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journal of the spinal research foundation

Your Spine through the Years

Aging is inevitable. How you choose to treat your body is up to you. Empower yourself by exploring and finding the right therapies, nutrition, exercise, and treatments for you. Embrace change and know that there is always hope.

 **SRF**
spinerf.org

WHAT'S NEW AT SRF

Introducing Sabrina M. Woodlief as SRF's Newest Employee!

Sabrina M. Woodlief, Research Analyst, supports the Spinal Research Foundation in their efforts of spinal research, education, and patient advocacy. In addition to serving as the Associate Editor of the Journal of the Spinal Research Foundation, Ms. Woodlief collaborates with medical staff at Virginia Spine Institute to coordinate and maintain the integrity of clinical trials within the research facility. She also provides support as the Research Coordinator for SpineOnline, a nationwide, multi-center technology project to prove the effectiveness of spinal treatment options. She is enthusiastic and honored to be involved in the collection of provider and patient reported treatment outcomes to help prove what works, drive innovation, and reduce the uncertainty associated with spinal treatments.

Feel like you want to get to know Sabrina more? Continue reading for a sneak peek into her passions, interests, and little known facts!

BLOG

Coming soon – our very own blog! Can't get enough of SRF's fascinating findings, impactful suggestions, and innovative treatments through our biannual journal? We are diligently working on releasing our blog this summer and welcome any ideas on hot topics or questions you would like us to feature and answer! Please contact Sabrina at swoodlief@spinerf.org with your requests.

SAVE THE DATE

SRF and VSI will be hosting our 9th annual We've Got Your Back race on Saturday, October 1st, 2016! While it's a little later than usual, it's still a perfect time for you to come join us in raising awareness about spinal injuries, disorders, and treatments! Celebrate with fellow Spinal Champions (those who have overcome their back or neck pain through non-operative or operative treatment), challenge yourself to participate in a 5k run/walk or 1 mile fun run/walk, and feel empowered with the roar of the crowds as you cross the finish line, rewarding yourself with a tasty treat to celebrate! Visit WGYBrace.org to learn more!

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FROM THE EDITOR:
Brian R. Subach, M.D., F.A.C.S.
Understanding & Accepting Change

It is my pleasure to welcome you to the Spring edition of the Journal of the Spinal Research Foundation for 2016. The undertaking of this Journal is both relevant and timely. Aging is an unpleasant phenomenon often denied, but is truly as certain as both death and taxes. No one is exempt from aging. Many of us first become aware of our aging when we reach our thirties. There may be a new wrinkle on the skin or a gray hair showing in a dark head of hair, but these superficial characteristics are external warning signs of an aging process which affects the muscles, joints, and spine as well. More than just bothered by the toll of aging on one's physical appearance, the spine weakens with age. At relatively young ages, women are dealing with osteoporosis - thinning of the bones - and commonly, degenerative disc disease (DDD).

Degenerative disc disease is not really a disease, but a term used to describe the normal changes of spinal discs as the aging process advances.

Spinal discs are soft and compressible shock absorbers which cushion the bones of the spine. The discs allow the spine to flex, bend, and twist, absorbing the stresses of life and recreational activities, such as lifting weights or running marathons. This degenerative process, or DDD, takes place throughout the spine, but most often occurs in the discs of the lower back (lumbar region) and the neck (cervical region).

Many patients diagnosed with low back pain, caused by degenerative disc disease, are left wondering exactly what this diagnosis means for them. As we age, our intervertebral discs lose their flexibility, elasticity, and shock-absorbing characteristics. The discs lose water, which is essential for the collagen within the disc space to maintain flexibility. The ligaments which surround the disc space, the annulus fibrosus, become brittle and more easily torn. At the same time, the soft gel-like center of the disc, the nucleus pulposus, starts to thin and shrink. The combination of repetitive damage to the intervertebral disc, the development of bone spurs, and a gradual thickening of the ligaments that support the spine, all can contribute to degenerative arthritis.

Pain generally occurs near the location of the affected disc. An affected disc in the neck area may result in both neck and arm symptoms, while a disc in the lower back may result in pain in the back, buttock, or leg. The pain often becomes worse with movement, such as bending over, reaching up, or twisting and may start with a seemingly trivial injury. Most commonly, pain occurs with prolonged sitting or prolonged standing, such as on a long car trip or an airplane flight.



Degenerative disc disease is diagnosed after a thorough study of the patient, the medical record, and the result of a physical examination. Common questions involve symptoms, previous injuries or illnesses, any previous treatment, habits, and activities that may cause pain in the neck, arms, back, buttock, or legs. When the presumptive diagnosis is degenerative disc disease, many people are first treated with nonsteroidal anti-inflammatory drugs (NSAIDs). Exercise programs to strengthen abdominal and spinal musculature, improvement of aerobic fitness, and reducing lumbar lordosis are often necessary to alleviate the symptoms. Corticosteroid injections are offered only after physical therapy, rest, and medications have failed to adequately relieve the symptoms of pain, numbness, or weakness. Further treatment, such as surgery, depends on whether the damaged disc has worsened into osteoarthritis, a herniated disc, or spinal stenosis causing compression of the traversing nerve roots within the canal.

Realize that degeneration or degenerative arthritis in the spine is as certain as death or taxes; however, we need not be held prisoner to the fear of aging.

Maintaining a healthy body weight, aerobic fitness, core muscular strength, and a well-balanced diet will all contribute to combating this natural aging process. We can still live active and vigorous lives as we grow older, calling on our healthcare providers to help us avoid illness or reduce pain when necessary. Indeed, we would do well to accept these changes, not deny them. Perhaps this journal will help you better understand the process.



PRESIDENT'S NOTE:
Thomas C. Schuler, M.D., F.A.C.S.
My Aging Spine

Life is a degenerative process! This sums up the ugly reality that plagues all of us. Due to my family's strong genetic predisposition for degenerative changes in the spine, I have experienced at a younger age than most the problems that come from a degenerating

spine, and consequently the miracles of modern spinal health care. This has given me much personal experience to add to my professional experience in the subject of the aging spine.

We are usually born with healthy structures. Over time, through injuries, genetic predisposition, environmental factors, and potentially self-induced abuse, body parts tend to break down. In the spine, this most commonly occurs in the intervertebral discs. These large ligamentous structures that sit between the vertebrae enable our spine to move. Discs are essential in the function of our spine. They often are thought of as shock absorbers, but they are much more than that. Discs allow for compression and distraction, rotation, side bending, tilting as solitary movements, as well as combined planes of motion. The more torsion we put on these structures, the greater the chance they have for injury. It is interesting to note that back injuries have become much more prevalent with golfers due to the emphasis on increased trunk rotation to provide for longer ball flight. This emphasis on increased rotation has led to a greater injury rate and more significant injuries in the golf world and has shortened the professional life of some well-known golfers.

In my own case, I have had significant breakdown in my lumbar discs, as well as in my cervical discs. I have managed this for years with strengthening and conditioning programs, flexibility programs, proper nutrition, proper ergonomics, occasionally anti-inflammatories, and always nicotine abstinence. While these approaches have kept me functioning, they have not solved all of my problems caused by severe disc degeneration. Fortunately for me and for my patients, there are many treatments that are available today to resolve these painful conditions.

My career as a surgeon and the need to hold my neck in a flexed position for many hours while operating has accelerated the symptoms initiated by my genetically predisposed degeneration. My occupation ultimately led to disc herniations and spurs in my neck that compressed the nerves. Because of these compressed nerves, I developed pain shooting into my arm and weakness. After failing non-operative treatment, I elected to proceed with surgery in order to eliminate the pain and restore my function.

My first procedure was a microsurgical minimally invasive operation in the back of my neck where bone spurs were shaved off of the spinal nerves. I was able to gain five years of excellent relief with this approach and was back to the operating room as a surgeon within three weeks of the procedure!

As expected, the degeneration progressed further and ultimately became an insurmountable problem. At this point, I was treated with an operation through the front of my neck, where a fusion was combined with two disc replacements. I had three levels that required treatment. The worst level and most degenerative was decompressed and fused from the front. The two levels above that had artificial discs placed in order to preserve the maximum amount of motion and to prevent increased break down of the adjacent levels. This hybrid construct has been very effective in relieving the pressure on my spinal cord, as well as the nerves. This eliminated my pain and enabled me to maintain optimal function of my spine.

Over three years later, I am excited to report that I have no ongoing symptoms, and I am fully capable of doing my occupation as a spinal surgeon, but most importantly, am enjoying my life as a father, husband, and friend.

Thanks to this surgery, I am actively engaged in many activities including golf, tennis, swimming, weight training, running, and wilderness travel.

I maintain an active exercise program emphasizing aerobic and anaerobic exercise, strength training, core and total body, as well as a flexibility program. My daily routine varies, but my goal is to perform some or all aspects of the above-mentioned program at least five days a week. This keeps me functioning optimally and is a routine that I recommend for all of my friends and patients. The old adage, "A rolling stone gathers no moss," could never be truer as we get older.

We must maintain a daily exercise and flexibility program in order to minimize the deterioration that occurs with time.

The better we maintain our appropriate body weight, use good ergonomics, and keep our muscles strong and our joints flexible, the better we will function and the less pain we will have as we move through life. People that develop weak or imbalanced muscles, or fail to maintain proper exercise, struggle with pain and function. My clinic is filled with patients that need the encouragement or guidance to get into and maintain a proper program. Unfortunately, our busy lives often derail these approaches, but is still an area we all need to constantly focus on to optimize our lives.

In the future, we will have new techniques and new technologies. One we are actively implementing today is the use of stem cell therapies to heal injured discs and spinal structures without surgical intervention. We are extremely excited by initial years of work in this field and see that there will be great promise in the future with these techniques. The concept of healing an injured degenerative structure to the point that we improve its function, decrease pain, and ultimately return the patient to a more functional state is extremely exciting.

The important take-home message from the current state of spinal health care is that there is hope for those suffering from neck and back problems today.

The current treatments and successes available from proper therapies, proper nutrition, injection procedures, minimally invasive surgeries, regenerative therapies, and motion preserving treatments are very exciting. The main limitation that exists today is an individual's commitment to doing what they need to do in order to live a healthy life. Also limiting an individual's access to the best treatment is insurance companies refusing to offer coverage for these great innovations. In spite of identifying a quality spinal health care provider, who has the knowledge and technical ability to provide these life improving techniques and technologies, that spinal specialist must obtain approval from the insurance company to make the treatments affordable for potential patients. Unfortunately, many insurance companies hide behind an "experimental clause" to deny coverage. While many treatments are far from experimental, until we have research data documenting their efficacy, insurance companies will continue to improve their profits at the expense of patient care.

We at the Spinal Research Foundation are continuing to improve the effectiveness of these treatments with the goal of educating the patients and providers, proving what works, while ensuring that coverage is available for individuals suffering from their painful conditions to receive the proper treatment. The end goal is to keep more of society pain-free, fully functioning, and happily engaged in their communities. With these results through modern technology, there is great hope for our patients and for the future of spinal health care. We need your help and support to continue driving these life-improving medical innovations.



ASK THE EXPERT: DEGENERATIVE DISC DISEASE 101

Douglas G. Orndorff, M.D.
Spine Colorado

1. What is Degenerative Disc Disease (DDD) and what causes it?

Degenerative disc disease is when the disc between the vertebrae in the spine begins to lose its ability to stay hydrated and begins to collapse. This is often painful and can result in significant disability. The causes are multi-factorial but there has been some correlation with smoking, genetics, obesity, trauma, and some lines of work.

2. What are the common symptoms of DDD?

The common symptoms of DDD often begin with either neck or back pain. It is a degenerative condition so there is often morning stiffness. Motion can be painful, but the level of pain can diminish as the body warms up. The pain can often be exacerbated by prolonged sitting, standing, or holding our heads in fixed positions. This pain can be described as central neck or back pain, but can radiate into the shoulders, lower back, and buttocks. As DDD progresses, the disc space collapses and bone spurs may occur, which can cause pressure around the nerves. This can result in radiculopathy, which is pain that radiates down the arms or legs.

3. How is DDD Diagnosed?

DDD is diagnosed by a patient's history, physical exam, and imaging. By listening to the patient's story, what types of activities cause pain, as well as what makes the pain level better or worse will help pin-point where and why the patient is having pain. A detailed physical exam can help determine the source of pain by testing the patient's range of motion, strength and sensation, and where on their neck or back they are most tender. In addition

to the history and physical exam, imaging studies are a necessary tool to corroborate the clinician's diagnosis. Standing radiographs are typically done to help determine the areas of disc degeneration, the number of vertebrae involved, and if there is any instability. An MRI scan is often ordered next to help determine what could be causing pressure on the nerves and the extent of disc degeneration.

4. What are the treatment options for DDD?

There are many non-operative options for DDD that should be thoroughly exhausted before surgery is considered.

The non-operative options include physical therapy, anti-inflammatory medications, oral steroids, steroid injections, and a short course of narcotic pain medicine and anti-muscle spasm medicine. Ergonomic adaptations, activity modifications, and weight loss also may alleviate a patient's symptoms.

Surgery should only be considered after 8-12 weeks of extensive non-operative care has been exhausted or in the case of progressive weakness and dysfunction. In well-selected patients and proper expectations, surgery may be beneficial and very successful. Most importantly, a patient should expect and request that their treatment plan is individualized.

Spine Tales

AARON MAY

No Sense in Suffering

In 2006, I was an infantry officer at Fort Campbell, KY in the 101st Airborne Division. I considered myself in pretty good physical shape without any health issues. One day everything was as it should be, waking up early doing physical training (PT) and working. The next day I woke up in excruciating pain in my back. It was completely unexpected. I went to work but was not able to conduct PT. Instead, I had a sergeant drive me to the emergency room where I had X-Rays and MRIs and was assigned a doctor who dealt only with spine issues. I was given pain killers and muscle relaxers just to survive. I was diagnosed with disc degenerative disease.

After this day, everything changed in my life. After I first went to the emergency room, there was never a moment in my life that I wasn't in pain until after my spinal fusion. I never did PT again in the Army and I spent lots of time at the hospital trying different treatments. I couldn't run anymore and stairs became very difficult because I couldn't lift my feet high enough. The toes of my boots were also scuffed because I would drag my feet a lot. I received a medical discharge from the Army because of my inability to do anything physical. Over the next seven years I was constantly in pain varying from a 7-10 on the pain scale. On a good day I was taking ibuprofen around the clock and suffered through my work and chores at home. On a bad day I was on the floor on pain killers and muscle relaxers. I thought the only time I would be pain free would be after I died.



