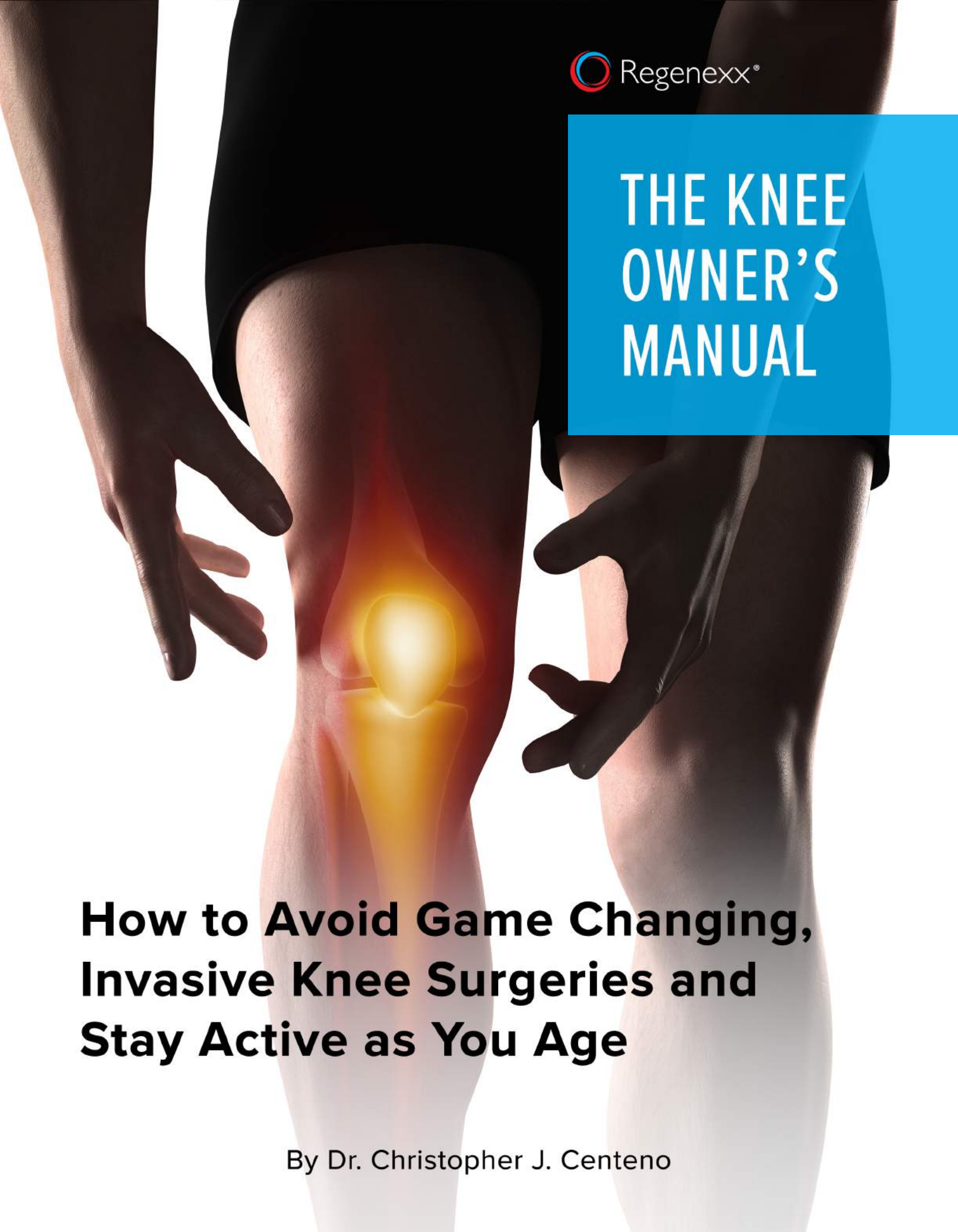

Regenexx®

THE KNEE OWNER'S MANUAL

How to Avoid Game Changing, Invasive Knee Surgeries and Stay Active as You Age

By Dr. Christopher J. Centeno

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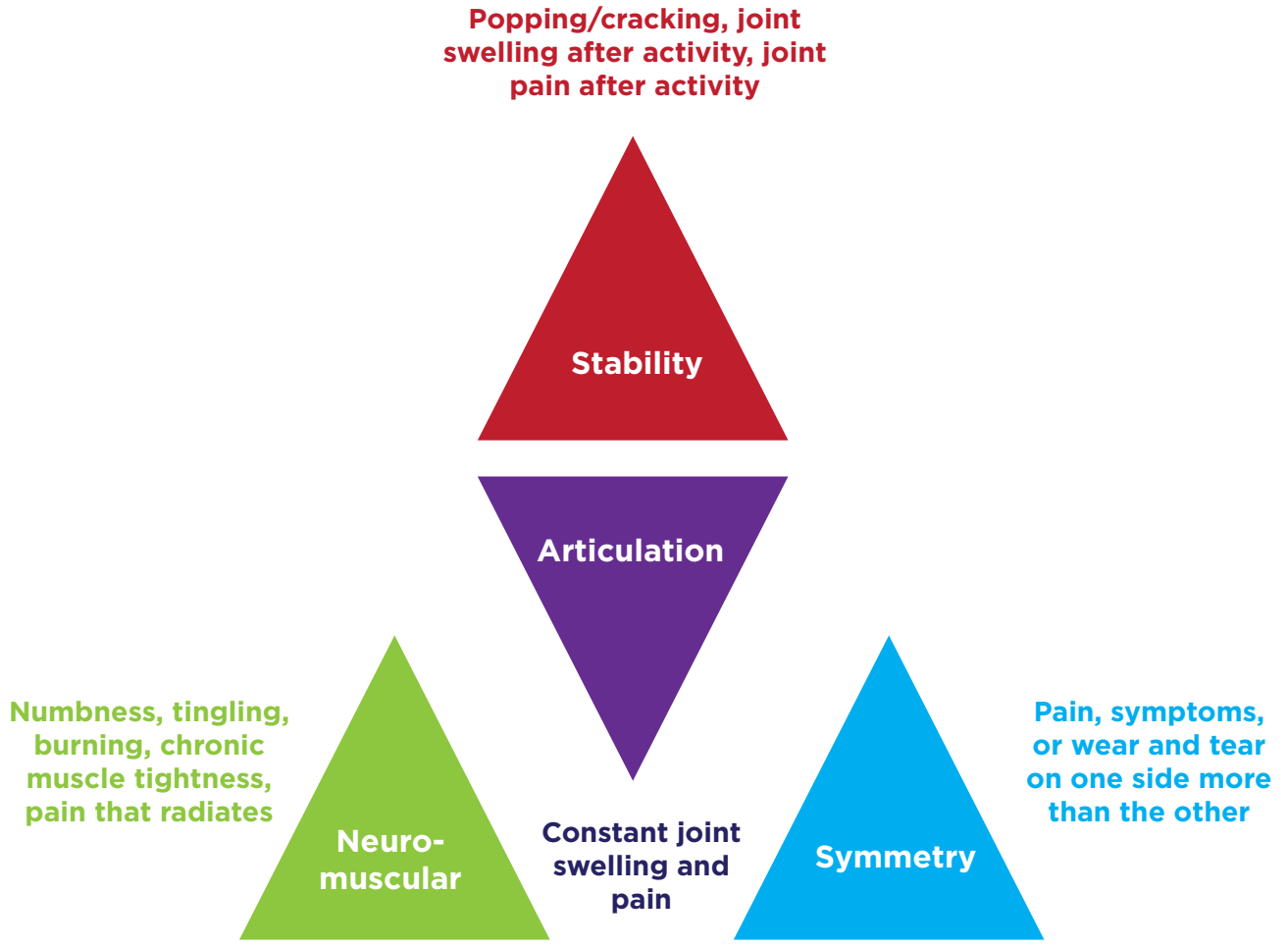
Introduction



First, this book and its big brother (Orthopedics 2.0) is part of a two-decade quest to find what I have termed the "Unified Field Theory." Physicists have long sought a single "theory of everything" that ties together all other theories into one grand explanation of the universe. I've sought to do the same for the knee and the entire musculoskeletal system. Many theories abound about how to diagnose and treat knee problems. Orthopedic surgeons have a surgical approach, family-practice and sports-medicine practitioners another conservative approach, chiropractors their own alternative approach, and physical therapists yet another. Within chiropractic, physical therapy, and alternative medicine, there are literally hundreds of wholly different theories about what's wrong with the knee and how best to address these problems. Having studied many of these, I always found a kernel of truth and some interconnection between them. As the research in this area has become more robust in the past 20 years, many of these concepts can now be vetted by scientific observation rather than intuitive guesses.

This book contains my own theories based on several decades of reading and observation and offers a way to organize that information for both doctors and patients. The reader should note that while many of the components of this new theory are supported by rigorous scientific research, the whole package as I present it hasn't been studied using what doctors call "level-I evidence." This type of medical evidence means that randomized controlled trials have been performed and the treatment approach has been found to be effective. Having said that, most of what we do today for patients with knee problems is not supported by level-I evidence. This includes joint arthroscopy, meniscus surgery, ligament repairs, arthroscopic and surgical debridement, chiropractic adjustments, acupuncture, massage, and most of all physical therapy. These surgical and nonsurgical approaches all lack the type of rigorous scientific support (level-I evidence) that shows they are effective. In fact, when some of these procedures have been studied in controlled trials, they have often been shown to be no better than placebo surgery or no surgery. For example knee meniscus surgeries and arthroscopic knee debridement is the most recent procedure shown to have no benefit.

This is an Internet book that instead of being about fifty to one hundred pages long is really several thousand pages long. How is that accomplished? The science behind many of these concepts would create an unwieldy publication that would be too difficult for patients to read and follow. By publishing this book on the Internet, I can easily hyperlink to in-depth blog posts, scientific abstracts, and other references so the reader can delve deeper into any subject or simply read the basic explanations. In addition, my goal is to allow patients to submit questions and feedback so the book can be updated and improved. Making this book better is as simple as clicking a link. To submit questions or ask for clarification on any part of this book, send an e-mail to the author by clicking here.

What is Orthopedics 2.0? In particular, Orthopedics 2.0 doesn't refer to the discipline of orthopedic surgery or its successor. While orthopedic surgery may well be used as a part of Orthopedics 2.0, Orthopedics 2.0 has a bigger focus beyond just fixing one part of the knee. We focus on each part of the knee as it is interconnected to the whole.

While the focus of this book is nonsurgical, there will always be situations where the best approach is surgical. What will likely occur over the next one to two decades is a slow and steady movement toward less-invasive orthopedic-type procedures. What we call "interventional orthopedics." This is identical to what's occurred in other areas of medicine, such as cardiology with fewer more-invasive open-heart surgeries and more X-ray–guided catheter procedures.

Interventional orthopedics represents the shift from knee salvage to repair. When the focus shifts to repair, the amount one needs to know increases exponentially. The pyramid at the beginning of the introduction outlines what we use to evaluate the knee. While I use stem cells in daily practice, it's important to note that helping patients is often not as simple as injecting magic stem cells. This book details the system our clinics use to decide which procedures and therapies to apply.

The problem with repairing the knee is its complexity. Think about your car. You know there are critical components to keep it running. The wheels should be aligned or the car won't go straight and the tires will wear unevenly. The connections between the wheels, the axle, the drive shaft, and the engine must be flexible and allow fluid movement. The engine, as it turns the drive shaft, has to be well oiled. As the engine cranks up to even faster speeds, the connections had better be stable or the whole thing will fly apart. Finally, your engine has miles of wiring and small computers on board to monitor the whole thing and to regulate the activity of the engine, brakes, gasoline usage, and monitoring systems.

Now think about your knee: its bones, joints, muscles, tendons, ligaments, and nerves. The same principles of alignment, good joint connections, stability, and sound wiring (nerves and minicomputers that impact everything from the timing of muscle firing to the information about joint position) apply. Regrettably, our surgical approach, to date, has too often just focused on bringing the car into the shop to replace a few worn parts or shave them down so they fit a little better, but it has not considered how the parts got that way.

Let's look at that analogy now as it applies to a person. If a 40- or 50-something-year-old patient who runs every day is suddenly diagnosed with right-knee arthritis, shouldn't we ask ourselves why only the right knee was impacted? Could it be that for years the right knee was getting worn down due to poor alignment? We'd all accept this premise at face value; a misaligned front wheel and axle could cause the right front tire to wear faster than the left. Yet for some reason, our medical-care system often ignores why one joint wore out faster. The reason: if the plan is to replace the joint, who cares? What if we wanted to save the joint? Would it matter more? Absolutely! This is the reason for the Ortho 2.0 approach and this book. When the shift is moved from replacement to repair, it matters how the joint got that way, if the joint is stable, if the surrounding muscles are firing correctly to protect the joint, whether the alignment is correct to support a healthy joint, and if the wiring is in order.

While stem cells are a great advance and represent a cutting-edge tool, their use without considering these other things doesn't get patients where they want to be, which is having a knee they can count on for many years to come. In this book, we'll look at all of the parts of the Orthopedics 2.0 paradigm listed above or, as my partner coined the term, **SANS**. This stands for stability, articulation, neuromuscular, and symmetry. Sans in Latin means "without"; hence, the focus of this book is to leave you sans pain.

Why Traditional Injection and Surgically Based Knee Care Needs a Serious Upgrade

If you're reading this book, you've likely been offered traditional injection-based or surgical care for your knee. You may have even tried some injections or had a surgery or two and weren't satisfied with the results. Maybe you're just exploring all your options before you pull the trigger on these or other therapies. Let's explore why many of these traditional options that your insurance will cover have big issues.

Before we get into how the knee is structured in more detail, I'll review this sophisticated and complex joint here a bit for the purposes of this discussion. The knee joint is formed where the bottom of the femur (the upper-leg bone) and the top of the tibia (the lower-leg bone) meet. They are connected via ligaments: the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL). The patella (the kneecap) covers the front of the joint. The knee joint has cartilage that covers the end of the leg bones and cushions the joint. The meniscus is an added shock absorber that helps to protect the cartilage.

Pain in the knee can be caused by arthritis, ligament or meniscus tears, injuries and so on. To complicate matters, knee pain may not be caused by the knee at all—it could be coming from an issue in the lower back, such as a pinched nerve or injured disc, or an issue in the hip or irritated muscles in the leg.

Now that we have that out of the way, let's review what's not quite right about some of the things traditional doctors have offered you for knee pain:

• **Narcotics:** These powerful medications can help with pain, and thanks to aggressive physician marketing by big pharma, we have a real epidemic on our hands. These drugs went from being barely prescribed to being routinely handed out in ever-increasing doses to patients with chronic pain. The problem? Recent research shows that they create more pain in the long run by rewiring your central nervous system.

• **Steroid Injections:** Steroid anti-inflammatories are powerful drugs at suppressing swelling. They are very commonly injected into knees that have arthritis and they generally work for a few weeks to months to relieve pain. Many recent studies would argue that routinely using these drugs is a bad medical practice that should be stopped. The issue is that while the high-dose steroids can relieve swelling, this medication type causes the local cells to become dysfunctional and die off. There's also the little problem of these medications markedly increasing the risk of fractures in older women.

• **Knee Meniscectomy:** A meniscus surgery (a.k.a. partial meniscectomy) is typically performed for a torn meniscus. However, the problems are twofold. First, meniscus tears are very common in middle-aged or older people without any knee pain. So just because your knee began hurting and an MRI was taken doesn't mean that this tear is causing pain and that your knee should be operated on. Second, multiple high-level studies have shown these surgeries don't work! Why? Removing parts of a meniscus is not a smart idea, despite the fact that a multi-billion dollar medical industry has thrived on the outdated concept. This is not only because the meniscus is an important cushion protecting the knee, but also because we should be adding cells to the knee, not removing them!

• **ACL Repair:** The anterior cruciate ligament (ACL) provides front-back and rotational stability to the knee and is commonly injured in sports. The concept behind surgically replacing the ACL (a.k.a. ACL reconstruction) is that with a torn ligament, the knee is unstable. This instability can lead to arthritis, so the idea is that by surgically replacing the ACL, we're reducing the likelihood that the knee will get arthritic. However, the research supporting knee ACL surgery for a tear is weak at best. If the athlete can avoid the surgery, there seems to be little difference in arthritis rates, meaning the surgery clearly doesn't protect the knee. In addition, based on the research we have now, return to play in the first year is faster without the surgery. Another problem is that the fake ligament goes in at too steep an angle and isn't able to stabilize the knee like the original equipment. Because of all of this, retear rates are very high, with athletes being six times more likely to retear the same or the opposite ACL. This is likely because the new ligament has none of the same fine-tuning position sensors of the original. Finally, the rehab time until full play can be six months to a year.

