Regenerative medicine allows the body to heal from within by rejuvenating and regenerating cells, replacing damaged tissue, and restoring function.
What’s New at SRF?

New and Improved Resources

You’ve probably already noticed the new look of our Journal, and it is a sign of exciting developments at SRF. As additional resources to this biannual publication, we now publish a monthly newsletter and a blog titled Spine Matters. Our website has also been redesigned to provide the information you need on your spinal health care journey.

Visit www.SpineRF.org to:

• Register for an upcoming We’ve Got Your Back race for spinal health
• Search for information and success stories related to your condition and/or treatment
• Access past issues of the SRF Journal
• Subscribe to the newsletter
• Find links to our social media channels

SpineOnline

SRF will launch one of the most ambitious and innovative treatment outcome projects in the nation. SpineOnline will be a nationwide, multi-center technology project to prove the effectiveness of spinal treatment options. Through SpineOnline, SRF intends to collect provider and patient reported treatment outcomes to help prove what works, drive innovation, and reduce the uncertainty associated with spinal treatments.
# TABLE OF CONTENTS

- **Editor’s Letter**  
  3

- **President’s Letter**  
  4

- **Ask The Expert**  
  Clarify Common Misconceptions About Stem Cell Therapy  
  5

- **Spine Tales**  
  - *Dennis Dempsey*, Extreme Obstacle Course Races Post Spinal Fusion  
  7
  - *Miles Edwards*, After His Fall, His Spine Looked Like A Crushed Pop Can  
  10
  - *Frank Everest*, Combining Surgery And Post-Operative Rehabilitation  
  13
  - *Mary Wykle*, Not A Success Story...Yet  
  15

- **We’ve Got Your Back Race For Spinal Health**  
  Our Favorite Way To Celebrate Spinal Champions  
  17

- **4 Categories of Regenerative Treatments**  
  Different Regenerative Treatments Are Available  
  18

- **Stem Cell Therapy 101**  
  What You Need To Know About Stem Cell Therapy  
  21

- **Easing Chronic Back & Neck Pain With Cell Therapy**  
  How Stem Cells Might Change The Future For Disc Regeneration  
  27

- **Are You A Candidate For Regenerative Therapy?**  
  Learn If This Might Be A Good Option For You  
  31

- **Translational Research: From Bench To Bedside**  
  From Lab Research To The Doctor’s Office  
  35

- **Spinal Cord Injury**  
  Spinal Cord Injury Solutions Possible With Stem Cell Therapy  
  38

- **The Impact of Back Pain**  
  Back Pain By The Numbers  
  40

- **Ask The Trainer: Functional Training**  
  Functional Training And Why You Should Make It Part Of Your Workout  
  41

- **Your Back At Work**  
  Tips To Keep Your Back At Its Best While At The Office  
  45

- **Spinal Hero**  
  Getting To Know Dr. David Rouben  
  48
FROM THE EDITOR: Brian R. Subach, M.D., F.A.C.S.
THE IMPORTANCE OF REGENERATIVE MEDICINE IN SPINAL DISEASE

As a practicing spine surgeon, I can personally tell you that low back pain is a condition which I see frequently in the office. The disease affects approximately 80% of people at one time or another. Many patients may experience an episode of acute back pain which resolves in a period of weeks to months; however, approximately 10% of patients show a gradual transition to chronic low back pain. Given the number of people affected by the acute disease process of disc degeneration, annular tears, disc herniation, and low back pain, the estimated health care costs associated in dealing with a degenerating spine is upwards of 20 billion dollars.

Degeneration of the disc is thought to play a role in the development of chronic low back pain. The aging process causes loss of cellular elements within the nucleus of the disc, resulting in a decline in production of the extracellular matrix. The loss of hydrophilic proteoglycans within the nucleus reduces the disc height and compressibility, therefore its ability to resist traumatic injury and maintain shock absorbing capacity. The biomechanical stress imparted to the disc leads to annular tears, disc herniation, and progressive arthritis. The end plates become less permeable to oxygen and nutrients, resulting in decreased metabolism in the central, relatively acellular portion of the disc.

Many of our strategies to deal with low back pain and lumbar disc degeneration include physical therapy, anti-inflammatory medications, and often steroid injections. For those who fail the basic conservative management strategies, surgery often becomes the only remaining option. There are minimally invasive surgical options including partial discectomy and artificial disc technology as well as dynamic stabilization techniques and spinal fusion. Any technique which directly affects the disc such as discectomy or arthrodesis (fusion) has been shown to accelerate the degenerative disease at levels adjacent to the index operation.

I feel that our current treatment options are limited.

Unless we shift our focus away from the biomechanics of the disease toward a regenerative solution, our strategies are relatively restricted. Instead, we should restore the cellularity of the disc space and the mechanisms used to produce the extracellular matrix within the disc before irreversible damage occurs. We may be able to restore disc space height with a variety of scaffolds; injectable or gene-based delivery of growth factors into the nucleus has been suggested.

In many cases we use autologous cells or bone marrow derived stem cells, which can be harvested, expanded in culture, and then delivered into the deteriorating nucleus.

This issue of the Journal of The Spinal Research Foundation specifically touches on such a paradigm shift.

There are a number of experts who discuss their experience using stem cells and regenerative strategies to combat a degenerating spine.

Hopefully, you will enjoy this issue as much as I have.
Imagine for a moment that you are no longer able to scoop up your child or grandchild into a hug; you can no longer perform your job, which supports your family; your favorite activities or travels with friends or family have to end or go on without you.

The scenarios described above are the unfortunate realities for the 90 million Americans who are afflicted with severe neck or low back pain annually. Low back pain is the number one cause of medical disability in the world. For years, we have been focused on treating the source of neck and low back pain with therapy, exercise, medication, injections, and surgery. While modern spinal surgeons have been very effective in improving people's lives, the ideal option is to develop ways to reverse the degenerative cascade. This is the focus of regenerative medicine.

Using stem cells and/or platelet-rich plasma (PRP) are the two most promising techniques that clinicians have available today. While these techniques are still considered experimental, the preliminary results are encouraging. Through a simple injection, spinal specialists are essentially turning back the clocks of time in people's bodies, improving people's painful conditions, and decreasing, if not eliminating, their disabilities.

Platelet-rich plasma therapy has been popularized in the athletic world for the treatment of various ligamentous injuries. Additionally, it is showing great promise in the spine for the treatment of degenerative discs. Encouraging results have also been found using an individual's own stem cells collected from his or her pelvis or fat tissue, centrifuged down, and then injected into the injured or degenerative disc in an effort to slow the degenerative process. It is important to recognize that these modern procedures are not going to be the best fit for all patients who suffer from neck or lower back pain; but for those who would benefit, the results can be life-changing.

The clinician must understand both the traditional and more modern approaches in determining what works best for a given patient and must also have the ability to move forward with the ideal form of treatment for the patient's given situation. This is becoming increasingly difficult in the changing health care arena.

The new health care structure in America is extremely counterproductive to advancing new treatments, especially when it comes to treating spinal conditions. Spinal health care has become an increasingly expensive item in American health care as the need and utilization of it has increased. In the fight by government and insurers to control cost, they have eliminated the ability to provide many optimal treatments and, more importantly, have restricted or prevented new technologies for many patients.

An individual's spinal health relies on two factors: first, the ability to prevent painful spinal conditions and second, the ability to heal them when genetics, injury, or time takes its toll. For the first, it's fairly basic. Nicotine avoidance, proper diet, appropriate sleep, a well-rounded exercise program, and practicing good ergonomics are highly beneficial and effective ways to reduce your chances of pain and/or degeneration. The second factor, however, is not so easy. It will require the support of government and insurers to allow the providers to do their jobs to the best of their ability and provide the appropriate treatment to each individual patient.

Our goal as spinal health care providers is to provide the patient with the best customized treatment for his or her pathology and needs. In order to do so, it is imperative that insurers and government health care entities have the patient's best interest in mind. They must support an environment which will allow for technologies and advancements, such as regenerative medicine, to be integrated into the modern health care armamentarium.

If we do not do this, we will find ourselves in desperate situations with the aging population in the United States and the world becoming more disabled. Researching simpler and better options to solve spinal pain must be an essential priority for our government, educational institutions, research organizations, and insurers. The Spinal Research Foundation is leading this charge.
**ASK THE EXPERT:**
Shekar N. Kurpad, M.D., Ph.D.
The Medical College of Wisconsin

**Q1: Where are stem cells sourced?**

**A1:** Research and development of stem cells has been an exciting new development as a potential treatment for many conditions that were previously considered incurable. Stem cell research for the spine (and in general) has hit its stride since the late 1990s, both in terms of basic research as well as various clinical applications. In fact, there are several diseases for which stem cell treatment is rapidly becoming a viable treatment option.

Stem cells are derived from various sources. For example, embryonic stem cells (ESCs) are derived from embryos; mesenchymal stem cells (MSCs) can be sourced from bone marrow, adipose tissue, and umbilical cord tissue to name a few; organ-specific stem cells are derived from specialized tissue (e.g. neuro stem cells (NSCs)); induced pluripotent stem cells (iPSCs) are stem cells that are generated from reprogrammed mature cells.

The original research that looked into the possibility of using stem cells as therapeutic tools focused on ESCs. These are stem cells derived from otherwise non-viable embryos. While many consider ESCs to be the best sourcing option, ethical issues continue to be a major factor in both funding basic research into ESCs as well as their translational applications. In 2001, the federal government under President George W. Bush restricted federal grant mechanisms to the research and applications to those embryotic stem cell lines that were already in existence at that time.

Since 2001, there have been various other modalities, including deriving more “mature” stem cells from each part of the human body (such as deriving organ specific stem cells from adult animals). Central to this approach has been the discovery by several groups of researchers that all adult mammals harbor organ specific stem cells in the mature state (like NSC in the brain and spinal cord, etc).

MSCs are derived from the bone marrow. Intrinsically, MSCs are thought by some to have pluripotent properties like ESCs. Additionally, many researchers have been able to reprogram these stem cells to drive differentiation and maturation into mature cells of other organ systems.

Approximately six to seven years ago, a more exciting development took place. Researchers at the University of Wisconsin, Madison and subsequently other locations were able to synthesize stem cells by reprogramming mature cells in the reverse direction such that they could take on stem cell-like properties. These so called iPSCs, while still in the early stages of research, represent a significant solution for future cellular engineering and derivation of stem cell populations without ethical issues.

**Q2: How is stem cell research regulated?**

**A2:** Stem cell research is heavily regulated in the United States, especially the efforts funded by federal grants. As noted above, stem cells by virtue of their pluripotency can have significant potential adverse effects after transplantation, principal among these being the formation of cancerous cells. Therefore, the FDA (Food and Drug Administration) has established strict guidelines in terms of conducting clinical trials that use stem cells that are considered to have significant treatment potential.
In general, stem cell research is subjected to very high standards of ethical scrutiny. Most institutions (both academic and private) have a cross-sectional regulatory panel that reviews and approves stem cell research projects. These panels are typically composed of stem cell researchers, ethicists, lay individuals from local communities, and individuals with legal and regulatory expertise.

**Q3: Is stem cell treatment for spine safe and effective?**

**A3:** Currently, stem cell treatments for spine problems, specifically for spinal cord injury, are in the early stages. To date, there have been very few clinical trials in the United States that look at the potential of stem cells for treating spinal cord injury. The first Phase I trial, sponsored by GERON Corporation, began in 2009 and involved the transplantation of embryonic-derived stem cells into patients with acute spinal cord injury. This study was terminated after approximately five patients were treated with transplanted cells due to funding concerns. More recently, Stem Cells Inc. has begun another study transplanting stem cells for chronic spinal cord injury (four months to two years after injury). While these studies have so far shown no untoward effects of stem cells after transplantation into the spinal cord, the therapeutic benefits are yet to be fully understood.