I still continued to work outside on our property as much as possible. One day, after cutting some locust trees down, I was taking a shower and noticed the cloth kept catching something on my right thigh. I discovered a locust tree thorn had broken off in my thigh. I didn't even know it was there! I gave my wife my deer skinning knife and some tweezers and had her remove the thorn. I sat and watched as she cut my skin without flinching. My wife prompted me to do something about my back because I was losing all sensation in my leg. It was on this day I decided I would try surgery.

Prior to trying surgery, I had undergone every kind of treatment imaginable. I had tried every kind of pain killer and muscle relaxer out there, which only masked the pain. I tried physical therapy which just seemed to make things worse. I had multiple steroid injections at several levels on the spine and SI joints. The only treatment that helped at all was traction, but the pain relief was only temporary, returning as soon as the weights were removed and my spine recompressed.

Finally, I sought out Dr. Good. I knew several patients of his that had made dramatic recoveries. He believed a spinal fusion would work for me. I was in so much pain I was ready to give it a try. I was afraid that the surgery would limit me on the very physical lifestyle I like to live. I was still deer hunting, cutting wood, hiking, and planting a garden, but at very high pain level and on a very limited scale. I had the surgery in January 2014. I remember the wake up test in the operating room after surgery when I was asked to move my feet.

I could not believe how easily they moved! I did not realize it had become a chore just to wiggle my feet. The recovery process was slow. I had surgery in January and wasn't completely healed until May. I followed all of Dr. Good's instructions precisely and attended physical therapy. My pain level went from a constant level of 7-10 to 0!

I have no pain at all anymore, not in my back, legs, hip, or feet.

The feeling has also come back in my leg and I can lift my feet high again. I still take the stairs instead of the elevator because I can. I still cannot believe how my life has changed. My back is back to the day before I went to the emergency room in 2006. In May, after physical therapy was complete, my wife and I flew to Bulgaria and picked up our two adopted sons. I could not imagine having a six and five year old with a bad back. I was able to carry them around the city and play games with them. Since then, we have had another son. I am now able to do all of things I enjoy with my sons - hunting, hiking, vegetable gardening, and cutting and splitting firewood.

I would recommend Virginia Spine Institute and Dr. Good to anyone who is suffering with a bad back.

I suffered for seven long years before seeking them out. I wish I had done it sooner. I was scared of surgery and it seems so silly now. I have my life back now. If spinal fusion is what is recommended by the team here, I would trust them and go into it eagerly. I hope this helps others decide to do it sooner rather than later. There is no sense in suffering.



THE CLINICAL PERSPECTIVE

**FROM CHRISTOPHER R. GOOD, M.D., F.A.C.S.
VIRGINIA SPINE INSTITUTE**

It is truly an honor to me to be able to help people who have served our country and Aaron is a great example of a tough, hard working American! When I met Aaron, he had been dealing with severe pain and weakness/ numbness in his legs for many years. I could not believe he was tough enough to keep working at his job and even fighting through heavy labor outdoors. He told me of his plans to adopt two boys and expressed his concern that he couldn't be the kind of dad he wanted to be because of his back. I knew that I could help Aaron and we decided right then and there to move forward with surgery so that he could be recovered in time for the adoption.

Aaron's problems all stemmed from trouble in the bottom two discs of his low back (L4/5 and L5/S1). He had developed disc degeneration which eventually led to disc herniations, spinal instability, and pinching of the nerves in his low back (spinal stenosis). It got to the point where every movement he made led to slipping of his bones and pinching of the nerves in his back, causing intense pain.

The surgery we performed to help Aaron had two main goals. The first goal was to remove the material that was pinching his nerves and the second was to stabilize the bones that were slipping. We fused Aaron's spine at two levels using a front-back approach. We first approached his discs in the front of his spine to remove the damaged discs and placed cages and bone graft to "weld" or "fuse" the bones together. The second approach was through an incision on his low back and through that approach, we removed the bones that were pinching his nerves (laminectomy) and placed screws and rods for additional fusion strength.

Aaron's successful recovery and return to a normal life has brought much joy to his family and his new children. He has also brought much joy to my life, as well. It has been a real pleasure to get to know Aaron, his wife, parents, and now his kids!

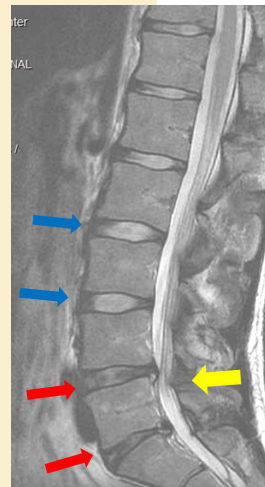


Figure 1: Sagittal (side view) MRI scan of Aaron's low back showing normal discs (blue arrows) at the top and degenerated discs (red arrows) at the bottom. The large yellow arrow shows where the nerves in his spine are being pinched.

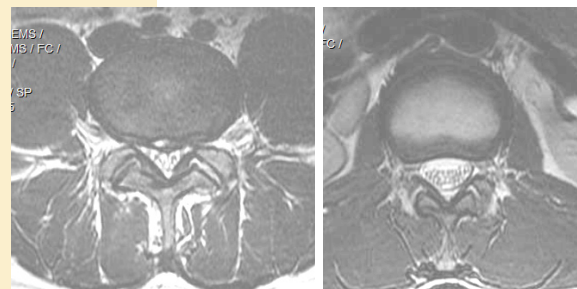


Figure 2: Axial (cross sectional) views showing one of Aaron's normal discs (Right) compared with one of his bad discs (Left). The space inside the spinal canal around the nerves is markedly decreased on the left view.

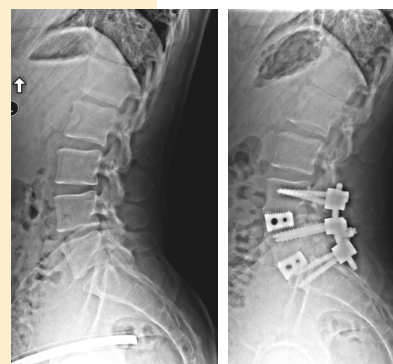


Figure 3: Aaron's lumbar x-rays before (left) and after (right) surgery. His spine has been stabilized with metal implants and his bones have "welded" together in a spinal fusion that allows Aaron to move without instability and pain.

MARIEL LYNCH

Exploring the Options

I had back pain and numbness in my legs for as long as I can remember. In the late 90's and early 2000's, I used to work with young horses and do Competitive Trail Riding. It got so bad that when I got off of a horse I couldn't stand up! I had more numbness than pain. When shopping or at work, often I would have to bend over to stretch out my spine to get the feeling back in my legs and feet. In 2002 I had a laminectomy and decompression to address the numbness. It helped for a while, although I never got the feeling back in my feet.

The pain gradually increased over the next few years. In the summer of 2008, my husband and I drove to California to visit family. My brother-in-law commented on how much I looked like my mother (which was a compliment); I even walked like her (cause for alarm). I started watching in windows and mirrors and I was walking all hunched over and pitched to one side like my mother used to. I was in a lot of pain. In 2009, we made a trip to Alaska. My in-laws drove up with their trailer and we flew in to spend a couple of weeks with them. I was in so much pain that I couldn't lie down, so I didn't get much sleep. In early 2010, I was referred to Dr. Orndorff.

When he said that he could help me, I felt like a life sentence had been lifted.



He had me go through all of the usual pre-surgery procedures. I especially remember the steroid injections, where there wasn't even room in my spinal column for the needle. We skipped straight to surgery.

The surgery lasted about eight hours. Dr. Orndorff made two incisions in my side and corrected a lot of my scoliosis and one incision in my back where he fused vertebrae L1-L4. After I woke up from the surgery I was able to walk a mile around the hospital floor that same day! There was still post-surgical pain, but not anything like what I was experiencing before the surgery.

Since the surgery, I have been relatively pain free. I have been able to resume normal activities. I work full time, mostly on my feet. I walk and bicycle and work in my garden. I can stand up straight. I am 65 years old and am planning a ten-year full-time RV adventure with my husband. Life is great!

My advice to anyone who is suffering from back and/or neck pain is to explore your options.

We are so fortunate to have a group of physicians of this quality in our back yard; there is no reason for anyone not to at least consult with them. I have sent several friends to Dr. Orndorff who have had excellent results. **And don't let the word "fusion" scare you!** If you are even considering this, your mobility is already so compromised that the surgical option will only serve to improve your range of motion.

THE CLINICAL PERSPECTIVE

**FROM DOUGLAS G. ORNDORFF, M.D.
SPINE COLORADO**



I had the pleasure of meeting Mariel Lynch in April 2010. She was a pleasant 59-year-old female with a surgical history of laminectomy and decompression in 2003. Unfortunately, her symptoms began to recur. Mariel informed me that she was only able to walk approximately a half-mile with the help of a cane and stopping to rest periodically. Additionally, she could not sit or stand for long periods of time. To combat these symptoms, she was using ice, pain medication, and physical therapy, as well as undergoing osteopathic manipulation, which gave her some but no long-standing relief. I also had her try injections, but they were unsuccessful and did not give her any solace either.

Given Mariel's long spinal history and exhaustion of conservative recommendations, her symptoms significantly affecting her activities of daily living, and her quality of life, Mariel and I agreed that surgical intervention was the next step. She was very engaged in her care and surgical decision making. She understood the risks and benefits of the surgery, researched the procedure, and had discussions with her family and other patients. No surgery is perfect and we had honest discussions about her future limitations, possible needs for further surgery, and set realistic expectations. The procedure she ultimately underwent in May of 2010 was a multi-level fusion and decompression.

After surgery, Mariel recovered remarkably well. Between surgery and her post-op visit, her complaints had resolved and she was walking several miles per day. She continued to remain pain-free and progressed to full activities. At one visit Mariel told me, "I've gotten my life back," and she was feeling better than she had in years. Of equal importance, her x-rays showed evidence of a solid fusion! Mariel fully embraced her success and outcome with a tremendously positive attitude. That is why she is a spinal champion.

When I first met Mariel, I was still in my first year out of fellowship. I learned three very important lessons in my relationship with her. The first was that to always take the time with each patient to answer their questions, be transparent about all the risks and benefits and recovery, and the possible need for further surgeries due to a fusion procedure. The second was to set realistic expectations for yourself as a surgeon and for the patient. The third is to stay positive - both the patient and the physician - and to have a mutual investment in each other. I have taken those lessons and have tried to implement them with every patient that I treat.

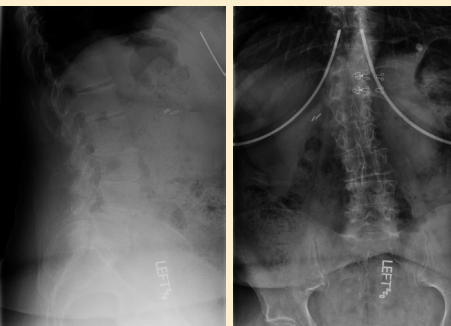


Figure 1: Pre op lateral and A/P x-rays demonstrating degenerative spondylolisthesis at L4-5 and significant degenerative disc disease at L2-3, L3-4, and L4-5.

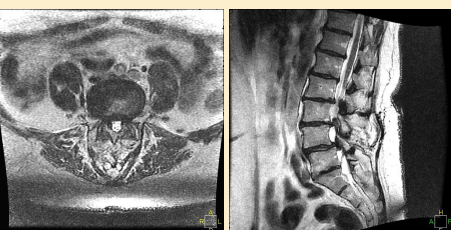


Figure 2: Pre op sagittal and axial (L4-5) MRI showing moderate to severe central stenosis at L2-3, and severe stenosis at L3-4 and L4-5 as well as associated foraminal narrowing.

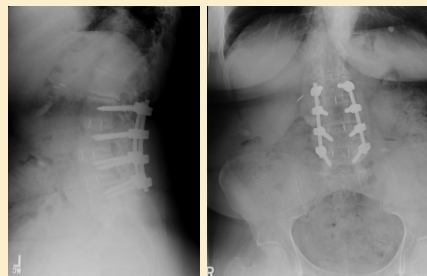
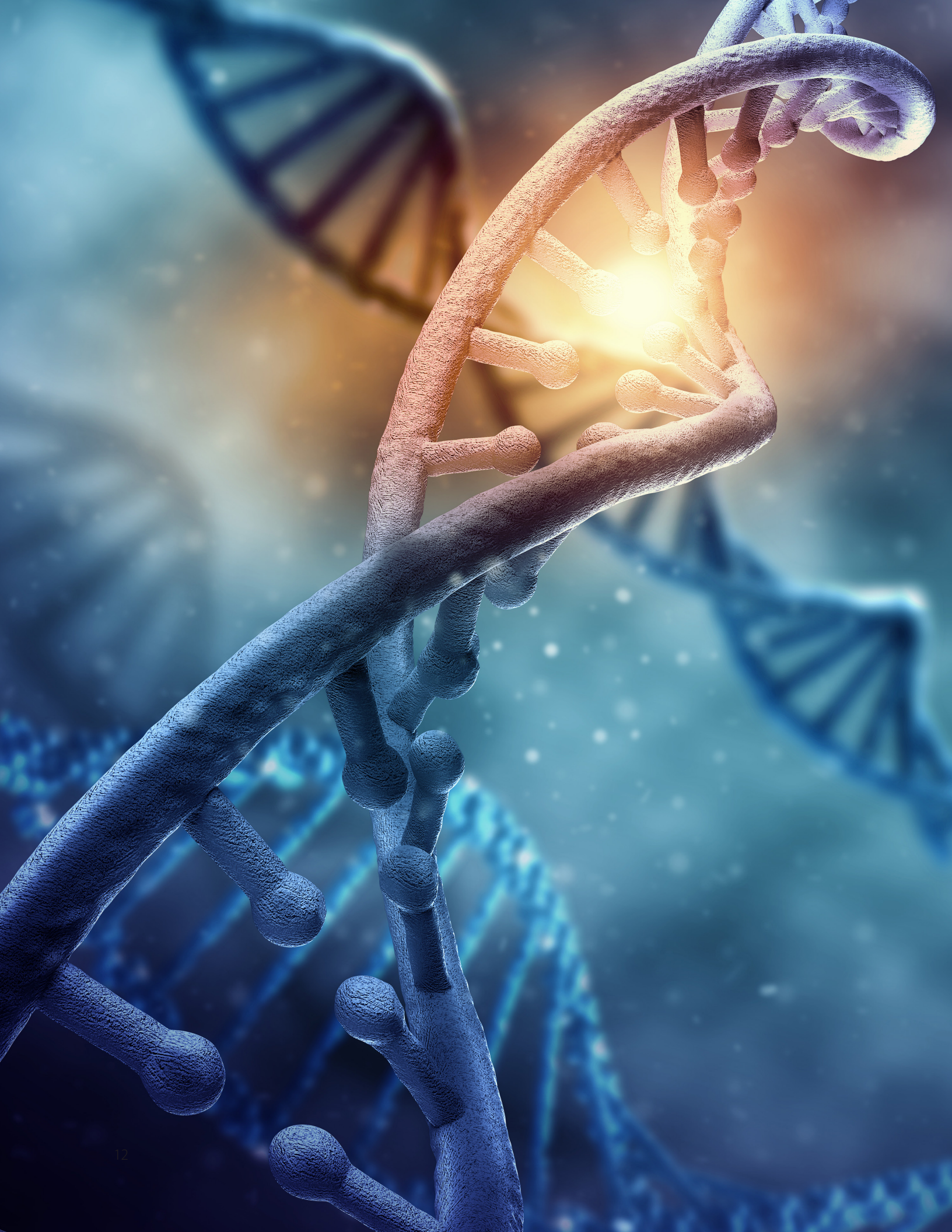


Figure 3: Post op lateral and A/P x-rays illustrating restoration of her coronal imbalance, appropriately positioned implants, and evidence of both interbody fusion and posterolateral fusion.