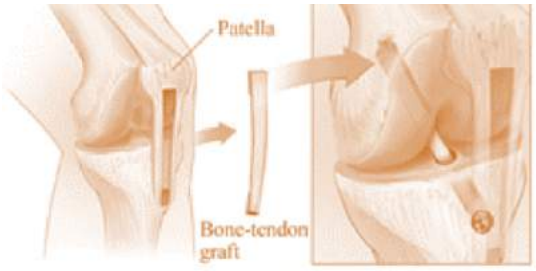
• **Knee Replacement:** The main reason you might make the drastic decision to undergo an amputation of the knee joint and insertion of a prosthesis (a.k.a. knee replacement) is to relieve your chronic knee pain, but many patients still have chronic pain after this very invasive surgery. I've shared many studies over the years that show you shouldn't count on a knee replacement to relieve your knee pain. While a few patients who get this surgery really need it, don't opt for this surgery just because steroid injections can't help your pain, as more-advanced solutions will be discussed in this book. What are the risks of cutting out a joint? A dramatic rise in heart attack and stroke risk, wear particles from the joint prosthesis, and toxic metal levels in the bloodstream.

The days of receiving injections of toxic substances and invasive surgeries are now over for the vast majority of patients with knee problems. Read on to find better ways to help. In the meantime, it's important that you learn how your knee works by understanding about stability, the joints, the nerves and muscles, and the symmetry of it all.

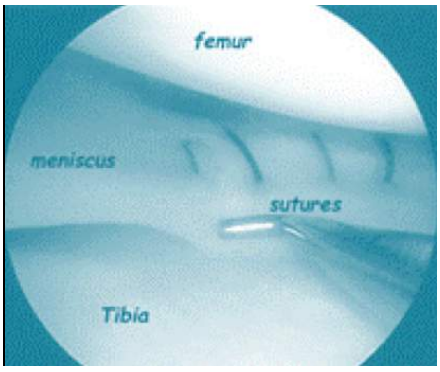
Is There a Better Way? Interventional Orthopedics and Its Approach in the Knee

Let's take a look at a movement in medicine that builds off of the SANS system as a whole (covered extensively in my book *Orthopedics 2.0*)—Interventional Orthopedics. This approach is different from traditional surgical orthopedics. So let's look at some of those differences as they relate to the knee.

Knee Replacement vs. Stem Cells: The surgical approach is to amputate the knee joint and insert an artificial joint. The interventional approach? Many knee joints with arthritis are unstable, so the physician places injections in the ligaments that need to be tightened to produce a more stable and better functioning joint. With a high degree of skill, using guidance, the stem cells are then placed into the portions of the joint that need help. Can this work? Our treatment registry data suggests that it helps many patients.



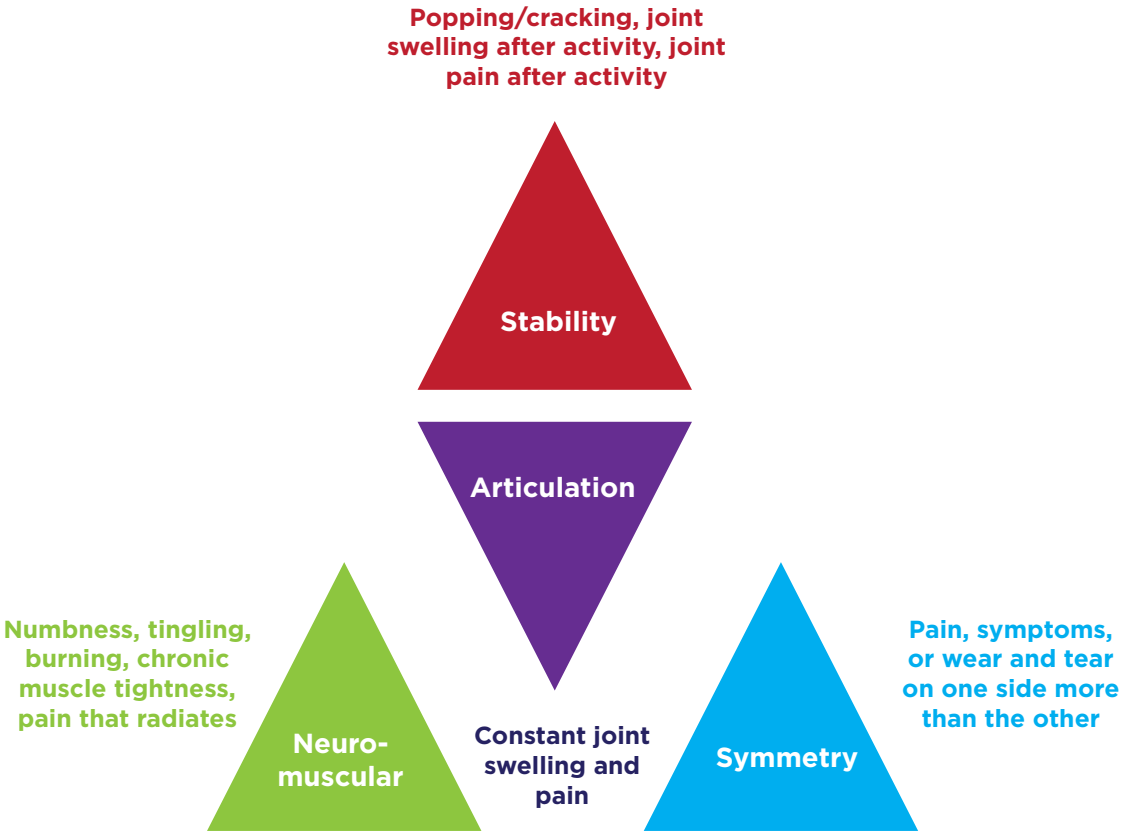
Anterior Cruciate Ligament (ACL) Tears: The surgical approach is to remove a torn ACL and install a copy. The interventional approach? Use the MRI image to map the location of the tear, and then use real-time X-ray to place a needle into the tear. Place stem cells into the tear to heal the area. The rehab time to full activity can be as little as a few weeks to two to three months.



Knee Meniscus Tears: The surgical approach to a partial meniscectomy is to remove parts of a torn meniscus to try and relieve pain. The interventional approach? First, treat any lax ligaments that may have also been injured but are often overlooked. Next, carefully map the location of the tears using ultrasound imaging, and inject platelets or stem cells (depending on the severity of the tears) into these specific sites. Recovery is quicker because no surgery is done and nothing is removed.

Other Ligament Injuries: Other ligament injuries in the knee are common, such as injuries to the MCL (medial collateral ligament). Many patients get surgery for these ligament tears, but in our experience about 70% of these aren't necessary as they can be healed through precise ultrasound-guided injection of highly concentrated platelets or stem cells. Other ligaments, such as the LCL and PCL, can also be treated without surgery.

Introduction to SANS



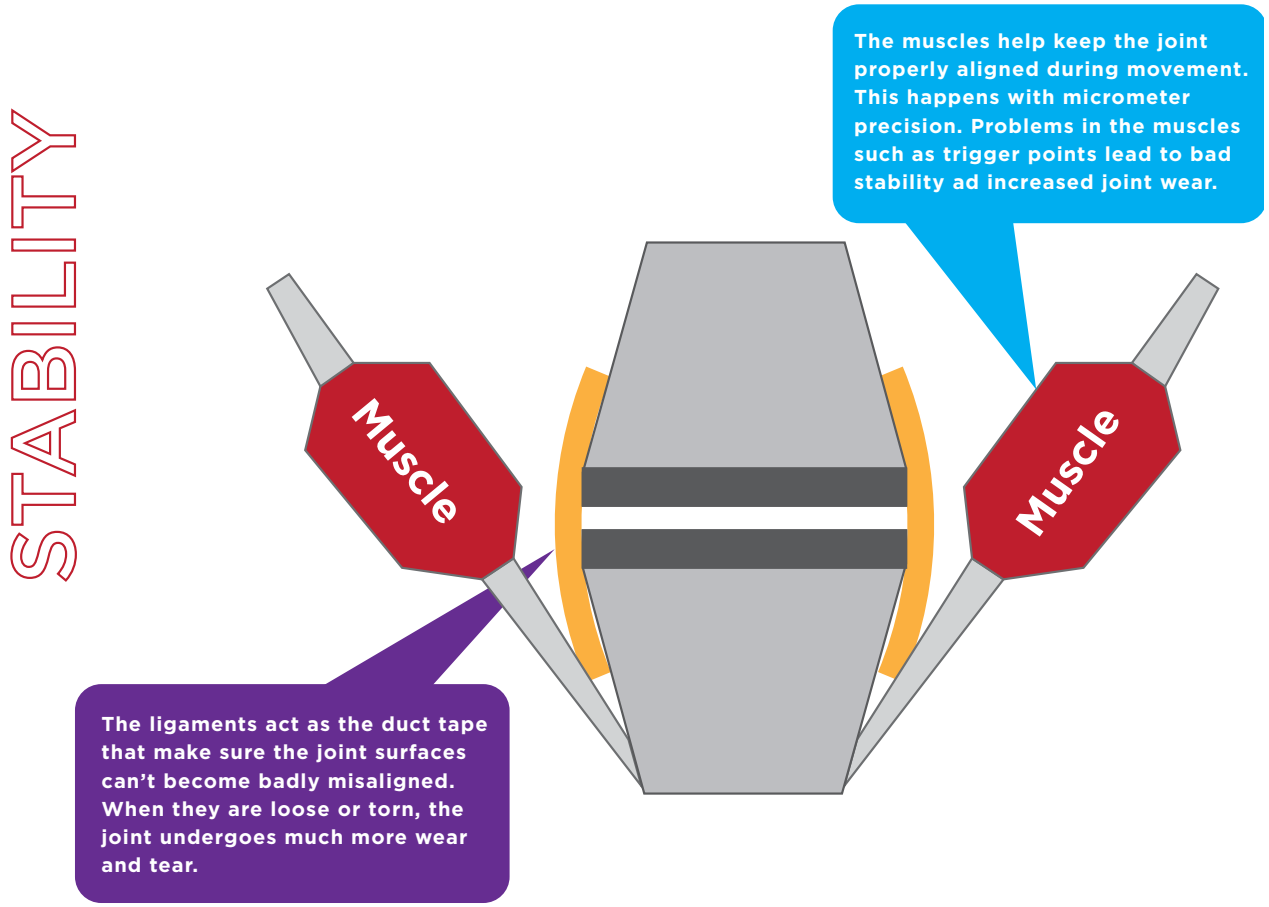
This book is designed so that if you read the next few pages, you'll have the gist of the message. The book is also rich in infographics—diagrams that allow you to use pictures and text to better understand the content. Finally, the pages that follow this section describe the concepts in more detail. **So if you're really busy, start here and end here for now. Read the rest later.**

The SANS concept breaks your pain problem into its root causes in four areas: stability, articulation (joint), neuromuscular, and symmetry.

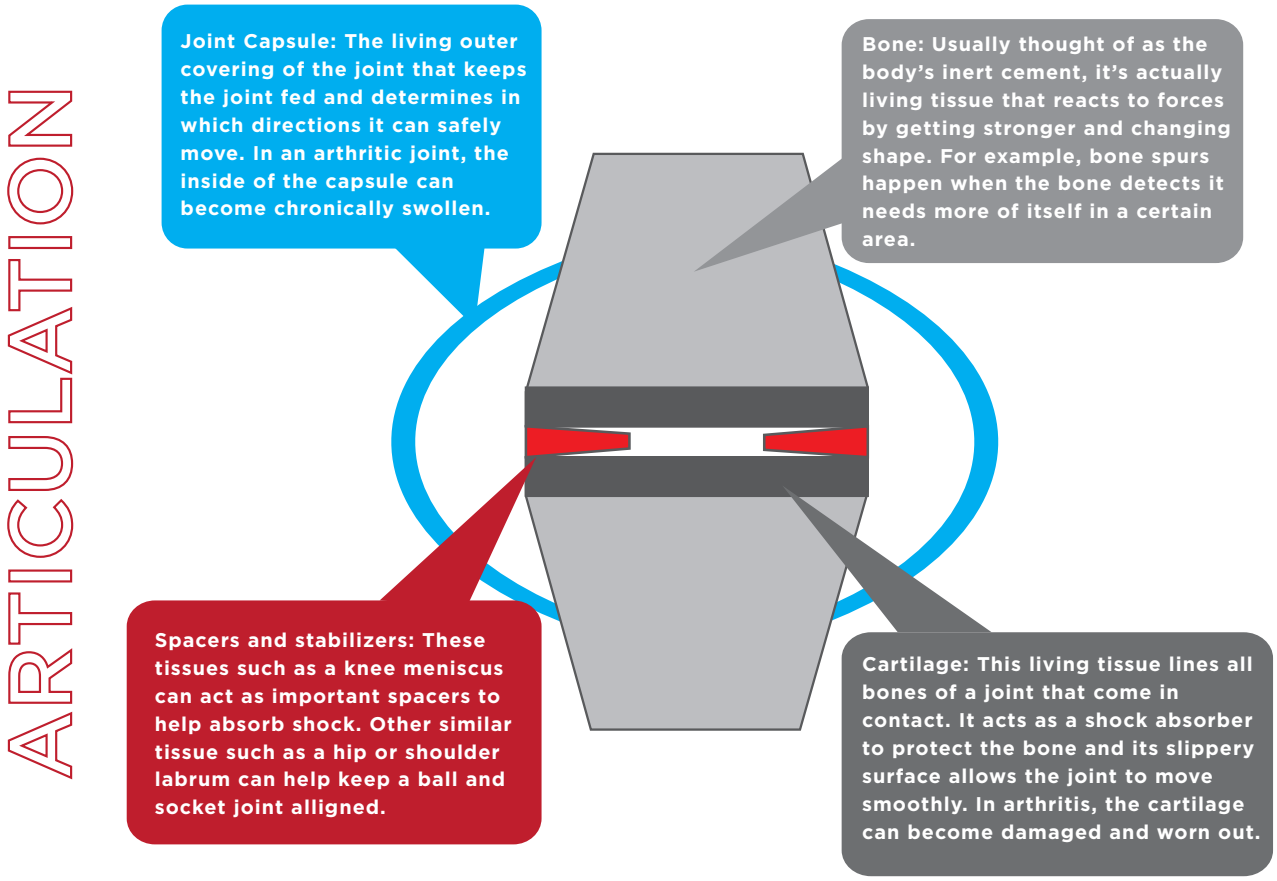
If you have chronic pain of almost any type, from knee arthritis to nerve pain and sciatica, you will be forever at its mercy if you don't understand its four parts. If you understand these, however, you can take control. So pay attention!

Stability: Your knee is made up of individual structures that precisely fit together to form a complex and sophisticated joint, one of the largest in the body. This, by its very nature, can lead to a mess if one of those structures becomes unstable.

Your knee and other joints may have small amounts of extra motion that is literally slowly destroying them. The real shocker is that many highly trained physicians and surgeons will likely never tell you about this instability, nor do many understand it themselves. More concerning is that it can generally be fixed with a few simple injections or exercises.



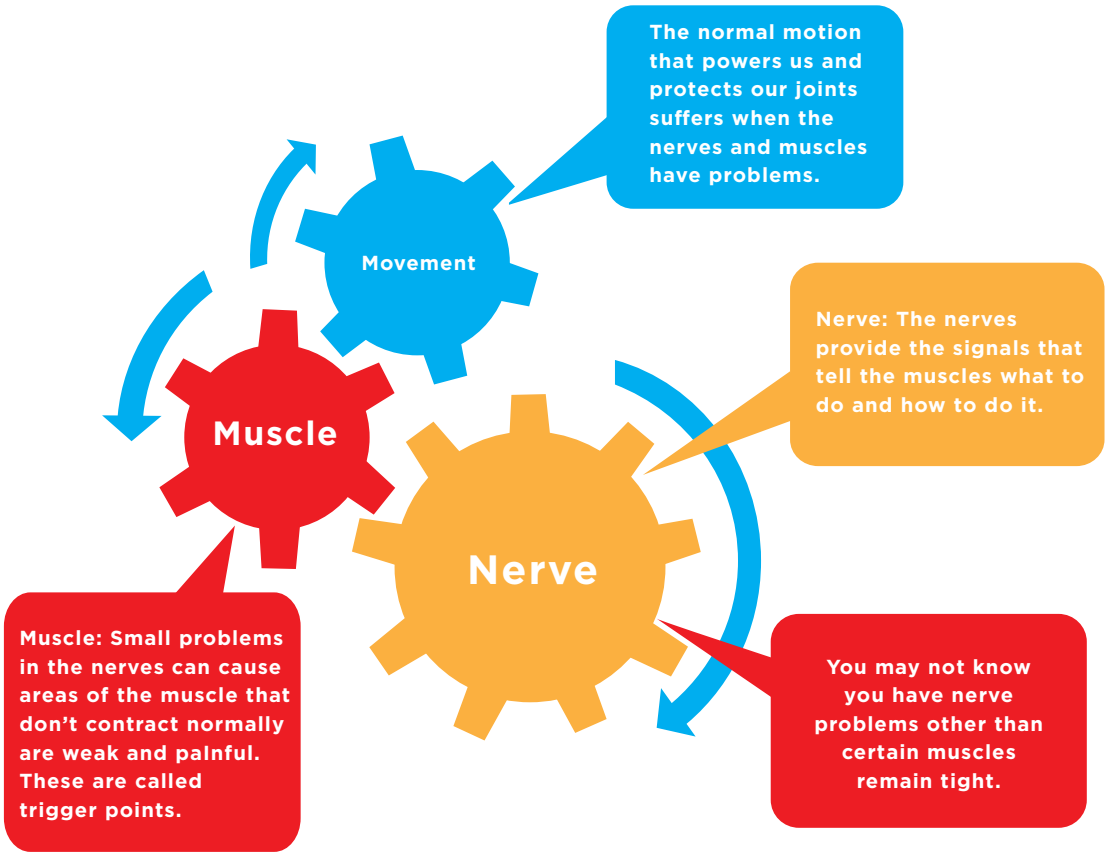
Stability means a joint that moves with the surfaces in general alignment, all the time. Ligaments are the living "duct tape" that prevents the joint from catastrophic failure. Your body also needs to make sure that the parts of the knee joint don't give too much when you stress the knee. Examples include when you walk fast, run, cut (the rapid lateral moves common in sports and exercise), or lift weights. On the other hand, muscles provide the slight adjustments that keep the joint surfaces in very precise alignment as you move. In the leg, the muscles fire in a symphony of movement with millisecond timing and micrometer precision to make all of this happen in the knee. How do you know if you have a problem with instability? You may or may not feel your joint popping and cracking—this tends to happen when the instability is severe. Instead you may have pain or stiffness after activity. If you don't feel these things, your joint may be more stable, but it may have more subtle problems that lead to a more rapid progression of arthritis. Click on the infographic labeled "Stability" to learn more.



