manage the delivery, are well informed about her neuromuscular condition. Serious problems can result if this step is missing.

Men with MMD1 or MMD2 may experience atrophy (shrinking) of the testicles and reduced fertility.

Blood pressure in MMD1 tends to be low. This is probably due to low tone of the smooth muscles in the blood vessels. It usually poses no problem and may even be one beneficial effect of MMD1.

The brain

Some people with type 1 MMD have been labeled by doctors and family members as slow, dull, uncaring, unenthusiastic or depressed. On the other hand, others are high achievers. Only recently have researchers tried to get at the truth or untruth of these descriptions.

First, as with other aspects of MMD, there's a wide range in severity of the mental and emotional symptoms of the disease. Some people function very well, others poorly, many somewhere in between.

Facial expression can be misleading in MMD1. Weakness of the facial muscles, with drooping eyes, can lead an outsider to think that the person with MMD1 is not interested or dull. Facial weakness is mild in MMD2 and is less likely to confuse observers.

Children born with the severe, congenital form of MMD1 have a lot of learning problems and may have cognitive disabilities. They often need special education because of these disabilities.

In adults, severe mental impairment is less common, but an overall inability to "settle down to something," apply oneself to work or family life, concentrate or become engrossed in a task often is reported in MMD1.

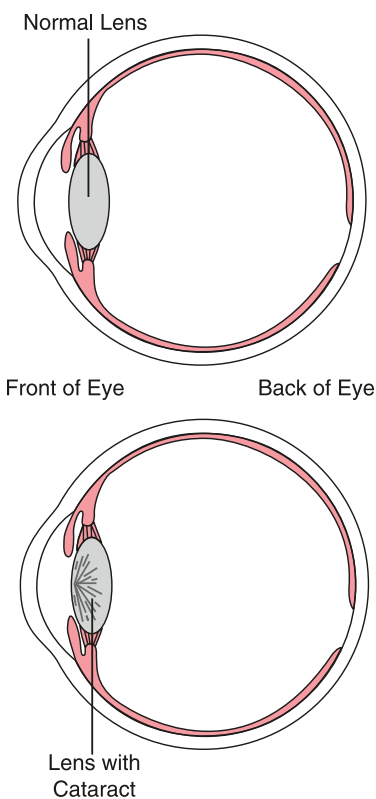
Adults with MMD1 often find they need much more sleep than other people do and may feel at the beginning of the day the way most people feel at the end of a long work day. This can be very hard for others to understand.

Research suggests that, in MMD1, there may be abnormalities in the parts of the brain that determine the rhythm of sleeping and waking. Respiratory regulation and weakness of the respiratory muscles, along with irregular breathing during sleep, all combine to make this problem severe in some people (though not in everyone).

Daytime sleepiness can sometimes be helped with medication. One drug that can be used is methylphenidate (Ritalin). A newer drug is modafinil (Provigil). These drugs may work on the brain's sleep-wake cycle.

Another approach that can be tried is to coax the body into a better rhythm of sleeping and waking by going to bed and getting up at the same time every day. Consult with a respiratory specialist familiar with muscular dystrophy to determine if breathing is compromised during sleep.

There isn't as much research on personality, cognition or sleepiness in MMD2 as in MMD1. As of 2008, it appears that people with MMD2 can have some of the same difficulties in these areas as people with MMD1, but these problems are much less



The eye's lens focuses light on the back part of the eye to allow vision. When cataracts cloud the lens, the visual image is no longer as clear.



If you're planning surgery, be sure the neurologist, anesthesiologist and surgeon know you have myotonic dystrophy.

evident. So far, no congenital form, in which cognitive disabilities can occur, has been identified in MMD2.

The eyes

Cataracts — cloudy areas of the lens of the eye that eventually can interfere with vision — are extremely common in both types of MMD. Cataracts are caused by a chemical change in the lens, which gradually goes from clear to cloudy the way the clear part of an egg changes to white when cooked. Exactly why cataracts occur in MMD isn't known.

The person with a cataract may notice that things start to look blurry, hazy or dim, and that this worsens gradually over time. It often happens in both eyes, but not necessarily at the same time or at the same rate.

Surgery can remove a lens that contains a cataract. Then, the surgeon either puts in an artificial lens, or the patient can wear special contact lenses or eyeglasses.