SCOLIOSIS: DIAGNOSIS, BRACING, TREATMENT

Christopher R. Good, M.D., F.A.C.S.
Blair Simonetti, PA-C
Virginia Spine Institute

Adolescent Idiopathic Scoliosis (AIS)

Scoliosis is an abnormal curvature of the spine that affects approximately seven million people in the United States. Idiopathic scoliosis is a well characterized condition in humans. Abnormal curvatures of the spine were first recognized by Hypocrites and the name idiopathic scoliosis was introduced in the mid 1900s by Bower¹. Idiopathic scoliosis is a structural curvature of the spine with lateral and rotatory components, which typically affects 2 - 3% of normal children in adolescence. Most scoliosis curves are minor and require no treatment. The more severe, progressive forms of scoliosis are rare and occur in only 0.2 - 0.5% of patients with adolescent idiopathic scoliosis.

Adolescent idiopathic scoliosis is most commonly diagnosed between the ages of 10 to 12 years old. It may be discovered by the teenager, parents, during school screenings, or at pediatric visits. When scoliosis is suspected, patients are referred to orthopedic scoliosis specialists who will evaluate the patient to determine the severity of the patient's curvature and what form of treatment, if any, may be appropriate.

Scoliosis is typically characterized by a three-dimensional deformity of the spine that involves a curvature in the sagittal, frontal, and transverse plane (Figure 1). Adolescent idiopathic scoliosis does not typically produce significant pain or limitation for the patient during the teenage years; however, larger curves or curves with significant rotation may cause a bothersome cosmetic deformity. There is much concern about the potential for heart, lung, or intestinal damage, but only very large scoliotic curves may decrease pulmonary function and, in the most

severe cases, can lead to a type of heart failure known as cor pulmonale². In the United States, it is very rare for idiopathic scoliosis to progress to this level because most patients are detected and treated at earlier stages.

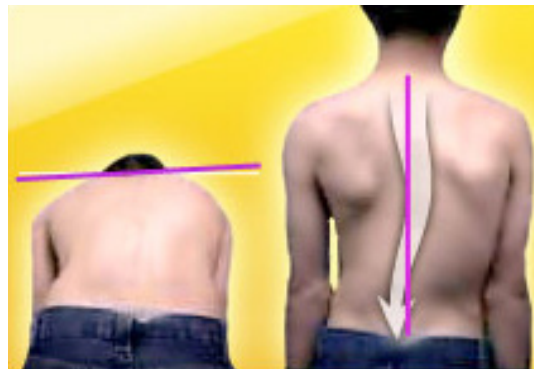


Figure 1: A scoliosis examination is done with the patient standing in a relaxed position with their arms at the side. The physician examines the patient from behind looking for curvature of the spine, shoulder blade asymmetry, waistline asymmetry or any trunk shift. The patient is then asked to bend forward at the waist and the physician examines the back once again to look for the rotational aspect of the scoliosis in the ribs or waist. (Image provided by Medtronic, Inc.)

There are a number of different factors that seem to be related to the risk for curve progression in adolescent idiopathic scoliosis. Scoliosis curves are known to get worse during periods of skeletal growth, which is why progression of scoliosis is commonly seen during the teenage growth spurt. Specific factors include the age of the patient at the time of diagnosis (the younger the patient, the more growing they have left to do), the maturity of the patient as determined by menarchal status and Risser sign, and the pattern of the scoliosis curve that is present. In adolescent idiopathic scoliosis, females are eight times more likely than males to have curves that progress to a point where treatment is required³⁻⁶.

Treatment options for idiopathic scoliosis include observation, therapy, bracing, and surgery.

Mild cases of scoliosis are usually observed with periodic physical examination and perhaps x-ray screenings (Figure 2). Most patients are seen on a four to six month basis until they finish growing. The majority of patients who are observed will have small curves that will have little, if any, progression as the patient reaches the end of growth. For patients with small curves who are observed, full activities are allowed, including competitive sports. For patients with small curves at the end of their growth spurt, no further treatment or observation may be necessary. Patients with curves that are at risk for progression during periods of rapid growth may need to be treated with a brace. In general, bracing is recommended for curves that measure between 25°-30° on x-rays in patients with significant growth remaining. The goal of bracing for scoliosis is to prevent the curve from getting bigger during the remaining growth spurt. The brace does not fix the curve that has already developed; it helps to prevent the curve from getting even bigger. There are a number of different types of braces and brace routines, but not all are equally effective. Some braces are very flexible, which may be more comfortable, but have not been shown to be as effective in preventing curve progression. Another common mistake that is made is wearing the brace only at night. While this may be more popular with patients, it is not the best routine if preventing curve progression is the priority. In fact, wearing the brace while the patient is standing upright (daytime) is probably even more important than while laying down (nighttime)



Figure 2: Full length spine x-ray of a patient with idiopathic scoliosis.

because of the effects that gravity has on the spine when standing. A recent study from the NIH clearly shows that the more hours a day the brace is worn, the more effective it is at preventing curve progression. In this study, patients who wore the brace over 17 hours per day had the lowest rate of curve progression.

In most cases, a low profile brace known as a thoracolumbarsacral orthosis (TLSO), or Boston brace, is recommended (Figure 3). A number of different bracing schedules have been described, but the more the brace is worn, the better it works. The goal is to maximize the positive effects of wearing the brace while still allowing the patients time out of the brace for social activities and sports. Brace treatment is usually continued until the patient completes their growth, which means that teenagers who are treated with a brace will usually wear the brace between two to three years.

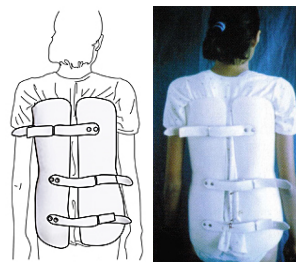


Figure 3: A thoracolumbarsacral orthosis (TLSO), or Boston Brace, is sometimes used to treat scoliosis in patients who are still growing. (Images provided by Medtronic, Inc.)

There has been much discussion and research regarding therapy modalities for teenage patients with scoliosis and, unfortunately, there is a great deal of misinformation regarding success of various treatments on the internet. For patients with scoliosis, there are two different reasons to consider therapy for scoliosis and it is important for patients and their families to know what goals they may or may not achieve with therapy. One goal of spinal therapy is to alleviate pain and stiffness while improving posture and strength to enhance overall back health. Most teenagers with idiopathic scoliosis have no pain or stiffness with their scoliosis and therefore there is no need for physical therapy to make them feel better or alleviate their pain. For the smaller group of patients who do have stiffness or pain, therapy can be very helpful at treating these symptoms. Another potential goal of therapy is to straighten the curve or prevent further progression. A number of different techniques have been tried, most not having shown any benefit when it comes to straightening the curve. More recently, a technique developed in the 1970s, known as the Schroth Method, has received increasing attention and may be effective for some patients. This method is very time consuming and requires intense dedication, but may be explored for some patients.

Spinal reconstructive surgery is generally reserved for progressive scoliosis curves greater than 45° or curves that do not respond to bracing treatment. The goals of scoliosis correction surgery are to correct the spinal curvature and to prevent the curve from progressing further during the patient's life (Figure 4).



Figure 4:
Postoperative
x-ray of a patient
with adolescent
idiopathic scoliosis.

A number of recent technical advances have taken place which allow for greater curve correction and earlier spinal stability. Because of these advances, most patients undergoing reconstructive surgery for adolescent idiopathic scoliosis are no longer required to wear a brace after surgery and typical hospital stays after surgery are less than one week. The decision to undergo surgery for scoliosis should only be made after a very careful evaluation and a detailed discussion between the patient, family, and surgeon.

Biomechanical Pathogenesis of Adolescent Idiopathic Scoliosis

Idiopathic scoliosis is a common pediatric spinal deformity and up to 80% of cases occur in adolescents⁷. Recent research has worked to identify potential factors involved in the etiology of scoliosis in order to enable physicians to more accurately predict the prognosis for patients with scoliosis and to offer more effective treatments. Although the exact etiology of adolescent idiopathic scoliosis is still unknown, a number of studies have examined a variety of neurologic and skeletal factors that may be involved in the development of scoliosis. Idiopathic scoliosis is unique in that it occurs exclusively in humans⁸⁻⁹. When scoliosis is seen in other vertebrates, it is either congenital, cicatricial, neuromuscular, or experimentally induced¹⁰. It is well established that humans are the only vertebrate animals that regularly stand with a fully erect posture. It has been postulated that this fully erect posture may be involved in the development of idiopathic scoliosis¹¹⁻¹³. In addition, human beings are the only animals that walk with the body's center of gravity located directly above the pelvis. Other animals closely related to humans in the ape family walk leaning forward, with the body's center of gravity well in front of the pelvis¹⁴. The fully erect posture of the human spine significantly changes the conditions under which forces are transmitted through the spine and these unique forces may play a role in the development of idiopathic scoliosis¹⁵.

Genetics of Adolescent Idiopathic Scoliosis

The involvement of genetic factors in the development of adolescent idiopathic scoliosis has become widely accepted. It is possible that genetic factors may be involved in specific aspects of scoliosis, including the shape of a scoliosis curve and the risk for curve progression. A number of population studies have

documented that scoliosis runs within families and that there is a higher prevalence of scoliosis among relatives of patients with scoliosis than within the general population¹⁶.

A number of studies have examined the role that hereditary or genetic factors may play in the development of idiopathic scoliosis. In 1968, Wynne-Davies conducted a screening study of 114 patients with idiopathic scoliosis. They screened first-, second-, and third-degree relatives of patients with idiopathic scoliosis. Based upon inheritance patterns amongst these patients and their families, the authors concluded that a dominant or a multiple-gene inheritance pattern was present in adolescent idiopathic scoliosis¹⁷. In another study, Robin and Cohen carefully evaluated the inheritance pattern of adolescent idiopathic scoliosis over five generations within one family. They found the direct transmission of adolescent idiopathic scoliosis from father to son on more than one occasion, which does suggest an either autosomal or multiple-gene inheritance pattern¹⁸.

Large population studies have shown that 11% of first-degree relatives of patients with scoliosis have scoliosis, as well. Similarly, 2.4% of second-degree and 1.4% of third-degree relatives of patients with scoliosis also have the condition. Studies on identical and fraternal twins have shown that monozygous (identical) twins have a high concordance rate for the condition at approximately 73%, while dizygous (fraternal) twins have a concordance rate of 36%¹⁹⁻²³. The incidence of scoliosis amongst dizygous twins is similar to that of first-degree relatives of a patient with adolescent idiopathic scoliosis.

At this time, the specific genes that are involved in adolescent idiopathic scoliosis have not been completely identified. Recent studies using a technique called genetic linkage analysis have identified multiple specific regions on a number of genes that may be involved with the development of adolescent idiopathic scoliosis²⁴⁻²⁷. In 2005, Miller et al. performed a statistical linkage analysis and genetic screening of 202 families with idiopathic scoliosis. Using linkage analysis, they were able to identify candidate regions for idiopathic scoliosis on chromosomes 6, 9, 16, and 17²⁸.

The Difficulty of Studying the Genetic Basis of Idiopathic Scoliosis

Studying the genetics of adolescent idiopathic scoliosis is difficult because there is a high degree of genetic variability amongst patients with scoliosis²⁹. For AIS, it is likely that a number of different genetic and environmental factors are involved in the development of scoliosis in any given patient. **Even when a single gene is responsible for the development of a condition, not all patients with the gene may demonstrate the exact same characteristics.** It has been well established that the patterns of inheritance of a single gene are susceptible to the principles of variable penetrance and heterogeneity. The principle of variable penetrance states that two patients with the same gene do not necessarily have to have the exact same characteristics. The principle of heterogeneity refers to the potential presence of many different genetic defects, all of which may eventually cause the same disease. This may be due to multiple different mutations of the same gene or multiple different genes that may all eventually lead to the same disease state. Because of the principles of variable penetrance and genetic heterogeneity, a simple mode of genetic inheritance may not always be clearly identifiable in one group even when a genetic basis clearly exists.

At present, the general consensus is that the etiology of idiopathic scoliosis is multi-factorial. Continued research in the field will hopefully lead to the identification of specific factors that may cause the disorder. In the future, it is likely that genetic testing will lead to earlier diagnosis and treatment of the condition.

Genetic Testing for AIS

Exciting recent research has been presented regarding the use of genetic testing to predict curve progression and failure of brace treatment in patients with adolescent idiopathic scoliosis. Kenneth Ward, MD and colleagues presented their preliminary work on genetic testing for AIS curve progression at the 2008 Annual Meeting of the Scoliosis Research Society. They presented the reports of a Genome-wide association study using Affymetrix HuSNP 6.0 microarrays to compare patients with idiopathic scoliosis with normal patients. The authors were able to identify genetic markers which were associated with progression of a scoliosis curvature. By using this panel of genetic markers, physicians may be able to predict which patients, at the time they are initially diagnosed, are likely to progress to a severe scoliosis³⁰.

Also at the 2008 Annual Scoliosis Research Society

Meeting, James Ogilvie, MD and coauthors presented their work using genetic testing to predict which patients will not have successful brace treatment for AIS. The study tested prognostic genetic markers for brace-resistant adolescent idiopathic scoliosis in fifty-seven patients with adolescent idiopathic scoliosis who wore a brace for at least one year but had curves that progressed and required surgery. By using a panel of genetic markers, the authors were able to predict which patients were likely to fail brace therapy³¹.

This exciting research has led to the development of a test for patients with mild or moderate adolescent idiopathic scoliosis between the ages of nine to thirteen years old. The simple test is performed analyzing the patient's saliva, which can be collected during a routine office visit. **The test will allow scoliosis specialists to better predict an individual's risk for developing progressive scoliosis.** Genetic testing allows the physician to offer earlier and safer treatment to patients with high risk for spinal curvature before the scoliosis progresses to the point that it causes severe pain or requires a major surgical reconstruction. In some cases, smaller surgical procedures are available to straighten a small curvature that was detected through genetic screening.