Articulation: This is a fancy word for joint. Your joints allow movement in very specific ways. Your knee has a different pattern of possible motion from your shoulder, which is still different from your ankle. A joint is generally made of two bones that come together and are cushioned by cartilage and by a spacer or guiding tissue (for example, a meniscus in the knee or a labrum in the hip). A joint is also surrounded by a tough leathery covering called a joint capsule and is further reinforced by ligaments. If you want to stay active as you age, you need to learn more about the status of your joints, as healthy joints are required for maximum activity.

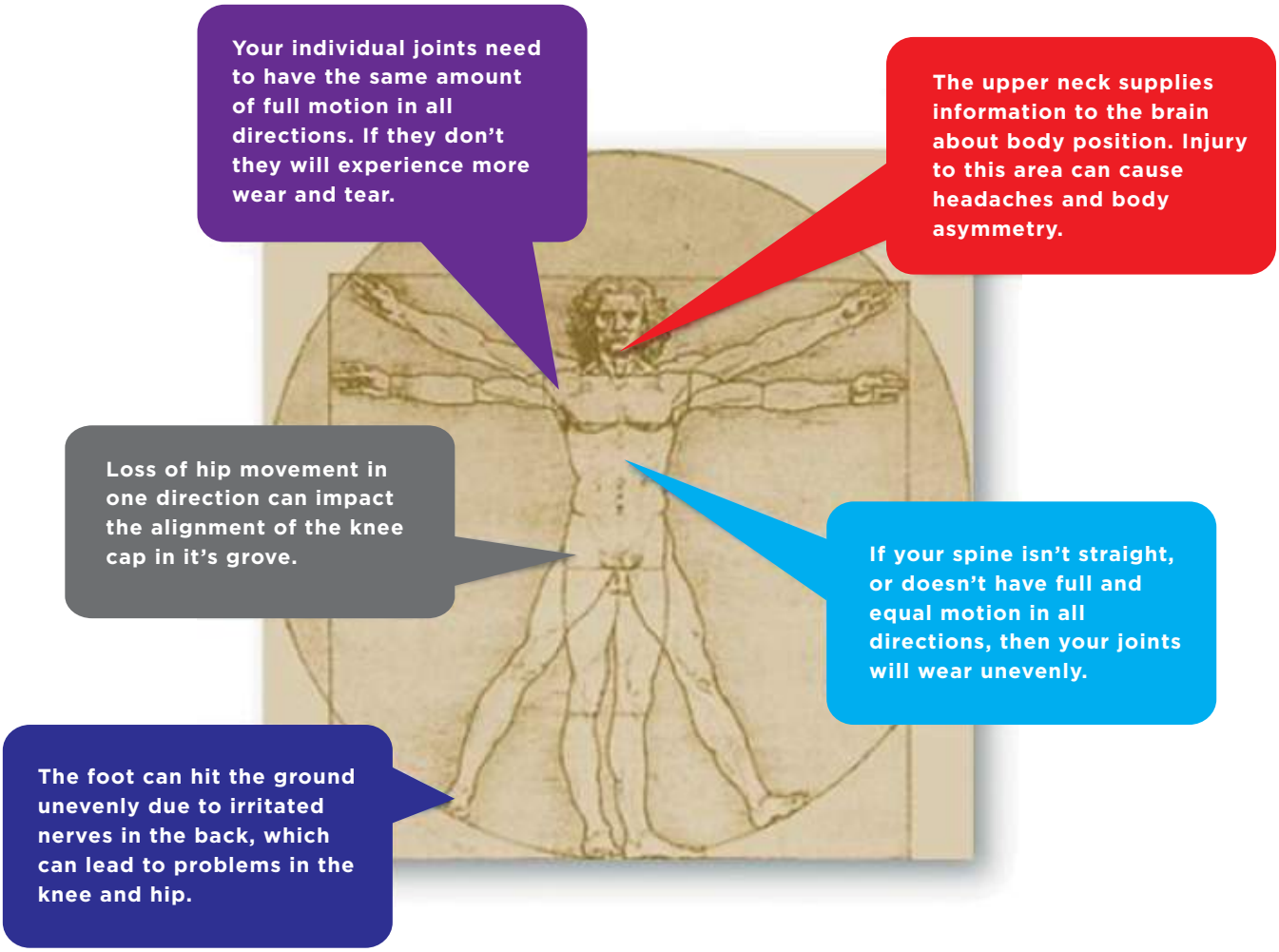
Everything you do injures your joints a little bit. The million-dollar question is whether they're able to keep up and repair the damage. Stem cells live in all our joints and are like little repairmen. As we age, there are less of these repairmen, so at some point, wear and tear can exceed the ability of the joint to repair itself and arthritis begins. Many physicians have begun to supplement this repair capability using various technologies, including stem cells. Click on the infographic labeled "Articulation" to learn more about your joints.

NEUROMUSCULAR



Neuromuscular: Your nerves drive your muscles, yet this fact seems lost on much of medicine today. We'd all accept that when the nerves are severed, muscles die (think Christopher Reeve's spinal cord injury that led to his severe muscle atrophy). Yet what happens when smaller amounts of nerve irritation are present? If you have a chronically tight or weak muscle in your arm or leg, you might not think it's due to an irritated nerve, especially one in your neck or back, but it may be. When the muscles are impacted, they develop tight and weak knots known as trigger points. All the muscle strengthening in the world won't help a muscle when it has lots of these trigger points. They need to be cleaned out before the muscle can work normally. Click on the infographic labeled "Neuromuscular" to learn more.

SYMMETRY



Symmetry: Why does one knee get arthritis and not the other? Sometimes these things are due to prior injury and sometimes to lack of symmetry. Our bodies are built to work well only when both sides are exactly like the other. When one of our joints loses normal motion, you can bet other parts will be impacted. When one leg is shorter or one ankle turns in more, again certain parts, including the knee, will wear out faster. Given how important left-right and front-back symmetry is, it's amazing more attention isn't paid to the problem. In order to get well, you must try to reestablish as much normal symmetry as possible. Click on the infographic labeled "Symmetry" to learn more.

In order to understand why you have chronic knee pain and how best to get rid of it, you must understand and deal with all issues in the SANS system. You must address any instability issues, problems with your joints, and irritated nerves and muscle trigger points, and, finally, you must get your body as symmetrical as possible. This book is a companion book to *Orthopedics 2.0* and will explain the Orthopedics 2.0 approach as it relates specifically to the knee and the Regenexx procedures that can help address knee issues.

Getting Personal: Why Should I Care About SANS?

While **everyone wants a quick fix**, what I hope to teach you in this book is that getting back to where you used to be is first about choosing the right technology to help and second about fixing all of the associated problems, like weakness in muscles, asymmetry, or poor stability that got you there in the first place. That may take some time beyond a magic-bullet shot or surgery. Here are some examples of quick fixes that don't work and some solutions.

Some doctor told me all I needed was a magic injection of fat, amniotic, placental, umbilical cord, or fetal stem cells and my knee would be fixed.

How is that supposed to work? Are these even the right kinds of stem cells? What are the right kinds of stem cells?

See these quick links:
"Amniotic stem cells" (a.k.a fetal or placental) have become an epic case of widespread consumer fraud.

Fat stem cells aren't as good as bone marrow stem cells at helping orthopedic problems.

I have pain in my knee(s), and my doctor said it's due to arthritis.

How did my knee get this way? It didn't just happen by itself. Was it an injury? Why can someone else get the same injury and not get arthritis? Can I slow down arthritis? Why does someone get it in the first place? Is there something I can do to prevent other joints from getting it? Is the pain in my knee really even due to a knee issue?

See these quick links:
Knee surgery for arthritis doesn't work.
What can I do to preserve cartilage?
Why your ACL ligament may be loose and you don't know it...
3 Signs It Could Be Your Back Causing Your Knee Pain

I have a torn or frayed ligament, tendon, or meniscus.

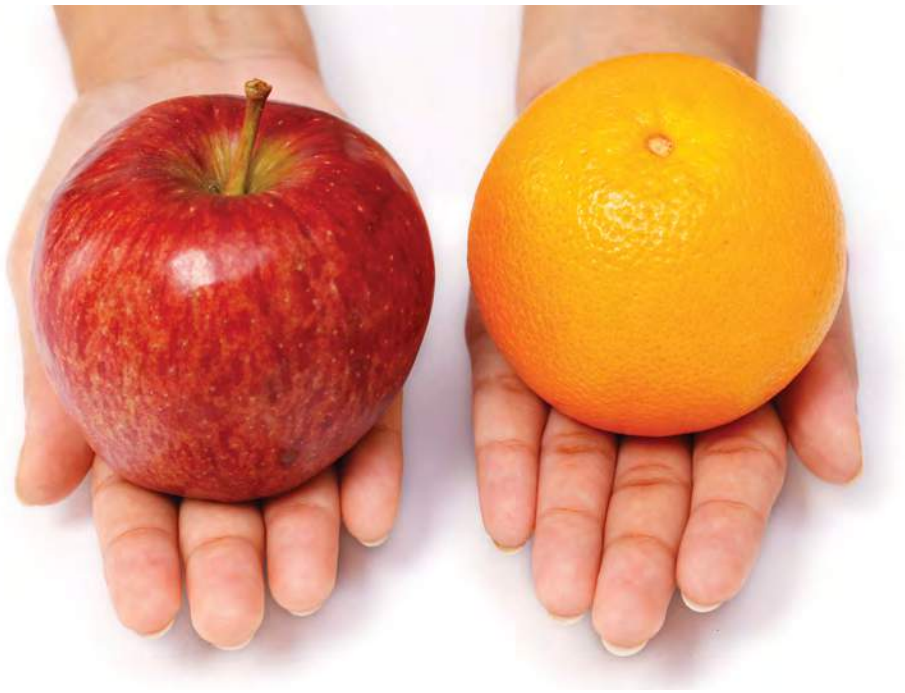
If the tear was due to an injury, why did just that tendon tear? If not, what caused the tear? Why didn't it heal? Can I prevent other structures from tearing? Can it be fixed without surgery? Is surgery even a good idea?

See these quick links:

Is a knee meniscus tear causing my pain, or does everyone my age have meniscus tears?

Should I Have Meniscus Surgery? No

Chapter 1: The Regenexx Difference



When we first pioneered orthopedic stem cell therapy for knees in 2005, we were the only physicians in the world doing this type of work. This last few years have seen a bevy of clinics opening and offering stem cell therapies for pretty much whatever ails you—from arthritis to ALS to COPD to MS. A few of these clinics are legitimately trying to do a good job, but most are not. How can you tell the difference? First, let's look at the clinic types that are popping up.

1. The Miracle-Fat-Stem-Cell Clinic: These types of clinics using stromal vascular fraction (SVF) fat as their source of stem cells offer treatments for a multitude of diseases, which include knee and hip arthritis. They perform a small liposuction to get cells, and as such are usually run by a plastic surgeon who oversees a processing facility that distributes cells to other medical specialists. Some claim to be operating research studies, but when I have investigated these further, most of this is more sales than reality (e.g., one clinic system claimed to have an Institutional Review Board [IRB] research approval that turned out to have been rescinded). Unlike Regenexx, who has published large amounts of registry-based data, these clinics don't ever seem to get around to getting research published.

In addition, on the orthopedic side of the treatments, these are usually blind, nonspecific injections (without any guidance to ensure placement) somewhere in the vicinity of the painful joint. They frequently will combine these local injections with an IV infusion of fat stem cells, 97% of which will end up in the lungs and never see the joint. As you know from the previous discussion, fat stem cells don't work as well as bone marrow cells for orthopedic purposes, so the orthopedic side of the business seems to be an afterthought to drive revenue.

2. The Little-Bedside-Machine Clinic: These clinics are often more focused on orthopedic problems, but they use an automated bedside "one size fits all" machine to process bone marrow cells and platelet rich plasma. Some of these clinics do offer guidance of the injection, but very little effort is placed on tracking patients or reporting outcome data. So the type of treatment registry data that you've read about here isn't going to be reported by these clinics, leaving the patient to fly blind on how well these procedures work or don't work.

These machines also produce about one-tenth to one-fifteenth of the stem cells per unit volume as a Regenexx-SD procedure (based on our lab studies). They also only isolate one fraction in the bone marrow that contains stem cells and discard the other fraction (not knowing that it has valuable cells).

3. The Magic Fetal-Stem-Cell Scam. This is a new phenomenon. Here we often see chiropractors, naturopaths, or acupuncturists hire a nurse practitioner to perform a blind injection of what they believe to be stem cells derived from fetal tissues, including amniotic and umbilical cord sources. You may also see legitimate interventional pain-management clinics or orthopedic surgeons use this stuff as well. The scam occurs when these providers tell patients that these are stem cell injections, despite nonprofit lab testing showing that these products have no living stem cells!

So what are the key components of a reputable clinic?

A. Treatment-registry tracking of patients
B. Guidance of the injection
C. A focus on orthopedic problems
D. Candidacy grading
E. Published research
F. A customized approach to the processing of your tissue
G. Dosing
H. A clinical training and certification program for affiliates

Treatment-Registry Tracking of Patients
Any new therapy that is standard of care needs to have data collected, even if it looks very promising from the standpoint of patient experience (e.g., a doctor says it has worked well in other patients). This means that standardized questionnaires are sent to the patients at set time points to see if they have less pain, more function, or had any complications with the procedure. This is a huge commitment on the part of the clinic and the doctor.

As an example, right now we use a nonprofit that has a clinical research organization (CRO) quality, customized software to assist us in collecting data on the patients we have treated. They have multiple full-time employees to collect data. Regenexx employs a full-time biostatistician to analyze this data. When we want to report the data, we

must enlist the help of expensive physicians to call patients who haven't responded to their questionnaires as this helps to make sure we have enough data to report. While we have a full-time biostatistician, we must also use more expensive doctor time to help our biostatistician decide what's clinically meaningful to analyze. Most importantly, we transparently report our registry data online so that everyone can pull up a real-time extract (updated monthly) of the patient results in our registry.

How can you tell if a clinic is doing this? They will have data from their patients that they have collected and reported, usually on an annual basis. Why is it important to see that clinic's data? A procedure like this may produce very different results in a different doctor's hands. In addition, the clinic will be able to tell you exactly how it collects its data, who collects it, how often, and so on. For example, a proper treatment registry collects data at set time points like one month, three months, six months, one year, two years, three years, and so on. If all you get is a call from a nurse, like you would after any common surgery, then this isn't nearly enough.

