Gillette Children's Specialty Healthcare

A PEDIATRIC Perspective

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Assessing Bone Health in Children

DXA Scans Play a Vital Role in Management

by Kevin Sheridan, M.D.

Providers often see bone fractures resulting from trauma. Fractures caused by osteoporosis and osteopenia occur most often in older adults, although some children and adolescents are also at risk. In particular, children who have disabilities and other chronic conditions experience poor bone health as a result of their underlying disorders (e.g., neuromuscular diseases and recurrent or chronic inflammatory disorders).

In those children, issues such as feeding difficulties, inadequate nutrition, medications (including anti-seizure and steroid medicines), limb contractures and an inability to perform weight-bearing exercise further contribute to abnormal bone growth and bone strength. As a result, children might be more susceptible to fractures and might experience a corresponding decrease in their quality of life.

Primary-care providers should consider investigating, or refer to a pediatric bone specialist, if they see patients who:
- Show signs of a known bone or neuromuscular disorder
- Display inconsistent patterns of growth
- Sustain unexpected (fragility) fractures
- Use steroid medications regularly (for conditions such as rheumatoid arthritis and asthma)
- Display any form of chronic inflammation or bone deformities
- Experience prolonged periods of immobilization

A specialist in pediatric bone conditions, such as a pediatric endocrinologist, often is needed to diagnose such problems and recommend appropriate interventions. Imaging modalities, including dual–energy radiograph absorptiometry (DXA) scans, help practitioners assess the extent of bone compromise and monitor treatments.

Children at Risk

Low bone-mineral density is the primary cause of compromised bone health. Many factors can contribute to low bone-mineral density.

First, a variety of nutritional issues often are associated with disabilities. For example, people who have cerebral palsy often have food allergies as well. If those people must avoid dairy products, their diets might lack sufficient amounts of calcium, phosphorus, and vitamin D — the facilitators of building strong bones. Even children who rely on gastrostomy tubes (G-tubes) for nutrition might require calcium and vitamin D supplementation.

Second, children who have neuromuscular and other syndromes might require anti-seizure and steroid medications. Because those medications affect the ability of bones to model and remodel, they can lead to low bone-mineral density. Some studies have linked the seizures themselves — and not simply anti-seizure medications — to a greater prevalence of fractures in both children and adults.

Third, neurological problems can result in skeletal deformities that impair bone health. For example, the high muscle tone in cerebral palsy creates abnormal mechanical stresses around the joints, leading to disordered growth and increased fractures. The frequency of fractures in some studies correlates with the degree of physical impairment: The greater the degree of physical compromise (e.g., spastic quadriplegia as compared to spastic diplegia), the greater the occurrence of fractures. Bone health becomes particularly important when surgery is performed to correct those deformities. Postoperatively, healthy bones are better able to heal and resist infection.

Finally, extended periods of immobilization (e.g., after surgery or a fracture) increases the loss of healthy bone. In addition, secondary health problems such as hyperthyroidism, rickets, growth hormone deficiency, excess lead exposure and renal problems increase bone loss or inhibit bone growth. Genetic bone diseases (such as osteogenesis imperfecta, idiopathic juvenile osteoporosis, and some inborn errors of metabolism) are less common causes of weakened bones and, ultimately, of fractures.

All of the above increase a child's vulnerability to fractures from daily activities or minimal trauma. Consider referring such children to a pediatric endocrinologist if:
- They have a chronic disability, such as cerebral palsy, and experience recurrent fractures.
- They have been diagnosed with a bone condition such as osteogenesis imperfecta.
- Their bone growth (height) lags significantly behind that of their chronological peers.

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Gillette Makes Musculoskeletal Research a Priority

Gillette Children's Specialty Healthcare is involved in musculoskeletal research. Gillette has established five primary areas of focus:

- **Bone health in children, particularly in the presence of chronic conditions.**
  Bone development during childhood is clearly altered in the presence of certain disabilities. A better understanding of bone health can help reduce pain, deformity, and fracture risk.
- **Long-term consequences of conditions that originate during growth and development and affect the musculoskeletal system.**
  Understanding the implications of childhood-onset disabilities in adolescence and adulthood can inform treatment decisions during childhood.
- **Effects of intervention (operative or non-operative) for conditions originating during growth and development.**
  Intervention has the potential to change a condition's natural progression and improve patient health. Determining whether intervention outcomes are superior to non-intervention – and whether the intervention process is tolerable – can influence treatment decisions.
- **Impact of nutritional status and associated health problems on surgical treatment.**
  Understanding the factors that influence postsurgical healing can help prevent debilitating complications and failures to achieve treatment goals.
- **Role of prenatal tests and postnatal genetic evaluations in conditions for which care is provided at Gillette.**
  New genetic evaluations might permit a better understanding of the natural history of some conditions and could alter treatment planning.

Evaluating Bone Density

DXA technology enables health-care providers to scan bones and then calculate their mineral density.

Benefits

The primary benefits of DXA scans are their precision, ease of use and low level of radiation. In comparison to the radiation of a standard chest X-ray, DXA scans emit just 10 percent of the amount of radiation. DXA scans are also more sensitive than routine radiographs in detecting bone loss. For example, patients would have to lose 20 to 30 percent of their bone density before those losses would be apparent on an X-ray; a DXA scan can identify bone-density losses of as little as 3 percent.