Elsewhere in the world, there have been many attempts to perform clinical studies with stem cells, mostly in China and Korea. These include ESCs and umbilical cord-derived stem cells as treatment modalities. These studies are being done with guidance from experienced researchers worldwide and are still in their early stages of performance. Results as to the benefit of such stem cell transplants are not yet available.

**Q4: What are the different potential applications for stem cells in spine treatment?**

**A4:** The applications and current state of stem cells for the treatment of spinal cord injury are noted above. Other spinal applications for stem cell research and eventually treatments include the use of stem cells for improving the grade of spinal fusion surgery, with efforts to regenerate other types of spinal supportive tissue, including ligaments as well as joints, and finally, for the regeneration of intervertebral discs in the lumbar or cervical spine. Disc degeneration and disc herniations affect 80% of Americans. These afflictions are a common problem that affects quality of life by causing back and neck pain, arm and leg weakness, and therefore are a significant source of lack of productivity in the workforce. Stem cell treatments developed to regenerate and/or repair degenerated discs would be of great benefit in the future.

**Q5: How are donor stem cells matched to the patient for transplantation?**

**A5:** In general, stem cells are transplanted under cover of immunosuppression, much like a patient receiving a liver or a kidney transplant. The duration of immunosuppressive treatment after transplantation can last from several weeks after the transplantation procedure has been completed and sometimes for life, as in solid organ transplants.

One of the most significant efforts in stem cell research has been to generate MSCs as described in response to Question #1. MSC transplants would involve developing the patient’s own stem cells, thus obviating the need for immunosuppression. iPSCs, if developed for viable clinical application, would also eliminate the need for immunosuppressants.
DENNIS DEMPSEY
“I Got My Life Back”

I had been diagnosed with cervical spine issues when I was in my late 20s. An MRI showed degeneration and stenosis from C5 through C7. Initial symptoms were pain and a loss of range of motion in my neck. Over time, that pain became worse, radiating into my back and upper arms. In May 2014, I became more symptomatic and began to notice pain in my forearms along with a loss of sensation and motor skills in my hands.

I am an athlete, and my training routine would include things to maintain strength and flexibility. But as my issue was structural, there was only so much I could do. The pain was persistent, and it affected my activities; I simply learned to cope. I would have periods where the pain would become bad enough to lay me up for a couple days, and as I got into my late 30s and 40s, it gradually started affecting more of my day-to-day activities.

I was a middleweight boxer who transitioned into mixed martial arts. In my late 20s, I transitioned out of contact sports and got into cycling and running. I raced with local clubs and shops, competing in regional and national series mountain bike races and have done several 6-, 12-, and 24-hour races. I still ride, but now I include more running as part of my training regimen. I love playing in the dirt, and over the past few years I have competed in several Obstacle Course Races (OCRs), or mud runs.

For the most part, I was able to keep my symptoms in check but would have flare-ups from time to time. Limited range of motion and neck stiffness would affect me on the bike. Sometimes weight training or running would bring on flare-ups in my neck, upper back, and arms. These symptoms would result in my activities being cut short or not happening at all.

In the summer of 2014, I started noticing pain in my forearms. My typical symptoms also became more pronounced and frequent. I started to notice a loss of sensation, motor function, and strength in my hands. I began to have issues doing simple things like holding a cup, using utensils, or doing anything that required fine motor skills. My fingers would feel like they were not attached or slow to respond to the things I wanted them to do. I would completely lose grip when picking up a heavy object or doing pull-ups. Eventually my left hand would either just give out or spasm, and I began noticing similar issues in my legs.

My symptoms gradually progressed from when I was in my early 20s until now (over the course of about 30 years). I sought treatment at different times throughout that period. Some doctors recommended surgery, but at the time that meant a complete fusion and giving up all of the activities that I enjoyed. So I did everything I could to avoid surgery. My treatments ranged from medication, chiropractic treatment, acupuncture, physical therapy, simple stretching, and range of motion activities. They provided temporary
relief. I knew surgery would have to happen eventually. However, my level of fitness helped in keeping the symptoms in check for the most part. I was able to put off surgery up until July 2014.

In the summer of 2014, I started to develop pain in my forearms and noticed atrophy along with a severe loss of strength in my arms and hands. My fine motor skills were becoming more and more affected which led me to begin actively seeking some long-term medical solutions. I started my research, looking for top-rated doctors who specialized in the field of spine surgery—specifically for athletes.

In June I competed in a Tough Mudder, doing back-to-back events Saturday and Sunday, 13 miles of mud and obstacles each day. In early July, something triggered a massive onset of symptoms. The nerves in my cervical spine became more entrapped, and my pain became constant and severe. Along with this new onslaught of pain, the right side of my body basically began to completely shut down. My arms and right leg were becoming weak, and motor function was impaired. By mid-July, I was bed-ridden.

I spoke to several specialists, and there was no doubt that I required surgery. I remember having a very negative outlook on this type of surgery. I was dreading it, but I knew that it was something I had to do at this point.

To be honest I was outright scared in regard to how it would affect my quality of life and the activities I enjoyed doing.

Upon meeting Dr. Subach and his team at the Virginia Spine Institute (VSI), I knew I had found my solution. Dr. Subach and his team invested a significant amount of time making sure I was properly diagnosed, educated on my situation, and that I understood my options.

Most of my fears were addressed and were replaced with facts and an understanding of the latest procedures available to people with my issues.

We were working through these options when my symptoms escalated. Everyone at VSI worked to put my surgery plan together on short-notice. The office staff even worked through issues with my uncooperative insurance carrier to get me into surgery the next day.

I remember waking up in recovery and noticing right away that all the neural pressure and pain were gone. I spent three days in the hospital recovering and instantly began adjusting to being pain-free. My recovery went quickly, and I was back on my feet in no time. After 90 days, I was cleared to begin normal activities with caution. At six months out, I was back to weight training, running, and riding. I plan to run another series of Tough Mudder and OCR races this summer with my son and daughter.

The curvature of my neck is coming back, and with that my posture has changed. I actually have more range of motion now than I did before surgery. Looking down is definitely restricted, but all other range of motion has improved. The pain and most symptoms resulting from my cervical spine issues are gone. The nerves will take a while to heal, and my remaining symptoms are simply a result of nerve healing slower than muscle.

My advice: don’t waste time! Consider surgical options if nothing else provides relief. Even more importantly, if the nerve is damaged and/or impinged upon, it will take a long time to heal and can become irreversible.

I am very happy with the procedure and even more so with the team. I now look forward to my post-operative visits. Everyone I have encountered at VSI is great to work with, a very professional team that really takes pride in and enjoy their work. Without hesitation, I would refer anyone suffering from spine-related issues, especially athletes, to VSI with my highest personal recommendation. Words could never express my gratitude and appreciation towards Dr. Subach and his team. I got my life back and I’m back out there kicking ass, what more can I ask for?
THE CLINICAL PERSPECTIVE
FROM DR. BRIAN SUBACH

I first met Dennis Dempsey in June 2014. This forty-eight year old consultant was extremely active, and involved in running, biking, and weight training. He presented complaining mostly of neck pain. He had symptoms for the past 15 years; however, he had begun having symptoms involving his right arm and shoulder blade. He had received a previous surgical opinion recommending a multilevel anterior cervical fusion for his complaints of decreased balance and dropping things. His two weeks of arm symptoms were not validated by an EMG study despite the fact that he had atrophy in his dominant right arm and significant weakness.

On physical examination he had a right-sided Spurling’s sign and weakness in his finger extensors and grip. His sensation was intact. He had brisk reflexes, a positive Hoffman’s sign, and positive crossed adductor sign.

On an MRI scan of the cervical spine performed in May 2014, he had evidence of severe spinal stenosis at C4/C5, C5/C6, and C6/C7 (Figure 1). The stenosis was clearly bad enough to flatten his spinal cord, give him imbalance, loss of dexterity, and even cause progressive loss of strength (Figure 2). The arthritis and the compression of the spinal cord were clearly worse on the right side.

In looking at his standing lateral x-rays, his cervical posture was clearly forward. He did not have normal lordosis (Figure 3).

I compared the MRI scan and the standing x-rays prior to surgery with his ultimate surgical intervention, which was anterior cervical fusion with decompression of the spinal cord and exiting nerve roots at C4/C5, C5/C6, and C6/C7 (Figure 4).

After surgery his pain has decreased tremendously. He has normal posture and no longer is dropping things. Overall, he is much improved from his severely compromised state. Mr. Dempsey is a Spine Tale since he has exhibited not only courage, but dedication to physical therapy and his own health.
My story began on the evening of March 12, 2006 when we experienced a ferocious storm. My wife and I heard water dripping over our heads from the attic. The next morning the storm continued to rage and water continued to drip, so I decided to go up into the attic to find the leak.

When I got up there, I noticed that the stairway opening was in my path. Instead of crawling around the stairway area, I tried to jump the 40 inch space. Big mistake! The hard soles of my tennis shoes offered no traction on the rafters, and I landed, very unbalanced, on the other side of the stairway. I grabbed for something to keep myself from falling through the wallboard, but alas, there was nothing there except air! I felt myself falling and then must have blacked out.

I soon awoke, discovered that I was sitting on the bottom basement step, and realized that I had just fallen approximately 30 feet! I was numb and felt as if I was in a trance or something. Carefully raising myself up, I slowly struggled to our small freezer to support myself and stand.

My wife heard the commotion and came downstairs. She said that she was going upstairs to call 911. I said no because I could still walk, and there was something I needed to do. I had told my oldest sister that I would be with her on the first anniversary of her husband’s death on March 17th of the previous year. Three days later, and in constant, overwhelming pain, I flew to be with my sister in Virginia as I had promised.

Upon my return to Kentucky, I saw my primary care doctor. He ordered x-rays and told me to take Tylenol and lie on my back until the pain went away. This activity brought no relief.

I soon went to a new primary care doctor who referred me to an orthopedic surgeon. He reviewed my tests and stated that I had multiple injuries to my spinal column (L4, L5, and S1 areas) and that, with no intervention, I would most likely lose the ability to walk. The surgeon performed a fusion surgery in October of 2007. Afterwards, he prescribed physical therapy as a follow-up. There was no improvement in my condition after the surgery or therapy that followed. My primary care doctor referred me to the pain clinic for five epidural shots to my spine. The first shot provided very brief pain relief, but the other four shots did not accomplish anything.

Next, my primary care doctor sent me for a consult with a neurosurgeon at a local hospital. He reviewed my tests and stated that nothing was cracked or broken so he could not do anything for me. He also told me that after surviving such a fall, I should feel very lucky to be alive.

The declaration by the neurosurgeon was the lowest point of my life. Instead of feeling lucky to be alive, I felt defeated, hopeless, and worthless! I knew then that I would remain a cripple and be debilitated with unbearable pain for the rest of my life.

In 2009, my wife happened to be talking with a wonderful woman she had become friends with while volunteering at one of our local elementary schools. My wife confided to her friend about my misfortune and how depressed I had become over the ordeal with my back. We were feeling very desperate and didn’t know where to turn. My wife’s friend thought that her son-in-law knew someone who might be able to help us.