Conclusion

Many factors may be related to the development of idiopathic scoliosis and no single cause has been identified at this time. Adolescent idiopathic scoliosis appears to be highly dependent on genetics, as well as to the unique biomechanics of the human spine. Ongoing research, including genetic testing, will lead to improved diagnosis and treatments for patients with adolescent idiopathic scoliosis.

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BACKPACKS & TEXT NECK: MODERN DAY SPINE AILMENTS

Melissa Treat, RN, BSN, CPT
Tyson's Sport & Health

First World Problems

An overwhelming number of Americans are awakening each day to upper back pain and neck stiffness, chronic ailments that can be a result of our neoteric lifestyle. Day-to-day life in the 21st century presents new, modernized “first world problems” from which our predecessors did not suffer. Two of the new-age culprits that cause chronic upper back and neck pain are the daily strain of carrying heavy backpacks and shoulder bags, as well as the worldwide smartphone epidemic, which can lead to “text neck” or iPosture issues. **“Text neck” is the term used to describe the neck pain and damage sustained from looking down at your cell phone, tablet, or other wireless devices too frequently and for too long.** Let’s take a biomechanical look at each issue, why it causes damage to your spine, and explore methods we can employ to keep our spines healthy and happy in our modern society.

A Biomechanical Perspective

When carrying a backpack, the weight of the load is carried on the shoulders. However, because the weight settles to the bottom of the bag, it strains the upper back and supportive muscles of the spinal column, causing neck and upper back pain. If this amount of strain and spinal compression continues each day, over time it can lead to long-term nerve damage. The skeletal structure of the spine is very delicate, with nerves passing through a hole in each of the vertebrae called the foramen. Any damage caused to nerves from being compressed by a heavy weight can last temporarily or can lead to more permanent chronic ailments. A backpack can easily

weigh upwards of 20 pounds, which places constant load and compression along the spine. This can potentially lead to the cervical vertebrae impinging on the nerves that run from the neck, across the shoulders, and down the front of the arms. This is a risk for both adults, who routinely carry backpacks, as well as college, high school, and elementary school students who carry heavy backpacks each day. If this is repeated for days, weeks, months, and so on, it is easy to see how this could cause long-term back problems and considerable medical bills to treat the numbness and loss of motor control caused by nerve damage.

Similarly, imagine the neck strain caused by looking at our handheld wireless devices for hours each day. The human head weighs about a dozen pounds. However, as the neck bends forward and down, as it does while texting, emailing, or surfing the web, the weight on the cervical spine begins to increase. **At a 15° angle, the head’s weight is about 27 pounds, at 30° it is 40 pounds, at 45° it is 49 pounds, and at 60° it weighs a whopping 60 pounds!** Imagine carrying an 8-year-old around your neck several hours per day. Smartphone users spend an average of two to four hours per day hunched over, reading e-mails, sending texts, or checking social media sites. That is 700 to 1,400 hours per year that people are putting stress on their spines, according to current research published by Kenneth Hansraj in the National Library of Medicine. According to Hansraj, “As you stretch the neck tissue for a long period of time, it gets sore, it gets inflamed. It can also cause muscle strain,

pinched nerves, herniated discs and, over time, it can even remove the neck's natural curve." Poor posture can cause other problems as well, such as reduced lung capacity, headaches, neurological issues, even heart disease and depression.

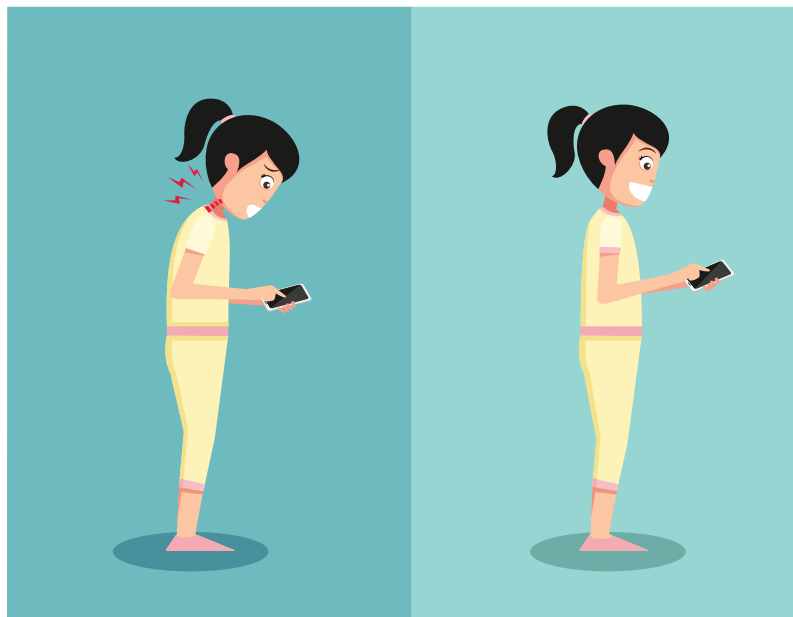
Keeping a Happy & Healthy Spine

So how can we combat the habits of our daily lifestyle that can be potentially damaging our spine and overall health? Prevention, mindfulness, and developing core strength and flexibility are essential. A good backpack should fit correctly and have several pockets and zippered areas so that the weight of the contents can be distributed more evenly. The best ones also have a strap that latches across the chest, pulling the pack forward and reducing some of the weight in the shoulder area. The shoulder straps should be wide and well-padded to cushion the shoulder area and reduce pain from pressure. Load the backpack with the lightest items on the sides and top and restrict the number of heavy items carried in the bottom. Reduce the weight by carrying only what is needed for the day. Make sure the backpack is the right size for the user. It's tempting to use a larger bag because it holds more items, but it also adds more weight.

We know modern technology is here to stay, so how can we continue to use our smartphones and wireless devices without causing long-term harm to

our spines? Individuals should make an effort to look at their phones with a neutral spine and to avoid spending hours each day hunched over. Look down at your device with your eyes, there's no need to bend your neck and compress your cervical spine. "I love technology. I'm not bashing technology in any way," says Hansraj. "My message is: Just be cognizant of where your head is in space. Continue to enjoy your smartphones and continue to enjoy this technology — just make sure your head is up."

Routine and consistent exercise and stretching plays a large role in preventative spinal health. Many people don't know this, but you need to have strong core muscles—the abdominal and spinal column muscles—to support your upper body, including your neck. Your core muscles usually do not get enough exercise during normal daily activities, so you need to do specific exercises to target these muscles. You also need strong and flexible muscles in the neck and back to minimize strain on your cervical spine and help support the weight of your head. Again, your neck will not get sufficient stretching and strengthening during normal daily activities, so it is best to learn specific neck exercises with the help of a health professional. By keeping a strong, healthy core and being mindful in your biomechanics and daily habits, you can continue enjoying your busy life in the 21st century, all while maintaining a healthy, happy spine and body.



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spi-nal cham-pi-on *noun* \ˈspi-nəl cham-pē-ən\

a person who has achieved an improved quality of life through treatment for back or neck pain.



WELCOME TO SRF, SABRINA!

Sabrina M. Woodleif, B.S.
Spinal Research Foundation

Why I came to SRF:

I come from two different professional backgrounds – customer service and research. Finding a position and organization that blends these two distinct sets of skills and interests was my goal – and that is exactly what I found at SRF! We incorporate research, education, and patient advocacy into our mission; I am able to direct my analytical and research experience into a patient-centered cause, all while learning something new and truly making a difference every day.

Greatest work-related accomplishment:

Being a master of adaptability! In my job, I'm required to wear many different hats, depending on the time of day and the task at hand. This type of environment necessitates being open to accepting and embracing new experiences and challenges. I appreciate the trust that has been extended to me and I look forward to meeting and exceeding all expectations! The three hats that I can consistently count on wearing are:

- Research Coordinator: Recruiting, screening, and enrolling patients into studies while maintaining accuracy of all related documentation and protocols
- System Administrator: Provide ongoing support for SpineOnline, a national web-based research platform, to patients and providers
- Associate Editor: Optimize production of the biannual journal by securing authors, editing layout and content of publication, and maintaining accurate records on website and social media platforms

What I enjoy most about my role at SRF:

Being a part of a community - I consider myself very fortunate to have found a workplace environment that encourages both personal and professional growth! It is truly a wonderful place to build a career, as well as a life – I really could not have asked for anything better!

How I will advance and elevate SRF:

I stepped into my position during one of SRF's most exciting times – a time of growth, development, and incredible potential! We are diving deeper into SpineOnline, having great success with our actively enrolling studies, and continuing to build and celebrate our We've Got Your Back race campaign! I will continue to create and implement different measuring tools to help evaluate and improve our successes, while using my research and analytical skills to discover and correct inefficiencies within our company. I look forward to managing myself, as well as managing team-based groups and projects. My ultimate goal is to lead my team in propelling and maintaining SRF as the "go-to" for spinal needs – not only because of our incredible staff of top medical specialists, but also because of our provider-patient relationship model. I want you, as a reader, patient, or even family or friend of a patient, to feel like family. From initial inquiry to two-year post-op evaluation, we want you to be comfortable, confident, and excited that you decided to go on this journey with us. We know that the journey to spinal health is not one that can be made alone. My commitment to empowering patients to take an active role in their health grows stronger each day.

WE'VE GOT *YOUR BACK*

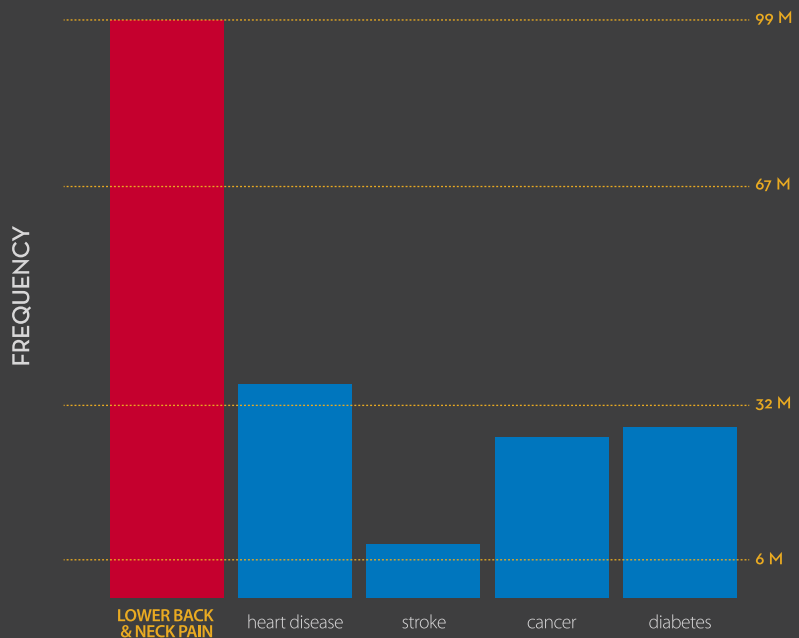
The Spinal Research Foundation envisions a nation where fewer people are suffering with spinal injuries and disorders. Through research, education, and advocacy programs; SRF is proving the effectiveness of treatments, supporting patients, and empowering all with knowledge and hope.

Together we will help patients return to the people and activities they love.

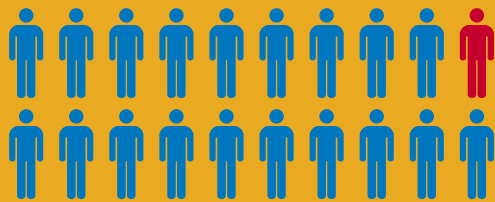
99.3 M

adults in the U.S. suffer from low back and neck pain each year

U.S. ADULTS IN 2012

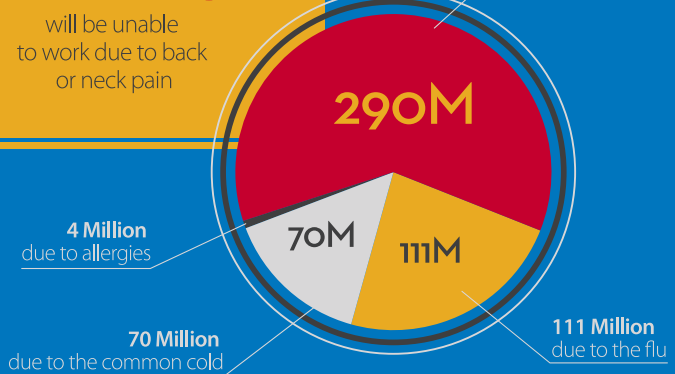


1 in 2.5
adults will experience low back or neck pain this year



1 in 20
will be unable to work due to back or neck pain

290 Million due to neck & back pain



Lost Workdays Per Year

Sources: Center for Disease Control, National Academy on an Aging Society/Asthma and Allergy Foundation of America, American Diabetes Association & American Academy of Orthopedic Surgeons



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DISC INJURIES IN YOUTH IN COMPETITIVE SPORTS

Hunter R. Voslow
Intern, Spinal Research Foundation

Throughout childhood and into adulthood, sports have many benefits but also have accompanied risks. For example, concussions have received much coverage and brought attention to the potential effects contact sports, like football, can have on the brain. Less high profile, however, are the dangers regarding the spine. Football and other sports can result in damage to the spine and, although unlikely, even paralysis. This is not to say that children should not participate in sports, but parents and athletes should be aware of the potential risks and the signs to look out for.

The types of spinal injuries that could affect athletes can be divided into two types. There are catastrophic injuries that are immediate or nearly so and the more long-term injuries or conditions that may be less immediate in their effect but can cause long term problems. An example of this difference is having a football player take a hard hit and having spinal cord damage and needing immediate medical attention versus a gymnast who has back pain that arises and continues to worsen with time. The catastrophic injuries are the ones that are most obvious and likely more present in the minds of athletes and parents alike. Who isn't horrified at the thought of a hard hit and having an athlete not be able to move their legs? I am not a parent but I do remember my mom telling me how much she hated watching me wrestle and seeing my neck get twisted and contorted.

For parents of teen athletes, having a child suffer a catastrophic injury, spinal or otherwise, is something they worry about at some point or another. Though this is a terrible situation, which unfortunately does occasionally happen, the bright side is that it is quite rare.

The reality is that as scary as severe and catastrophic injuries are, they are unlikely to occur.

The key to handling catastrophic injuries to the neck or back is prevention.