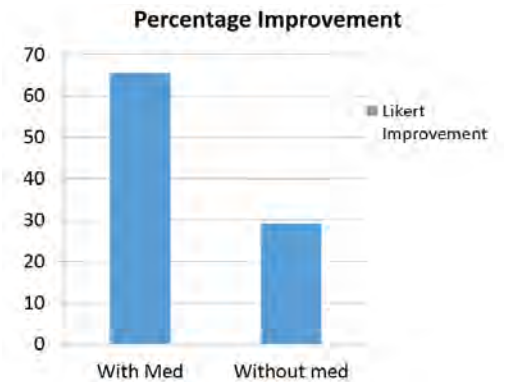
Guidance of the Injection

How we deliver stem cells as part of interventional orthopedics makes a big difference. While delivery into an arm vein (IV) is attractive because of the low level of expertise needed to deliver cells, studies have consistently shown that adult stem cells delivered in this fashion are trapped in the lungs (pulmonary first-pass effect). Of even more concern is a recent study showing that for patients considering the use of stem cells to treat central nervous system (CNS) disorders, only about 1 in 200,000 cells injected via an IV route reaches the brain and central nervous system (1.5–3.7% made it past the lungs, 0.295% made it to the carotid artery, and 0.0005% made it past the blood-brain barrier into the brain).

At this point, until these pulmonary first-pass issues are worked out, credible stem cell delivery is local. This means placing cells directly into the tissue or into the arterial circulation that directly supplies the tissue. In addition, based on our clinical experience, for orthopedic applications (and likely for others), it's hyperlocal, meaning that placement of cells into one part of the joint may provide results; whereas, nonspecific placement in the joint may provide fewer results. This means imaging guidance to place cells into joints is very important.

What does imaging guidance look like? The doctor will use either ultrasound or real-time X-ray (a.k.a. C-arm fluoroscopy) to direct the needle to a specific area. This is not something that the average family doctor or even orthopedic surgeon knows how to do. In fact, it requires additional training that can take months to years to master. The video here explains the differences between a simple joint injection and the type of precise placement that doctors who are experienced in interventional orthopedics can perform.

A Focus on Orthopedic Problems



Figuring out how to maximize the effects of stem cells is critical. Let me give you some examples. Early on in our experience, we added in the use of a billionth of a gram of a common medication based on many research papers showing that it helped stem cells create more cartilage. We then had a natural experiment where we were able to compare patients who didn't have their cells exposed to this very low-dose medication versus those who did. The graph to the left shows how much better the patients who got the medication did, and as a result, this medication became a standard part of our protocol. This is just one example of how little things about how stem cell procedures are performed can make big differences.

At Regenexx we have many patents that cover our proprietary procedure. All of these are specific tweaks to improve the ability of our procedure to help patients. Thus, it's not credible for a clinic to offer therapies for 10 different diseases that have little to do with each other. Credible clinics focus in on one or two body systems and perfect their treatment protocols. This is why we've kept our hyperfocus only on orthopedics and why we continue to do the basic science needed to improve our treatments. For a short video break, click on the Regenexx video link below.

Candidacy Grading

There is no medical procedure available (including stem cells) where all patients are great candidates and expected to do well. For over a decade, we have been offering stem cell treatments, and during that time we have graded patients with regard to candidacy. These good, fair, or poor candidate grades have literally dissuaded hundreds of patients who were considered less-than-stellar candidates from undergoing the procedure.

Several years ago, after we had enough outcome data on the Regenexx-C cultured procedure, we lifted those grades as the statistical analysis didn't show that more-severe arthritis patients did any worse than patients with mild arthritis. However, we kept them in place for the Regenexx-SD procedure as the literature on platelet rich plasma did show that while PRP worked well in mild arthritis, it often failed in patients with moderate and severe arthritis. In addition, the same holds true for knee microfracture. Again, we turned away hundreds of patients because adopting a conservative candidacy system was the right thing to do.

In 2012, our first registry analysis of Regenexx-SD showed that these candidate grades roughly followed the outcome (patients then considered "poor" candidates with severe arthritis generally had less robust outcomes than those who were "good" candidates with mild arthritis). So we continued to try to convince many patients with more-severe arthritis not to undergo the procedure.

In late 2013, we again ran the data with more knee cases in our registry. Interestingly, as the numbers of patients being tracked increased, the association between severe arthritis and poor outcome didn't hold up, meaning that the severe-arthritis patients who chose to do the procedure anyway had about the same outcome as the mild-arthritis patients. So after many years of turning away hundreds of patients, we now feel comfortable in the statement that the Regenexx-SD patented knee stem cell procedure and its three-part treatment process works as well in severe-arthritis patients as it does in mild-arthritis patients.

So ask the clinic about your candidacy. Is it good, fair, or poor, and why? Is anyone considered a poor candidate? For example, I can tell you that based on our existing registry data, if you have hip arthritis and are over the age of 55, you're less likely to do as well as someone who is younger. However, this doesn't apply to knee arthritis.

Published Research

In any new procedure, research should be published as the data becomes mature enough. We have always prided ourselves in submitting our data to peer-reviewed journals for publication. This takes an immense amount of work as any single publication often goes back and forth for months to a year before it's in a form that will appease reviewers. So ask if the clinic's providers have research that they've published. Be careful here as this is a prime area for bait and switch; I've seen clinic websites that show research that has nothing to do with the stem cell type or procedure the clinic is using. For example, showing research done by someone else on bone-marrow-isolated mesenchymal stem cells when the clinic actually uses fat stromal vascular fraction (an apples-to-oranges comparison). Ask the following: *Where is your data on what you do? Where can I find publications with your name on them?* Ninety-nine percent of the time, you'll find that the clinic has no such data.

A Customized Approach to the Processing of Your Tissue
Every patient is unique, yet many clinics use automated one-size-fits-all machines to process tissue because the capital and time investment is less. Most of these machines treat every sample as if it were the same, yet every sample is really quite different. Hence what comes out of the machine is often not processed based on the individual characteristics of that tissue, so the stem cell yields are compromised. In addition, for bone marrow, all commercially available machines on the market today discard valuable stem cells that the Regenexx-SD procedure retains. Ask the clinic providers if they process your tissue by hand or if they use a small bedside machine that will treat you like a number rather than an individual.

Dosing
The fact is that almost all clinics have no idea how many cells they're injecting into your knee. Why? The automated bedside machines they use have no ability to count the number of cells. In no other area of medicine would this be appropriate; however, somehow in stem cell treatments, it's the norm.

We published research several years ago that demonstrated that in knee arthritis patients, we needed a minimum of 400 million total cells in the sample to help the patient achieve the best outcome. Thus, every Regenexx clinic counts the cells and determines their viability (the percentage that are alive). This helps us advise patients as to whether they have enough cells to do one, two, or more joints. In this regard, every other clinic is literally flying blind.

A Clinical Training and Certification Program for Affiliates
There's a saying in medical training: "See one, do one, teach one." Regrettably, it refers to the practice of physicians often having very little experience or training before working on patients. The stem cell "wild wild west" exemplifies this problem.

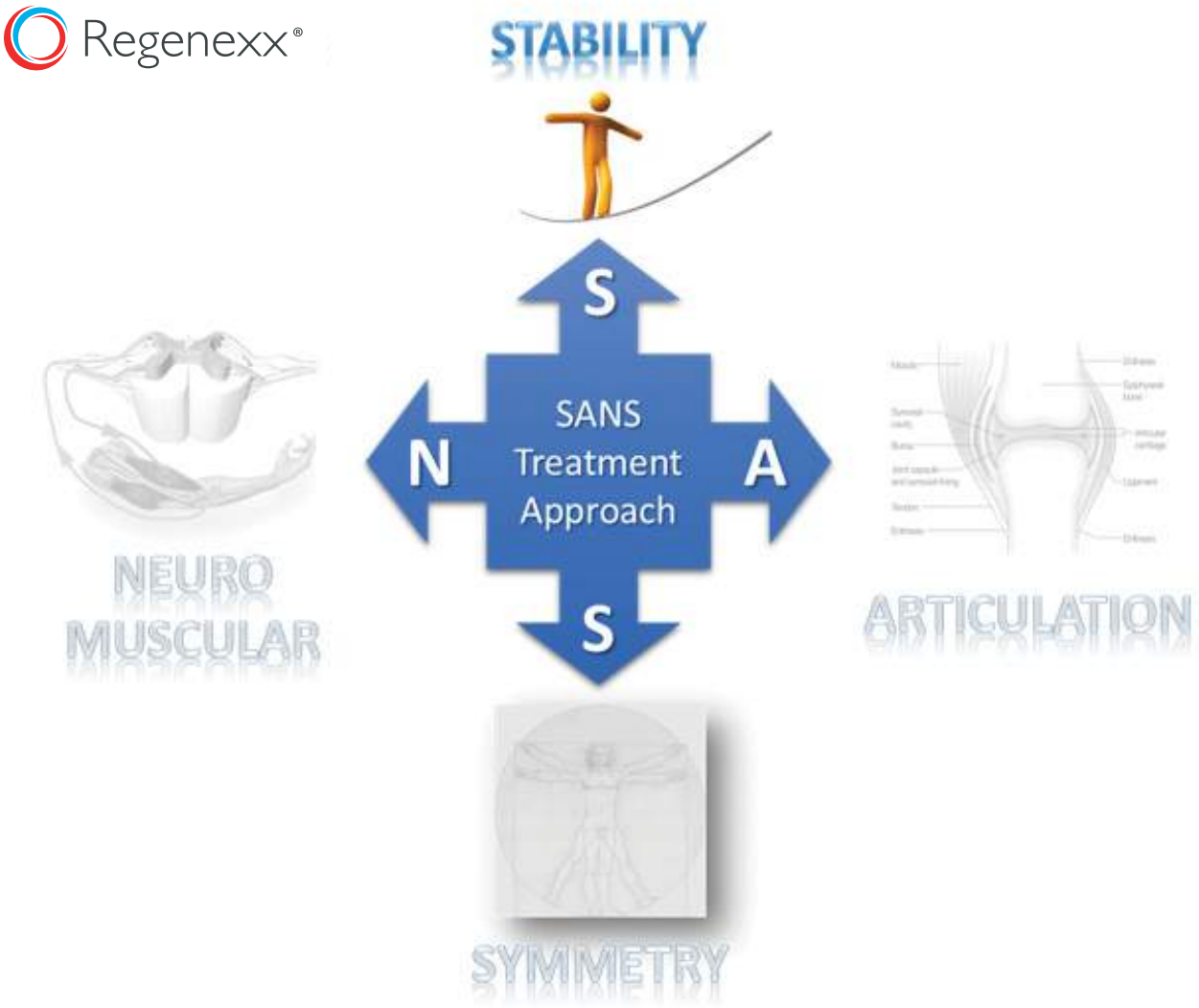
Let me give you a real-world example. A few years back, I met a physician at a conference who was using bone marrow stem cells. He was describing his cell harvest technique from the back of the hip and mentioned that he took 100 cc of bone marrow from one site. I stopped him and asked who had taught him to do it that way? It turns out that a physician who visited our clinic (and was never trained by us) in 2007 had taught him this was the correct method. In fact, what that physician had seen was us taking six to eight much smaller volume samples because our own research and that of others had shown this increased the number of stem cells in the sample. The doctor who had visited simply didn't know why we were taking so much time to get so many samples, and the doctor simplified the technique to a single high-volume sample. In the process, he also dramatically reduced the number of stem cells. He then went out and taught this inappropriately modified technique to hundreds of physicians!

As a result, the Regenexx Network of physicians, whom we have officially trained, is the only stem cell provider network in the world with an extensive and mandatory clinical-training program. This is highly structured course-work that is taught in part through a nonprofit and in part by Regenexx.

First, rather than taking any willing provider, we turn down about 8 to 9 in 10 physicians who want to join, because they don't have the right skills to practice interventional orthopedics. Second, the few providers who we do accept are extensively trained in a **core-skills checklist** of procedures they must know. In addition, treatment of any area (e.g., shoulder) has both a didactic education and hands-on demonstration of skills in a cadaver lab.

Regenexx Network physicians use the platelet procedures (Regenexx-PL and Regenexx-SCP) and same-day stem cell procedures (Regenexx-SD) and have in-house processing labs so they can customize the tissue processing to meet the needs of your sample. They also are part of our treatment registry. This means the outcomes we report include our own data plus the results obtained by our network providers.

Chapter 2: Stability



"In all of Shakespeare's plays, no matter what tragic events occur, no matter what rises and falls, we return to stability in the end."
Charlton Heston

What does it mean to be stable? Stable in a mechanical sense means resistance to falling apart or falling down. For your body, joint stability is a very big deal, yet you likely haven't been told the whole story. You see, you've only been told about a very unstable knee that requires surgery to fix a completely torn and retracted ligament. Yet it's the instability you don't know about that could be **slowly frying** your knee joints, one movement at a time. Discovering which ligaments are loose, causing this kind of instability, called subfailure, may save you from a knee replacement.

What is subfailure instability, and how do you know if you have it? Subfailure instability means that the surfaces of the joint aren't kept in exact proper alignment during movement. Why is this important? When the knee surfaces uncontrollably crash into one another or even just can't be kept in perfect alignment, the knee wears down much faster. An unstable part of the joint literally experiences many times the wear and tear of a stable joint, and bone spurs form. Since stability in many joints is the number one determinant of whether that joint will have a long happy life or become "old" before its time, it's a wonder more time isn't spent assessing this component of joint health.

Let's slice and dice joint stability a little further by separating the type you've heard of and that is usually easily diagnosed from the type that will slowly destroy your joints and will likely never get diagnosed. There are two major types of instability: surgical and subfailure. Surgical instability is less common than its more prevalent cousin—subfailure instability. However, surgical instability is usually the only type that the orthopedic establishment treats. This means that a knee, for example, is very unstable and unable to hold itself together at all. In these cases, surgery is often needed to stabilize the joint. Examples would be a completely torn and retracted ACL in the knee. A true surgically unstable knee may need a new cadaver or artificial ACL implanted through surgery, but, regrettably, the new ACL will go in at the wrong angle and will likely cause more problems down the road.

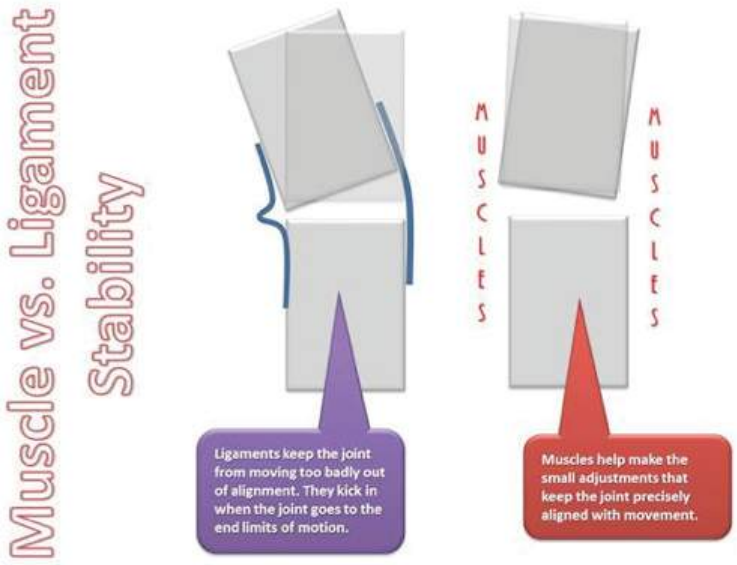
Subfailure means that the ligament hasn't completely failed (torn apart like a rubber band) but instead it's only partially torn, degenerated, or just loose. This much more common type of instability often doesn't require surgery and is characterized by small extra motions in the joint just beyond the normal range. In fact, if you have this type of instability, you likely aren't aware you have this problem.

Our understanding of subfailure instability is younger and more immature, so while we have some diagnostic tests to detect this type of instability, our understanding of what is normal and abnormal is only now coming into focus. However, this type of instability is quite real, and it's a clear and long-term insidious drag on joint health. A good example of this is the research showing that replacing an ACL in the knee will lead to earlier and more significant arthritis in that knee joint. Why? While surgeons take great care to make sure the replaced ligament is identical to the torn one, there is no way to ensure the replacement ACL has exactly the same specs as the original. The new ligament can be too

tight or too loose or may simply not have the identical load-bearing characteristics of the original equipment. This can lead to small amounts of extra motion or compression in the wrong directions, which can slowly damage the joint.

More on Subfailure: It's All About Your Ligaments and Your Muscles

There are two types of subfailure instability: ligament and muscular. Passive ligament stability keeps our joints from getting badly misaligned. Think of ligaments as the living duct tape that holds our joints together. An example would be an ACL in the knee, which keeps the tibia bone from sliding forward under the femur bone. Without this ligament, every step would cause the joint to experience a potentially damaging shift. On the other hand, active muscular stability is made up of the firing of muscles that help keep the joint aligned as we move and represents the stability fine-tuning system. In this case, the quadriceps and hamstrings muscles help provide a second layer of stability.