The woman’s son-in-law had been Dr. Rouben’s lab partner in medical school and highly recommended his old friend, now a highly renowned orthopedic surgeon, as the doctor for us to see.
My wife called to make an appointment with Dr. Rouben, and the two of us went to find out if he could give us any hope. When Dr. Rouben reviewed the x-rays performed at his facility, he told us that my back was a mess and that the spine looked like a crushed pop can! He realized that I must be in severe pain. He definitely thought that he could help me by using a technique that he had developed and perfected. He explained what the surgery involved in great detail, and I told him that I wanted to do it. My wife and I left Dr. Rouben’s office that day feeling more optimistic than we had since the accident.

In October 2009, I arrived at the hospital and waited. Dr. Rouben, as busy as he was, actually took the time to come and see me before the operation. He went over the entire procedure again and wished both of us good results.

My operation was quite long, and during the procedure, the doctor inserted two titanium rods and eight titanium screws into my back.

After the surgery, Dr. Rouben emerged from the operating room and talked with my wife. He informed her that he had to tear out everything the previous surgeon had done because it was not correct. Dr. Rouben said that it was a challenge, but that it was FUN!

I stayed in the hospital for three days. I was fitted for a back brace and an electronic belt (stimulator) to wear every day for at least six hours.

The surgical wounds took several weeks to heal. During this period, I was sore but able to walk around the house. Dr. Rouben prescribed pain medication to assist with any discomfort I felt. I was soon able to begin water exercises and then physical therapy. Later, I began to walk around the track at the YMCA.

In a year’s time, I was able to do many activities that I could not have accomplished before Dr. Rouben’s healing hands touched me. He gave me my life back, and I will be forever grateful for this supremely talented and dedicated physician. I am thankful every day of my life that God put Dr. Rouben in my path and that He guided Dr. Rouben’s hands as he performed my surgery.

I have something to look forward to each day. I am a man of worth instead of being a depressed cripple.

I am able to work part-time, by choice, stocking beverage shelves and waiting on customers. This position requires me to stand for seven hours at a time. I am also able to ride my tractor to cut grass and was happily able to have a garden last summer.

The best way to find a doctor is to talk with your primary care doctor and your friends to get a recommendation. Follow your doctor’s instructions completely and healing will happen for you.

The most important thing that I will tell you is this: Please don’t give up. There is a gifted doctor out there who can help you lead a normal life once again; I am living proof of that!
In 2006, this 60 year old male fell through his roof at his home and sustained fractures of his T6, T7, L1, and L2 vertebral bodies. Although being treated conservatively for his fractures initially, he was subsequently treated by his original spine surgeon at that time with a laminectomy at the L3-4 and L4-5 lumbar levels.

When evaluated three years later in our health care facility, he was home and in a wheelchair with significant neurologic weakness to both legs and severe low back pain. He was profoundly miserable and dramatically restricted to his independent activities of daily living. Extensive neurologic, urologic, and radiologic examinations were performed. Although his original fractures had healed, his evaluations were consistent with a spondylolisthesis (slippage of the vertebral bone segments) at the L3-4 and the L4-5 levels with instability. He suffered from lumbar spinal stenosis at both levels and a large herniated disc at L5-S1.

After detailed discussions with Miles and his family were completed, the patient chose to undergo a decompression of the L3 through S1 spinal segments and a fusion with pedicle screw fixation and interbody fusion cages from L3 to S1. He worked diligently in post-operative rehabilitation as an out-patient for 6 months. He is now six years post-op and is totally independent as it relates to both home and community activities of daily living. He has taken no analgesic medication for years.
I put up with it for about 2 to 3 years. I lived with pain that radiated from the bottom of my spine all the way to my ankle. It was very painful, but I just learned to live with the pain. I couldn’t split wood anymore, and doing my gardening was challenging.

My friend, Guy Beatty, told me about the surgeon that helped him, Tom Schuler, at the Virginia Spine Institute. Upon his suggestion, I made an appointment myself and decided to get surgery.

Dr. Schuler operated on my spine by shaving off a couple of nodules that were poking my spinal cord. After spending a few months recovering, there was a significant reduction in the amount pain I felt.

I have outlived my body; that’s all. I have two artificial knees; I have had my left shoulder operated on, in addition to back surgery. I know what it is like to be a surgical patient.

I continue non-surgical treatment with physical therapist Rich Banton at the Virginia Therapy and Fitness Center. I would like to go to physical therapy twice a week, but I usually just make it once a week. It loosens up everything.

Now, I may not be able to split wood again, but I can garden. I only had to miss a season of gardening while I was recovering, and then I was back to it.

I have had such great success with physical therapy, I would suggest people try physical therapy before considering surgery. You might even be able to control the pain with therapy.

For some patients, sometimes surgery is needed. For example, I know my wife, Jean, had to have back surgery or she would have been in a wheelchair now.

My biggest piece of advice though:
Be good to your body.
THE CLINICAL PERSPECTIVE
FROM RICH BANTON, PT, DPT, OCS, CMPT, ATC

Frank Everest is an example of what is possible if you choose your surgeon wisely and identify an excellent physical therapy center to perform your rehabilitation. When Frank underwent his microdiscectomy, it was common for patients to only receive about 5 years of relief before having to undergo another surgery. Most commonly, the next surgery would involve a spinal fusion. Mr. Everest understood the risks involved with his surgery and because of the extensive degenerative changes in his lumbar spine and his age, he knew the odds were not in his favor to avoid spinal fusion. However, in choosing Virginia Spine Institute, Frank benefited from the state of art, minimally invasive procedures, performed by a pioneer in the field of spinal surgery. Mr. Everest’s microdiscectomy was successful without creating further destabilization of his disc. In addition, Mr. Everest chose a physical therapy center that was tailored to his needs and provided one-on-one therapy without the use of lesser trained aides or assistants. Early intervention facilitated the stages of healing to allow the vertebral disc to heal properly, avoiding re-herniation, and allowing him to return to his previous level of function. A combination of manual therapy and stabilization exercises have not only allowed Mr. Everest to maintain an active lifestyle, but they continue to promote a healthy state for his aging spinal discs.

Mr. Everest is now over 10 years out from his original surgery. He is living proof that minimally invasive surgery, performed by experts in the field, when combined with an experienced physical therapist, can lead to outstanding results. Mr. Everest continues with his maintenance program of manual therapy and exercise once to twice per month to allow him to maintain his active lifestyle. Mr. Everest is an avid gardener, hunter, and fisherman. He eats a well balanced diet, maintains a healthy weight, and practices good wellness habits. Despite his age of 83 years old, Mr. Everest is proof that you are never too old to get stronger or improve upon your functional abilities. He is also a reminder of how practicing a healthy lifestyle can reward the mind, body, and soul.
I am not a success story. Yet. Despite everything, I’ve never doubted my ability to overcome any physical obstacle in my way.

This is where Dr. Brian Subach enters the picture. It is his task to keep me “screwed” together – quite literally. He is my support and my advisor.

My saga began on Christmas Eve, 1982 on top of the Zugspitze (highest mountain in Germany). My husband and two oldest sons were busy exploring all of the runs, and I agreed to ski with my 3 year old on the easy slope. I had just spent the past winter as a ski instructor, so to entertain myself, I was skiing the slope backwards and doing 360° turns. As luck would have it, I caught a tip and went down, suffering a complete spiral fracture of the right tibia above the ankle. The German doctors wanted to use plates and screws to straighten the fibula. The orthopedist at the American hospital recommended cutting out a section of the right fibula in order to heal the tibia. Being an Army family assigned to Germany, we went with the American recommendation. I spent six months in a cast, but the piece removed from the fibula was too large and it never healed. But, I was on the slopes again by Thanksgiving and was more of a daredevil than ever as I knew I could heal and overcome.

I continued to run, swim, and ski. Physical activity and fitness drive me to push myself beyond the ordinary. All was going smoothly until the mid-1990s when severe ankle pain led to the discovery that I had lost the cartilage in my right ankle because the right lower leg had never set straight. This led to arthroscopic surgery followed by a simple fusion that failed within the year. By now, I had completed my doctorate and was teaching at Northern Virginia Community College (NVCC) – Physical Education of course – every activity and lecture course offered. Next they found a stress fracture near the original tibial break. I spent that summer in a cast, but I taught through all of it. I remember when the cast was removed after the second fusion that my first words were that the right foot didn’t touch the ground where I expected.

First red flag. That’s when I found Aquatic Therapy & Rehab Institute and soon began teaching for them – in addition to the NVCC. I also got certified in Aquatic Exercise and ran that program at the pool where I had been swimming for years.

I can look at my mother and my sister and see a definite genetic and environmental link in the progression of symptoms. The past ten years have been a journey. I was being followed by a military orthopedic spine specialist, but when my gynecologist asked him to re-check my back, he was shocked to find extreme scoliosis and rotation that had developed within a year. Solution – nine level fusion.

Within weeks I was teaching again – aerobics, yoga, Pilates, ballroom dance, fitness lectures. In barely a year, that fusion had failed, and a complete fusion from T2 to the sacrum was required. Before I agreed to this, I first met Dr. Subach who agreed that this was necessary. Because of insurance, it was done through the military. The surgery was posterior and anterior, with major complications.

At this point I limited my teaching at the college, but not the aquatics. In less than two years, I was having pain again that I thought was sciatica. I went to Dr. Subach for help. He found a broken screw.

On my way home from seeing Dr. Subach, my car was rear-ended. Minor inconvenience as two days later in the train station in New York City, I was pushed backwards down an escalator and trapped on my back. I was thankful I could still move. In extreme pain and bruised, we made it to the Broadway play that night, formal dinner the next night, and then flew to Germany for a conference and vacation.
When I returned, Dr. Subach removed the pieces of the broken screw, and with his expertise, I required no pain medication. The next year the second ankle fusion required a triple arthrodesis.

I continue to swim 10,000 to 12,000 yards per week, do deep water running 2 days a week for 45 minutes, and weight training. I am a senior instructor for the Aquatic Therapy & Rehab Institute and continue to develop and teach new courses for them and the Aquatic Exercise Association. I travel and train internationally. I am still a member of my masters swim team. I present at the International Aquatic Exercise Association conference and sit on their research board. I am a board member and very involved with many aquatic companies, including the International Swimming Hall of Fame to which I was inducted five years ago. I developed and conducted the study on Aquatic Programs for Wounded Warriors for the Army’s Surgeon General in 2010. I followed that with developing the AMP-IT (Aquatics Maximum Power-Intense Training) that is now required of every Marine. I spent the past year working with Warriors with traumatic brain injuries and post-traumatic stress disorder on defining a non-pharmacological intervention.

I schedule regular appointments with Dr. Subach so that I can continue my active lifestyle. Last year he found another broken screw, but the decision is to not touch it unless it causes symptoms.

I repeat – I am not a success story. I am still a challenge in progress. What is the bottom line? Most likely it goes back to the broken leg not healing correctly, leading to uneven leg length, and ultimately leading to my spinal issues. If the skeletal system is weakened or misaligned, another has to take on its works. The song about each bone being connected to the next one is true.

I continued to run five miles a day in addition to swimming, golf, skiing, and teaching. With each ankle fusion, I lost some length in the ankle joint that eventually led to a lifelong slight scoliosis to a significant diagnosis that required surgery. The water is my environment where any limitations disappear.

The Virginia Spine Institute and the Spinal Research Foundation offer the most outstanding care and options. I wish I had been with them on this journey.

Never doubt what you can do. Persistent perseverance lets me continue to live and love life to the fullest and mentor others.