Using proper techniques, avoiding dangerous maneuvers - such as 'spearing', where a football player leads with the front of their helmet in a tackle - and proper treatment are all also vital in preventing spinal injuries. A National Athletic Trainers' Association task force executive summary released in August 2015 recommends that each school have an Emergency Action Plan developed in conjunction with the local emergency services. It also recommends that, although an athletic trainer at all events would be ideal, sports administrators should develop a procedure for implementing the Emergency Action Plan and coaches should be trained to administer appropriate care until medical personnel arrive. Parents concerned about a spinal injury occurring can ask if an appropriate plan has been developed and if the coaches have been trained.

Along with catastrophic and immediate injuries, there are also more subtle and long-term injuries to the spine resulting from sports. As a former wrestler, I had my first back/neck problem in middle school. After a hard impact to the mat, I had pain and the athletic trainer told me that discs in my spine were being compressed. It was not a significant problem and I quickly returned with little trouble. In high school, however, I was not as lucky. I hurt my back and experienced intense pain and flare-ups throughout the end of my wrestling career. I saw the trainer and was able to return back to wrestling shortly thereafter. Throughout the rest of my time wrestling, I experienced periods of lower back pain and back problems arising from those injuries. Soreness and pain were intermittently present at different levels. During practice and matches, I repeatedly tweaked my back, causing worsened pain. I went through a cycle of reinjuring my back, taking time off to recover, and having pre-practice treatment with hot pads or electro stimulation. I did not visit a spine doctor or get x-rays, although I realize now that I could have found relief if I had done so. Unfortunately, this pattern of chronic problems in athletes is not uncommon.

Although my back problems were likely not due to any true spinal injury but rather due to injured muscles or ligaments, spine problems can arise later in life. Spine University's Guide to Back Pain in Teen Athletes suggests that the most common causes of back pain in teen athletes are muscle or ligament sprains and these should be treated with rest, ice, and pain medications when appropriate. More serious back problems can also occur; examples of these injuries are disc herniation, spondylolysis, and spondylolisthesis.

Basic Anatomy of the Spine says that spondylolysis refers to a defect in the vertebrae, typically in the area of the pars interarticularis. In Figure 1, the middle picture shows a case of spondylolysis; the pars interarticularis is the section of bone with the red line representing a fracture. In the context of a young athlete, spondylolysis typically refers to a 'stress fracture' or a defect arising from micro-fractures forming as a result of repeated excessive loads. This stress fracture of the pars interarticularis is more common in certain athletes, such as weight lifters, gymnasts, and football linemen than the general population. Spondylolysis can also lead to further spine problems because the stress fracture can destabilize the spine and allow excess movement. A stress fracture of the pars can essentially lead to 'wobbling' of the spine. Spines have vertebrae with discs in between them. The fractured pars and wobbling of the spine place more stress on the disc below and can cause degeneration of the disc. Disc degeneration can lead to additional problems in the back. Spondylolysis can also lead to forward slipping of the spine, known as spondylolisthesis. The fracture of the pars allows the vertebrae to move out of alignment, sometimes putting pressure on nerves, which can be very painful.

Spondylolysis can be found early and steps can be taken to mitigate the damage. A common scenario seen by physicians that demonstrates the value of early detection is when a young patient exhibits symptoms of spondylolysis; perhaps they suffered a stress fracture at some point and the disc below the fracture has noticeable degeneration. Though the symptoms are not too severe and there isn't any real forward slippage of the spine yet, the disc degeneration would likely lead to long-term problems. The discs in the spine degenerate with

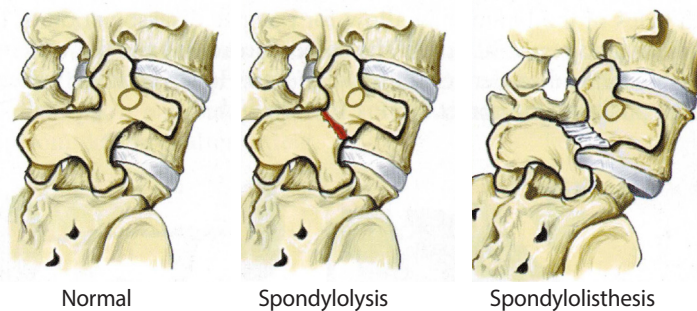


Figure 1: A comparison of a normal spinal, a spine with a fractured pars interarticularis (spondylolysis), and forward slipping of the spine (spondylolisthesis). (Image provided by Medtronic, Inc.)

age; a young teenager who exhibits a disc that behaves similarly to a 30 year old's is alarming. Early detection of spondylolysis and similar conditions can allow for quicker healing and preventative care, rather than continued suffering later in the patient's life. Further damage can be mitigated by strengthening the core to provide support and modifying sports activities to avoid excessive wear. If the problem is not addressed, the disc can be severely degenerated by the time a diagnosis is actually determined. Failure to detect spondylolysis allows damage to progress and damaged discs do not heal on their own, although, stem cell therapy may help with deteriorated discs. The Nationwide Children's Hospital advises that sports involving arching of the back with rotation and repetition are risk factors, along with poor physical conditioning. The risk, however, can be reduced with proper technique, appropriate equipment, and good conditioning. Signs to look out for which may indicate spondylolysis are chronic pain, stiffness in the lower back, and tight hamstrings. Pain in the back may also get worse when arching the back and twisting.

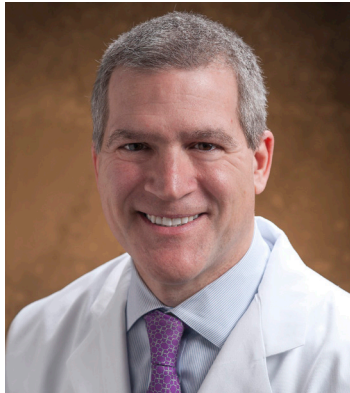
Although less common in adolescents than adults, disc herniations can also occur to young athletes. The discs contain a softer center that acts as a shock absorber and an outer covering. Sports can put stress on the spine and a disc herniation can occur if the outer covering tears and the center material in the disc is pushed out. This material can press on nerves in the back and cause symptoms such as sciatica and leg pain. Numbness, pain, and tingling are all potential signs of a disc herniation. Some disc herniations are asymptomatic and do not cause pain. If a disc herniation poses a problem, it can be treated in different ways. If conservative treatments are not successful, surgery can be used to remove the inner disc material which has spilled out from the disc. Work with your doctor to decide on a course of action that is best for you.

Sports offer many benefits, both physically and mentally. While there are risks, they are not so severe as to outweigh what can be gained by participating. Parents and athletes should both do what they can to protect their spines.

To prevent injury to the spine, build and maintain a strong core, no matter what age you are.

The muscles of your core can support and brace your spine, decreasing the risk of injury, while benefiting your long-term spinal health by preserving your discs. Athletes should be sure to use correct techniques and avoid dangerous techniques, such as spearing in football. Stretching and warming up before practice and games is also very beneficial. Symptoms for back injuries and conditions vary from person to person, as do treatments. For this reason, be sure your doctor discusses all the treatment options and is thorough. If you or someone you know is suffering from chronic back pain, weakness, numbness, pain, or tingling in arms or legs, it is a good idea to get it checked out by a physician. It is important to seek help early on because nerve damage can occur that may not heal and if there is ongoing damage, it is vital to stop it as soon as possible. If you are a parent, listen to your child and do not assume a problem will go away. Keeping your spine healthy will benefit you for the rest of your life. If you are in doubt, get it checked out.

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CURRENT TRENDS IN CERVICAL ARTHROPLASTY

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Cervical Arthroplasty: An Introduction

Cervical radiculopathy is the clinical term for pain or neurological symptoms from any condition that irritates a nerve in the cervical spine (neck). One of those conditions is cervical myelopathy, which occurs when the spinal cord in the neck is compressed or damaged. People with cervical radiculopathy or myelopathy can suffer from a variety of symptoms including neck pain, neck stiffness, headaches, trouble walking, bowel or bladder problems, numbness in the arms and hands, or pain that radiates into the shoulders and arms.¹

Surgical techniques used to treat these conditions – such as anterior cervical discectomy and fusion (a damaged or protruding disc is removed with the intervening vertebrae above and below fused together), and posterior cervical laminectomy with or without fusion (unroofing of the bone covering the back side of the spinal canal that is compressing the spinal cord or nerve) – have been utilized for decades with good results. These two procedures typically produce improvements in the 85%-90% range for radiculopathy and in the 70% range for myelopathy.

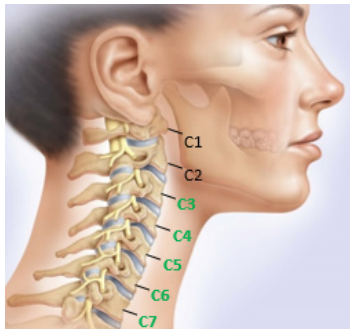


Figure 1:
A Healthy
Cervical Spine
(Source: LDR
[<http://www.cervicaldisc.com/cervical-anatomy>])

Another treatment, arthroplasty (artificial disc replacement), which replaces a damaged disc with a mechanical disc prosthesis, has not been widely adopted by surgeons for procedures in the lumbar region (low back) but seems more promising in the neck. This could be because it is more difficult to access the anterior lumbar spine compared to the cervical region; surgeons must follow a long learning curve to become adept at the surgery, due to the higher degree of risk associated with the surgery and concerns about complications. It is the author's opinion that lumbar arthroplasty has not gained universal acceptance because lumbar degenerative disc disease is a very different disease entity compared to cervical disc disease and, for the reasons stated above, is harder to treat.

When arthroplasty is used to treat disease in the cervical region, however, the procedure achieves positive results and has enjoyed significantly higher adoption rates by surgeons.

The Cervical Spine

When considering these treatments, it is helpful to understand the anatomy.

The cervical spine consists of seven rectangular box-like bones, called cervical vertebrae, which are stacked on top of one another in the neck. Cervical discs between the vertebrae are like cushions that act as shock absorbers to allow the neck to move freely. Think of the discs like mini steel-belted radial tires lying on their side sandwiched between the boxes.

The cervical spine also forms a structural and protective armored bony tunnel for the upper part of the spinal cord to pass through. In this tunnel, spinal nerves branch out through openings between the vertebrae, much like branches coming off of a tall tree. These nerves supply the upper body with sensation, as well as movement.

As a person ages, it is common to lose disc space height between the cervical vertebrae due to cervical disc degeneration or wear and tear. Over time, discs can collapse and bulge out the sides, similar to getting a flat tire. This is common in most people by age 50 or 60. It is unknown why some people have more symptoms from cervical disc degeneration than others, but wear and tear, dehydration, toxins like alcohol and tobacco, and genetics are all likely contributing factors.

Symptoms occur when part of a vertebrae or a cervical disc presses on the spinal cord or nerves. If the symptoms do not respond to non-surgical treatments such as medications, physical or chiropractic therapy, or pain management, a surgical procedure may be appropriate.

Anterior Cervical Discectomy & Fusion: The Prevailing Treatment

For over sixty years, the anterior cervical discectomy and fusion procedure has been the mainstay of surgical therapy for cervical radiculopathy and myelopathy. This procedure involves performing a discectomy and subsequent application of a rigid or semi-rigid metallic plate for internal immobilization of the intervening vertebrae, also known as fusion. This procedure, pioneered by Cloward, Smith, and Robinson, remains the most commonly performed procedure for the surgical treatment of cervical radiculopathy and myelopathy and has excellent success rates.

Adjacent Segment Disease: Myth or Reality?

Although a highly effective and safe procedure, it has been theorized that anterior cervical discectomy and fusion may contribute to a recurrent form of cervical degeneration called adjacent segment disease, a deterioration of spinal segments adjacent to a fusion. The proposed theory is that when a vertebral joint is fused, the joints above and below the fused joint

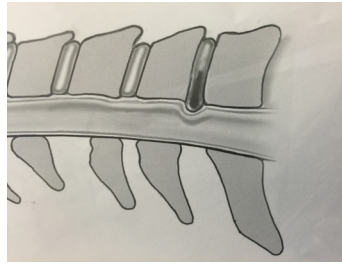


Figure 2:
Narrowing in
Cervical Spine
(Source: Haid,
McLaughlin,
Rods. Atlas of
Cervical Spine
Surgery, Elsevier
Saunders.

must work harder to provide the same amount of motion in the spine, which causes deterioration from the increased forces adjacent to the fusion.

This perspective is supported by a 1999 study published in the Journal of Bone & Joint Surgery, American Volume. The study followed 374 patients who received fusion procedures to treat cervical radiculopathy, cervical myelopathy, or both. The investigation evaluated patients for a maximum of 21 years after their surgeries and concluded that "Symptomatic adjacent-segment disease may affect more than one-fourth of all patients within ten years after an anterior cervical arthrodesis [fusion] ... patients should be informed of the substantial possibility that new disease will develop at an adjacent level over the long term."²

A 2009 study published by the American Academy of Orthopaedic Surgeons had a similar finding: "Anterior cervical discectomy and fusion is one of the most common cervical spine procedures. Although it is usually successful in relieving the symptoms of radiculopathy and myelopathy, the subsequent development of clinically significant disc disease at levels adjacent to the fusion is a matter of concern. Adjacent segment cervical disease progresses at a rate of 3% per year after spinal fusion;



Figure 3: The Mobi-C
Cervical Disc (Source:
LDR - <http://www.asodocs.com/orthopedic-surgery-procedures-dallas/mobi-c-cervical-disc-replacement/>)

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the incidence is expected to increase to more than 25% of patients within the first 10 years after the index fusion procedure. A combination of factors probably contributes to development of the disease, including the increased biomechanical stress placed on the disc space adjacent to a fusion ... Symptomatic disc disease adjacent to a cervical fusion is a significant clinical problem, and therefore, motion-sparing technology has been developed to reduce its incidence.”³

Other studies in both the cervical and lumbar spine literature suggest that adjacent segment disease may not be solely related to motion segment fusion alone and that the causes of this problem are multifactorial. ⁴

Preserving Range of Motion

Although there is no definitive proof that the immobilization inherent in a spinal fusion procedure causes adjacent disease, research and logic suggests that a surgical procedure that preserves a large range of motion may be more desirable to achieve proper long-term function of the spine.

If surgery relieves compression on the spinal cord or nerves and does not diminish normal range of motion – or at least reduces disruption of normal anatomy and physiology – it is intuitive to conclude that that procedure is a potentially better option, provided the outcomes for pain relief and neurological recovery are similar or better.