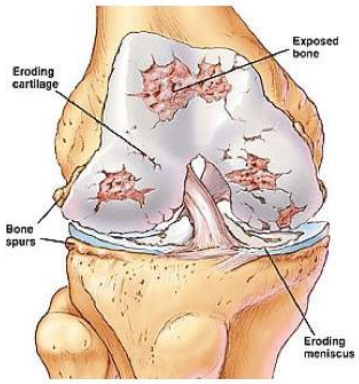


So how does this second later of muscular stability work? Our joints tend to want to slip slightly out of alignment as they bend, twist, or slide, even with intact ligaments. As this happens, signals are sent to selective muscles that surround the joint so that they adjust and correct the alignment. Without this active system, our joints would be "sloppy." This muscle firing is a muscular symphony, with microsecond precision being the difference between the poetry of beautiful joint movement and an asynchronous chorus of potentially damaging "joint noise." The muscles provide the fine tuning. They act as constant stabilizers for the knee, keeping it in good alignment while we move

This small area where the knee must stay to prevent damage as we move is called the "neutral zone." This means the area of alignment between the joint surfaces that nature intended.

So in summary, stability is about both muscles and ligaments. Our muscles provide constant input to the knee to keep its alignment fine-tuned as we move. When the knee moves too much, the ligaments act as the last defense to prevent joint damage from excessive motion. Think for a second about what would happen if the muscles didn't work

in microsecond precision to keep your knees perfectly aligned? What would happen if the ligaments didn't check excessive motion when the knee went a little too far? Both things are recipes for sudden disaster or for slowly damaging the knee one movement at a time! This last bit is called microinstability. What's that?



Microinstability: A Constant Drag on Joint Health

It's important to note that most subfailure instability might not be felt by you as the joint giving too much in the wrong direction—in fact, smaller movements may be happening without your knowledge. These small amounts of extra motion are called microinstability, and while any one or ten events might not lead to injury, they can have a big impact as thousands of small insults add up over long periods of time. Even an extra millimeter of motion, when repeated 10,000 times, can damage a joint. As a result, often the best way to look for these small amounts of extra motion is by having a good physical exam by a physician trained to look for these small amounts of extra motion. The American Association of Orthopaedic Medicine is a good place to find such physicians. This group provides educational seminars for doctors interested in treating instability with injection therapy.

Knee Ligaments

• Anterior Cruciate Ligament (ACL): The important front-back stabilizer in the middle of the knee joint. This ligament is often lax but rarely gets noticed because it's not the type of "torn in half" injury that needs surgical removal and replacement. When it's loose, it leads to more wear-and-tear type arthritis.

• Medial Collateral Ligament (MCL): This is an often-injured inside-of-the-knee ligament. Injuries occur when someone is tackled from the side, such as by a football player or a dog. It takes a long time to heal, and in our experience, even after it stops hurting, it's often still lax. When it's lax, it can cause the inside meniscus (shock absorber) to move in and out of the joint resulting in wear-and-tear damage to the meniscus. This can cause pain on the inside of the knee.

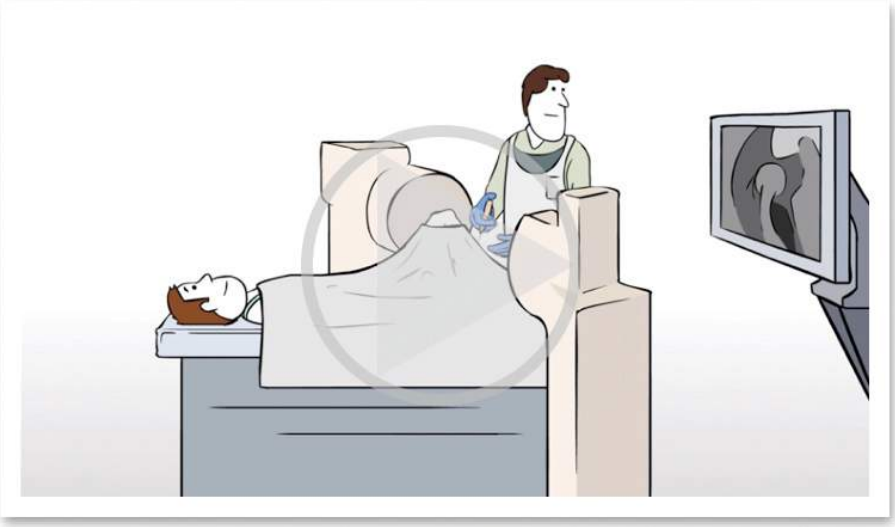
• Lateral Collateral Ligament (LCL): This is the ligament on the outside of the knee that's linked into complex fascia that go from the outside of the hip to below the knee. Thus, patients with lax LCLs often feel pain from the outside of the hip to below the knee. When it's lax, it can also cause the outside meniscus to be yanked in and out of the joint, leading to wear-and-tear damage to the lateral meniscus.

• Posterior Cruciate Ligament (PCL): This is the ligament on the inside of the knee that prevents it from being overextended. When it's damaged, the knee can extend too much and the structures in the front of the knee can get pinched (like the front parts of the meniscus). This laxity again often goes unnoticed by physicians.

• Anterior Lateral Ligament (ALL): This is a newly discovered ligament that is on the outside-front of the knee and is often injured when the ACL is torn or injured. It helps to stabilize the knee in rotation and is one reason many researchers think that knee ACL replacement surgeries may be unsuccessful.

An Example of the Kind of Ligament Damage That Can Be Treated with a Needle
There are three types of damaged ligaments: partial tears, complete non-retracted tears, and complete retracted tears. The best way to conceptualize these tears is by using a big rubber band. Our piece of stretchy rubber can have small tears within it or a tear that doesn't go all the way through: in a ligament, these are examples of partial tears. Next up in severity is a complete tear where the rubber band is badly mangled in one area and there are small tears that go all the way through the structure, but the band still holds itself together: in a ligament, this is called a complete non retracted tear as our band hasn't snapped back into two halves. Finally, there is a complete tear where the two halves snap back: in ligaments, this is called a *complete retracted tear.*

Now consider the ACL as an example. The ACL is a major stabilizer of the knee, and tears of the ligament are common sports injuries. The ACL can have a partial tear where only some fibers are broken but much of the ligament remains intact. It can also have a complete tear without retraction (an area of light color on the MRI, but the ligament hasn't snapped back like a rubber band). Finally, it can have a complete tear with retraction where the ligament fails completely and does snap back like a rubber band. In our clinical experience, a partial tear, a complete non retracted tear, and even a tear with a small amount of retraction can generally be treated via placing stem cells into the tear under very precise X-ray guidance. A complete retracted tear requires surgery. Despite this, we still see many patients getting their ACLs surgically ripped out and replaced with an inferior ligament. To learn more about how we treat torn ligaments, like the ACL, with stem cells, click on the video link below:



To see how precise this injection needs to be to help heal the ACL tear, check out the video below:

Why Can't Strong Muscles Substitute for a Bad Ligament-Stability System?
If your knee has one or more loose ligaments, maybe you can just get stronger by doing lots of physical therapy and that will suffice. After all, can't the muscles just substitute for the loose ligaments? As discussed, there are two types of stability systems, the fine-tuning is provided by the muscles while the ligaments prevent serious abnormal movements that can lead to catastrophic knee damage. If the ligaments are stretched out a little bit, but still intact, the muscles may be able to substitute and protect the knee in most situations. However, if the ligaments are stretched or damaged so that they allow bigger abnormal motions in the joint, no amount of muscular stability will help. In the end, while having stronger stability muscles may help reduce some of the wear and tear, the knee will still get into abnormal alignments that will lead to accumulated damage. So if ligaments are stretched, it's best to tighten them, and this can often be done without surgery though rarely, if they're completely torn and retracted, the only option may be surgery.

How Do I Know if I Have a Knee-Stability Problem, and What Can I Do to Help It?
How do you know if you have a knee-stability problem? Patients often complain of popping or cracking in the knee. They may at times feel sudden shifts in the knee. For example, when performing cutting exercises, they may feel their knee "give way." In other patients, there may be no perceptible sense of instability or popping/cracking in the joint, just knee pain or swelling after activity. These patients usually have smaller amounts of microinstability.

Take this short quiz to see if this section applies to you. If you answer any question with a yes, you may have a knee stability problem.

1. My knee gets very sore or swollen after I exercise. Y N
2. I hear cracking/popping in my knee when I do certain activities. Y N
3. My knee feels like it's loose or moves too much. Y N

Regenexx Simple Muscular Stability Tests

When you get evaluated using the SANS system, these are the quick and simple physical exam tests that will determine if you have good or poor stability in the core and leg. Knee pain, for example, can actually be caused by a spinal issue rather than a knee issue, so this tests all areas. **If you have pain with any of these movements, make sure that you pay attention to the rest of these chapters.**

We expect our patients to be participants in their own recovery, so we want them to take this test on a monthly basis when being treated. If you're a Regenexx patient, before your first evaluation, please take the test, print out the work sheet, and bring it to your first evaluation. If you were given a physical book, you can find the work sheet in Appendix A. If you're not a patient, you can take the test and use the work sheet to record where you are at any given time (click here for a printer-friendly link to the work sheet).

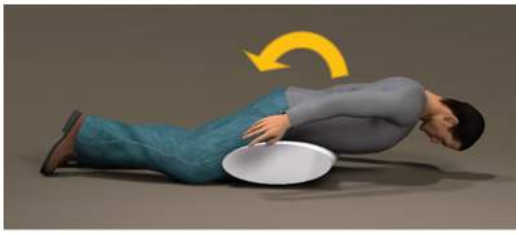
Caution! These tests may cause injury or exacerbate the conditions of patients who have a more fragile stability system or who are at a lower level in their stability. Please do not attempt these if you get injured easily. If you do decide to perform this assessment, if you get significant pain during any given test, stop immediately. You are performing these tests at your own risk.

Core—Abdominals: There are two stability tests for the lower back, both pioneered by a Japanese researcher. The first is a simple sit-up maneuver where you begin by lying faceup and bringing your hips and knees to a 90-degree position as shown. Make sure you keep your neck flexed. Set a timer and hold this position. The normal time for men is 182 seconds (3 minutes), and for women it's 85 seconds (1.5 minutes). **If you experience significant pain with this maneuver, stop**! If you have a lot of pain with this maneuver, you may have a disc-pain issue as flexion places more pressure on the disc.

Lie on your back with your hips and knees both at 90 degrees and lift your torso off the ground. Time how long you can hold this position.

Scoring: Write down your timed score.

Core—Low-Back Extensors: The next test starts with lying facedown on the floor and placing a firm pillow under your stomach with your hands at your side. The pillow should be firm enough or doubled up so that you can extend your back and lift your chest off the floor as shown. Your neck should remain flexed. Set a timer and hold this position. For



Lie on your stomach on a stiff pillow and extend your back so that your chest is off the floor and hold. Time how long you can hold this position.

men, the normal hold is 208 seconds (3.5 minutes), and for women it's 124 seconds (2 minutes). If you experience significant pain with this maneuver, stop!

If you have pain with extension like this, you may have either a facet or lumbar stenosis problem.

Scoring: Write down your timed score.

Hip/Knee: There is a single test for hip and knee stability as both of these are linked. Stand and then balance on one foot (the side you want to test). You then perform a single-leg squat while trying to keep your body as straight as possible. If you're able to balance so that you're straight for about one-half of the deep-knee bend and for the return back up, then you pass the test on that side. If you must tilt your body over to that side and/or your knee drives inward, you have poor hip and knee stability and fail the test. If you can't perform the half squat, you fail as well.

Normal

Abnormal

Scoring: Write down your timed score for each side as the number of seconds you can hold that side in the position shown in the picture above (Normal) versus the right (Abnormal).

Ankle: You can test the ankle from the same standing-on-one-leg position. Given that the ankle is supplied by nerves in the low back, subtle weakness here can also originate in the spine. Count to 10 while balancing on one leg, and watch your ankle. With your body straight (which is again measuring your hip stability) and hands to your sides, does the ankle roll or have to move back and forth during that 10 seconds? If so, you have an unstable ankle. If not, and the ankle remains rock solid for the 10 seconds, you pass this test. If you have a tough time with this, you may have an ankle-stability issue. This can impact things all the way up to the knee and can even, in some patients, cause a kneecap issue.

Scoring: Write down your timed score for each side as the number of seconds you can hold the ankle stable.

What if I failed some of these tests? This means you have poor stability in these areas. This could be due to pain shutting down muscles, weak muscles, or irritated nerves that make them weaker or misfire. If it's pain, then you have to find and fix the source of that problem. If it's weak muscles, they may just need strengthening. Finally, if its irritated nerves, no amount of getting the muscles stronger will help; you need to reduce the nerve irritation. These things will all be covered later in the book.

As you get treated, use this Regenexx Stability Test as your monthly spot-check to gage your progress. You want to increase your scores in each problem area.

Other Tests for the Knee

For peripheral joints, such as the knee, the most common tests for stability would be X-ray tests and stress radiographs, which would be used to detect too much movement in the knee. For smaller amounts of microinstability (very common), we use various tests. Another method for detecting smaller amounts of instability in the knee is a KT-1000 arthrometer. This is a machine that replicates the physical exam for small amounts of laxity in the ACL ligament. There are also other devices that can test many different joints in a similar fashion. We currently use the Telos Stress Device.

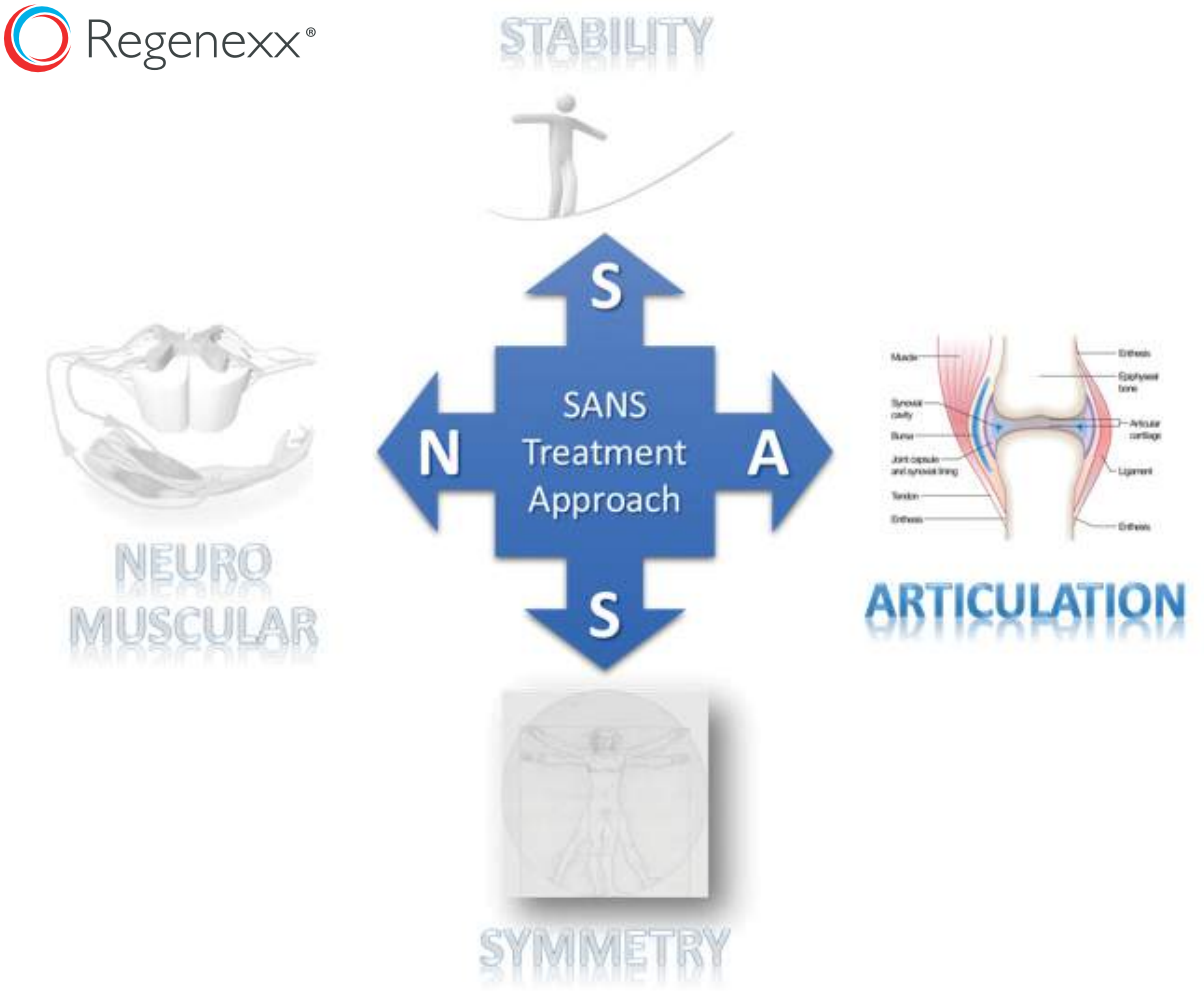
While diagnostic tests for instability and hypomobility are just becoming popular, the best way to diagnose these problems is still through history and exam. An experienced physician can compare joint motion from side to side (good side versus bad side) as well as stress the joint to look for signs of instability. As discussed above, the American Association of Orthopaedic Medicine (AAOM) is a good place to look for doctors experienced in diagnosing smaller amounts of instability. Many orthopedic surgeons can also diagnose instability, but realize their focus will be on the larger amounts of instability that we have called surgical instability. Thus the focus will often be on surgical solutions.