Vision correction with cataract surgery is quite good. However, with this operation or any procedure requiring anesthesia, the medical team must be informed about the underlying MMD. Anesthesia can pose special problems, especially in MMD1.

The muscles that move the eyes, as well as those that open and close them, occasionally are affected in MMD1, and other eye problems sometimes occur. Your primary care provider or MDA clinic physician can refer you to an eye doctor (*ophthalmologist*) for regular checkups or when eye problems need attention.

Diabetes

If you read about MMD in books or on the Internet, you may find diabetes listed among the problems in this disorder.

Fortunately, most people with MMD1 and MMD2 don't have diabetes, but they may develop a condition that is sometimes referred to as *insulin resistance*. This

means the body makes insulin (a hormone needed for the cells to take up and use sugars), but for some reason, it takes more insulin to do the job because the muscle tissues don't respond normally to the usual amounts of insulin.

Your doctor may order blood and/or urine tests to see if you have insulin resistance or diabetes. If you do, you may be advised to change your diet or exercise habits or to take medication. Your doctor may refer you to a specialist or primary care physician for further treatment for diabetes.

Anesthesia

An unusually high rate of complications and even deaths associated with general anesthesia (given during surgery) have been reported in people with MMD1. This can occur even if the MMD is mild. In fact, mild cases can be particularly dangerous because the surgeon, anesthesiologist and patient may be less likely to pay attention to the MMD when planning surgery.

Surgery usually can be safely undertaken with careful monitoring of cardiac and respiratory functions before, during and after the surgery. Be sure to tell the entire medical team, especially those responsible for the anesthesia, that you or your family member has MMD (even if the disease is MMD2, since little is known about this disease and anesthesia). If at all possible, have the anesthesiologist and the neurologist communicate long before the surgery.

What happens in congenital MMD?

The most serious form of MMD is the congenital (at birth) form of the disease. Congenital MMD only has been observed in MMD1. When a child with congenital MMD1 is born, it's almost always found that the mother has adult-onset MMD1 — even though her symptoms may be so mild that she doesn't even know she has the disorder.



A child born with congenital myotonic dystrophy is likely to have facial muscle weakness and an upper lip that looks “tented.” The eye muscles also may be affected.



Early physical, occupational and speech therapy can help children with congenital myotonic muscular dystrophy make the most of their abilities.

Mothers with MMD also can pass on the adult-onset form. A child can inherit the disease from the father, but it’s almost always the adult-onset form. These unusual features aren’t seen in other genetic disorders.

Weak muscles

Babies with congenital MMD1 have very weak muscles and a lack of muscle tone (*hypotonia*). They appear floppy, have trouble breathing, and suck and swallow poorly.

In the past, many infants with congenital MMD didn’t survive. Today, with special care in neonatal intensive care units, such children have a much better chance of survival, although they still will face multiple challenges in childhood.

Voluntary and involuntary aspects of respiration usually are affected in congenital MMD and respiratory support, such as artificial ventilation, probably will be needed, at least at first. Because swallowing muscles are affected, special feeding techniques or a feeding tube that goes into the stomach may be needed to provide adequate nutrition and prevent choking.

Children with congenital MMD have facial muscle weakness, leading to a bland expression and an upper lip that comes to a point — known as a *tented upper lip*.

Babies with congenital MMD often are born with *clubfeet* — a curvature of the feet and lower legs. Clubfeet need surgical correction for the child to be able to walk. The problem may be due to abnormal muscle development in the lower legs and feet during fetal life.

Infants with MMD don’t have myotonia at first but develop it later in life.

Cognitive disabilities

Infants born with congenital MMD1 are likely to have cognitive disabilities (sometimes called mental retardation), although

this isn’t always the case. This seems to be related to improper development of parts of the brain, presumably caused by genetic abnormalities.

Some experts have suggested that the very high incidence of labor and delivery complications in mothers with MMD also could be a contributing factor to the cognitive problems seen in these babies. For this reason, it’s very important to make doubly sure that everyone on the medical team is aware of and can work to minimize the risks surrounding labor and delivery to the mother and child with MMD.

Speech and hearing difficulties

The muscles involved in talking often are affected in congenital MMD1. Hearing also can be impaired.

Therapy from a *speech-language pathologist* (in a medical center) or *speech therapist* (in a school) can help. Even before a child enters school, early intervention programs are vital. Talk to your pediatrician, MDA clinic physician or medical social worker about such programs.

