



OI Issues: Type I—Understanding the Mildest Form of Osteogenesis Imperfecta

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Type I OI

Osteogenesis imperfecta (OI) is a genetic disorder characterized by bones that break easily. OI is highly variable. Its signs and symptoms range from mild to severe. In addition to fractures (broken bones), people with OI sometimes have muscle weakness, loose joints (joint laxity), curvature of the spine (scoliosis), brittle teeth (dentinogenesis imperfecta), and hearing loss. A classification system dividing OI into several types is commonly used to help describe how severely a person is affected. Type I is the mildest and most common form of OI. It is believed that 50 to 60 percent of people with OI have Type I.

Type I OI can have the characteristics of an "invisible disorder," meaning it is not apparent to a casual observer.

What Is Type I OI?

Nearly all cases of OI, mild or severe, are caused by a dominant genetic mutation that affects the body's production of type 1 collagen. Although the body produces several types of collagen, only type 1 collagen has been associated with OI. Type 1 collagen, the main protein building block in bone, is also important in other connective tissues such as tendons and ligaments. When there is a problem with the body's production of type 1 collagen, the bones are brittle and break more easily.

Type I OI is different from all other types of OI in an important way. Generally, people with Type I OI have *normal* type 1 collagen but approximately half the typical amount. People with Type II, Type III, or Type IV OI (the moderate to severe forms) have low levels of *abnormal* type 1 collagen.

Signs and Symptoms of Type I OI

OI affects people in several ways and may vary from person to person. Even among people with Type I OI in the same family, there may be differences. Below is a list of signs and symptoms common among people with Type I OI. Many people with Type I OI have only some—not all—of these characteristics:

- Bones are predisposed to fracture. Most fractures occur before puberty and again in later years.
- Joints are somewhat predisposed to other connective tissue injuries, such as dislocations.

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- Skin may bruise easily.
 - Height is variable and generally below average for age. Adult height may be similar or slightly shorter when compared with unaffected family members.
 - Joints are loose, with some muscle weakness and lax ligaments.
 - Spinal curvature (scoliosis) is frequently seen but tends to be mild.
 - Scleras (whites of the eyes) usually have a distinctly blue or gray tint.
 - Face shape is somewhat triangular.
 - Bone deformity is absent or minimal and occurs after fractures have occurred.
 - Brittle teeth (dentinogenesis imperfecta) are possible.
 - Hearing loss is possible, often beginning during teen or young adult life but perhaps starting sooner.

Some people with Type I OI are very mildly affected. They may have only a few fractures. They are of average or even above-average height; are able to walk and run; and have signs of OI that are barely noticeable, such as blue-tinted sclera or loose joints. In fact, some people are so mildly affected that they are not diagnosed until their teen or adult years. In some cases, they are not diagnosed until after they have a child diagnosed with Type I OI.

Other people with Type I OI have more distinct symptoms. They may have several dozen or more fractures; sometimes use a wheelchair, walker, braces, or crutches for mobility; be somewhat smaller than the rest of their family; or require treatments such as rodding surgery.

In most cases, people with Type I OI seem to experience fewer fractures after puberty, when the bones are no longer growing as quickly. Even so, the genetic defect still exists, and adults with Type I OI need to be aware of how the disorder may affect them throughout life. This is especially important for women when they go through menopause and men age 50 and older. Bone density will be lower throughout life in people with OI than in their peers.

Diagnosis of Type I OI

Babies with Type I OI may or may not be born with fractures. A baby may have other outward signs of OI, such as blue-tinted sclera or loose joints, but these signs may go unnoticed in a family with no history or knowledge of OI. Furthermore, blue sclera can be seen even in infants without OI until about 18 months of age.

A child with Type I OI may sustain his or her first fracture during some ordinary activity, such as when a caregiver pulls on the ankles while changing a diaper, a doctor does a physical exam, or a toddler falls while learning to walk. Other children with OI may not experience fractures until the school years, when they begin participating in physical education, sports, and recreational activities.