Knee Therapies and Exercises

Knee stability exercises are also commonly taught in many physical therapy programs. The Kinesio Taping programs (look up McConnell Taping Techniques) are a good bet for kneecap pain and combine taping to provide better proprioceptive feedback from the joint being trained. This method can also be used for other joints.

Knee stability exercises

Chapter 3: Articulation

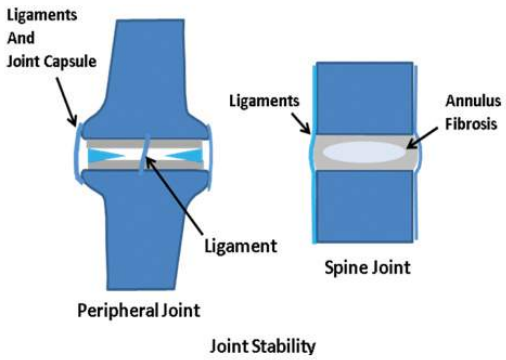


"The universe as we know it is a joint product of the observer and the observed."
Pierre Teilhard de Chardin

Articulation means joint, such as the knee. The knee is a peripheral joint that allows motion and does so in a controlled manner. A knee, like any other joint, has certain standard components.

Cushioning: The cushion in the knee would be the cartilage or meniscus. They are not inanimate pieces of rubber, but living tissues with cells and structure. Once these components die off, the knees would lose their ability to provide shock absorption.

Stability: This is provided by the joint capsule (tough outer covering of the joint) or the ligaments that help hold the joint together.



Notice that while our entire medical-care system in orthopedic knee surgery revolves around the joint, in the SANS system, the joint is simply one part of a bigger picture where ligaments, nerves, muscles, and symmetry is equally important or more important. What are the implications of paying too much attention to the joint? Today's modern ineffective knee surgery!

Arthritis in the knee means that the parts and pieces, like cartilage, meniscus, and bone, are degenerating or wearing down. So how do we access the degree of arthritis in the knee? We image it using an MRI. However, do these images paint an accurate picture of why you hurt?

Imaging Insanity, or the Very Poor Correlations Between Structure and Function
Every patient I have ever met wants an MRI, which is a fancy picture of the soft tissues that's created by powerful magnetic fields. While our practice uses MRIs to help define pathology, what if I told you that if you placed a bet that I could tell from your MRI what was causing your pain, I could give you only 1:1 odds (50/50)? For example, several knee studies have shown that patients with severe problems on MRI are often pain free, while other patients with severe pain often have limited structural changes on MRI of the knee.

Let's start with the most pervasive musculoskeletal MRI finding of the late 20th century, knee meniscus tears. If your doctor sees a meniscus tear on your MRI, it's a sure thing that the meniscus tear is causing your pain, right? **Wrong.** A recent study published in the New England Journal of Medicine showed that about 60% of patients without a history of active knee pain have meniscus tears on MRI. This study was completed by the famed Framingham Heart Study group. They observed two groups of middle-aged to elderly patients, with one group having recent active knee pain and the other having no recent or remote history of knee pain. Turns out they both had about a 60% rate of having meniscus tears on their MRI. This study calls into question the reasoning behind hundreds of thousands of knee surgeries performed over the past two decades. Since many meniscus tears aren't likely causing the patient's pain, **why are we operating on them?** Good question!

Once we find problems on a knee MRI, a traditional orthopedic surgeon often likes to operate on that knee. Let's look a bit more at whether that's a good or bad idea.

"Cleanup" Surgery: Helpful Pain Relief, or a Slippery Slope to More-Rapid Arthritis?
Often with only a cursory exam and an MRI (which you now know is pretty worthless in diagnosing a painful meniscus tear), a patient ends up with knee surgery. A common procedure used to help "clean up" the knee is called arthroscopic debridement. The concept is that the surgeon will cut out loose pieces of cartilage, meniscus, or other tissues. While this may make some sense at face value, the tissues we're removing in debridement are made up of live cells often critical for the overall health of the joint.

Let's take an example. Say you owned a house where one day one of the walls started to crack and fall apart (like the meniscus seen on MRI), but the house is still structurally sound. You can repair the wall or remove the wall. Since you don't have the technology to repair the wall (which is what happens in many of today's joint surgeries—words like "repair" are actually a misnomer, and they often mean "cut out"), you decide to remove it. You may get some temporary benefit from removing the wall as it was an eyesore, and perhaps removing it makes the house flow better. However, since it's a load-bearing wall (helping to hold up the second story), things in the long run get worse. The floor on the second story starts to sag, and other walls begin to crack under loads they weren't designed to handle. Before long, it's clear that removing the wall was a bad idea.

This is exactly what happens in many of today's modern joint surgeries. In the knee, we remove chunks of supporting meniscus with each surgery, despite the fact that research has shown that doing so means that arthritis will likely develop much more quickly.

How About Surgery for a Meniscus Tear?
Surely this must help as this is one of the most common surgeries performed in the United States today. Not so much.

Believe it or not, meniscus surgery had its final epitaph written recently with a level-1 study showing that surgery for meniscus locking is no better than placebo. Given that this was the final indication for the surgery, based on the research, to use a party analogy, the booze has run out for this little soiree. So if you're asking yourself, "Should I have meniscus surgery?" the research on the topic has now spoken, and the answer is a resounding "NO!!!" Let's explore why.

The meniscus is a natural shock absorber in the knee that provides some spring in your step and helps to protect cartilage. It can become torn with age or trauma, and greater than 90% of the surgeries on the structure are not repairs, as most patients believe, but are instead excisions, or cutting out, of the torn part of the meniscus.

The big misconception that has been propagated like a scandalous rumor in a small town is that meniscus tears as seen on MRI after a middle-aged patient reports knee pain are significant. THEY ARE NOT. Just as many of your middle-aged friends who don't have any knee pain or problems have meniscus tears; hence, the fact that your MRI has one is as important as those new wrinkles on your forehead in need of a little Botox.

The Research Showing Meniscus-Tear Surgery Doesn't Work

The first canary in the meniscus surgery coal mine happened way back in 2002, when a study by a Baylor College of Medicine orthopedic surgeon showed that debridement (the cleaning up of a knee that has arthritis and degenerative meniscus tears) was no better than a placebo. After many surgeons published comments that in medical parlance equated to wanting to blow up the poor guy's car, the procedure over the last fifteen years has slowly slipped into medical oblivion.

The next study came from an unlikely source; turns out the Framingham, Massachusetts, town that has given us such great heart data through the years also has a government-sponsored osteoarthritis study. This and other studies concluded that just as many middle-aged people without knee pain had meniscus tears as those with knee pain. Ouch...

In 2012 a large high-level research study published in the New England Journal of Medicine showed that on average, patients who had meniscus surgery didn't do any better than those who skipped the surgery and just had physical therapy. Many orthopedic surgeons criticized the study by saying that these patients had some arthritis and that there was still a justification for performing the procedure on patients with a meniscus tear without arthritis. That fantasy went bye-bye in 2013 when a high-level study showed that meniscus surgery in patients without arthritis was no better than a fake surgical procedure. There was still one condition left where meniscus surgery might be helpful—a meniscus tear that was causing locking of the knee. However, a recent study has burst that bubble!

The new study out of Finland looked at 146 patients who had "mechanical symptoms" (i.e., locking or catching thought to be caused by the meniscus). They randomized about one-half of the patients to meniscus surgery, and about half got a sham surgery. They found that the surgery provided no benefit to relieve knee catching or occasional locking, and they cautioned against patients getting the surgery.

Now, I know surgeons will argue that there still may be a justification for the surgery in patients with severe frequent locking of the knee or in patients who are younger and have an acute meniscus tear. In the first instance, they may be right, and in the second, given that studies have shown a rapid onset of arthritis and increased forces on the cartilage after a meniscus surgery, I would caution that the circumstantial evidence is that surgery should be avoided in those patients as well.

The summary? It was a heck of a party while it lasted. However, not only has the booze run out, but someone has turned on the god-awful lights, and the after-party has been cancelled. Uber drivers have been called, and the hosts are showing us the door. In other words, there is little scientific justification at this point in patients thirty-five and older that operating on their torn meniscus will do any good, and it's only a matter of time until insurers and national healthcare systems begin relegating this procedure to the dustbin of medical history. So, if you're asking yourself, "Should I have meniscus surgery?" answer yourself with a resounding "NO"!

Holes in the Cartilage

The ends of the knee bones have cartilage covering them, which acts like a cushion. When there's a hole in the cartilage, it's called an OCD. This is the medical abbreviation for osteochondral defect. It literally means "bone-cartilage" defect.

The term OCD can be confusing, as the abbreviation is also used for osteochondritis dessecans, which is where the cartilage dries out. The OCD where the cartilage dries out can lead to it flaking off, and this can leave a hole-type OCD. Confused? The hole-type OCD is most commonly found in middle-aged, active people on the medial (inside) of the knee, and it's more likely to be caused by trauma. The dried-out-type OCD is more common in active adolescents and more likely to involve an issue in the bone beneath the cartilage.

If you have a hole in your knee cartilage on your MRI...are you doomed? A new study would suggest you may want to ignore the hole, as your other knee that doesn't hurt likely has one, too.

MRI is a wonderful tool, but, regrettably, it's a two-edged sword. What do I mean? As discussed above, study after study continues to show that doctors place too much weight on knee MRI findings. For many patients, this is heresy, as they focus on their MRI results as if they were critical. It's not their fault, as most physicians look at knee MRI reports as if they came from the Oracle at Delphi.

Studies have shown that the general severity of knee arthritis either on MRI or knee X-ray also doesn't predict pain. Now, a recently released study again shakes up the world of the knee MRI believers. Almost all practicing physicians who read knee MRIs would be

convinced that a patient with an isolated hole in the cartilage would have knee pain. After all, the cartilage protects the bone and there's a hole in it, so that's got to hurt! In fact, we have created an entire surgical industry based on fixing these holes—microfracture, OATS procedures, ACI, MACI, and so on—so these knee-cartilage lesions must be critical, right? Nope, not per this new study.

The new research looked at groups who had reported that they either had knee pain or didn't have any knee pain. They then looked at research grade 3.0T MRIs and tried to match those images with focal cartilage lesions to those patients who reported knee pain and those pictures without knee lesions to those who didn't report knee pain. They couldn't, meaning that those patients with a knee-cartilage hole didn't have any greater chance of having knee pain as those without a cartilage hole. They also noted that the patients with only one-sided knee pain had just as many bilateral knee-cartilage lesions as those with bilateral knee pain.

More Severe Loss of Cartilage—Arthritis

Knee arthritis is when the joint loses cartilage and begins to degrade. The joint eventually becomes sloppy and unstable and, as a result, bone spurs develop. More on that below.

We all have an irrational fear of arthritis; however, many of us will get this problem by the time we're old. I hear patients all the time tell me of their "bone on bone" arthritis (meaning they have no cartilage left). However, just like with meniscus tears, the fact that you have little cartilage left may not mean much.

What if I told you that the big-time research of the last five years is actually showing that the idea that bone on bone is causing pain is an urban myth? How would this change everything?

There are two very large, ongoing studies that are tracking patients with knee arthritis with many different modalities, such as X-ray, MRI, exams, blood work, questionnaires, and biomarkers. These are the Osteoarthritis Initiative (OI) and the Framingham Osteoarthritis Study. Both are sponsored by the NIH, and these ongoing studies have felled many orthopedic myths to date, not the least of which is the idea that cartilage loss equals pain.

So what do these huge studies say about knee-cartilage loss and pain? Does lost cartilage equal pain? A recent analysis of the Framingham study data showed that among more than seven hundred patients who had no evidence of arthritis on X-ray, many middle-aged and older patients had MRI findings of arthritis. Here's what the authors reported in this group:

The prevalence of (bone) attrition (38% v 30%; P=0.04), bone marrow lesions (59% v 50%; P=0.03), and subchondral cysts (31% v 23%; P=0.04) was higher in participants with painful knees than those without pain (table 2). The prevalence for the other features were within

about 4% of one another among painful and painless knees with no significant differences (table 2). Indeed, the prevalence of at least one type of MRI detected pathology ("any abnormality") was high in both painful (91%) and painless(88%) knees(table 2). Regardless of the definition of pain used, MRI detected abnormalities were highly prevalent in people with (90-97%) and without (86-88%) knee pain. While the prevalence of MRI abnormalities was not significantly different in those with versus those without knee pain for most definitions of pain we tested, the prevalence of "any MRI abnormality" was higher in those with WOMAC pain compared with those without pain (P=0.002). Even so, the prevalence of any MRI abnormality was as high as 86% in those without WOMAC pain.

So what the heck does all of that mean? Problems in the bone were the only thing associated with pain. All of the rest of the problems seen on MRI that we doctors and almost all patients would think should be associated with knee pain, weren't. In particular, 72% of patients with cartilage problems had pain, but so did 68% of those without knee pain! These differences weren't statistically different.

From the other major study, the Osteoarthritis Initiative, despite looking at cartilage loss in almost five hundred patients, the amount of lost knee cartilage on X-ray and MRI also wasn't strongly associated with pain. Let me put the conclusions of these large studies in all-caps and in italics:

LOST CARTILAGE IN THE KNEE IS NOT ASSOCIATED WITH PAIN OR LOST FUNCTION.

The conclusion of this last study is also important, so it should be emphasized as well: *"Osteoarthritis is a multifactorial process and the need to treat patients based off their symptoms and rely on radiographs as confirmatory modalities, and not diagnostic modalities, when talking about OA and medical intervention."*

Translation? If your doctor is looking at an X-ray or MRI and concluding that he or she knows the cause of your pain without a thorough exam, find a new doctor.

Bone: The Structure of the Knee

Bone is the structure that gives form to the knee—a place where two bones meet. Ligaments and muscles help keep the bones aligned, and cartilage acts as their cushion. When the knee suffers from arthritis, the cartilage breaks down, reducing the cushion. But can the bone develop issues, too?

While we think of bone as cement, it's actually like hard plastic that gives and absorbs shock. However, it relies on the cartilage to help it work properly as a machine to mitigate forces. When that cartilage is damaged, the bone can swell, and this is called a bone marrow lesion (BML) and is readily seen on certain types of MRI images as a bright spot. These areas are places where microfractures have occurred. In addition, research shows that while these areas of bone swelling may be caused by poor cartilage not absorbing the

forces of the joint, the swelling of the bone may also cause more cartilage damage. Can this problem be helped? We have seen good results with what we call percutaneous stem-cell-assisted subchondroplasty (PSCAS). This involves careful mapping of the lesion using MRI and then placing a needle into the bone and injecting stem cells to shore up the area. By helping the bone, in this technique, we believe we can help the cartilage.

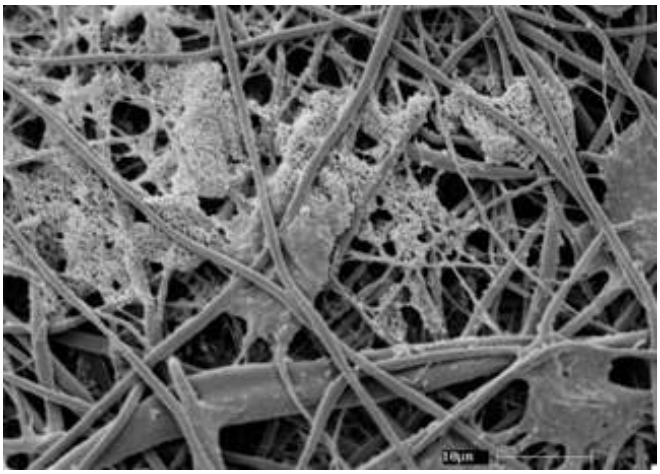
Bone and Joint Tissues Are Alive!

Bone spurs inspire fear in the hearts and minds of most patients, kind of like The Blob from a bad 1960s horror movie. When patients hear that they have them, they're immediately freaked out. However, much like the title of Stanley Kubrick's '60s movie Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb, patients shouldn't get immediately frightened when they hear they have bone spurs as most are there to provide stability to the knee and other joints and are an important part of you! Only every once in a while, do these bone spurs that you should learn to love cause problems that you should fear.

Why do bone spurs develop? When are they good or bad? Bone is made up of mature cells (osteoblasts) and stem cells that react to their environment. It's well known, for instance, that when the cushioning cartilage in the knee wears out, the bone underneath makes itself thicker to handle the new forces. We know that people who don't exercise or who pursue non-weight-bearing exercise have more brittle bones and that people who lift heavy weights have more-dense bones. So bone is alive and quickly reacts to its environment. How quickly?