Cervical disc replacement was first introduced in Europe in the late 1990’s. At that time, three prospective, randomized Investigational Device Exemption (IDE) trials regulated by the U.S. Food and Drug Administration (FDA) were initiated in the U.S. These studies ultimately led to the first three FDA approvals for cervical disc replacement devices – artificial cervical discs – in the U.S.⁵

Gradually, cervical arthroplasty became recognized as a viable surgical option. A 2012 study published in *Surgical Neurology International* describes this: “Since its original description over 50 years ago, numerous studies have demonstrated the effectiveness of anterior cervical discectomy

and fusion; patients generally experience rapid recoveries and dramatic improvement in their quality of life. However, when Hillebrand et al. in 1999 reported a 2.9% incidence of symptomatic adjacent segment disease attributed to ACDF fusions’ altered kinematics, cervical disc arthroplasty emerged as a new motion-sparing alternative to fusion.”⁶

A 2016 study published in *PLoS One* shows that cervical disc arthroplasty may provide superior results compared to anterior cervical discectomy and fusion. The research investigated the mid- to long-term outcomes of cervical arthroplasty versus cervical discectomy and fusion for treatment of symptomatic cervical disc disease. The findings showed that patients who received cervical arthroplasty achieved significantly higher rates of overall success, Neck Disability Index success, neurological success, and significantly lower rates of adjacent segment degeneration compared with participants who received anterior cervical discectomy and fusion⁷

Arthroplasty Is Proven & Effective

According to a 2016 issue of the *International Journal of Spine Surgery*, research shows that cervical arthroplasty is a proven, effective surgical procedure: “The safety and efficacy of cervical arthroplasty has been established with a growing body of evidence that is compelling enough to no longer consider the procedure investigational. This evidence is bolstered by experience with multiple devices, at multiple sites, in and out of the investigational setting, and with short-, intermediate- and long-term follow-up. Cervical arthroplasty is a viable alternative to cervical discectomy in select patients with cervical radiculopathy or myelopathy.”⁸

For cervical arthroplasty, several manufacturers produce artificial disc devices that demonstrate good results. The device that I currently use for this procedure is the Mobi-C Cervical Disc (Figure 3). The Mobi-C is an FDA-approved cobalt chromium alloy device that is specifically designed as a bone-sparing cervical disc replacement for both one-level and two-level indications.

In 2014, the *International Journal of Spine Surgery* published the results of a multi-center, FDA-regulated Investigational Device Exemption (IDE)

study that evaluated 245 patients: 164 received cervical arthroplasty using the Mobi-C device; 81 received the traditional anterior cervical discectomy and fusion. The primary outcome measure was overall success based on improvement in the Neck Disability Index, no subsequent surgical interventions, and no adverse events classified as major complications. Secondary outcomes included assessments of arm and neck pain, patient satisfaction and adjacent level degeneration. Patients were evaluated at 3, 6, 12, 18, and 24 months.

According to the study, the overall success rates were 73.6% for cervical arthroplasty using the Mobi-C device and 65.3% for anterior cervical discectomy and fusion. The study concluded that “Mobi-C total disc replacement is a safe and effective treatment for single-level disc degeneration, producing outcomes similar to anterior cervical discectomy and fusion with less adjacent segment deterioration.”⁹

In 2015, the FDA approved an update to Mobi-C labeling to include five-year clinical results. The updated data is consistent with the previous findings at 24 months; at 60 months, Mobi-C remained statistically non-inferior in terms of overall study success for one-level use. Another important finding of the study is that Mobi-C is statistically superior for two-level use – the device is the first and only artificial cervical disc in the U.S. that is FDA approved for treating more than one level of the cervical spine.¹⁰

A number of variables enter into the decision-making process for whether a patient is a candidate for cervical arthroplasty as opposed to cervical discectomy and fusion. For example, arthroplasty is not usually appropriate for patients with significant facet degenerative disease. In properly selected patients, however, one- and two-level cervical arthroplasty is an established, effective option for the treatment of cervical radiculopathy and myelopathy.

Conclusion

Cervical arthroplasty has gained wider acceptance in the spine community and experienced better outcomes for the treatment of selected patients with one- and two-level cervical radiculopathy and myelopathy compared to lumbar arthroplasty. Many factors could be contributing to this phenomenon, including more familiar anatomy in the anterior

cervical region, clearer patient selection, and easier revision strategies. It appears that cervical arthroplasty will continue to gain acceptance and become a significant tool for the treatment of cervical radiculopathy and myelopathy.

The author has no financial interest or relationship with any product or manufacturer discussed in this communication. The author discloses that he is a shareholder in Spinewave, Inc.

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ELECTROMYOGRAPHY & NERVE CONDUCTION STUDIES

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Diagnostic Imaging & Electrodiagnostics

Diagnostic imaging is one of the most important techniques in evaluating a musculoskeletal or spine-related condition. Unfortunately, diagnostic imaging is able to look only at structure. Electrodiagnostic testing is a technique which evaluates the function of the peripheral nervous system and is complimentary to diagnostic imaging. With the use of diagnostic imaging and electrodiagnostics, a more accurate diagnosis can be made for many musculoskeletal and nerve-related issues.

The spinal cord is a thick bundle of nerves and other tissue that extends from the brain through the spinal column. As the spinal cord descends, there are spinal nerves that branch off and go to various parts of the body.

It is very important to be able to evaluate the nerves when dealing with spinal problems or other musculoskeletal issues.

Electrodiagnostic testing involves two separate specialized nerve tests, including Electromyography (EMG) and Nerve Conduction Studies (NCS). They are designed to diagnose abnormalities in the functioning of nerves.

EMG and NCS are electrical tests for your nerves and muscles. The purpose of these tests is to localize and pinpoint where your symptoms are coming from. The tests can be used for a variety of conditions including pain, numbness, weakness, muscle atrophy, tingling, and fatigue.

Nerve Conduction Test

Most electrodiagnostic studies start with a nerve conduction test. This is a diagnostic test which provides information about abnormal conditions in the nerves. In this test, a nerve is stimulated with a brief electric shock and then the signal travels down the nerve. It is usually not painful and most people are comfortable during this portion of the test. Electrodes are placed on the skin to pick up the electrical impulse downstream from the stimulation point. The impulse is then captured and diagnostic variables - such as conduction velocity and amplitude - are calculated. This result is then interpreted by the physician. If the nerve is damaged, there is slowing of the signal and the signal is weaker than expected. This part of the test will assess both motor and sensory nerves.

Electromyography Test

The next portion of the test is the EMG portion. This is a technique to examine and evaluate the electrical activity produced by muscles. EMGs can detect abnormal muscle electrical activity in many diseases and conditions. It is particularly useful in conditions such as muscle inflammation or myositis, pinched peripheral nerves like carpal tunnel syndrome, disc herniation with pinched nerves, Amyotrophic Lateral Sclerosis (ALS), and many more conditions. During this part of the examination, a fine needle is inserted into select muscles. The needle prick is similar to an acupuncture needle in sensation. The needle has an active tip and is able to analyze the electrical activity in the muscles. The needle is placed in one muscle at a time and the sound and wave form of the electrical

impulses are analyzed while at rest. The patient is then asked to contract the muscle and the electrical activity during the contraction is assessed. Based on the sound and the wave patterns at rest and while contracted, the type of injury can be diagnosed. There are no shocks during this part of the test.

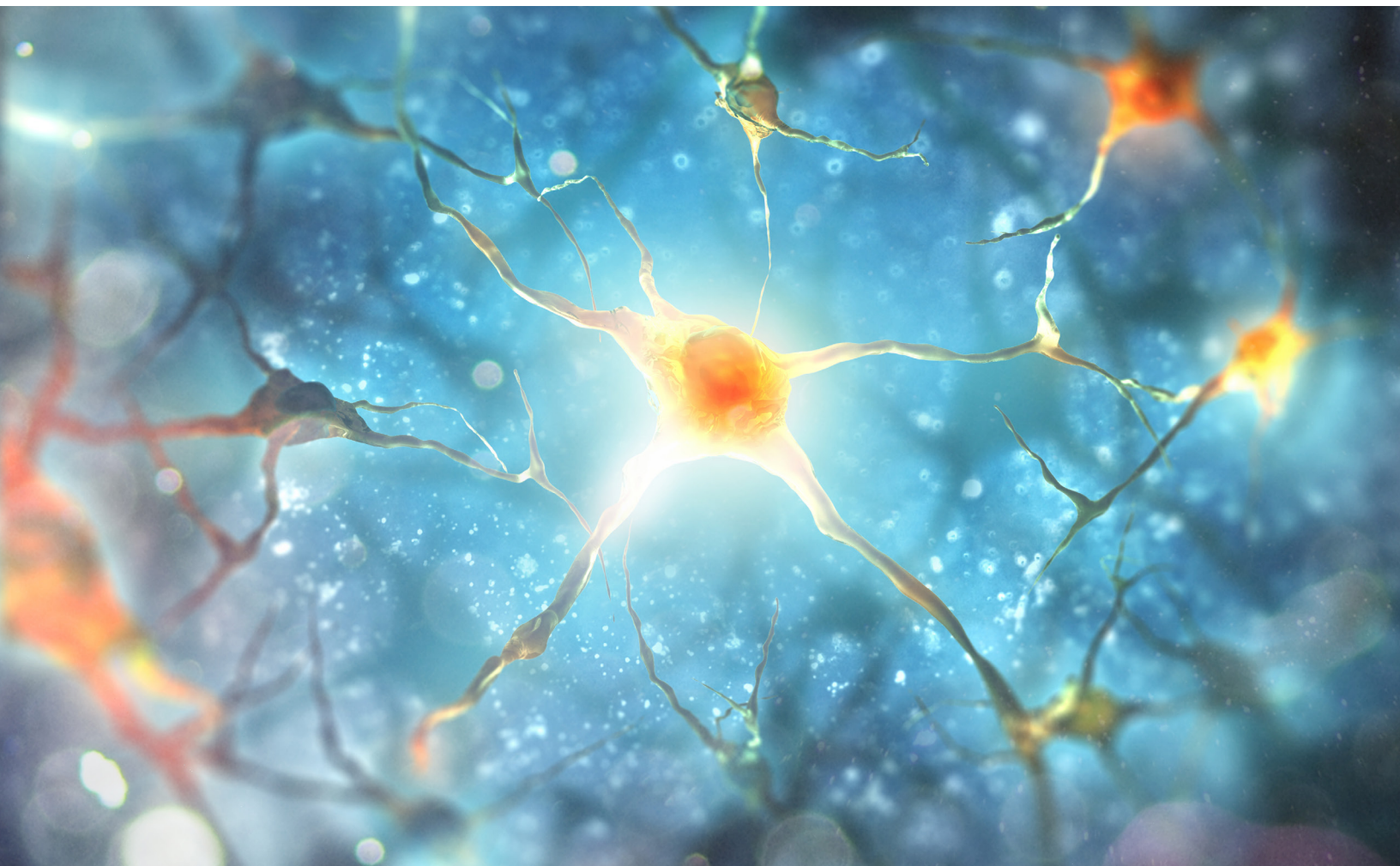
When is Electrodiagnostic Testing Helpful?

Electrodiagnostic testing is very important with evaluation of the nervous system, however, it is only able to assess pathology in the peripheral nervous system. The peripheral nervous system includes the motor neuron, sensory neuron, nerve root, plexus, peripheral nerve, neuromuscular junction, and muscle. Unfortunately, this type of testing is not helpful in the diagnosis of central nervous system diseases like multiple sclerosis, tumors, etc.

In spinal and musculoskeletal health care, there are many reasons in which electrodiagnostic testing can be useful. For example, in the case of a patient who has symptoms of severe arm pain and numbness which seems to travel from their elbow to their hand, there are many types of pathologies that

could give the patient these types of symptoms; however, the most important thing to rule out is a nerve-related issue. This could be related to median nerve compression at the wrist (also known as Carpal Tunnel Syndrome), ulnar nerve compression at the elbow, pinched nerve in the neck, etc. Unfortunately, it is very difficult to localize where the nerve is injured simply by utilizing imaging studies such as an MRI. In this example, both EMG and NCS studies would be able to establish a correct diagnosis, help in planning the potential treatments, and also help with prognosis.

Studies resulting from electrodiagnostic testing are the only ones that directly assess the functioning of the peripheral nervous system. Without the use of the EMG/NCS tests, we are limited in the use of diagnostic techniques to search for a structural problem. Despite the potential uncomfortable feelings some patients may experience during these tests, the conclusion coupled with the history, physical exam, and imaging studies can provide physicians with a more accurate diagnosis and treatment for their patients.







HEALTHY SPINES: TIPS, TRICKS, & TREATMENTS

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What is a healthy spine?

There are plenty of tips, tricks, and guides out there that educate people on how to maintain and restore a healthy spine - including this article! There always seems to be something missing from these articles, though – what exactly is a healthy spine? The first step in maintaining a healthy spine is understanding what a healthy spine is.

So, before we dive into our recommended techniques in maintaining and restoring a youthful spine, empower yourself to first learn what a healthy spine truly is.

Some of the qualities of a healthy, youthful spine are that it:

- *Is pain-free*
- *Moves well*
- *Is supple*
- *Is strong*
- *Allows us to do the things we want to do*

A back or spine that is damaged, injured, arthritic, or just wearing out loses these qualities. A back may become painful, stiff, and the bones may become weak and have osteoporosis. Muscles and ligaments may not support strength, therefore not allowing motion.

Treatments & Interventions

The goals of treatment, including non-operative treatments of exercise, therapy, medicines, and nutritional supplementation, as well as interventions, including injections, stem cells, platelet-rich plasma, or even surgery, are designed to restore the spine's function more closely to

that of a healthy spine. Minimally invasive surgical techniques, as well as motion sparing techniques, can help maintain or restore some of the qualities of a youthful spine.

Someone who has an intervertebral disc that is wearing out and is painful, degenerated, or otherwise no longer functioning well may be a candidate for an artificial disc. The goal of an artificial disc is to maintain and potentially restore some motion in the spine and is often used in order to avoid fusing that portion of the spine. Maintaining motion is good, as long as the motion is within the normal range and is overall stable. This motion may help prevent adjacent discs from wearing out faster than they normally would.

Many people are not candidates for artificial discs, though. What else can be done to avoid further degeneration?

The ability to use smaller incisions for surgery, or placing these incisions in a way that muscles or ligaments are not cut, but rather are lifted or separated along their normal tissue plains, can often help make the healing process faster, and without disrupting the normal alignment of the muscles and ligaments, the spine structures are kept in more of a normal alignment. This can also help improve the rate of healing and maintain the spine.

Examples of some minimally invasive surgeries include, MIS TLIF (minimally invasive surgical transoframinal lumbar interbody fusion), direct

lateral interbody fusions, anterior lumbar interbody fusions, anterior cervical surgery, artificial discs in the cervical spine and lumbar spine, and using tubular retractors for muscle-splitting approaches.