The occurrence of a fracture after little or no injury is often the first clue that a child may have OI. To diagnose the disorder, a doctor can look for other clinical features of OI, including standard x rays, which may show evidence of “thin bones.” The doctor also can obtain a family history to determine if other family members have had repeated fractures or other OI symptoms.

Diagnosis of OI is based primarily on clinical signs. Collagen testing of a skin biopsy sample or DNA testing of a blood sample can help confirm a diagnosis of OI in most situations. However, a negative OI test does not necessarily rule out an OI diagnosis. Some individuals test negative for OI despite having the disorder. In some especially rare forms of OI, there is no collagen defect.

Families in which one parent has OI may be able to arrange for prenatal testing through chorionic villus sampling or amniocentesis. In most cases of Type I OI, this type of prenatal diagnosis requires knowledge of the affected parent's genetic mutation. Ultrasound may not detect Type I OI in a fetus, because the child is unlikely to have fractures or bone deformity before birth. When prenatal diagnosis is impossible or not desired, a sample of blood from the child's umbilical cord can be taken at birth and sent for DNA analysis.

When a parent has OI, it is recommended that the newborn be tested and examined as soon as possible by a doctor who is knowledgeable about OI. The information will help parents make decisions about their baby's care and help protect the family from unwarranted child abuse allegations.

Managing and Treating Type I OI in Children

The cornerstones of treatment for children with Type I OI are fracture management, healthy diet, therapy to regain strength and mobility after fractures or surgery, and an ongoing program of safe exercise and activity to develop muscle control and build strength. Recognizing that prolonged immobilization can weaken muscles and bones, many orthopaedists prefer short-term casting for fractures, followed as soon as possible by a splint or brace that can be removed for appropriate exercise.

For all children who have had a fracture, physical therapy, including water exercise, will reduce the effects of immobilization. This is recommended for even the most mildly affected children. Inactivity and inappropriate diet should not be permitted to cause obesity, because excess weight adds stress on the bones and tends to limit activity even more. Developing healthy lifestyle habits is an important part of managing OI.

Rodding surgery (in which metal rods are inserted into the long bones) is a standard treatment for children with OI in two situations:

- to set a particularly bad fracture
- to straighten and strengthen a bone that is bowed (curved) enough to break repeatedly.

Many children with Type I OI have minimal bone deformity and do not require rodding surgery unless they have a particularly bad fracture. However, some children with Type I OI do have problems with repeated fractures and increasing deformity of a long bone. In such cases, rodding surgery may be appropriate.

Some infants with mild OI have delays in gross motor skills, such as pulling to a stand, crawling, or walking. These delays may be caused by fractures, low muscle strength, loose joints, or a child's fear of

movement because of previous fractures. Physical and occupational therapy are recommended as soon as such delays are noticed. Therapists can instruct parents in the best ways to hold or position their children, and to encourage children to learn new skills. Most infants with OI will qualify for their state's early intervention program, which provides therapy and other services free of charge.

Older children with Type I OI also will benefit from physical and occupational therapy to maximize strength and function. In addition to therapy, regular exercise geared toward children's individual interests helps them to socialize with their peers, develop bone and muscle strength, and maintain a healthy weight. Water therapy and swimming are particularly good exercises for children with OI, as the gravity-free environment reduces fracture risk. Many children with Type I OI swim, dance, ride regular or adapted bikes, and participate in other recreational and competitive activities.

For long-term health and comfort, it is important to develop the habit of protecting the spine. Back pain or compression fractures of the spine can be minimized both by avoiding activities that jolt or twist the spine and by using proper techniques for lifting, reaching, or sitting. It is also wise to protect the joints. Hyperlaxity (being double-jointed) can be amusing in childhood, but it can lead to painful arthritis in adulthood. A child's doctor or therapist can advise the family on safe exercises.

Children with Type I OI may have feeding problems, including difficulty chewing and swallowing foods of different textures. Adults with Type I OI may experience gastric reflux. Nutrition counseling can address both types of problems. A nutritionist can design a diet that is rich in nutrients but will not cause obesity.