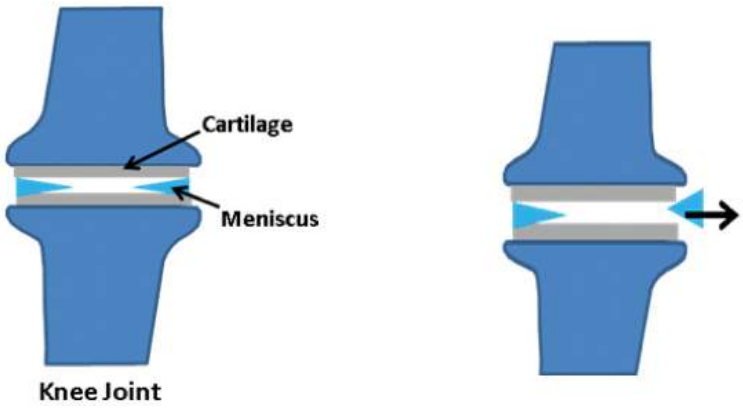
As an example, for many years most physicians were convinced that bone spurs took years to form. This was based on the theory that bone was dumb, inanimate cement. However, more-recent research shows that when instability is created as part of an experiment, bone spurs begin to form in the one-to-two-month time frame.

The same holds true for muscles, tendons, and ligaments. They all react to increased strain forces by making themselves thicker and stronger. This ability to react quickly to increased (or decreased) demands is mediated in part by adult stem cells. The switch from seeing these orthopedic tissues as inanimate filler (bone, cartilage) or pieces of inanimate duct tape (ligament, tendon) to living tissues that react is a key concept in understanding why alignment of the joints is so important in Orthopedics 2.0.

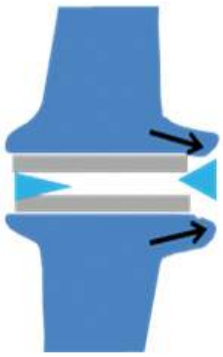


Functional Bone Spurs?

Bone reacts to forces. I've spoken to many patients over the past few years who are planning to have surgery to remove bone spurs. While I can think of a few situations where this makes a lot of sense, like when a bone spur is pressing on a nerve, most times bone spurs are better off left where they are. The bone spurs that are causing mischief, I call nonfunctional bone spurs. However, in many situations, bone spurs are functional. What does this mean? Let's take the example of bone spurs that develop in a knee that need to be left intact.



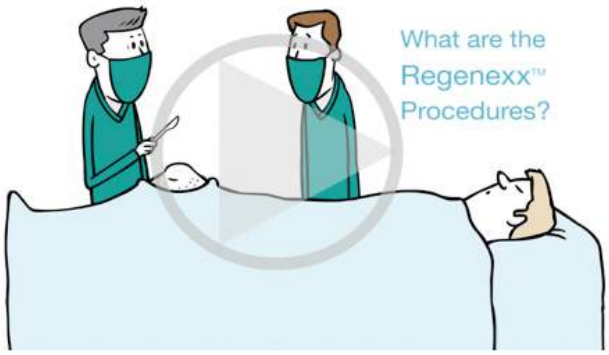
The knee has cartilage and a fibrocartilage meniscus (spacer). Both the cartilage and meniscus components are shock absorbers with the meniscus also acting as a spacer to help keep the joint surfaces apart. When the meniscus is healthy, it stays within the joint (see picture at top left). When the meniscus gets degenerated or pieces of the meniscus are removed surgically, the meniscus starts to migrate out of the joint (see top picture to the right). Since bone is alive and reacts to these forces, the body responds by placing bone in this area to take advantage of this new meniscus position (see picture to the bottom right). This response is called a bone spur or osteophyte.



We've been conditioned to believe that all bone spurs are bad. However, as you can see here, these bone spurs allow the knee to take advantage of this new meniscus position and continue to use the spacer (meniscus) to absorb shock. If we remove these bone spurs, the knee loses its ability to absorb shock, and the body will just place more bone spurs in this location. I call these functional bone spurs in that they serve a purpose, and their removal doesn't positively impact the joint. Since all bone spurs are a reaction to instability or joint forces, we have to be careful about removing this reactive tissue, to make sure that the joint will be better off after removal.

Is There a Better Way?

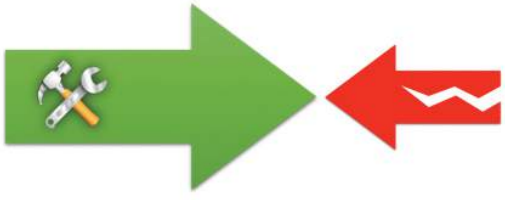
Rather than cutting out tissue, our practice was the first in the United States to pioneer a new approach, starting in 2005. Rather than surgically removing or repairing the tissues, we began using the patient's own stem cells in an attempt to heal damaged tissues. There's even a nice little video that helps to explain why we think this approach is better. Click on the image below to play that video.



Understanding the Body's Repairmen: Stem Cells

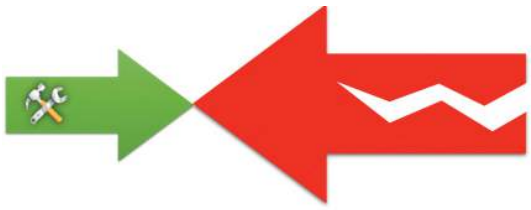
Remember that house in your neighborhood that was inhabited by an older person who couldn't keep up with the maintenance? We'd all accept at face value that a house left unattended for years will weather and begin to slowly degrade and fall apart. Our joints and bodies are the same. A quick run around the block, a workout in the gym, or just daily use will cause microdamage in any number of tissues. Left unrepaired, these areas will begin to break down over time (just like the unattended house down the street).

So what keeps us from falling apart after just a few years? The figure to the left tells the story of the opposing forces of damage versus repair. Everything we do every day adds small (or large) amounts of damage or wear and tear on our tissues. On the other side of that coin is repair. This is the mechanism that fixes the damage. When these two systems are equally matched (our repair system can easily keep up with the damage), you have healthy joints.



Young or Older and Healthy Joint: Repair abilities far exceed wear and tear.

Turns out we have billions to trillions of tiny little repairmen in all the tissues of our body. These repairmen are called adult stem cells. As an example, consider an adult stem cell type called a mesenchymal stem cell (MSC). These cells live in



Older or Unhealthy Joint: Wear and tear exceeds repair abilities.

your tissues and are called into action once damage is detected. They can act as a general contractor in the repair response, giving signals to activate other subcontractor cell types that are needed for the repair job or even firing (deactivating) cells that may be causing trouble. They can also "differentiate" (turn into) the final cell type needed for the repair. For example, if the cells are repairing the cartilage of your knee, they can differentiate into these cartilage cells. When we're young, while there may be a lot of abuse on the body, in general, the amount of repair capability (adult stem cell numbers and function) generally far exceeds the amount of damage we can inflict. As we age, we have fewer of these stem cells around. Even when we're younger, an area can become injured so that it doesn't allow the repairmen in the door (less blood flow, or there just aren't enough cells to affect a proper repair). At this point, the amount of damage starts to exceed the body's ability to repair.

What if we could turn that equation around? What if, despite being older, or even younger with an area that has too much damage for the local repair cells to handle, we could amplify repair in the area? As you might have guessed, this is a basic tenant of Orthopedics 2.0. The doctor's job is to increase the local repair response in nonhealing tissues so that it exceeds the existing damage or wear and tear on the area. This also includes the other side of the coin—the doctor should avoid prescribing or injecting medication that will harm or slow this repair process. In addition, the final part of the doctor's job is to reduce the local damage on the area. How is this done?

Improving the Repair Response

We can increase the repair response by dividing it into approaches with three levels of sophistication.

Level I: Microinjury

Level II: Improving the Healing Environment

Level III: Stem Cells

Level I: Microinjury

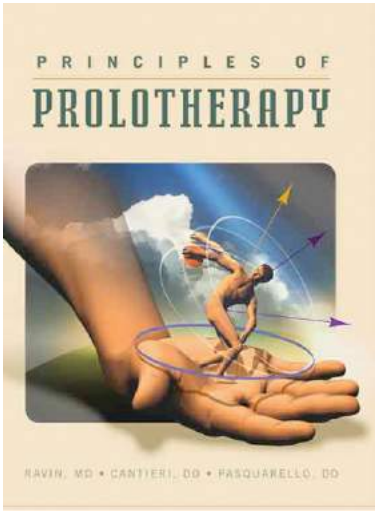
Ever since ancient times, creating a small injury to prompt healing has been considered a good idea. For horses, this was called "pin firing." The technique was to take a hot poker and place it into a nonhealing ligament to cause small amounts of damage to the area, which caused the body to kick up a repair response. While barbaric, it generally worked. For centuries doctors have created small injuries in a nonhealing wound by "roughing" up the tissues.

Physicians still use this concept today for tendons, ligaments, and joint capsules. For example, in a shoulder capsulorrhaphy, a surgeon usually inserts a small catheter that heats the tissue to prompt healing in a damaged shoulder capsule (the covering of the shoulder joint that helps control motion). Doctors still score ligaments with scalpels and beat up tendons with a needle (percutaneous tenotomy), all to prompt a healing response. Another example is microfracture surgery, which is a procedure used to treat a hole in the cartilage in a damaged joint. In this surgery, the doctor pokes holes in the bone to cause the cartilage to heal. Finally, the procedure known as prolotherapy is in this same category. In this procedure, rather than a mechanical injury being initiated, the physician injects a chemical irritant to cause a chemical microinjury. These types of treatment rely on the same concept—that we usually get only one bite of the healing "apple," and if something fails to heal completely the first time, we can create more bites at that apple simply by causing a small injury to the area.

The big advantage to microinjury techniques is that these basic procedures are simple and often inexpensive. The downside is that while many times they work well, sometimes they don't have enough oomph to produce the right type of healing or enough healing. In addition, they also tend to do better when fibrous tissue repair is what's needed. This means they can heal ligaments and tendons with much the same composition as the original tissue, but for things like cartilage, they produce inferior-quality tissue. For example, for a microfracture, it's been well known for years that lower-quality fibrocartilage is predominantly produced rather than true hyaline cartilage.

The Original Regenerative Injection Technique—Prolotherapy

Prolotherapy is an injection method where chemicals are injected to cause a small inflammatory healing reaction. In the 1940s, this was a mainstream orthopedic procedure used to treat lax ligaments and spinal pain. Heck, it even had its own pharmaceutical (Sanusol). However, in the next half of the twentieth century, prolotherapy fell out of favor. Why? Some say it was linked to the bad outcome of a single injection placed where it shouldn't be in the spinal canal. However, others place prolotherapy's demise on the fact that it had no sustainable medical business model. It was simply replaced by big surgical procedures that were far sexier and had better reimbursement through a new concept at the time—employer-sponsored medical insurance.



While we may never know what happened, the procedure was revived in the 1980s, and over the past two decades, I've seen this simple and inexpensive technique work for patients who otherwise would not have been helped. I've published on prolotherapy's ability to tighten loose spine ligaments simply through injection, and others have published on the same observation in lax knee ligaments.

If you have a loose knee ligament, prolotherapy may be a good option. However, like any regenerative injection technique, accuracy of placement matters. As a result, prolotherapy should almost always be performed under imaging guidance, especially when deep specific structures are being treated. I wrote an article on this topic a few years back that explains how this works.

Level II: Improving the Healing Environment

The next level of sophistication beyond just creating a healing microinjury is making the conditions in the area more conducive to healing, or "anabolic." You may have heard this term associated with body builders who use steroids. This is not the same use here, although body builders "build" muscle, so this is why they use "anabolic" steroids (literally "steroids that build"). Here the term means making an area pro-repair, or better able to heal.

Creating an anabolic healing environment is not a new concept in medicine and surgery. For centuries, physicians have known that some people have better innate abilities to heal, while others have fewer healing capabilities. The acronym PPP (piss-poor protoplasm) was used in my medical school training to mean a patient who, due to disease or extreme old age, was unable to heal after surgery. While surgeons have always known that some patients could have a compromised ability to heal, not much attention has been paid in how to make routine and otherwise healthy patients heal better. Doctors have always understood the basics, like good nutrition, young age, high levels of fitness, and good blood supply. About 20 years ago, that started to change in the dental community. Some dentists began experimenting with a simple concoction called PRP (platelet rich plasma). The dentists used this stuff made from their patients' own blood to help dental implants heal.

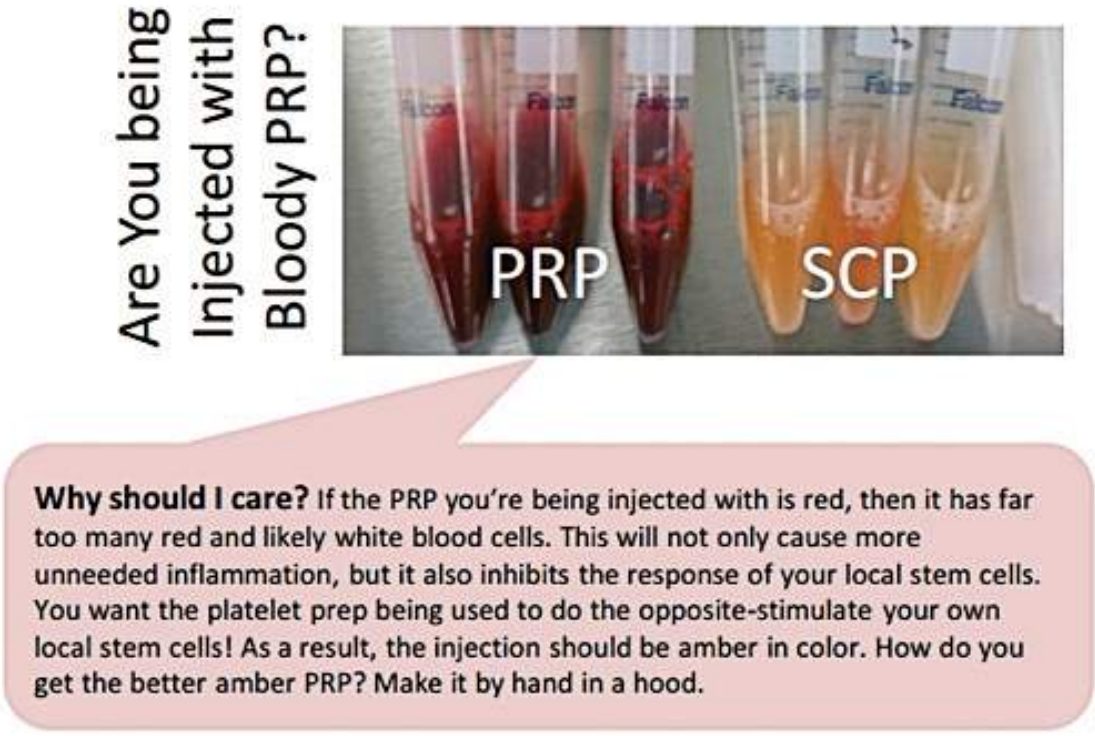
PRP is a simple example of how we can improve the healing environment. Your blood has platelets that contain growth factors that help to ramp up healing. To understand how these platelets work, a paper cut will illustrate the basic points. When we cut ourselves, we bleed into the cut. The blood coagulates because of cell fragments that live in our blood called platelets. The job of the platelets doesn't stop there. They go on to release certain growth factors that stimulate local cells to heal the cut.

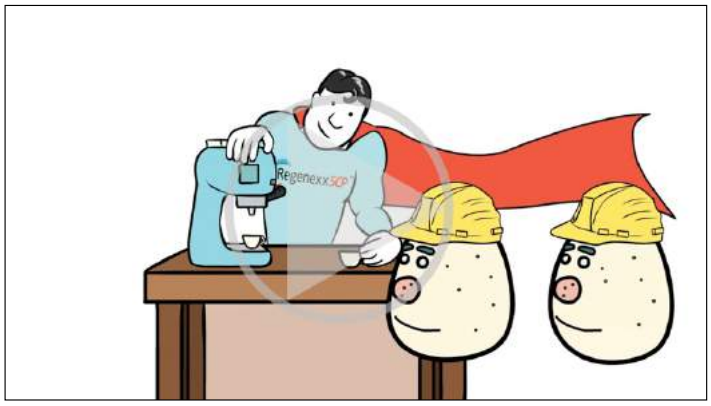
Growth factors are like espresso shots for cells. A cell works at a certain pace to do its job. If we add growth factors (like those in PRP), it's like buying all of the cells trying to repair the area a bunch of Starbucks gift cards. The cells react to the growth factors like people react to triple espresso shots: they work harder and faster. So if we use an example of a construction site where we have a few bricklayers building a new wall and we add growth factors (espresso shots), our bricklayers will build our wall faster.

As you might have guessed, Orthopedics 2.0 uses these same concepts to promote healing. The most basic level-II procedure today is PRP, which can be mixed up from a patient blood sample in a bedside centrifuge or more preferably in a simple hospital- or clinic-based lab. PRP means that the healing platelets have been concentrated. Injecting the patient's own blood can often accomplish the same thing as it's also rich in platelets.