THE CLINICAL PERSPECTIVE
FROM DR. BRIAN SUBACH

Mary Wykle’s story is truly amazing. It is impressive to look at the extensive surgery to her thoracic and lumbar spine on AP (front-to-back view (Figure 1)) and lateral (side view (Figure 2)), and know that she has recovered to the point of having a relatively normal life. Figure 1 shows two of the broken screws at the bottom of her spine. Mary, whatever you break, I promise you that I will be here to fix it.
For eight years, in multiple cities across the nation, we’ve raised awareness about the widespread impact of spinal injuries and disorders, celebrated spinal treatments, and educated the public about the importance of spinal health.

Visit WGYBrace.org to learn more.
Regenerative medicine and techniques are tools frequently used to help our own body heal itself. The goal of regenerative medicine is to enhance the body’s healing, growth, and renewal properties to decrease pain, increase function, and improve overall health. The following are four categories to accomplish these goals.

**ONE:** Stimulate our body’s own natural healing process. Includes: prolotherapy, injections with barbotage, and possibly even dry needling

Prolotherapy (proliferation therapy) is an injection of a mildly irritating substance, typically dextrose or sugar water, in and around a painful area with poor or slow healing, and often with poor vascularization (blood supply). Placing this substance around the areas of concern (tendon insertions, ligaments, etc.) can cause local inflammation and encourage the body to heal. The body will often send in cells to remove the dextrose and stimulate the local healing process by laying down collagen, scar tissue, or other tissue that can help heal and stabilize the area.

Similarly, the technique of barbotage can increase local bleeding, and introduce red cells, white cells, and platelets to the injured area and assist in the healing process.

**TWO:** Transport our own specialized functional cells into injured areas. Includes: platelet-rich plasma and bone grafting

Platelet-rich plasma (PRP) is the resulting product of a sample of a patient’s own donated blood that is spun in a centrifuge to separate the platelets from other components of blood. The concentrated layer of platelet cells is re-injected into the injured area of the body that is causing pain and needs help healing. Platelet cells initiate local healing themselves, but they also release various hormones that recruit additional cells to the injury site to encourage repair and healing.

**THREE:** Introduce biological adjuncts to create an optimal healing environment. Includes: vitamin supplements and hormone therapy

Using adjunctive treatments can improve healing by increasing the cellular and hormonal response, or optimizing the nutritional environment for the cells.

This can include nutritional supplementation, including vitamins and minerals. For example, vitamin D is an important hormone-like vitamin which is essential for many, many growth and development functions.
Other types of adjunctive interventions can include optimizing hormone levels, such as testosterone, estrogen, progesterone, or even human growth hormone if indicated. These can optimize the body’s response to stimulate appropriate healing and growth as necessary.

Hyperbaric oxygen can also be very useful to improve the oxygen supply for local cells and can improve healing as well. In the treatment of osteoporosis, parathyroid hormone (known as Forteo) would also fit in the category of biological adjunctive treatment in the regenerative medicine world.

**FOUR:** Stimulate undifferentiated cells to differentiate and specialize into cell types.

**Includes:** placing undifferentiating cells (pluripotential) in regions to encourage a response for healing or tissue growth

Placing undifferentiated cells in various areas of the body with the appropriate stimulation, can help the cells differentiate into the appropriate cells needed for treatment. For example, there are studies underway in which undifferentiated cells, often described as stem cells, can be placed in cardiac muscle in some patients with weak hearts, and the cells differentiate into cardiac cells, which can improve cardiac muscle function.

Additionally, undifferentiated cells can be placed in areas near tendons to aid in their function. They can be placed in areas to encourage bone growth or fusion. They can be placed within damaged intervertebral discs, which can help some patients with back pain.

What’s PRP?

In our blood there are basic cell types, each with a specific function: red blood cells transport oxygen; white blood cells help fight infection; and platelets assist with healing. Due to platelets’ unique ability to facilitate healing, doctors have utilized platelet rich plasma (PRP) to help facilitate the healing process.

Platelets aid in local healing by aggregating, or bonding together to seal the cut. They also release many growth factors or small chemicals that signal for other cells or tissues to start the healing process.

Platelet-rich plasma is obtained by drawing some of your own blood and then putting it in a machine called a centrifuge to create a solution rich in platelets. This concentrated solution of platelets can then be injected in and around the area that we want to have helped stimulate to heal.

Some conditions that can be treated with PRP include inflamed tendons or tendinitis, inflamed ligaments, strained muscles, or inflamed joints. Tendons and the anatomy in the surrounding area have relatively low blood supply. If there is a ligament strain or irritation, the lack of blood supply can lead to slow healing. Injecting a platelet concentrate, a concentrate of cells whose job it is designed to help with healing, can often jump start the healing process and allow the body to heal on its own.

In this form of regenerative treatment, the medicine encourages our own body to heal and renew itself.

I have had much success in the use of platelet-rich plasma in patients who are appropriate candidates for this treatment. This has helped patients heal faster and possibly even avoid surgery. Also, in patients who have had surgery, platelet-rich plasma has also helped patients heal faster after their operations.
Words like regeneration, rejuvenation, and regrowth conjure up hope and potential when used in a medical context.

Every scientist or clinician that has harnessed the potential application of stem cells in a clinical setting for patients has pondered what the next frontier is. Even after decades of peer-reviewed, published information on stem cells, the whole issue of their use in regenerative medicine is shrouded in mystery thicker than Sir Alfred Hitchcock’s screenplays. So what is in it for patients seeking regenerative medicine such as stem cells as plausible treatments and therapies for their respective medical conditions? What is a stem cell? This article is not an effort to dispel or unravel the politicking on stem cells in medicine. Additionally, the myriad of complex issues of stem cell biology are beyond the scope of this publication.

Undifferentiated stem cells can replicate into more stem cells, thereby providing a reservoir of even more blank cells. These blank cells can be targeted through controlled differentiation to provide specialized cells. It is this aspect of the stem cell’s controlled differentiation into certain or desired cell types that holds the potential for therapies. Mammals at the biological system level are made up of organs, tissues, and bones. Each one of these biological systems is a collection of specialized cells. Various diseases at the organ, tissue, or bone level thus have the potential to be addressed by cellular therapies.

In an effort to better explain stem cells, it is best to use the broad classification of embryonic or adult. As the name implies, embryonic stem cells (ESCs) are obtained from early stage embryos. They are harvested from a ball-like structure called the blastocyst during the early development of mammals including humans. The cellular mass found inside the blastocyst goes on to form the embryo and is a rich source of ESCs. These embryonic cells are termed pluripotent which means that they have an unlimited potential to produce any cell type that makes up the body. As the embryo grows in to a fetus, the pluripotent capacity of the cells diminishes and progresses to a more differentiated state involved with the formation of organs. So the cell’s potency, i.e. ability to give rise to any type of cell, is greatly reduced and is restricted to the type of tissue or organ it is part of. All organs and tissues in the body possess a reservoir of stem cells whose potency is geared towards the tissue that hosts it.

**Stem cells are undifferentiated biological cells which can be thought of as blank cells with great potential to differentiate into specialized cells.**
Human ESCs can be used as regenerative therapies for various diseases such as spinal cord injury, Parkinson’s disease, and diabetes. Most of the advances in the developmental biology of stem cells have been made with studies on mouse ESCs. Even though the mouse is the primary animal model for understanding mammalian embryology, there are vast differences between mice and human embryos. Namely, the formation of early structures like the placenta, embryonic membranes, and the egg cylinder all vary vastly from their counterparts in human embryo. Non-human primates such as rhesus monkeys are commonly used to address these scaling up problems of animal models to humans. The primary reason for using non-human primates is to prevent immune rejection of transplanted cells and to demonstrate the safety and efficacy of embryonic stem cell-based therapies comparable to humans.

Due to restrictions on human embryonic stem cell research in the U.S., it is important to have a strong grasp on the developmental biology of rhesus monkeys and their ESCs. They provide a much more accurate model and consequently aid in furthering the understanding of basic developmental biology for human ESCs. This is especially important when human embryonic stem cell research gains mainstream acceptance and government restrictions are removed for its application in medicine. Great progress has been made in the basic developmental biology of mice, rhesus monkeys, and various other animals. It is only a matter of time and thawing out politics and stigmas associated with human ESCs that will link this progress even more closely to the prevention and treatment of human disease.
At this juncture, it is prudent to define adult stem cells. More precisely, as we just learned, they can also be referred to as tissue-specific stem cells. Adult stem cells are specialized cells that are found in tissues of adults, pediatrics, and fetuses. These cells are focused to form the tissue that they are part of. Hence, an adult stem cell specific to blood, liver, heart, skin, or brain will only become the cell of that particular organ or tissue. So, an adult stem cell in the heart will not give rise to non-heart tissue.

There are many differences between embryonic and adult stem cells apart from the obvious potency of the cells. Unlike the ESCs, the inability to grow adult stem cells indefinitely in the lab as a source for regenerative therapies has seriously impacted their viability for regenerative medicine. Similarly, the moral, political, and ethical clout shrouding the use of ESCs in medicine has limited stem cell research.

The basic science behind stem cells has now been well developed over the last three decades. However, moving forward on stem cells as regenerative therapies will require the application of stem cell biology to medicine. This step of translating basic science to bedside or clinical application is called translational science. The step of bringing stem cell therapies formulated to address specific diseases of tissue or organ is to-date performed using adult stem cells.

So what now? Are we stymied with our ability to channel the potency of stem cells into actual therapies that would improve patients’ lives because of the two stated types of stem cells? Recently, stem cell research has yielded some fruitful results in that adult stem cells can be re-programmed to behave like ESCs. These types of cells are called induced pluripotent stem cells (iPSCs). This means that adult stem cells that were previously specialized for a targeted role of developing into a specific tissue or organ now have the ability to form any cell type in the body. This is remarkable progress as the induced pluripotency is the key for adult stem cells to be used as effective regenerative therapies.

Shinya Yamanaka and John Gurdon were awarded the Noble Prize in 2012 for their work on induced pluripotent stem cells that can be generated directly from adult cells. The technology was pioneered by Dr. Yamanaka’s lab in Kyoto, Japan in 2006. His early work demonstrated that the introduction of four specific gene encoding transcription factors could transform adult cells in to pluripotent stem cells. Transcription factors are proteins that bind to specific DNA sequences to control the first phase of gene expression. The much deserved Noble Prize for induced pluripotent stem cells solved the puzzle for other scientists who were struggling to reprogram adult stem cells to behave like ESCs. It also ushered in a new age of regenerative medicine using stem cells.
Yu et al. demonstrated that targeted genetic modification of adult human stem cells can yield pluripotent stem cells that behave like ESCs.\(^5\) What this means for biomedical science is that cells that were previously committed to development of designated tissue or organ can now be reassigned to give rise to any type of cells. Thus employing genetic engineering techniques, researchers are now able to reprogram adult stem cells to behave like ESCs. What Yu et al. demonstrated is that this transformation from non-potent to potent stem cells can be triggered with just four transcription factors (specifically: OCT4, SOX2, NANOG, and LIN28). These four responsible factors can reprogram somatic cells (any cell in the body that is not a sperm, egg, or undifferentiated stem cell is called a somatic cell) into pluripotent stem cells that have essential characteristics of ESCs.\(^5\)

Similar results were also found in animal models and support the findings by Yu and his colleagues. Wernig et al. demonstrated that just four transcription factors, (specifically: OCT4, SOX2, NANOG, and LIN28) were responsible for transformation of mice fibroblasts to a pluripotent state.\(^6\) The group found that the laboratory-generated iPSCs were identical to ESCs in both biological potency and heritable changes in gene expression (epigenetics). Research done by Takahashi et al. in mice demonstrated that differentiated cells can be reconfigured using genetic engineering to an embryonic-like state.\(^7\) In their study, iPSCs were shown to have morphology and growth characteristics similar to that of ESCs including expression of embryonic stem cell marker genes.\(^7\) Okita and his research group found that fibroblasts in mice can induce pluripotent stem cells through genetic modification.\(^8\) Animal studies like these offer great insights in to the basics of stem cell biology. Strong evidence from animal studies has the ability to be translated in to clinical studies and eventually in to approved customized treatments for patients.