Vision problems

The eye muscles are affected and can cause the eyes not to work together; this condition is called *strabismus*. If severe, it can be corrected with surgery.

Cataracts, common in adult-onset MMD, *aren’t* a feature of congenital MMD during early childhood. However, children with MMD are likely to develop them later.

Outgrowing congenital MMD

Infants and children with MMD1 symptoms may “outgrow” many of the muscle-related aspects of the disorder as they mature. Although cognitive difficulties don’t improve, children can learn when given the right tools, instruction and environment.

However, despite early gains during childhood, all children with congenital MMD will develop the adult form of MMD when they reach adolescence or adulthood.

How is MMD diagnosed?

Doctors with experience in neuromuscular disorders find it easy to diagnose type 1 MMD. They often can just look at a person, examine him and ask a few questions to make the diagnosis. Teenagers and adults with MMD1 usually have a characteristic long face with hollow temples and, in men, early balding.

Many people tell the doctor about recurring abdominal pain, constipation or obstetrical complications. Others say their parents had some muscle problems.

Sometimes, an eye doctor will notice the particular type of cataract found in MMD and suspect the disease, referring the patient to a neurologist.

Many people may not realize they have any trouble relaxing their grip, while others say they've had trouble letting go of a shovel, screwdriver or some other device, especially in cold weather.

The doctor may check for myotonia by lightly tapping the area just under the thumb with a rubber hammer. In most people, there is little or no response. In people with myotonia, there's a swift contraction of the muscle, which takes several seconds to relax.

The doctor may want to do electrical testing of the muscles and nerves, using an *electromyogram*, or *EMG*. In this exam, small needles are inserted into muscles to measure their electrical activity. Myotonia produces a characteristic sound often described as the noise made by a dive-bombing airplane.

The doctor may move from the history and physical exam to a *DNA test* to

confirm a diagnosis of MMD. The DNA test involves only a blood sample and, in almost all cases, can determine whether the family is affected by MMD.

In some cases, a *muscle biopsy* may be considered. In this test, a small piece of muscle is surgically removed for examination.

How is MMD treated?

At this time, there's no specific treatment that "gets at the root" of MMD1 or MMD2. Treatment is aimed at managing symptoms and minimizing disability.

Canes, braces, walkers and scooters can help with mobility problems. Careful monitoring of cardiac and respiratory functions can lead to early treatment of these problems with a cardiac pacemaker or a portable "breathing booster" (see "Breathing and swallowing muscles," page 5).

Medications and other treatments for constipation and other digestive tract complaints can be employed.

Surgery for cataracts and either surgery or special eye crutches for drooping eyelids can markedly improve vision.

New medications to treat excessive sleepiness can make life more enjoyable for the person with MMD and his or her family.

In children with the congenital form of MMD1, early intervention is crucial. Hearing and vision abnormalities should be diagnosed and treated as soon as possible. Surgery for uncoordinated eye muscles and special education are among the interventions that can greatly influence a child's success in life.

If you have a child with congenital MMD1, it's very important to seek out an early intervention program through your MDA clinic, pediatrician, medical social worker, school system or other resources.



A cane can provide support when lower leg weakness makes walking hazardous.

Comparison of MMD1 and MMD2

Feature	MMD1	MMD2
facial muscle weakness	common, early	uncommon
neck muscle weakness	common, early	common, early
finger muscle weakness	common, early	common, early
arm muscle weakness — elbow area	uncommon	common
arm muscle weakness — forearms	common	uncommon
ankle muscle weakness	common, early	uncommon
hip and thigh muscle weakness	common, late	common, early
myotonia	common	common
muscle pain	common	common
respiratory muscle weakness	common	uncommon
cardiac conduction abnormalities	common	can occur over time
cardiac muscle impairment	uncommon	can occur over time
cognitive impairment	common	not as common or severe as in MMD1
mental retardation	occurs in congenital MMD1	not reported
psychological dysfunction	common	not as common or severe as in MMD1
excessive daytime sleepiness	common	not as common or severe as in MMD1
cataracts	common	common
gastrointestinal problems	common	absent or mild
atrophy of testicles and reduced fertility	common	can occur
insulin resistance	common	common
premature balding in men	common	can occur

Does It Run in the Family?