Five Components of a Healthy Spine

A healthy spine is a critical element in order to sustain a jubilant and satisfying lifestyle. Elements that categorize a healthy spine are strong vertebrae, flexible spinal ligaments, cushiony discs, strong back muscles, and healthy, moveable facet joints. The question is, how do we maintain these elements? To start, here are the five components in detail.

1. The bones of the spine are strong. It is important to maintain good bone density to keep our bones strong and avoid osteopenia or osteoporosis. Bone density is maintained by diet and strength training combined, which in turn provides the robust vertebrae for the human body. Multiple studies have shown that people who lift weights and participate in resistance training have overall stronger bones. For example, tennis players often have stronger bones in their racquet arm compared to their non-racquet arm. Additionally, nutrition plays a big role in maintaining bone health. Maintaining a good diet helps supply minerals (calcium, magnesium, etc.) as building blocks for our bones. Vitamins are also essential to bone health, particularly Vitamin D, which aids in the absorption of calcium. Lastly, avoiding excess carbonated beverages is also important to maintain bone health. The acid of carbonated beverages often needs to be buffered by the bicarbonate in bone, and bones can be sacrificed in order to help digest and maintain our body's acid-based balance. Maintaining an overall active lifestyle and having good nutrition helps maintain bone strength.

2. The ligaments are strong and flexible. Being physically active, including stretching and strengthening exercises, helps maintain ligament strength. A healthy dose of proteins, which are the building blocks for ligaments, need to be included in your diet. Isometric stretching, meaning holding a stretch for a period of time, is one of the best types of stretching techniques one could utilize. We need to move and have good nutrition to maintain ligament, as well as bone, health.

3. Discs are healthy, are cushiony, and support motion of the spine. A unique feature of our intravertebral discs is that there is not a good blood supply to the disc. Most of the nutrition comes to the disc through diffusion, meaning that as we move our back and spine, the discs act like little pumps; as the discs move up and down, nutrition diffuses into the disc spaces. Activity is important to maintain disc health and since discs are made out of collagen, similar to the structures that ligaments are made out of, the same nutritional requirements are needed for discs as for ligaments.

4. Muscles are strong and they support the back. Not only are muscles required to lift and move things, but having a strong core of muscles allows our weight to be shared with the spine to take pressure off of the spine. Just imagine sitting on a beach ball, bouncing on the beach ball, and the ball supports you because there is air inside of the ball. The outer portion of the ball holds in that air and supports you. The muscles of the core act like the outer part of the beach ball and can help support your body, taking some pressure off of the spine. It is important to maintain good core strength to help support the spine.

5. Facet joints are smooth, free of arthritis, and can support the spine. The best thing we can do to help protect the facet joints is to maintain our motion and flexibility. We can also help protect the joints by maintaining strong muscles and a strong core.

Maintaining a Healthy Spine

Now that we have an understanding of characteristics of a healthy spine and back, here are five action items we can do to help maintain a youthful, flexible, and healthy spine. These include maintaining an active lifestyle, eating correctly, and avoiding things that can injure or hurt our spine.

Do your best to incorporate some of these ideas to maintain a pain-free and active lifestyle.

1. Be active. Moving our body energizes many muscles and the movement supports a good blood supply to our ligaments, muscles, and discs. This blood supply is crucial because it carries the nutrients that our back needs. Movement also puts some stress on our bones to help protect the bones from osteoporosis. One of the worst things for your spine is sit for a long period of time. Sitting often puts your back in a bad posture, putting three to four times the normal pressure on the facet joints and the discs, causing them to wear out. When you sit, there is not much motion to the discs; therefore, they have a poor blood supply. Sitting can lead to muscles losing their tone and strength, therefore becoming weaker and no longer being able to support the spine. To avoid this, I recommend standing up, changing posture, and doing a few deep knee bends every thirty minutes or so. This not only invigorates the body, but can help keep your spine mobile and youthful.

2. Lose excess weight. The more you weigh, the more strain is on your spine. The muscles need to work harder to lift this weight. There is excess strain on the spine when the weight is poorly distributed and can put you into a bad posture. Additionally, when one weighs more, there is a tendency to be less active. When you are less active, you are not in as good of shape and there is less blood supply to the muscles, ligaments, bones, and discs. With time, the spine becomes less healthy overall. Lose weight and not only will you feel better, you will also take pressure off of your spine, helping maintain a youthful, strong back. Lastly, adipose tissue, or excess fat, is shown to secrete harmful inflammatory effects and chemical stressors that potentially aid in joint damage.

3. Eat well and consider taking supplements. It is important to have an adequate amount of protein in your diet, but not excessive. Approximately 1 gram of protein for each kilogram of lean body weight is a good start for determining how much protein is appropriate. A rough guide for determining the correct amount of protein would be using the size of the palm of your hand to portion one serving of protein per meal. Some supplements that can be useful include omega-3 fatty acids, which many of us eating a western diet do not get enough of. One resource for this would be ocean-raised fish or fish oil supplements. Vitamin D and magnesium are also supplements to consider. The actual amount of supplements can be based upon lab tests that are obtained from your personal physician.

4. Do not smoke. Smoking causes hosts of problems. You may notice that most smokers age more rapidly than their peers. This is because smoking affects the healing of collagen, which is found all over our bodies, including the part of the skin that causes wrinkles. The damage not only occurs within the skin, but also affects the ligaments and intervertebral discs, often causing premature aging. Smoking is also associated with osteoporosis, and, of course, increased risk of lung and heart disease. In general, the general recommendation is to not smoke.

5. Be careful when bending and reaching. Learn to lift correctly. Squat down and lift with your legs. Do not bend forward and lift with your back. Particularly, do not twist to the side and lift, as this can significantly increase the pressure on your back. Store heavier objects at waist height so that you do not have to bend and twist to lift them. Do not put the heavy things on the ground, as you will have to bend forward and get into awkward positions to lift these objects.



LIFELONG NUTRITION FOR HEALTHY BONES

Susan Brady, MPT
Nurtured Bones

Ours bones play many roles in the body, from providing structure and support and protecting our organs to acting as a mineral storage for calcium and phosphorus. However, bone health is often overlooked until the diagnosis of osteoporosis or the occurrence of a fragility fracture later in life.

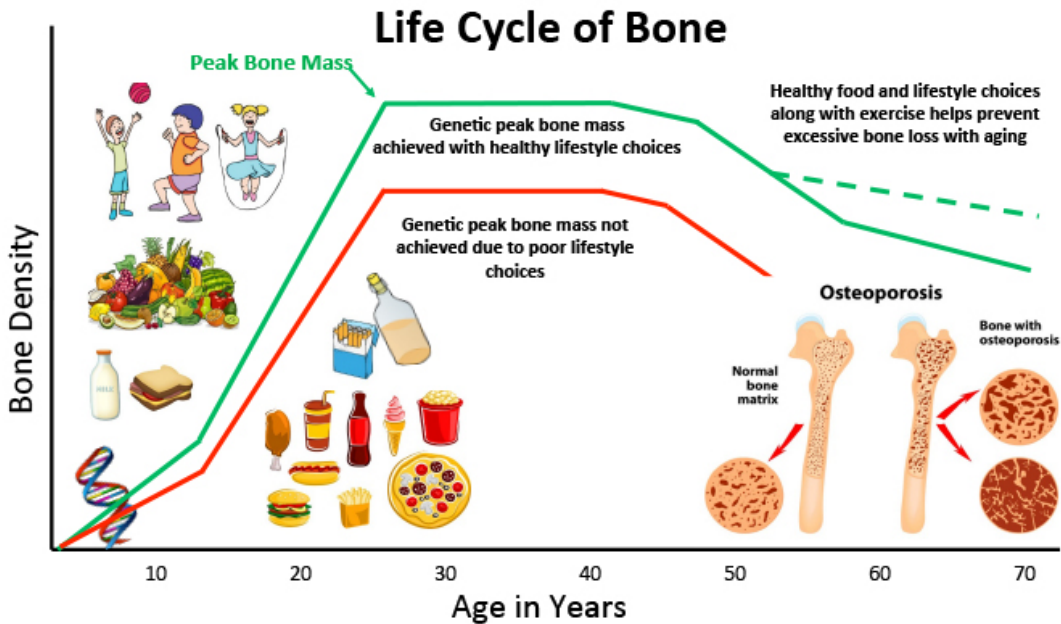
Good nutrition throughout life plays a vital role in building strong and healthy bones.

Taking steps to ensure you are getting bone building nutrients during childhood and adolescence, as well as the adult years, will help to maintain bone density and reduce your risk of developing osteoporosis later in life.

Bone is a dynamic living tissue that is able to rebuild and replenish itself. It is continuously changing as new bone is made and old bone is broken down. It does this through the workings of two key bone cells: osteoclasts and osteoblasts. Osteoclasts help to break down and reabsorb old bone cells while osteoblasts generate new bone cells to replace them. When you are young, your body makes new bone faster than it breaks down old bone. As an adult, although bone remodeling continues, you begin to break down bone cells faster than you generate new ones. Osteoporosis, defined as a chronic progressive disease characterized by a deterioration of bone tissue, occurs when the old bone cells are being broken down faster than they are being replaced. Osteoporosis results in bones that are weak and fragile, leaving them at an increased risk for fractures. Maximizing bone accumulation during the adolescent years, known as peak bone mass, is the first crucial step to ensuring strong bones later in life.

During the adolescent years, bone grows rapidly until peak bone mass is achieved. Peak bone mass refers to the greatest mass, strength, and density your bones genetically can accumulate. You can think of bone building as if one is climbing a peak during adolescence, reaches the peak in early adulthood, and then starts to decline later in life. By age 18, 90% of peak bone mass has been achieved and most young women and men reach their maximum bone density by their late 20's. Although genetics determine 60 - 80% of peak bone mass, lifestyle choices, including diet and physical activity, are also predictors of bone accumulation during growth. Any condition that interferes with achieving optimal peak bone mass can, therefore, increase fracture risk later in life. The figure on page 39 illustrates the life cycle of bone and how diet and lifestyle choices during the adolescent years can influence peak bone mass.

Physical activity and nutrition are essential to achieving peak bone mass. Many studies addressing nutrition and bone health in children have concluded that inadequate nutrition, particularly insufficient intake of calcium and vitamin D, during growth may negatively affect peak bone mass. Moreover, malnutrition that occurs with eating disorders has also been shown to have a direct effect on bone mass development. In young individuals with anorexia nervosa, bone loss can be detected after only six months of illness and deficits can remain even after weight gain recovery. The severe deficiency of nutrients that occurs with anorexia results in a reduction of bone formation, as well as increased bone resorption. Even nutrient deficits



from short-term fasting, (four days or longer), results in a marked decrease of bone formation markers in normal healthy young people. Achieving peak bone mass cannot be emphasized enough. It has been shown that achieving peak bone mass during the adolescent years could significantly delay the onset of osteoporosis by 13 years, reducing the risk of osteoporotic fractures later in life.

By the age of 40, we all slowly begin to lose bone mass. However, as with adolescents aiming to achieve peak bone mass, quality nutrition and regular exercise also help adults avoid the severe bone loss that leads to osteoporosis. A recent study examining the effects of diet on bone health found that postmenopausal women who ate a Mediterranean diet were less likely to suffer from hip fractures. The Mediterranean diet is well known for its emphasis on eating foods like fish, vegetables, fruits, legumes, whole grains, nuts, seeds, and olive oil. Meat, cheese, and sweets are very limited. This study highlights how an overall healthy diet may be more important in supporting bone health than focusing on the intake of any single nutrient. The health and strength of our bones rely on a balanced diet that provides a steady stream of many key nutrients, most importantly, calcium and vitamin D. Calcium has always been known as one of the vital nutrients for building strong bones.

This is because the matrix of bone is mineralized with calcium and phosphate, which in turn gives strength to its structure. Calcium is also important for muscle contraction, heartbeat regulation, nerve impulse transmission, regulation of blood pressure, and immune system function. 99% of calcium is stored in our bones, and unfortunately, when you don't get enough calcium in your diet, the body will pull calcium from the bones to support these other functions. Without adequate calcium, bones become weak and fragile.

Recently, there have been ongoing debates surrounding the intake of calcium supplements. While they do not question the importance of calcium in maximizing bone strength, they do question the healthiest or safest amount recommended for optimal bone health. Some studies found no evidence that calcium supplements prevent fractures in adults or increase bone mineral density in healthy children. Calcium supplementation has also recently been associated with an increased risk of heart attacks. Therefore, healthy adults and children should aim to get the recommended daily amount of calcium from food first and supplement only if needed. In fact, there is no added benefit to taking more calcium than you need in supplements and doing so may increase your risk of other health issues.

Although dairy products are the most well-known sources of calcium, it's not healthy to solely rely on milk, yogurt, and cheese to supply your calcium needs. Adding leafy green vegetables, fish, beans, nuts, and seeds to your diet will also help you reach your recommended daily intake of calcium. Pairing calcium-rich foods with foods high in vitamin D, such as egg yolks, shiitake mushrooms, and fish (specifically salmon, mackerel, sardines, and canned tuna), will help the absorption of calcium from your food. Safe sun exposure and supplements are also ways to maintain adequate vitamin D levels. The national osteoporosis foundation recommends women and men over the age of 50 years to consume 800 - 1,000 IU of vitamin D daily.

Magnesium is another mineral component of the bone matrix and plays an important role in bone metabolism. Magnesium stimulates the hormone calcitonin, which enhances the absorption of calcium from the blood into the bone. Magnesium also helps to convert vitamin D into its active form, which then aids in calcium absorption. Unfortunately, most people don't get enough magnesium through diet alone. Additionally, eating a diet high in processed foods and even supplementing with excessive calcium can result

in magnesium deficiency. You can help to maintain healthy magnesium levels by including these foods that are high in magnesium in your diet: spinach, pumpkin, sesame and sunflower seeds, Mackerel, beans, quinoa, brown rice, cashews, and almonds. Aim for 400 - 800 mg of magnesium a day.