Research like this offers hope by utilizing existing and permissible biotechnologies to provide greater and translatable therapies from bench-side (laboratory) to bedside (clinic). However, it has to be noted that scientists are still trying to learn more about factors that facilitate this reprogramming of adult stem cells. A thorough understanding of the biological mechanisms that influence transformation from non-potent differentiated cells to potent embryonic stem cell-like states is needed to advance this technology. Among them is the ability for researchers to generate iPSCs safely. As genetic engineering is the technology used, researchers have to grapple with fact that the transformation does not result in the cells forming tumors.\(^7,8\) Furthermore, discoveries in vitro (i.e. a lab environment) have to be reproduced and validated in vivo, human body, to be deemed applicable for clinical applications. The transformations of the differentiated cells in to the desired types of specialized cells will have to meet clinical criteria suitable for use in patients.\(^5,7\) The discovery of iPSCs has great implications for disease research and drug development. Ethical limitations in the use of human ESCs sourced from embryos can effectively be avoided by the use of patients’ own cells that have been genetically engineered to exhibit pluripotency.\(^7\)

This approach also solves the issue of tissue rejection following transplantation in patients.\(^7\) One way to address this issue is the generation of pluripotent cells directly from the patients’ own cells.\(^7\) Genetic engineering has provided medicine with a marvelous tool to transform non-potent adult stem cells to potent embryonic stem cells. This has implications for
understanding how the disease actually happens—researchers can watch the process in a laboratory—and for searching for and testing new drugs. Studies using animal models provide applicable knowledge on the wide range of disease research being carried out around the world using iPSCs.

Comprehension of basic stem cell biology is critical for researchers to develop complex clinical applications that are ethically acceptable by the biomedical community and safe for patient use. Patients, as the consumer of this biotechnology, have a say in regenerative therapies that can benefit them. An educated patient can review the plethora of data available in scientific journals on the different types of stem cell therapies and in consultation with their clinician evaluate if one of these treatments is a viable option for them. As regenerative medicine is mostly in the clinical trial stage in spinal research, patients can equip themselves with basic science knowledge on stem cells to better assist them in their decision to participate in these clinical studies.

*For a full list of references please visit SpineRf.org*
The problem in orthopedics is the body parts we are treating have very little or no blood supply; the articular cartilage in your joints has no direct blood supply; the discs in your spine have no direct blood supply. You cut your face, and it bleeds a lot but heals quickly. You damage your joint cartilage or tear a disc in your spine, and it heals slowly or not at all, leading to progressive arthritis or chronic back and neck pain.

Beginning five years ago, the Orthopedic Stem Cell Institute (OSCI) began extracting bone marrow under IV sedation and concentrating the bone marrow to extract the patient’s own mesenchymal stem cells (MSCs). We then place the patient’s own MSCs into damaged discs in their neck, back, or any arthritic joint. We are the only clinic to have prospective, IRB-approved studies that have been peer-reviewed with published results for spinal injections. Your MSCs have many positive attributes. MSCs are anti-inflammatory, secrete numerous growth factors, stimulate blood vessel formation, modulate your immune system to enhance healing, fight bacteria, and turn into cartilage cells to potentially heal your arthritic joints or damaged discs in the cervical or lumbar area. High concentrations of these amazing cells are stored in your iliac wing. At OSCI, we are simply moving your MSCs from your iliac wing and placing them in your damaged joints and discs where they are normally unable to be transported because these areas of your body have no direct blood supply. This technique is optimizing your body’s ability to heal itself. The procedure itself is generally done under IV sedation, and the entire procedure typically requires 45 minutes.

The recovery time from the procedure is usually a day or two, and substantial improvement in your pain and function are often experienced within three months following the procedure. The overall results of extracting MSCs from bone marrow concentrate at the OSCI are 70% of the patients are 70% better at one year following the procedure.

What We Are Learning About Lumbar Injections

OSCI has published our minimum one-year results and is about to publish our two-year results in treating patients with severe chronic low back pain in documented one or two bad lumbar discs. All patients were surgical candidates. Patients were evaluated with visual analog scale (VAS) for pain and an Oswestry Disability Index (ODI) for function. A visual analog scale is a scientific method for recording patient health outcomes by having patients place a vertical line through a horizontal line that is 100mm long, with 0 at one end and 10 at the other. For pain, patients draw a vertical line closer to 10 the more intense the pain is, and the mark is measured from 0 and scored in millimeters (however many mm the line is from 0, with possible scores from 0 to 100). The Oswestry Disability Index is a proven method for assessing physical limitations that arise from low-back pain and disability. The ODI includes questions about every day activities like sitting, standing, walking, and personal care; answers gauge the level of impairment in these activities. It is scored as a percentage with the worst being 100 (virtually immobile and completely dependent on others) and the best being 0 (minimal to no pain, limitations, or restrictions).
**Average ODI Scores vs. Time**

*P-values for initial scores versus follow-up were less than 0.0001 at all points*

**Average VAS Scores vs. Time**

*P-values for initial scores versus follow-up were less than 0.0001 at all points*
Two years after the stem cell injection, the average pain improvement was 72% (VAS) and functional improvement was 65% (ODI). Only 19% of the patients underwent surgery.

Millions of people have MRI scans which document abnormalities in almost all of their lumbar discs. The etiology of this premature degeneration is most likely genetic. These patients have limited surgical options for the treatment of their chronic back pain. Many of these patients are on chronic narcotics and are unemployable. These patients live on a regular basis with a very desperate situation. The OSCI has injected over 60 patients in three to five of their lumbar discs. The average person has five lumbar discs. The results of injecting three to five lumbar discs are:

<table>
<thead>
<tr>
<th>Patients w/ follow-up</th>
<th>Follow-up Time Point avg. VAS/ODI for Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 Patients w/ 3 month follow-up: 37.81 ODI, 60.00 VAS</td>
<td>At 3 months: 14.52* ODI, 21.06* VAS (~ 63% improved)</td>
</tr>
<tr>
<td>38 Patients w/ 6 month follow-up: 37.00 ODI, 60.26 VAS</td>
<td>At 6 months: 16.42* ODI, 23.68* VAS (~ 60% improved)</td>
</tr>
<tr>
<td>16 patients w/ 12 month follow-up: 35.07 ODI, 60.94 VAS</td>
<td>At 12 months: 14.72* ODI, 20.00* VAS (~ 64% improved)</td>
</tr>
</tbody>
</table>

*p-values for initial scores versus follow-up were less than 0.0001 at all points

The OSCI is about to embark on a prospective randomized study comparing patients with three or more bad discs randomized into stem cell injection versus conventional chronic pain treatment.

<table>
<thead>
<tr>
<th>Days After Procedure</th>
<th>Avg. ODI for patients w/ follow-up</th>
<th>Avg. VAS for patients w/ follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>41</td>
<td>59</td>
</tr>
<tr>
<td>45</td>
<td>24# (41% improved)</td>
<td>30# (49% improved)</td>
</tr>
<tr>
<td>90</td>
<td>26* (61% improved)</td>
<td>22.5* (62% improved)</td>
</tr>
<tr>
<td>180</td>
<td>20* (51% improved)</td>
<td>24* (59% improved)</td>
</tr>
<tr>
<td>365</td>
<td>15* (63% improved)</td>
<td>21* (64% improved)</td>
</tr>
</tbody>
</table>

What We Are Learning About Cervical Injections

OSCI has currently injected 128 patients for chronic neck pain involving 290+ discs. The results have been surprisingly positive. Thus far, none of these patients have had a surgical procedure post stem cell therapy. Patients were evaluated utilizing the Visual Analog Scale (VAS) for pain and Neck Disability Index (NDI) for function.

Final Thoughts

The use of regenerative medicine will continue to expand in all areas of medicine in the coming years. Any physician asked whether stem cells offer potential in the future of medicine will answer in the affirmative. I encourage you to research further the potential benefits of regenerative medicine.

*For a full list of references please visit SpineRf.org
For spinal conditions, the primary condition where stem cells may be of value is recent MRI-confirmed symptomatic degenerative disc disease of mild to moderate degree that is causing axial neck or back pain. Stem cells would be of little value for radicular pain (radiating pain to an arm or a leg) as a result of a disc herniation or spinal stenosis. Likewise, stem cells would be of little value for advanced degenerative disc disease, facet joint pain, myofascial soft tissue strain or spasm, spinal instability, vertebral compression fractures, scoliosis or spinal deformity.

Back Pain and Degenerative Disc Disease

The intervertebral discs in our spines are shock absorbers, or cushions, between the vertebral bones of the spine. Think of the discs as a jelly donut with an inner jelly-like portion, called the nucleus pulposus, and an outer dough-like portion, named the annulus. Beginning in our twenties, the discs in our spine begin to deteriorate with advancing age, but these discs also deteriorate due to wear and tear and in some, due to genetic predisposition. The discs may develop tears in the annulus (the outer wall) as well as dessicate (lose hydration). In these annular tears, tiny nerves may grow. The nucleus pulposus (the inner portion of the disc) contains chemicals that are highly irritating to surrounding tissue including these nerves that grow into the annular tears.

A common cause of chronic axial low back or neck pain in patients in their twenties to fifties, peaking at age forty, is degenerative disc disease. However, determining whether a particular disc is the source of one’s back or neck pain can be a challenge. Typically, lower back pain from disc degeneration is intermittent; it becomes worse with prolonged standing or sitting, bending forward, coughing, sneezing, or vibration (i.e. riding in a car). Typically this type of pain is restricted to the back and perhaps buttocks or back of the upper thighs.

To aid in the diagnosis of disc induced pain, some advocate the use of a diagnostic procedure called provocative discography. During this procedure, a volume of contrast dye is injected into the disc at a measured pressure that is typically not painful or even noticed by the patient when placed in a healthy asymptomatic disc. In a symptomatic disc, however, this procedure creates a significant reproduction of the location and character of the usual pain. There is currently no consensus whether provocative discography needs to be done in order to decide to do a stem cell procedure because it is not a fully reliable test. Fortunately, discography carries a very low risk of disc infection or even further disc degeneration.
Using Stem Cells in the United States

Regenerative therapy for spinal conditions in the United States, as dictated by the FDA (Food and Drug Administration), is currently limited to utilizing autologous (a patient’s own) adult stem cells found in either bone marrow or fat, with minimal manipulation of the collected cells, and gathered at point of care. The injected cells are not processed in a laboratory; there is no risk of immune rejection or development of cancer with autologous cells. This therapy does not include the use of embryonic stem cells and should not be confused with platelet rich plasma (PRP). PRP simply concentrates the platelets found naturally in blood and is not mesenchymal stem cell therapy, but rather contains a very small number of hematopoietic stem cells which do not develop.

These multipotent stem cells differentiate (or specialize) into healthy chondrocytes when placed into the disc via environmental signals.