MMMD is certainly a disease that runs in families. Both types are inherited in an *autosomal dominant* pattern, meaning it takes only one flawed gene to cause symptoms of the disease. So, if one parent has the disorder, every child of that person has a 50 percent chance of inheriting the gene that causes it.

If either the type 1 (chromosome 19) or the type 2 (chromosome 3) genetic abnormality is passed on, the child almost will certainly develop the disease. MMD1 very often is more severe in the child than in the parent. In MMD2, this increase in severity between generations also occurs, but not as consistently.

A 'growing' gene

In 1992, with MDA support, a landmark genetic discovery was made by three teams of scientists. They found in people with what is now called MMD1 an area of DNA (the basic genetic material that makes up our genes) on chromosome 19 that's larger than it should be.

The expanded DNA is in a gene that carries instructions for *myotonin protein kinase*. The expanded DNA isn't in the "working" part of the gene — the part that carries instructions for making protein. Instead, in MMD, the genetic flaw is in a part of a gene called the *untranslated* DNA, an area of DNA that the cell doesn't use for protein manufacturing.

The experts were puzzled to find that an expanded section of this untranslated DNA could cause so much trouble, and the mystery still isn't entirely solved.

There was more puzzlement to come. The expanded section of DNA seen in MMD1 was found to grow even more as it was passed from parent to child. This explained the observation that children generally are more seriously affected by MMD1 than are their parents.

The expanding DNA also explains why children with the congenital form of type 1 MMD

can be born to parents who have the less severe, adult-onset form. However, it doesn't fully explain why this phenomenon occurs so often when mothers have MMD1 and so rarely when fathers do. It may have to do with a difference in the way egg cells, as opposed to sperm, are made in the body.

In 2001, MDA researchers in Minnesota, working with their counterparts in Germany, identified a gene on chromosome 3 that carries instructions for a protein called *zinc finger 9*. When this gene contains an expanded section of DNA, it too causes a form of MMD.

That type of myotonic dystrophy, MMD2, is found chiefly in Northern Europeans or their descendants. In Germany, MMD2 may be as common as MMD1.

The expanded DNA on chromosome 3 that underlies MMD2 can change size but does not "grow" in size as consistently as it does in MMD1.

Today, scientists are investigating how expanded areas of DNA cause the various symptoms of MMD1 and MMD2. There are many possibilities. As of 2008, experts generally believe that, in both forms of the disease, the DNA expansion leads to expanded strands of RNA and that these RNA expansions have toxic effects on cells.

In addition, direct effects of the DNA expansions on local genes on chromosome 19 or chromosome 3 may play a role.

Ongoing research to answer these questions should lead to treatments for MMD.

Genetic testing

Genetic testing for the expanded DNA that leads to either type of MMD can be performed in several laboratories. Ask your MDA clinic physician or genetic counselor to refer you for a genetic test.

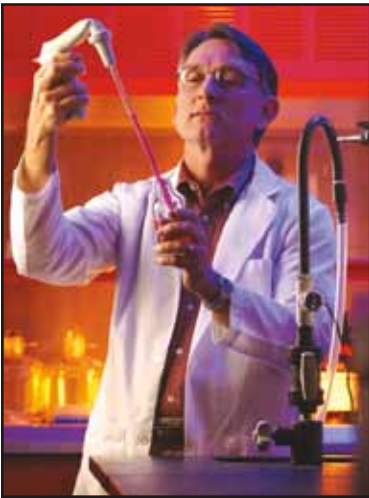


MDA's Search for Treatments and Cures

The MDA website is constantly updated with the latest information about the neuromuscular diseases in its program. See the latest research news at www.mda.org.

The years since the discovery of the genetic cause of myotonic MD in 1992 have been fruitful ones for MMD research.

Scientists, many of them funded through MDA's worldwide research program, are gaining understanding of how the expanded DNA sections on chromosome 19 and chromosome 3 cause so many physiologic changes. Such discoveries are likely to provide valuable insights for future treatment avenues.



Some MDA research grantees are pursuing nonspecific approaches to maintain muscle tissue despite the presence of a degenerative muscle disease. For example, blocking myostatin, a protein that limits muscle growth, is a promising research area.