Low levels of vitamin K are also emerging as a dietary risk factor for osteoporosis. Vitamin K deficiency has been linked to an increased risk of osteoporotic fractures. Studies have shown that postmenopausal women with osteoporosis who supplemented with vitamin K2 achieved significant improvement in vertebral bone mineral density and reduction in the overall risk of fractures. In addition, improved vitamin K status in healthy young girls was associated with a decreased rate of bone turnover. Vitamin K, and more specifically vitamin K2, is necessary to ensure that calcium gets absorbed into the bones and prevents it from being deposited in other areas of the body, such as organs, joint spaces, and arteries. Vitamin K2 is also essential for the activation of osteocalcin, a protein needed to bind calcium to the bone matrix and for blocking the formation of too many osteoclasts. Dietary sources of K2 are primarily found in fermented foods such as Natto, cheeses such as Brie and Gouda, meat, poultry, and eggs. Two common supplemental



Bone Building Nutrients

NUTRIENT	THERAPEUTIC RANGE	HEALTHIEST FOOD SOURCE
Calcium	1000-1300 mg/day	Low fat dairy products, Leafy green veggies, Canned Sardines, Almonds
Phosphorus	700-1250 mg/day	Pumpkin seeds, Salmon, Low fat dairy, Pork, Veal, Beef, Lentils, Soy
Magnesium	400-800 mg/day	Dark leafy greens, Nuts and Seeds, Mackerel, Lentils, Brown rice, Avocado
Silica	5-20 mg/day	Oats, Millet, Barley, Potatoes, Artichokes, Beets, Asparagus
Zinc	20-30 mg/day	Beef, Lamb, Wheat Germ, Spinach, Nuts, Seeds, Chicken, Beans
Manganese	10-25 mg/day	Nuts, Seeds, Beans, Fish, Spinach, Kale, Tea, Tofu
Copper	2-3 mg/day	Kale, Mushrooms, Seeds, Nuts, Beans, Dried Fruits, Avocados, Goat Cheese
Boron	3-5 mg/day	Raisins, Nuts, Apricots, Avocado, Dates, Kidney Beans, Peanut butter, Lentils
Potassium	4,700-5,000 mg/day	Beans, Dark leafy greens, Baked potatoes, Dried Fruits, Low fat yogurt, Bananas
Vitamin D	2,000-4,000 and up IU/day	Cod liver oil, Fish, Eggs, Fortified diary, Soy, cereal products
Vitamin A	5,000 IU or less	Sweet potatoes, Carrots, Dark leafy greens, Dried Apricots, Cantaloupe, Paprika
Vitamin C	500- 2,000 mg/day	Peppers, Dark leafy greens, Broccoli, Cauliflower, Kiwi, Oranges, Strawberries
Vitamin K	1,000 mcg/day	Dark leafy greens, Scallions, Brussel sprouts, Broccoli, Asparagus, Cabbage, Prunes
Vitamin K2	150 mcg/day	Butter, Egg yolks, Hard cheese, Natto, Chicken breast, Kefir, Miso, Supplements
Vitamin B12	100-1,000 mcg/day	Fish, Beef, Low fat dairy, Eggs, Fortified cereals and soy products
Vitamin B6	25-50 mg/day	Wheat and rice bran, Pistachios, Garlic, Fish, Pork, Molasses
Folic Acid	800 mg/day	Beans, Lentils, Spinach, Asparagus, Avocado, Broccoli, Tropical fruits, Wheat bread
Omega 3 Fat	2,000-4,000 g/day	Ground flax seeds, Walnuts, Sardines, Salmon, Soybeans, Omega 3 enriched eggs

The National Osteoporosis Foundation (NFO) Recommended Daily Intake of Calcium

TYPE OF PERSON	DAILY INTAKE OF CALCIUM
Adolescents 13-18 years old	1,300 mg.
Women 50 and younger	1,000 mg.
Women over 50	1,200 mg.
Men under 70	1,000 mg.
Men over 70	1,200 mg.

forms of vitamin K2 are menaquinone-4 (mk-4) and menaquinone-7 (mk-7). Mk-7 is derived from a natural fermentation process and has a longer duration of action, making it a better choice for supplementation. Studies have shown 45 - 150 micrograms of K2 in the form of mk-7 per day is important for increasing bone strength. Use caution when supplementing with vitamin K if you are taking anticoagulant medications because vitamin K is a fat soluble vitamin, meaning it needs to be taken with fat to maximize absorption.

For years, there has been ongoing debate about the effects of animal protein on bone health. Many in the field of nutrition suggest that eating foods such as meat can create a more acidic environment in the body, causing calcium to be leached from the bones. However, recent studies suggest that, although eating animal protein may increase calcium excretion, it also significantly increases calcium absorption resulting in no adverse effects on calcium balance. Animal proteins also provide many important bone growth factors that aid in bone mineralization. Many plants provide proteins, too, and are also an excellent source of vitamins, minerals, fibers, and antioxidants that are essential to bones. For optimal bone health, add variety to your diet by intermixing nutritious plant-based proteins (beans, legumes, nuts, seeds, natural soy) with high-quality animal proteins (eggs, salmon, lean meats). This will ensure you get all the valuable nutrients needed to build a strong body. Not only nutrient deficiency, but also poor dietary choices, can have a negative impact on bone health. Diets high in refined sugar have been shown to impair bone growth and mechanical strength. Drinking carbonated soft drinks containing phosphates and coloring has been shown to interfere

with calcium metabolism. It is also well known that salt, especially abundant in processed foods, increases the excretion of calcium through the urine. Excessive caffeine, such as four or more cups of coffee a day, can result in loss of calcium and magnesium, predisposing you to higher risk of fractures. Alcohol also has a negative effect on bone health for several reasons. It alters bone formation and remodeling, interferes with calcium balance, causes disruption in hormones, which can lead to irregular menstrual cycles in women and decreased testosterone in men, and can elevate cortisol levels, leading to bone break down. To maintain healthy bones, limit your alcohol to one or two drinks a day.

Your lifestyle choices also affect your bone health. By far, one of the biggest risk factors for osteoporosis is smoking. Smoking a pack of cigarettes a day increases your risk of osteoporosis by 60%. It has been shown that adolescents that smoke fail to achieve peak bone mass. Getting enough physical activity can also mean the difference between a frail and strong skeleton. There is no question that both children and adults who exercise regularly are at less risk of bone loss. Impact exercises, like power walking, jogging, and racket sports, as well as weight lifting, increase bone density.

Recent research indicates that just hopping for two minutes a day can increase bone mass in the hip!

Because osteoporosis has no symptoms and is often not discovered until a broken bone occurs, importance lies in taking steps to prevent osteoporosis at an early age. A balanced and varied diet is an important key factor in ensuring proper bone development among young people. As we age, proper nutrition continues to be necessary to maintain a strong skeleton. If you already have osteoporosis, the good news is that by improving your diet, adjusting your lifestyle habits, and beginning an exercise program, you can slow down bone loss and, in some cases, even reverse it!

Take these steps to ensure a lifetime of strong, healthy bones:

1. Aim to achieve peak bone mass as an adolescent through diet and exercise
2. Eat a nutrient-dense diet that includes these bone building power house foods:
 - **Good-quality proteins:** Lean poultry, fatty fish, eggs, beans, lentils, quinoa, nuts, seeds, Natto, tempeh, organic tofu, edamame
 - **Vegetables:** Spinach, kale, collard greens, peppers, broccoli, asparagus, cabbage, cauliflower, carrots, sweet potatoes
 - **Fruits:** Citrus, berries, dates
 - **Nuts & Seeds:** Pumpkin seeds, sunflower seeds, almonds, cashews
 - **Grains:** Quinoa, wild/brown rice, oats
 - **Calcium Rich Foods:** Leafy greens, sesame seeds, plain yogurt, skim milk, Kefir, white beans, figs, almonds, canned sardines and salmon (with the bones!)
 - **Healthy Fats:** Avocado, olive oil, coconut oil, flax seeds, sardines, salmon
3. Reduce consumption of sugary & processed foods
4. Reduce your consumption of coffee and alcohol
5. Stop smoking
6. Perform at least four hours of weight bearing and weight lifting exercises a week

Try any or all of these delicious meals that anyone can make – even you!

BREAKFAST

- *2 Scrambled eggs with 3 or more of the following vegetables: broccoli, mushrooms, tomatoes, peppers, onions, raw spinach, parsley, avocado*
- *Oatmeal with chopped raw almonds, berries and almond, coconut or rice milk*
- *Apple with almond or cashew butter*
- *Green smoothie with an apple, kale and other greens, whey protein and 1 tsp flax oil*
- *Low fat plain yogurt with mixed berries and sunflower seeds*
- *½ grapefruit, 1 slice whole grain toast with almond butter or sliced avocado*
- *Warm lemon water or herbal tea*

LUNCH

- *Whole grain wrap with hummus, spinach, cucumber and tomatoes*
- *Green salad with assorted vegetables, 3 oz of chicken or fish, 1 tbsp olive oil and balsamic vinegar dressing*
- *Spinach salad with strawberries, slice almonds, and 1 tbsp olive oil and balsamic vinegar dressing*
- *Lentil soup with green salad*
- *Bean and vegetable soup*
- *Steamed vegetables with ½ cup of brown rice*
- *Kale roll-up with 3 oz of turkey, chicken, or tuna with sliced tomatoes, avocado, cucumbers, onion, and sunflower seeds rolled up in large kale leaf*
- *Iced herbal tea, mineral water, lemon water, Kombucha, fresh vegetable juice*

SNACKS

- *A piece of fruit and a handful of sunflower or pumpkin seeds*
- *Kale chips*
- *Hummus with carrots, celery, and peppers for dipping*
- *Apple slices dipped in almond butter*

DINNER

- *4 oz. of baked chicken, turkey, or fish with sweet potatoes and mixed green salad with assorted vegetables*
- *Stir-fried broccoli, peppers, onions, garlic, and bok choy in coconut oil served over brown rice*
- *Grilled fish and vegetables, grill on top shelf of grill with lower heat as to not charcoal grill the food*
- *Vegetable chili with mixed green salad*
- *Lentil stew with mixed green salad*
- *Brown rice pasta with low sugar pasta sauce with added sautéed onions, garlic, and tomatoes, and mixed green salad*
- *Herbal tea, mineral water, fresh vegetable juice*



SPINAL RESEARCH FOUNDATION'S **SPINAL HERO**

Niteesh Bharara, M.D., D.A.B.P.M.R.

Specialization:
*Interventional Pain Management Specialist, Physical Medicine
& Rehabilitation, Sports Medicine*

Practice:
Virginia Spine Institute

1) Why did you choose your specialization?

During high school, I was playing soccer and broke my leg during a game. Our team doctor was a physiatrist (one who treats a wide variety of medical conditions affecting the brain, spinal cord, nerves, bones, joints, ligaments, muscles, and tendons). He made the diagnosis and immobilized my leg on the playing field – before I even went to the Emergency Department at the local hospital; this saved me from worsening my injury. After multiple surgeries, I went to see a musculoskeletal and pain physician who guided my rehabilitation and controlled my pain. It was then that I knew that I wanted to take the very same career path as these physicians who helped me during the toughest medical situation I had ever experienced.

2) What is your favorite way to stay healthy?

In my opinion, one of the best ways to stay physically healthy is knowing the fundamentals of nutrition. Understanding the right balance of carbohydrates, protein, and fats will keep your body physically healthy. I have found that the key is to pick the foods that have the best ratios for you and are the least processed.

Staying active is really important to me. Don't get me wrong, there are days that I like to lounge and there are times that I'm forced to sit in one place and not move for awhile; however, whenever I'm able, I like to move around - either by engaging in sports or even going for a brisk walk or run. I think it is incredibly important for us, especially in this era of technology, to remain as physically active as possible. Getting in some form of exercise each day is a big part of my life.

No less than four times a week and whether I'm at home or at a gym, I fit in exercise that hits every part of my body. Everyone's health goals are different, but I've found that combining a consistently healthy diet and regular exercise - no matter what's going on in my life - helps me feeling most healthy and at my best.

3) Why is research in the field important to you?

When it comes to rapidly evolving technologies in interventional musculoskeletal medicine, research is particularly important for providing the most effective treatments to our patients. Field-specific research is more vital than ever before as it provides options and a greater understanding of the modern approach I can take to assessing and treating the underlying cause of my patients' pathology. Also, my research interests cover a range of areas within the discipline of Physical Medicine & Rehabilitation -- from bench to bedside and beyond; remaining apprised of the latest research allows me to treat each patient, regardless of what is ailing them, in a more efficient and proper manner.

4) What is your favorite quote - and what does it mean to you?

"Success is not final, failure is not fatal: it is the courage to continue that counts." --Winston Churchill

This quote speaks to me because it can be applied to a wide variety of situations that my patients and I experience both personally and professionally. It reminds me that, sometimes, focusing on the end result isn't the best way to approach certain matters; Sir Churchill's words couldn't be more true when it comes to how success should be viewed.

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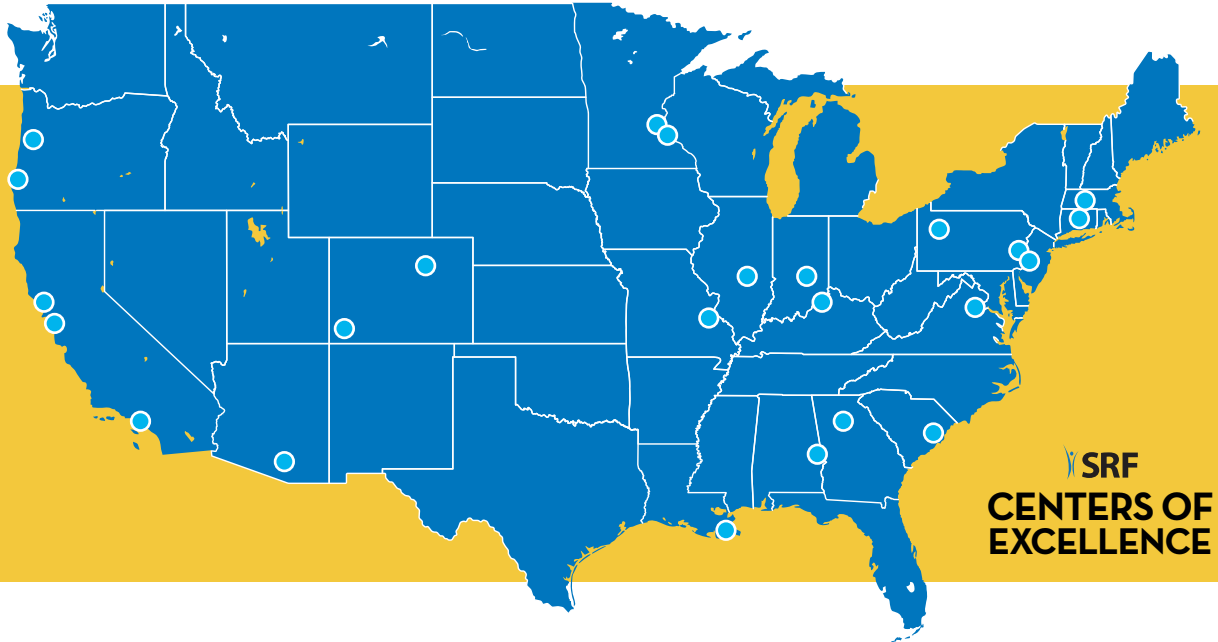
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The Spinal Research Foundation has named 26 Research Partners across the country that share one core mission: improving spinal health care through research, education, and patient advocacy.

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