For orthopedic conditions, including the environment in spinal discs, bone marrow-derived mesenchymal cells may be superior to fat-derived mesenchymal cells. Mesenchymal cells in bone marrow are more closely related to the type of cells that are needed for orthopedic conditions than those found in fat, despite a higher number found in fat. In fact, the studies published to date far more strongly support bone marrow-derived over fat-derived stem cells for orthopedic conditions involving bone repair, cartilage repair, or soft-tissue ligamentous repair, likely due to the homologous nature of this route. Furthermore, while there may be claims that fat may provide a higher count of mesenchymal stem cells than bone marrow, this may not be valid as these cells may simply be fat tissue.

Finally, collecting the stem cells by aspiration from bone marrow, especially under x-ray guidance, is much less invasive and better tolerated than a liposuction procedure. A simple needle liposuction may be less invasive than liposuction, but is unlikely to do much more than provide fat tissue. Furthermore, to properly obtain stem cells from the fat after liposuction, an enzyme such as collagenase is likely needed to separate out the stem cells. However, doing this may be in violation of the FDA’s rule for minimal manipulation of cells, and it is unclear whether adding this or another enzyme may damage or perhaps modify these cells with unanticipated negative consequences.

What to Expect

An autologous bone marrow concentrate injection into the spinal disc typically involves an outpatient procedure (meaning the patient is discharged on the same day of the procedure) at a surgical center. Local anesthesia and perhaps light sedation may be utilized.

Bone marrow aspirate contains platelets, immune cells, mesenchymal stem cells, and hematopoietic stem cells. Thus, there is no need to add additional platelets via PRP. Mesenchymal stem cells exert their effect not only by proliferation of new cells including cartilage, but may also act by regulating surrounding tissue, immune modulation, and anti-inflammation.
The bone marrow aspirate is typically taken from the posterior hip bone (posterior superior iliac spine), but may also be taken from the anterior hip bone (anterior superior iliac spine) under x-ray guidance. With ample local anesthetic placed, most patients do not find this part of the procedure to be too painful, and often times this is the least painful aspect of the procedure. Approximately 60 cc are taken from one site. Likewise, the placement of cells into the disc is done via needle placement under x-ray guidance. A specialized centrifuge system processes the autologous bone marrow concentrate at the point of care, with a way to separate out and maximize the largest amount of stem cells. Approximately 3 cc of the highest concentrate cells, with another 7 cc of a lesser concentrate cells result. An average lumbar disc can hold around 2-3 cc maximum, while the average cervical disc can hold around 1 cc maximum. Typically, most patients have 1 or perhaps 2 discs treated, and rarely 3 discs at a setting.

The entire procedure takes less than an hour from start to finish. Caution must be taken for those with anemia, bleeding disorders, active infection, immune system disorders, or patients on blood thinners.

By putting any type of volume or pressure into the disc, whether it be one’s own cells or any type of liquid, it is common to have temporary increased pain for up to several days post procedure. Most patients do not notice the benefit of the procedure until four to twelve weeks after, with most reporting improvement by ten to twelve weeks after. Typically, the maximum benefit is noted between three and six months afterward. Most patients should only require a single procedure, and published data has shown persisting benefit achieved at three to six months out to at least one to two years. There is not data available as to whether the benefit persists after one to two years. There is also no clear data whether there is any need for supplementation orally or intravenously in addition to the stem cell procedure. There is data to suggest that patients should avoid non-steroidal anti-inflammatory drugs, like ibuprofen or naproxen, or steroids for up to two weeks before and after, as these drugs may impair the regenerative process. Activity can be gradually resumed after the procedure, and there is no clear need for bracing or specific physical therapy protocol.

Final Takeaways

It cannot be emphasized enough that currently, regenerative medicine is considered investigational and is not covered by insurance. This is an evolving field with continued contribution from basic science, clinical studies, and physician consensus guidelines in progress.

As of now, this field is still relatively young, and what is considered cutting-edge today may be totally outdated tomorrow.

It is vital that any patient considering this therapy must carefully evaluate any physician or clinical center offering such procedures with regards to ensuring the highest level of experience, training, safety, and ethics are present. Bone marrow aspiration technique, centrifuge equipment utilized (with regard to not simply total cell count, but actual cell recovery as measured by colony forming units, not total nucleated cell count, to properly reflect mesenchymal cell count), and proper technique to properly and safely place the needle into the disc are vital to the success of the procedure. In addition, this treatment option should only be considered for moderate to severe pain of six months or more duration that has not responded to conservative options including medication, physical therapy, or chiropractic care, and likely facing spine surgery as the only other option.
Basic science lends to the conceptual understanding of complex subject matters in medicine. The field of medicine is dependent on applying knowledge of medical sciences such as anatomy, physiology, biochemistry, microbiology, pharmacology, and pathology to better understand disease at the cellular, tissue, organ, and biological-system level. However, the foundation of this rigorous medical sciences subject matter finds its roots in biology and to a lesser extent, chemistry.

Most scientists and clinicians who are exploring the realms of clinical research are well-versed in the basic science. Basic science involves studying cell biology, biochemistry, microbiology, immunology, neurobiology, pharmacology, and genetics in organisms such as bacteria, mice, pigs, and humans. The application of basic science principles and concepts to address complex clinical research questions drives discovery in clinic. This application of basic science to clinic is called translational research. It is also referred to as bench to bedside, i.e. laboratory to clinic.

The development of novel treatments, procedures, and technologies relies on tapping the wealth of knowledge that resides in the silos of basic sciences. It is the application of principles and concepts from basic science silos to the dynamic field of medicine that holds the key for finding cures for diseases, developing new treatments, and designing innovative medical technologies. Most scientific investigations to understand the underlying disease mechanism can be effectively had by unraveling the basic science behind it.

Application of basic science concepts in the laboratory setting or outside the human body is called in vitro and is part of the translational research spectrum. The translational research spectrum encompasses application of bench or laboratory findings to benefit patients in clinic. Lately, another arch of the spectrum has extended the translational to the community by disseminating the information to the patients through clinicians and public health officials.

One such field that is making a huge impact on translational research is stem cells. Rather than construct grandeur content on stem cell treatments as the panacea, I would like to take the path less taken. I would like to provide the translational research aspect of stem cells that makes them such a great candidate for regenerative medicine.

Fourteen years ago, while working with a prominent stem cell researcher, Dr. Steve Stice, at the University of Georgia, I learned to truly appreciate the meaning of taking stem cells from the bench-side and finding applications for them in clinic. Dr. Stice has been on the forefront of stem cell research. Among his many accomplishments, he produced the world’s first cloned rabbit in 1989. In 2001, his lab produced the world’s first human embryonic stem cells derived from discarded embryos.

In 2005, Dr. Stice further enhanced the field of regenerative medicine by collaborating with Dr. Zhang from the University of Wisconsin to develop human motor neurons from embryonic stem cells.
In 2012, his lab created revolutionary “fracture putty” that can heal bone fractures in days rather than months. The last two examples demonstrate the translation of basic science to clinic.

Dr. Stice and other researchers like him have a solid understanding of stem cell biology that enables them to eventually apply that knowledge to clinic in collaboration with clinicians. The basic science knowledge of stem cells by itself is an island; once the concepts and mechanisms behind the science find applications in clinic, it opens up avenues for developing treatments. In the words of Dr. Stice:

“...there are multiple diseases that could be benefited through the use of stem cell technology. Stem cells could be differentiated into specific cell types and offer a source of replacement cells from damaged tissues. Some of these diseases include Alzheimer’s disease, Parkinson’s disease, ALS, spinal cord injury, retinal disease, stroke, heart disease, diabetes, and fracture repair. Curing these diseases and injuries would be very exciting; however, intensive research still needs to be performed to make sure that the therapies are safe and effective in human patients.”

Dr. Stice’s lab finding on the bone regeneration process through “fracture putty” is basic science research performed on mice. The lab used adult stem cells capable of producing protein involved in bone healing and generation. In collaboration with Dr. Peroni, they inserted the putty using a stabilizing device into fractures in mice. In an effort to translate this treatment into humans, the next step in this research is to conduct this study in large animals. Once a large animal model is established for healing fractures using the stem cell gel mixture, then it can be translated into clinical studies.

In the grand scheme of things in the clinical research world, minus the million-dollar budgets required for clinical trials, basic science is at work behind the scenes. As is the case with basic science research, with a budget of just a few thousand dollars per project, scientists are busy furthering the application of basic science findings to the clinic, including spinal surgery. Clinical studies including clinical trials are an expensive proposition and can cost millions of dollars for testing the safety and efficacy of drugs and devices including stem cell-derived regenerative medicine for use in humans.

A report submitted by the Eastern Research Group, Inc. to the Department of Health and Human Services in 2014 determined that it now costs between $161 million and $2 billion and about 7.5 years to bring a new drug to market. The high financial cost and lengthy timelines puts the pressure back on the basic science to have highly applicable findings that can be translated into clinic. The basic science research costs are a fraction of the clinical trials. A study by Light et al. showed that in 2003 the gross cost for an FDA-approved drug was $7.6 million for animal studies, while the Phase I, II, and III of a clinical trial was $70.7 million, $77.6 million, and $126 million, respectively.

The cost-ratio of conducting clinical research to bench research in animals is lopsided.

Stem cells’ applications in spine have advanced rapidly in the last few decades. According to Orthopedics This Week, around one million patients in the US were treated with stem cell-based therapies in the 15 years preceding the start of 2012. Furthermore, the article reports that in 2012, 100,000 patients were recipients of these stem cell therapies. Spine surgeons, along with ophthalmologists and wound care physicians, were the most frequent users of stem cell therapies. The article attributes the strong adoption of stem cells therapies by spine surgeons to their use of Infuse Bone Graft (commonly called BMP—bone morphogenetic protein—a genetically engineered version of a protein found naturally in everyone's body that helps regulate bone growth and healing) and allograft. The fact that spine surgeons have had experience using regenerative therapies as alternate treatments in their practices provides the rationale for increased use of stem cells in spine practices across the country.

There is one clear distinction between the biomaterials, allografts, and growth factors that spine surgeons have used in the past and stem cells: all the aforementioned materials used in spine surgery have been well characterized.

There is quality peer-reviewed literature on basic science, animal studies, and the viable translation of these investigations into clinic. However, stem cells have not been studied in depth to elucidate
the effective translation of animal models to clinical practice.

The specialization of spine and the orthopedic field as a whole has been heavily influenced by biomedical engineering. Spine surgeons, similar to their non-spine orthopaedic counterparts, have used metal and polymer implants, fixation screws, plates, cages, and other instrumentation to address patients’ neck and back problems. So it is logical that spinal surgeons would be open to the use of stem cells as regenerative medicine for their patients.

Stem cells used as biologics have been widely embraced by the spinal research community.4 Spine researchers in their adoptions of stem cells as regenerative therapies have demonstrated their utility for translational research. Spine surgeons are adept at using instrumentation, devices, and biomaterials to assist them in their surgeries to better heal the patient. Incorporating biologics into their practice is a logical next step to further the non-surgical options available to their patients. The minimally invasive nature of these stem cells as biologics that can be injected at the site of a degenerated disc or assist with spinal fusion are a welcome resource for spine surgeons.