Although the Food and Drug Administration (FDA) has not approved any medications for the treatment of OI, clinical trials are currently studying several bisphosphonate medications.

Most clinical trials initially accepted only children severely affected with OI. Over the years, some trials have expanded to include children who are moderately and mildly affected as well as those who have three or more major fractures in a year.

To date, there is not enough evidence that bisphosphonates are helpful for children with mild OI to recommend this treatment for all children. However, the individual child's bone density and fracture history may warrant treatment with bisphosphonates. Doctors must use their clinical judgment before prescribing "off-label" bisphosphonates for OI. Research on this issue continues.

Children with Type I OI should be monitored regularly for OI-related problems such as hearing loss and scoliosis (spinal curvature). An orthopaedist should examine a child for scoliosis annually starting around age 6, ordering x rays if needed.

Hearing tests by an audiologist in a soundproof room should begin after a child's first birthday and be repeated on a regular basis, possibly every 3 years. Approximately 50 percent of people with Type I OI experience hearing loss starting in their teens or young adulthood. Hearing loss, depending on what type it is, can frequently be treated with hearing aids. Surgery, such as a stapedectomy or possibly a cochlear implant, will benefit some people.

Managing and Treating Type I OI in Adults

Osteoporosis (low bone density) is an almost universal consequence of having OI. Therefore, it is vital for teens and adults with OI (both males and females) to build bone density and prevent bone loss through safe exercise, diet, and, in some cases, medication. OI experts recommend that adults with OI have a bone density test to establish a baseline, which will allow their doctor to monitor whether their bone density is changing over time. Commitment to a healthy lifestyle and maintaining a healthy weight are key to managing OI as an adult.

Exercise is important not just for bone density, but also for maintaining strength, function, and general health. Swimming and other water activities provide excellent, safe exercise for people with OI. Walking (with or without aids), safe weight training, and noncontact recreational sports also may be appropriate for some people with Type I OI. Exercise remains important in adulthood because it protects the spine and joints. Learning to stand correctly, lift objects safely, and avoid twisting motions will reduce

the chance of injury. Adults with OI are encouraged to consult their orthopaedist, physical therapist, or other professional knowledgeable about OI to determine the most appropriate fitness program.

Bone density can be maintained by eating appropriate but not excessive amounts of calcium-rich food. Low-fat dairy products are the richest source of calcium. But some vegetables and nuts, as well as tofu and calcium-fortified products such as orange juice and cereal, are also rich in calcium. Adults with OI have the same needs for calcium as other adults. Excessive consumption of calcium or use of supplements is neither necessary nor recommended, and it can lead to other health problems. Caffeine and alcohol should be consumed in moderation, because excessive intake can lead to bone loss if adequate calcium is not present. Some medications, such as steroids (for example, prednisone) and corticosteroids, also contribute significantly to bone loss. The Surgeon General's 2004 *Report on Bone Health and Osteoporosis* states that smoking and exposure to secondhand smoke can lead to bone loss and an increased risk of fracture.

Many adults with OI take bisphosphonate medications. These medications are approved by FDA for preventing and treating osteoporosis in adults. The goal is to prevent additional loss of bone density. Several researchers are conducting clinical trials of bisphosphonates to measure their effectiveness for treating adults with OI. Other drugs, such as the parathyroid hormone teriparatide, also are being studied as possible treatments for adults with OI.

Many women with Type I OI are concerned about menopause and the possibility of more frequent fractures. The experiences of postmenopausal women with OI vary greatly. Some report an increase in fractures, while others do not. The strategies mentioned above to maintain bone density and general health will help each woman maximize her chances to stay active and healthy as she ages. It is important to continue exercising throughout life. Women should discuss bone density testing, as well as medicines or hormones to prevent bone loss with their doctors.

Adults with Type I OI seem to have the same risks as the general population for common health problems such as diabetes, heart disease, and cancer. Maintaining a healthy weight, exercising regularly, eating a nutritious diet, and avoiding risky behaviors such as smoking and excessive alcohol consumption are vital not only for bone health but also for general health and well-being.