The ultimate "cure" for MMD1 and MMD2 is likely to involve blocking, silencing or removing the expanded areas of DNA on chromosome 19 or chromosome 3 (or the expanded genetic material called RNA that's made from this DNA) so that they lose their toxic effects on cells. As of late 2009, several MDA research grantees are pursuing strategies to accomplish this.

MDA Is Here to Help You

The Muscular Dystrophy Association offers a vast array of services to help you and your family deal with myotonic muscular dystrophy. The staff at your local MDA office is there to assist you in many ways. The Association's services include:

- nationwide network of clinics staffed by top neuromuscular disease specialists
- MDA summer camps for kids with neuromuscular diseases
- help with locating durable medical equipment through its national equipment program
- financial assistance with repairs or modifications to all types of durable medical equipment
- annual occupational, physical, respiratory or speech therapy consultations
- annual flu shots
- support groups for those affected, spouses, parents or other caregivers
- online support services through the e-community *myMDA* and through *myMuscleTeam*, a program that helps recruit and coordinate in-home help

MDA's public health education program helps you stay abreast of research news, medical findings and disability information through magazines, publications, educational speakers, seminars, videos and newsletters.

MDA's website at www.mda.org contains thousands of pages of valuable information, including disease specifics, research findings, clinical trials and past magazine articles.

Everyone registered with MDA automatically receives *Quest*, MDA's award-winning quarterly magazine. *Quest* publishes detailed articles about research findings, medical and day-to-day care, helpful products and devices, social and family issues, and much more. Other MDA publications can be found at www.mda.org/publications; many booklets are available in Spanish. Ask your local office for "MDA Services for the Individual, Family and Community" and for help with obtaining copies of other publications.

If you have any questions about myotonic muscular dystrophy, someone at MDA will help you find the answer. To reach your local MDA office, call (800) 572-1717.



On the cover: Andy had MMD and used a wheelchair, but that barely slowed him down. A successful businessman, textbook author, world traveler and travel writer, including for MDA's *Quest* magazine, Andy lived to age 76.

MDA's Purpose and Programs

The Muscular Dystrophy Association fights neuromuscular diseases through an unparalleled worldwide research effort. The following diseases are included in MDA's program:

Muscular Dystrophies

Myotonic dystrophy (*Steinert disease*)
Duchenne muscular dystrophy
Becker muscular dystrophy
Limb-girdle muscular dystrophy
Facioscapulohumeral muscular dystrophy
Congenital muscular dystrophy
Oculopharyngeal muscular dystrophy
Distal muscular dystrophy
Emery-Dreifuss muscular dystrophy

Motor Neuron Diseases

Amyotrophic lateral sclerosis (*ALS*)
Infantile progressive spinal muscular atrophy
(*Type 1, Werdnig-Hoffmann disease*)
Intermediate spinal muscular atrophy
(*Type 2*)
Juvenile spinal muscular atrophy
(*Type 3, Kugelberg-Welander disease*)
Adult spinal muscular atrophy (*Type 4*)
Spinal-bulbar muscular atrophy
(*Kennedy disease*)

Inflammatory Myopathies

Polymyositis
Dermatomyositis
Inclusion-body myositis

Diseases of Neuromuscular Junction

Myasthenia gravis
Lambert-Eaton (myasthenic) syndrome
Congenital myasthenic syndromes

Diseases of Peripheral Nerve

Charcot-Marie-Tooth disease
Friedreich's ataxia
Dejerine-Sottas disease

Metabolic Diseases of Muscle

Phosphorylase deficiency (*McArdle disease*)
Acid maltase deficiency (*Pompe disease*)
Phosphofructokinase deficiency
(*Tarui disease*)
Debrancher enzyme deficiency
(*Cori or Forbes disease*)
Mitochondrial myopathy
Carnitine deficiency
Carnitine palmityl transferase deficiency
Phosphoglycerate kinase deficiency
Phosphoglycerate mutase deficiency
Lactate dehydrogenase deficiency
Myoadenylate deaminase deficiency

Myopathies Due to Endocrine Abnormalities

Hyperthyroid myopathy
Hypothyroid myopathy

Other Myopathies

Myotonia congenita
Paramyotonia congenita
Central core disease
Nemaline myopathy
Myotubular myopathy
Periodic paralysis



MDA's website, mda.org, is constantly updated with the latest research news and information about the diseases in its program. Follow MDA on Facebook, Twitter and YouTube.



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