There are numerous basic science and animal studies that provide evidence for its success in disc regeneration,5,6,7 spinal fusion,8,9 and spinal cord injury.10,11 Studies in each of these respective areas of spinal research have found their way to clinical trials. Clinical trials as defined by the National Institutes of Health, a division of Health and Human Services, are research studies that test how well new medical approaches work in people.12 The translation of basic science studies, especially of animal model to clinical trial, represents a major step in bringing discoveries to clinics. To-date there are clinical trials for disc regeneration,13,14 spinal fusion,15,16 and spinal cord injury.17,18 How critical is the link between animal studies in the lab to human studies in the clinic? In the field of spine, translational research holds great promise as is witnessed by the influx of biologics like BMP in most spine practices across the world. Dr. Marshall Urist, a pioneer of biologics in orthopedics discovered BMPs and helped make them a common utility in spine practices. However, his work on animal models facilitated the application of his basic science discoveries of BMPs into clinic.

Dr. Pettine, co-inventor of Medtronic’s Maverick motion preserving disc replacement, extensively uses stem cell therapies to treat patients in his clinic.14 Nearly 100 patients have been treated with stem cells in Dr. Pettine’s clinic, and he is seeing them benefit from the biologics injection.14 Similarly, Dr. Richard Steadman, M.D. from the Steadman clinic in Vail, Colorado is starting a stem cell practice for his orthopedic patients after rigorous research studies with animal models. These examples of prominent clinicians assimilating stem cell therapies to their clinical practice demonstrate the growing trend for regenerative medicine.

Biologics are an attractive alternative for spinal surgery. If the data from the last fifteen years is any proof of the demand for stem cells in the spine, then the next fifteen years is going to result in a wider adoption in spine practices as ongoing trials result in FDA approval of them for clinical use. Clinical trials will move the use of stem cells from investigational to clinical adoption through well designed randomized controlled trials which are widely accepted as the highest form of clinical evidence.19 The paradigm shift from invasive procedures using scalpels for spinal procedures to the non-invasive method using needles to inject stem cells to the affected site is taking place.

At the forefront of translational research are basic scientists collaborating with inquisitive clinicians wanting to bring regenerative therapy alternatives to their patients. Spine surgeons understand that spinal procedures are limited by the restricted or absent blood flow to the anatomical features that they operate on. Pharmaceutical agents thus have little effect on the repair of degenerating discs or fusing of vertebrae. A strong understanding of stem cell biology and developing animal models that can be effectively translated for application in human spines seems like a viable regenerative treatment alternative to invasive surgical procedures.

*For a full list of references please visit SpineRf.org
Long gone are the days when a spinal cord injury (SCI) was a death sentence. Current medical advances allow SCI survivors to live quality lives with their injuries and prevent further health complications. In the 21st century, we are now hoping that those with SCI not only manage their disability, but that they can regain motor and sensory abilities that they lost due to their injury.

Many new innovations and areas of research have ignited hope and new possibilities among SCI survivors. One of these areas of research is with cell therapy. While hesitations and objections exist and much more research is needed before cell therapy is standard of care for SCI, cell therapy is a hopeful frontier that could drastically improve a SCI survivor’s quality of life.

To understand the research being done with stem cells and spinal cord injuries, let’s go back to the days of biology class and refresh ourselves on the nervous system. The spinal cord has a major role in our central nervous system along with our brain. The spinal cord serves as the brain’s personal messenger to the rest of the body. Nerves extend from the spinal cord and innervate to other parts of the body (including: arms, legs, internal organs, etc.) to relay the brain’s messages. When the spinal cord is injured it can no longer serve properly as the brain’s messenger. Therefore, parts of the body can no longer function as they were meant to since they are no longer receiving messages from the spinal cord.

Depending on the location of an injury, people with a SCI might have differing levels of motor and sensory function.

The use of cell therapy has the potential to return motor and sensory function. Different types of cells have been identified and research is currently being conducted to determine the effectiveness and safety of their use. The types of cells include: human oligodendrocyte progenitor cells, Schwann cells, bone marrow stromal cells, and nasal olfactory ensheathing cells.

Human oligodendrocyte progenitor cells, when transplanted, can spark regrowth of nerves allowing them to return to their role as messengers. This could allow function, both motor and sensory, to return. The transplantation of human oligodendrocyte progenitor cells has been found to work best when the transplant occurs soon after the initial injury.
Schwann cells (which are not stem cells) are found around the spinal cord and serve as insulation for peripheral nerves.\(^1\) When a nerve is injured, the insulation allowing for nerve conduction to occur is lost. The injection of Schwann cells helps regenerate the lost insulation around damaged areas.\(^3\) With Schwann cells, growth and function can continue and nerve fibers can be regenerated. The nerves are the path for messages to be sent from the spinal cord, and with regeneration the message paths can be used once again. Translation: there is potential for more mobility and sensory function to return.

Bone marrow stromal cells are found inside the tissue of bones and can be injected into the fluid found around our brain and spinal cord. Clinical trials have found that the injection results in promotion of blood vessel growth.\(^4\) There is an initial loss of blood flow in those with SCI which results in tissue death.\(^3\) The injection of bone marrow stromal cells then can help recreate the communication, or nerve signaling, in injured scarred areas.\(^1\) The injection of bone marrow stromal cells then can help recreate the communication, or nerve signaling, in injured, scarred areas.

Nasal olfactory ensheathing cells can also restore damaged nerves recreating the ability for messages to be sent through these nerves.\(^5\) This is all done from transplanting cells found in the nose into the spinal cord.\(^1\) It is noted from studies that these types of cells work best when the injury was recent.

*For a full list of references please visit SpineRf.org*
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.

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.

Lost Workdays Per Year

290 Million due to the flu

111 Million due to the common cold

70 Million due to allergies

4 Million due to neck & back pain

Sources: Center for Disease Control and Prevention, American Academy of Orthopedic Surgeons, National Institute of Arthritis and Musculoskeletal and Skin Diseases, American College of Rheumatology, National Institute on Aging.
Chances are, if you find yourself flipping through a *Journal of the Spinal Research Foundation*, you or someone you love have been struggling with back pain and its various symptoms for quite some time now. And if you are like most patients when they first walk through the door of a physical therapist’s office, you have already been given so many exercises by various practitioners that you have a stack of papers an inch thick with no idea which ones you should do, so you either….

If you fit in to any of the above-mentioned categories (whether you have had spinal surgery or not), there is a good probability that your pain will continue until your body begins to deviate from its problematic motor patterns (pain postures). Specific strength exercises (i.e. clamshells) can help strengthen weak muscles (gluteal muscles). However, unless you learn how to apply the strength gains to better postural movements (functional exercise), your body will continue to experience pain. When the posture in which you move is at the root of your pain, addressing pain postures before surgery is extremely helpful for a quicker recovery. Returning functional movement to the patient as soon as possible after surgery is equally as important for long term success.

As we age, injuries occur to the spine and other parts of the body (minor and major injuries), causing structures within the body to start breaking down. Whether from injury, weakness, stiffness, or even hypermobility, these assaults slowly start to affect the way we move by causing minor compensations that over time can cause major problems. An understanding and implementation of functional exercise can be very useful in identifying these improper movement patterns and helps correct them through thought-invoking exercises, as well as posture and movement re-training. Without proper re-training of the body and the postures we encounter every day, those same improper patterns you had before surgery can come back to haunt you.

**WHAT IS FUNCTIONAL EXERCISE?**

*Training the body for the activities performed in daily life.*

_Carrie Seifert, CSCS_

_Virginia Therapy and Fitness Center_

Chances are, if you find yourself flipping through a *Journal of the Spinal Research Foundation*, you or someone you love have been struggling with back pain and its various symptoms for quite some time now. And if you are like most patients when they first walk through the door of a physical therapist’s office, you have already been given so many exercises by various practitioners that you have a stack of papers an inch thick with no idea which ones you should do, so you either….

If you fit in to any of the above-mentioned categories (whether you have had spinal surgery or not), there is a good probability that your pain will continue until your body begins to deviate from its problematic motor patterns (pain postures). Specific strength exercises (i.e. clamshells) can help strengthen weak muscles (gluteal muscles). However, unless you learn how to apply the strength gains to better postural movements (functional exercise), your body will continue to experience pain. When the posture in which you move is at the root of your pain, addressing pain postures before surgery is extremely helpful for a quicker recovery. Returning functional movement to the patient as soon as possible after surgery is equally as important for long term success.

As we age, injuries occur to the spine and other parts of the body (minor and major injuries), causing structures within the body to start breaking down. Whether from injury, weakness, stiffness, or even hypermobility, these assaults slowly start to affect the way we move by causing minor compensations that over time can cause major problems. An understanding and implementation of functional exercise can be very useful in identifying these improper movement patterns and helps correct them through thought-invoking exercises, as well as posture and movement re-training. Without proper re-training of the body and the postures we encounter every day, those same improper patterns you had before surgery can come back to haunt you.
To introduce the importance of functional exercise, let’s use an example of a bridge over a bay:

Let’s say there is a bridge, which was constructed perfectly. Every brick, beam, and concrete slab of the bridge was put meticulously into place many years ago, creating a beautifully efficient highway across the bay. But over time, the bridge starts to show signs of aging (much like an aging spine). The ground beneath it (posture) starts to erode slowly, while the heavy traffic offers its own battery of assault from above. Every week, accidents occur (both major and minor), temperatures fluctuate, and storms batter the bridge over the years until eventually there is a need for a traffic halting repair (much like when a patient alters his/her life for surgery). Now, since this bridge is so important to the communities it supports, they bring in the best bridge repair team in the area to fix the structure. After weeks of construction, the bridge looks like new and opens for business. But after a short time passes, the bridge begins to show the same signs of disrepair it had before the massive re-build, only fifty feet from the original repair site. As it turned out, a major item had been overlooked. The erosion of the ground beneath (posture) had not been properly dealt with. The communities were shocked to learn that the erosion repairs were just as important as the structural repairs. And, had they been addressed together from the beginning of the project, they would have produced a much better end result, rather than resulting in an entire re-build again.

This scenario is similar to that of many spinal surgery patients. Without the proper guidance from your medical support team, and coupled with groundwork (posture exercises) being done vigilantly by the patient to support the newly renovated structure, the same structural defects can continue to cause pain down the road. However, with trained professionals helping you along the way and your own hard work on postural retraining and functional exercise, you can break the pain cycle and take control of your recovery and quality of life for years to come. So that leads us to the question at hand…

What is Functional Exercise?

By definition, everyone has the capability to do functional exercise. Just think about your day-to-day life, and you can see where the six basic functions of movement stem from.

These basic human functions can be surprisingly difficult for someone out of touch with his or her neutral posture and suffering from pain. Simple tasks, such as rolling over to get out of bed or even getting out of your car, can trigger painful, yet seemingly unpredictable muscle spasms. The main goal of functional exercise is to produce normal everyday tasks while maintaining a neutral spine. In case you hadn’t heard that term before, neutral spine is a term used to describe a spinal position with no imposed flexion, extension, or rotation. It should also be a posture that every one of us should not only be familiar with, but should be able to recreate, no matter what position we find ourselves in throughout the day. After all, our hips, knees, and ankles are where we were designed to bend from. And while you may not notice when you are bending your back too much, your back is smarter than even you sometimes. If you have no idea what position your spine should be in, then it will start telling you to stop, by way of pain. Slowly, but surely, your spine will start shutting down ranges in movements that it does not feel safe in, and if you to continue not to listen, the pain will shut you down completely. When kept out of proper neutral alignment for too long, surgery becomes a necessity, and learning neutral posture becomes harder to learn, yet still possible.