In addition, people with small stature, scoliosis, or barrel-shaped chests are advised to pay particular attention to respiratory health by having their pulmonary function tested. This test should be repeated every 2 to 3 years depending on the extent of scoliosis or chest deformity. All people with OI are urged to seek treatment promptly for all respiratory infections. Flu shots and pneumonia vaccines are often recommended.

Social, Emotional, and Family Issues

Many people with OI Type I do not appear disabled, so others may misunderstand or underestimate the disorder. Parents may provide information about preventing fractures to teachers, babysitters, or other caregivers, only to have the caregivers dismiss them as being “overprotective.” Meeting with teachers and other school staff and providing written information, such as this fact sheet and a letter from the child’s doctor briefly explaining the OI diagnosis and the recommended precautions, can help reinforce the information provided by parents. It is important to set up a system to ensure that substitute teachers also are aware that a child with Type I OI is in the class.

In addition, it is important for a child’s siblings and peers to receive age-appropriate information about OI. It is common for peers to wonder why their classmate does adapted activities during physical education or can’t participate in contact sports. Some children with mild OI are accused of being “clumsy” or “lazy” or of “faking it” when they have yet another injury. In most cases, such teasing comes out of ignorance, not malice. Many children with OI or their parents give a brief presentation to the class at the beginning of each school year to explain OI. Visual aids and props, such as the child’s braces or a cast or splint, are particularly meaningful to young children.

Some families with mildly affected children have been accused of child abuse after their child went to the hospital emergency department with unexplained fractures. Once an OI diagnosis is made, families should ask for a letter on medical letterhead confirming the diagnosis and explaining what it means. Copies of the letter should be kept in the diaper bag, in the car, with the child’s medical and school records, and anywhere else where they may be useful, particularly when the family is traveling or visiting the emergency department.

Adults with Type I OI usually know about their diagnosis when deciding whether to have children. There is a 50-percent chance that a person with Type I OI will pass the disorder on to his or her child, and that chance remains the same for each child. Usually, a child will inherit the same type of OI as his or her parent. However, it is possible that the child’s signs and symptoms will be different than the parent’s—either milder or, in some cases, more severe.

Adults with Type I OI who are considering having children may wish to consult a genetics counselor to obtain information about their options, including preimplantation genetic diagnosis. It is worthwhile to obtain a skin biopsy or DNA analysis to confirm an OI diagnosis *before* conceiving a child. Having this information on file expedites testing a newborn for OI, if the parents desire it. Type I OI does not appear to affect fertility or predispose women to particular pregnancy complications. Research suggests that pregnancy and breastfeeding may affect a woman’s bone density and increase the risk of fracture. Therefore, it is particularly important that women with OI eat a calcium-rich diet and exercise appropriately while pregnant and breastfeeding.

People with Type I OI often have to deal with the conflict between their outwardly healthy appearance and their underlying fragility. Deciding who to tell about their condition in social or employment situations can be difficult. Concern about strength, stamina, and changes as a person ages also can affect decisions about family life, housing, and careers. Adults with Type I OI recommend developing an effective personal support network.

Resources

For more information about osteogenesis imperfecta, contact the:

**NIH Osteoporosis and Related Bone Diseases
National Resource Center**

Website: www.bones.nih.gov

Osteogenesis Imperfecta Foundation

Website: www.oif.org

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For Your Information

This fact sheet contains information about medications used to treat the health condition discussed here. When this fact sheet was developed, we included the most up-to-date (accurate) information available. Occasionally, new information on medication is released.

For updates and for any questions about any medications you are taking, please contact the U.S. Food and Drug Administration (FDA) toll free at 888-INFO-FDA (888-463-6332) or visit its website at www.fda.gov. For additional information on specific medications, visit Drugs@FDA at www.accessdata.fda.gov/scripts/cder/drugsatfda. Drugs@FDA is a searchable catalog of FDA-approved drug products.

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