For these reasons, DXA scans are the preferred method of following changes in bone-mineral density over time.

Limitations

DXA scans do, however, have limitations — particularly in children and teenagers. Bone size varies less in adults than in growing children. During the rapid growth phase of puberty, the bones grow longer before they grow wider. A smaller or thinner bone might falsely appear to have a low bone-mineral density on a DXA scan. Thus, age and puberty maturation are important considerations when interpreting DXA scans in pediatric patients.

In children with disabilities, previous fractures, abnormally shaped bones, and surgically placed hardware all interfere with interpretations of bone-mineral density.

Proper positioning of the patient for scanning the bone region of interest (hip, spine, arm, and distal femur) is sometimes a problem in scanning people who have disabilities. Muscle contractures in the hips and arms, or scoliosis in the spine, impede the ability to replicate the same position from scan to scan. If a patient's position changes between scans, the test results will indicate a false bone density change.

Given these difficulties, it is important to use appropriate pediatric reference standards and to have the scans done at appropriate DXA centers, which are experienced in the positioning problems of people who have disabilities.

Pediatric Reference Base

Henderson[1] and colleagues explored the use of alternative sites to measure bone-mineral density in children with cerebral palsy. He and his colleagues found that the lateral distal femur site was more accessible and reproducible than other sites (at the hip, spine, and arm). Children with neuromuscular conditions tolerated scanning of the lateral distal femur site much better than scanning of other sites, and the site was more frequently free of artifacts.

Henderson has published a reference database of 256 healthy children, ages 2 to 18, using the lateral distal femur site. Most of the bone-health centers that perform DXA scans deal primarily with adults; a few also will scan the spine, hip, and arm of children. Gillette Children's Specialty Healthcare is one of a limited number of centers that offers DXA scans of the usual regions of interest in addition to lateral distal femur sites. Gillette uses pediatric reference data for all sites, including the distal femur site.

Treating Low Bone Mineral Density

Once low bone mineral density is identified, the next question is: What treatments are appropriate and effective?

At Gillette, the first step is to review a patient's nutritional status and use of medications; we then make alterations, if necessary. Sometimes simply improving the amount or composition of the diet, addressing vitamin or mineral deficiencies, or changing medications can be enough to improve bone density. The U.S. Department of Health and Human Services[2] estimated that a 10-percent increase in bone mass can reduce fracture risk by as much as 50 percent in adults.

Decreasing the potential for falls and stabilizing limbs in children who have cerebral palsy and other disabilities reduce the likelihood of fractures. Weight-bearing activities, when possible, strengthen bones and improve balance. Although studies have looked at the effects of standers and vibration platforms on bone-mineral density, more studies are needed to determine whether changes in bone-mineral density correspond to decreased fractures.

Other treatment options include administering medications that diminish the breakdown of bone. Bisphosphonates, such as pamidronate, have been shown to temporarily decrease fracture rates in some children. Other bisphosphonates commonly used in postmenopausal osteoporosis are oral risendronate, alendronate, ibandronate or intravenous zolendronate. Those medications have been less well-studied in children, especially children who have disabilities. In addition, much less is known about the long-term effects of the medications when begun in childhood. Complications such as adynamic bone are a concern, but rarely seen. Use of bisphosphonates around the time of surgeries might also compromise bone healing. Sometimes, however, the benefits may outweigh the uncertain risk in patients who sustain frequent fractures (e.g., patients who have osteogenesis imperfecta). A few studies have examined the effectiveness and side effects of growth-hormone treatment in children with cerebral palsy.

Conclusion

Life expectancy is increasing for people who have disabilities and many chronic conditions. At the same time, the osteoporosis that elderly people experience can occur at a much younger age in adults who have disabilities — especially if those adults experienced compromised bone health during childhood. Compromised bone health is associated with increased morbidity and mortality in elderly adults. Therefore, bone health is becoming an important determinant of the quality of life in both children and adults who have disabilities. DXA scans can play an important role in assessing and treating bone disorders.

Resources

[1] Henderson RC, Lark RK, Newman JE, et al. *Pediatric reference data for dual X-ray absorptiometric measures of normal bone density in the distal femur.* Am J Roentgenol 2002; 178:(2) 439-43.

[2] U.S. Department of Health and Human Services. *Bone Health and Osteoporosis: A Report of the Surgeon General.* Rockville, Md.: U.S. Department of Health and Human Services, Public Health Service Office of the Surgeon General; Washington, D.C.; 2004.

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Moving Forward in the Treatment of Pediatric Neurological Disorders

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The course is intended to increase providers' understanding of advances in research, diagnoses and treatment interventions for pediatric neurological disorders. Day 1 will focus on congenital disabilities; Day 2 will focus on acquired disabilities; Day 3 will focus on cognitive development, executive function, and ethical issues related to pediatric neurosciences.

The conference is intended for pediatric neurologists, pediatric neurosurgeons, pediatric rehabilitation medicine specialists, pediatric orthopaedic surgeons, primary care physicians, physical and occupational therapists, speech and language pathologists, nurse practitioners, nurses, physician assistants, orthotists and other providers who treat congenital and acquired disabilities.

If you have questions related to course content, contact Sue Murr, manager of pediatric neurosciences, at 651-290-8712 or 800-719-4040 (toll-free). For registration information, call Mary Grimm at 651-578-5002 or 800-719-4040 (toll-free). To register online, visit www.gillettechildrens.org.