You see, without the knowledge of where your correct neutral posture should be, it can quickly get lost completely, and the pain postures start shoving their way in, making your daily life miserably restricted.
Examples of Six Basic Function of Movement Exercises & Progressions:

1. Squat Action
   • Level 1: Sitting in a Chair and Standing
   • Level 2: Stationary Squats (shown)
   • Level 3: Squat with Kettlebell
   • Level 4: Side Step Squat

2. Lunge Action
   • Level 1: Stationary Lunge (shown)
   • Level 2: Use a Step and Step Down or Step Up with One Leg for Lunge
   • Level 3: Add Rotation or Use Weight for Resistance

3. Push Action
   • Level 1: Plank with Straight Arms Against Wall
   • Level 2: Plank with Straight Arms on Table
   • Level 3: Plank with Straight Arms on Floor
   • Option at Each Level: Add a Push-Up from Wall, Table, or Floor Plank (shown)

4. Pull Action
   • Pull with Both Arms or Single Arm Rows

5. Twist Action
   • Level 1: Twist while on the Floor (shown)
   • Level 2: Twist while Seated
   • Level 3: Twist while Standing

6. Gait
   Balance
   • Level 1: Single Leg
   • Level 2: Single Leg Eyes Closed
   • Level 3: Single Leg Hops
   Walking Program
   • Progress to Walking Program When Ready
Food for Thought

The following statements make up the majority of our patients’ feelings. Which one do you currently identify with?

**Some back pain sufferers don’t want to do the work in order to get better. Giving into the pain is all they care to do anymore.** Common phrase - “I can’t.”

**Other back pain sufferers work too hard in order to get better. Fighting the pain therefore perpetuates their pain.** Common phrase - “Why won’t the pain stop?”

**A few back pain sufferers do the work, learning to avoid pain. Finding amazing moments of life; they live with less pain.** Common phrase - “That didn’t hurt!”

**The past back pain sufferers did the work, learned to slow down, and move without the pain. Living life to their functionally-fullest, maintaining great spinal health with every step they take.** Common phrase - “I feel better than I ever thought I could.”

Now you know where the six basic functions identified earlier came from and why they should be at the heart of any exercise program you enter into from this point on, whether you are a current spinal patient or hope not to become one. Rather than charging into a trendy, vigorous, training regimen, you should first attempt a supervised, functional training session. Let a trained professional discuss with you the pros and cons of various training philosophies and what impact they may have on your body.

While all these functional exercises are important to everyday life, if they produce any pain during or after your workout, is important to discontinue them and consult a Functional Movement Specialist. They can help you identify and control your pain postures before entering into any future workout routines.

If you or someone you love is dealing with posture-altering pain during every day functions, you should immediately be directed, or direct them towards a facility specifically targeting this type of training. Functional Movement Specialists can help you identify what patterns create your pain, and most importantly, what patterns and postures get rid of your pain. Functional exercise teaches you how to identify your pain patterns, re-train them to be pain-free, and with time spent practicing, the ability to develop the strength and mobility to work within or significantly closer to normal ranges. So yes, functional exercises are safe; however, just as with any new exercise program, you should consult your doctor before getting started. Also keep in mind, any Functional Movement Specialist you trust your spine with should keep open lines of communication with your therapist and/or doctor to maximize your end results.
Lifting at Work

We often cannot avoid lifting, but we can optimize our environment so that when we lift, we use the strongest muscles in our body to stabilize our spine. To lift safely, we should lift straight up and down, no twisting or bending maneuvers. Instead of lifting with our back, we should bend from the hips and knees, then use the leg muscles to come upright. If what needs to be lifted is still too heavy, ask for assistance.

In terms of storage, all heavy items should be stored at waist height to avoid excessive bending and unnatural body alignment to lift that item again in the future.

What is the Best Sitting Position?

There are two options for the best seated position at work. Both begin with the same foundation. Sit with both feet flat on the floor and with hips and knees flexed at approximately 90 degrees. Your chair should not be too short or too tall.

From this foundation, there are two good options for sitting:

Option 1: Sit in a slightly reclined position with lumbar support. There is less pressure on the discs in the lumbar spine with this position than sitting in a very upright, rigid posture. Also, having lumbar support allows the spine to be in a more supported neutral position.

Option 2: Sit balanced at the front of your chair. Many people practice this seated position by using an exercise ball as their chair. The advantage of using an exercise ball is that it requires proper body alignment and core muscle engagement.

You can approximate sitting on an exercise ball by using some of the advice that my old piano instructor gave me when sitting at a piano. He said to sit at the front part of the chair, feet out front with weight equally placed on each foot, with the rib cage slightly elevated to create a well balanced position when getting ready to play.
Additionally, this position can lead to more focus and more work productivity, depending upon the job at hand.

In addition to having a proper sitting position, you should get up every 30 minutes.

Try to stand up and walk around your office every 30 minutes or so, it will make a difference. This practice may actually improve your oxygenation and your thinking on your work. Additionally, doing a couple of deep knee bends can help as well.

How To Do a Deep Knee Bend

Put your feet about shoulder distance apart. Keep your heels on the ground as you slowly bend your knees as though you are going to sit on your chair. Once you get down to where your chair is, touch your seat to the chair and then stand back up. Once you can do this, you can actually start bending even more deeply. It is important to keep your knees apart, heels on the ground, and maintain balance.

Another exercise you can do once or twice an hour would be some simple range of motion exercises for the neck, shoulders, and upper back. Take some gentle deep breaths and imagine a balloon tied to the top of your head, allowing the head to feel lighter and the neck to stretch. In this relaxed position, gently roll your head clockwise and then counter clockwise. Follow this with some shoulder rolls, both forward and backwards, using deep breathing to engage your core to assure that you have good balance in your seated position.

These little breaks for posture, flexibility, standing, and deep knee bends, not only help your circulation, but it can also increase your awareness and focus for work and help decrease your incidence of back pain.

The Proper Position of Computer Monitors and Keyboards

The tools you use at work, such as the computer monitor, keyboard, or mouse, should be in a position in which you can sit and work in good balance. They should not be too low on your lap; they should not be too far forward where you have to reach them; overall they should be positioned to avoid straining.
Similarly, the work screen or computer monitor should be at a position where you are looking slightly down toward the monitor, and no straining up to look at a monitor.

Looking slightly downward takes pressure off of the facet joints and muscles in the back of your neck. It also allows for better overall balance of your head on your neck on your shoulders. If you are chronically looking up at a monitor, not only are the muscles in the back of your neck more tense, but the facets are more constricted and it can lead toward more tightness overall in your neck and upper back. Additionally, this imbalance can then lead toward compensatory changes in how you are actually sitting and can affect your low back as well.

Some people will actually use a standing desk at times at work. A few points for the use of a standing desk include making sure the work surface is still in a good position for use so that you are not reaching either too high or too low to work. Secondly, make sure the surface you are standing on is well supported and not too hard or soft. Thirdly, consider having a small step-up for one foot. You may recall that the bars in the old Wild West would have a brass rail at the bottom of the bar so the cowboys could put one foot up on the rail while they were standing at the bar. This is good ergonomics. It helps take pressure off of the lower back as well. Consider a small step-up for one foot or the other when you are standing at your desk.

In summary, although most of us will have an episode of back pain, many of us can take steps to help decrease the frequency or likelihood of having back pain at work. By making some relatively simple changes to our work environment, it is possible to decrease the incidence of work-related back pain.
1. **Why did you choose your specialization?**

My paternal grandfather was a butcher from Russia. My father was a civil engineer-contractor who built most, if not all of the telephone company buildings in the state of Kentucky. As a physician, what was I to do? It was as if I had to become a surgeon in a specialty that builds and reconstructs the skeletal structure of the people I took care of.

2. **What is your favorite way to stay healthy?**

Don’t explain away a commitment to good health by claiming you’re too busy. That’s bogus! Without being committed to our personal health, you won’t last very long. Remember that you are what you eat, so eat safely and stop when you feel full. Finally, there is always one hour of time every day to exercise, even if it means walking. I look for 90 minutes of walking to think and relax. It seems to work for me!

3. **Why is research in the field important to you?**

Change is inevitable, so why not be a part of and help direct those changes. Research is nothing more that figuring out what works and what doesn’t and using that information to improve ourselves and those around us. Research is just that simple and just that necessary. Since what we do today may be gone tomorrow, why not be a direct part of what is coming and help make it happen. It isn’t boring, but actually pretty fun to be a part of.

---

David P. Rouben, MD

Specialization: Orthopedic Spine Surgeon

Practice: Norton Spine Specialists – Rouben & Casnellie
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.

These centers offer the best quality spinal health care while focusing on research programs designed to advance spinal treatments and techniques.

**Allegheny Brain and Spine Surgeon**
James P. Burke, MD, PhD
Altoona, PA

**Atlanta Brain and Spine Care**
Regis W. Haid Jr., MD
Atlanta, GA

**Desert Institute for Spine Care**
Christopher A. Yeung, MD, Anthony T. Yeung, MD, Justin S. Field, MD, Nima Salari, MD
Phoenix, AZ

**Colorado Comprehensive Spine Institute**
George A. Frey, MD
Englewood, CO

**The Hughston Clinic**
J. Kenneth Burkus, MD
Columbus, GA

**Indiana Spine Group**
Rick C. Sasso, MD
Carmel, IN
INova Health System

INova Research Center
Zobair M. Younossi, MD, MPH
Falls Church, VA

Midwest Orthopaedic Center
Patrick T. O’Leary, MD, Daniel S. Mulconrey, MD
Peoria, IL

MUSC Darby Children’s Research Institute
Inderjit Singh, PhD
Charleston, SC

New England Neurosurgical Associates, LLC
Christopher H. Comey, MD
Springfield, MA

Norton Spine Specialists-Rouben & Casnellie
David P. Rouben, MD
Louisville, KY

Oregon Neurosurgery Specialists
Robert J. Hacker, MD, Andrea Halliday, MD
Springfield, OR

The Orthopaedic and Sports Medicine Center
Gerard J. Girasole, MD
Trumbull, CT

The Orthopedic Center of St. Louis
Matthew F. Gornet, MD
Chesterfield, MO

Princeton Brain and Spine Care
Mark R. McLaughlin, MD, FACS, Nirav K. Shah, MD, FACS
Langhorne, PA

Rutgers University
Department of Biomedical Engineering
Noshir A. Langrana, PhD, PE
Piscataway, NJ

South Coast Orthopaedic Associates
Aleksandar Curcin, MD, MBA
Coos Bay, OR

Southern Brain and Spine
Najeeb M. Thomas, MD
Metairie, LA

Spine Clinic of Los Angeles
Larry T. Khoo, MD
Los Angeles, CA

Spine Colorado
Jim A. Youssef, MD, Douglas G. Orndorff, MD
Durango, CO
SpineCare Medical Group
Paul J. Slosar, Jr., MD
Daly City, CA

Stanford
University
Menlo Medical Clinic
Allan Mishra, MD
Menlo Park, CA

Twin Cities Spine Center
James D. Schwender, MD
Minneapolis, MN

University of Minnesota Medical Center, Fairview
David W. Polly, Jr., MD
Minneapolis, MN

Virginia Spine Institute
Thomas C. Schuler, MD, FACS, Brian R. Subach, MD, FACS
Reston, VA

Virginia Therapy & Fitness Center
Richard A. Banton, PT, DPT, OCS, CMPT, ATC, E. Larry Grine, PT, MSPT, ATC, CSCS
Reston, VA
RESEARCH
EDUCATION
& PATIENT
ADVOCACY

SPINERF.ORG