Not All PRP Is Created Equal

One of our focus areas since 2005 has been figuring out how to use various forms of PRP to get stem cells to grow better. This extensive experience has led us to understand that there are different "flavors" of PRP and that some of them seem to work better for kicking stem cells into high gear. How can you tell the difference? Look at the color of the PRP. Based on our lab data, red PRP doesn't work as well to promote stem cell activity as amber PRP. Most automatic bedside centrifuges used by doctors today produce this red, bloody PRP.



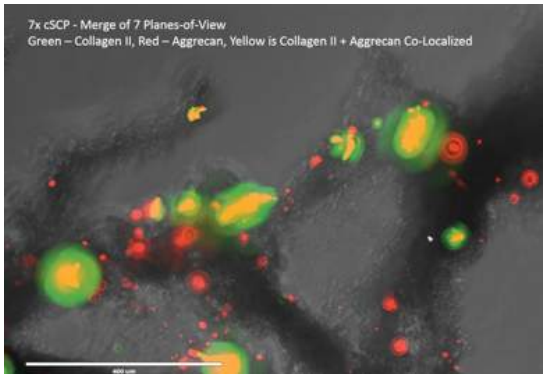


Why is red PRP a problem? It's rich in red and white blood cells. When it comes to energizing stem cells toward repairing more tissue, our lab experiments show that red PRP doesn't have the same "espresso shot" kick as PRP without red and white cells (amber PRP). Based on these experiments, we have created what we call a "super concentrated platelet" procedure (SCP) to maximally stimulate stem cells into action. Click here for an infographic that explains the issues and lab data in more detail. In addition, click on the video link below to see a two-minute animation that explains these differences.

The other big difference with SCP is that since we create it by hand for every patient in a lab rather than mass manufacturing it in an automated push-button centrifuge, we have much more control over the composition of the final preparation. While most bedside centrifuges can only concentrate to about 5–7 times more platelets than are normally present in the blood, we can concentrate SCP all the way up to 40 times over baseline! Is getting to higher platelet concentrations better? Yes, with this type of PRP, we see more activity in local stem cells with higher concentrations of platelets. For this lab data, click here. In our clinic, we also use next-generation level-II tools beyond PRP. These tools include platelet lysate (PL). In the case of PL, our advanced cell biology lab makes PRP from the patient's blood and then breaks open the platelets to allow all of the growth factors to be immediately available. The difference between PRP (or SCP as we call it) and PL is the same as between a time-release pill and an immediate-release pill. PRP has whole platelets that release their growth factors over time. PL has all the growth factors immediately available. Based on our experience, there are specific reasons to use one or the other. For example, in our clinical experience, PL is excellent to use around nerves.

We now produce an advanced-generation platelet lysate that we call PL-M and cPL-M. In our lab experiments, we noticed that despite blowing up platelet bodies and releasing growth factors, there were still many whole platelets left. This meant that there were still growth factors to be released. As a result, we developed a proprietary type of triple lysate that gets all of the available growth factors out of the platelets.

Can We Create a PRP That's Better at Making Cartilage?

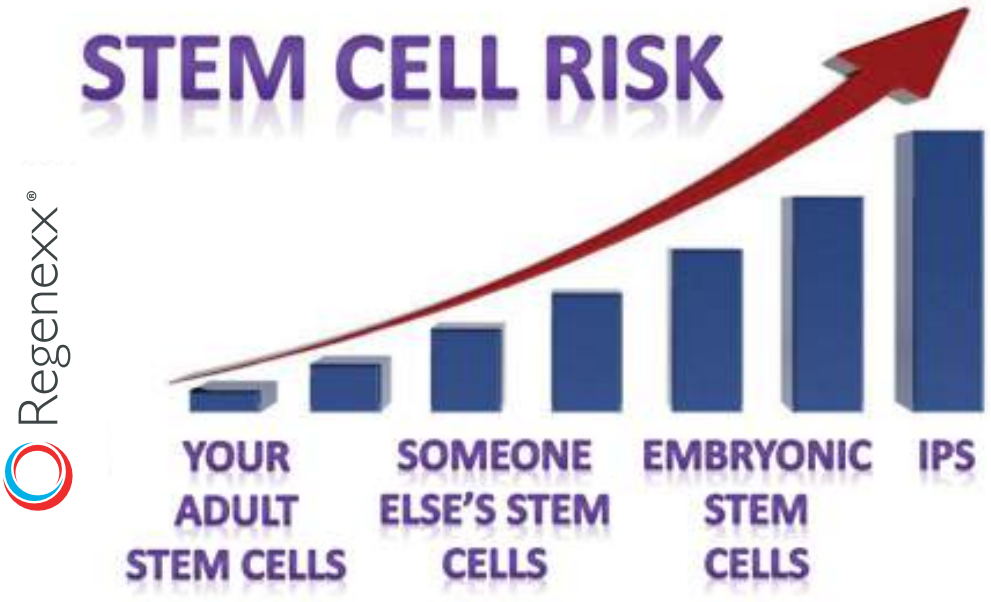


Since PRP is often used in joints, and one of the major regenerative-medicine concerns there is healing cartilage, is PRP good at cartilage repair? One of the growth factors in PRP is TGF-beta, which is very good at helping cartilage grow. However, PRP also contains a soup of growth factors, some of which may or may not promote cartilage repair. As a result, we have been researching this issue for some time and have created novel platelet mixes that are better at helping stem cells make cartilage in lab experiments (see illustration above that shows that our chondrogenic PRP produces more cartilage components than a control in the lab—the green is cartilage being made).

How about SCP? We have tested our SCP in the lab for its ability to promote stem cells to produce cartilage and found it to be very capable of this feat (see fluorescent microscopy image to the left).

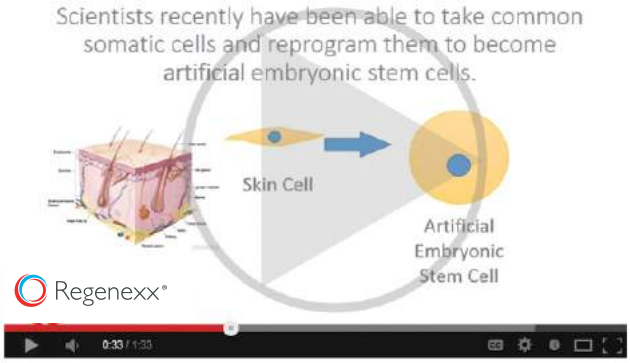
Level III: Stem Cell Therapy, or Adding in the General Contractors of the Body
While level-I therapy is about causing a little injury to prompt healing and level II about getting the local cells to work harder, level III is about adding more workers to the area. Staying with our construction site metaphor, a general contractor (GC) is the person who pulls a construction project together. He or she hires subcontractors, like plumbers, carpenters, and electricians. Does your body have a GC cell that can help coordinate its daily repair jobs?

Yes. The GC's of your body are stem cells. So level-III advanced techniques use concentrated or cultured stem cells to help repair tissues. There are several different types of stem cells. We've all heard of embryonic stem cells that are taken from a growing embryo. While these cells are very potent stem cells, they also have the nasty habit of forming tumors.



Cells can also be taken from cord-blood stem cells or adult stem cells. However, while some of these cell types might be appropriate as last-ditch efforts to save someone's life, their risk of transmitting genetic disease makes them too risky for orthopedic applications. As an example, in one study, an older rat bred to have osteoporosis donated stem cells to a young rat without the disease. **The young rat acquired osteoporosis in the bargain!** Since we currently don't possess the technology to screen donors for all inheritable diseases, the risk of using someone else's stem cells is too high for now (in my opinion).

You may have also heard of placental or amniotic stem cells. These are newer entrants to the list of stem cells that are being offered to patients. The problem is, as you'll see later in the book, that amniotic and placental products being used by physicians, chiropractors, and others are all dead cell products. That means that they contain no living stem cells.



Finally, the newest stem cell types are called induced pluripotent stem cells (iPS or iPSCs). While all of this sounds very daunting, the basic concept is that these are artificial stem cells that don't exist in nature, created from natural cells. These are created by heavy-handed genetic manipulation of the normal cells from the body (like skin cells) or by exposing these same cells to a stimulus (like putting them in an acid) and are likewise very dangerous until proven otherwise. We're much more than a decade away from seeing iPS cells used in real everyday patients. To learn more on iPS, click on the video link to the left.

Mesenchymal Stem Cells

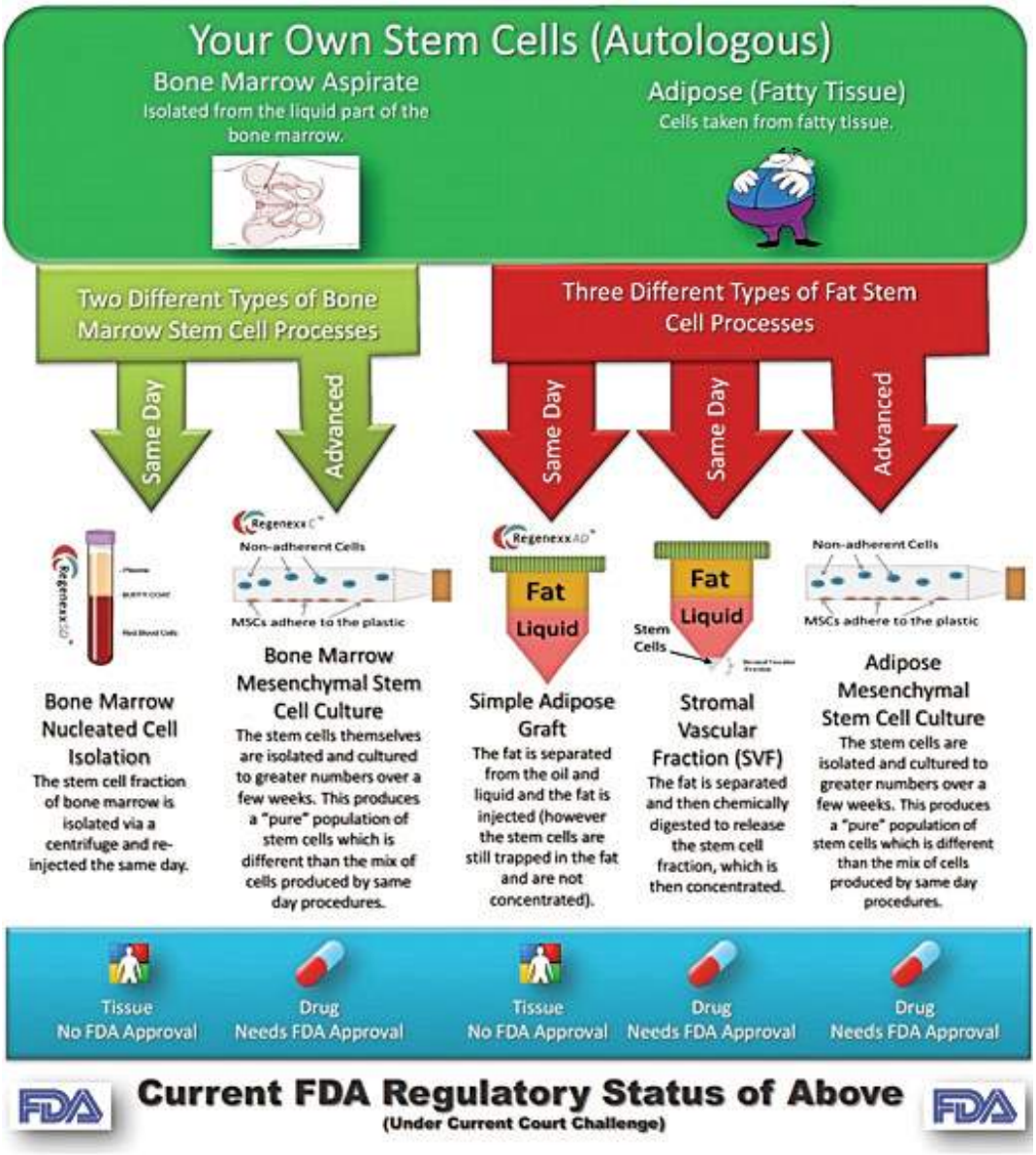
There are many types of adult autologous stem cells, but for the purposes of this orthopedics discussion, one stands out as the best candidate for our general contractor position: the mesenchymal stem cell (MSC). These cells are found in many tissues (for example, as above, they are found in bone marrow aspirate and fat). For orthopedic applications, their ability to help coordinate the repair response as well as turn into cartilage, bone, tendon, muscle, and ligament make them ideal. Other cells, such as very small embryonic-like or embryonic-like stem cells (VSELs or ELSCs), are also promising for orthopedic use, but not enough research has been done yet on these adult stem cell types with regard to safety to make them practical for everyday use. Also realize that there are likely hundreds of classes and subclasses of adult stem cells that will eventually be used for therapy. Many of these may even be combined with mixtures of other non-stem cells or tissue-engineered scaffolds to better promote healing.

Fat vs. Bone Marrow Stem Cells

Anyone perusing the Internet can see that there are two stem cell types from the same patient (autologous is the term for this) that seem ubiquitous: fat and bone marrow stem cells. When we began using stem cells in 2005, we investigated which of these we should use. At the time, there was mounting evidence that bone marrow stem cells had real utility in orthopedic applications and very little data was published showing that fat stem cells were very helpful. What's amazing is that this data isn't all that different today.

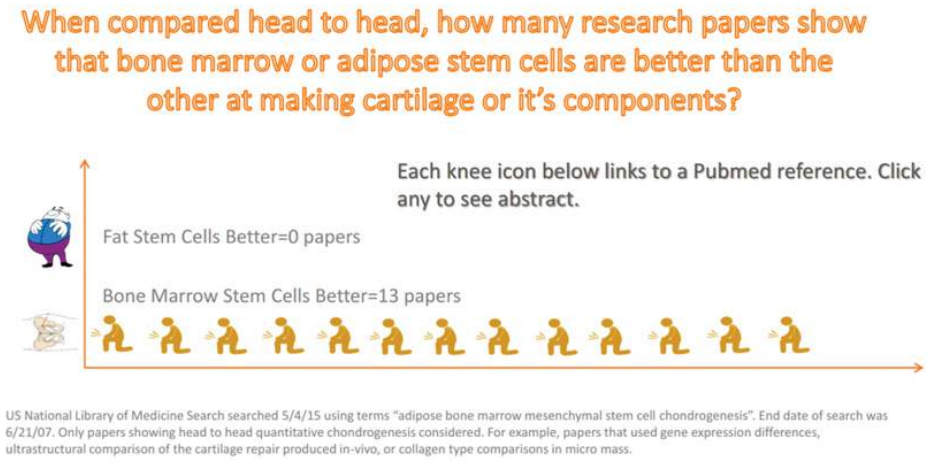
Before delving into that research, let's review the five most common procedures being offered in autologous stem cells for orthopedic injuries (illustration below).

As you can see in the illustration, there are two different bone marrow procedures (same day and advanced) and three different fat procedures (two same day and one advanced). The same-day bone marrow procedure is equivalent to the Regenexx-SD procedure, and the advanced bone marrow procedure is Regenexx-C where cells are cultured for two weeks. On the fat stem cell side, there's a simple adipose fat graft and an isolated stem cells procedure that are equivalent to the Regenexx-AD procedure. Finally, just like in the bone marrow procedures, you can culture the cells to get more, so there is an adipose advanced procedure.

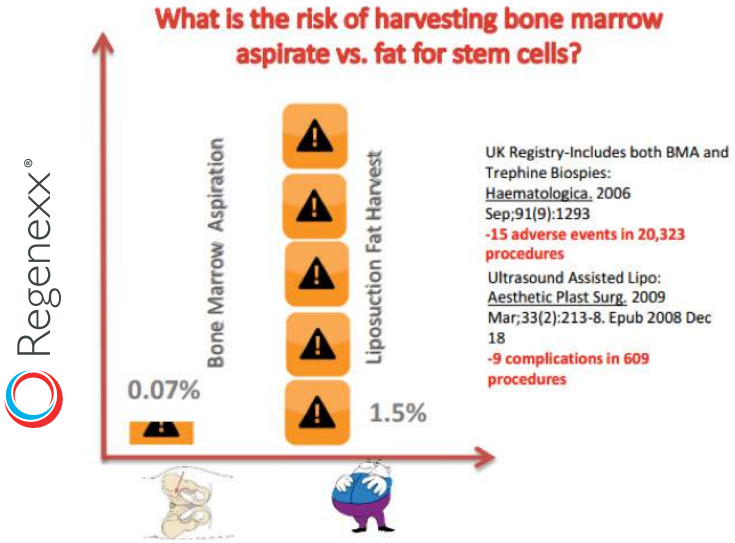


[1]The Regenexx-C cultured stem cell procedure is only offered through independently owned and operated medical services providers operating exclusively outside the United States. These service providers are not part of or affiliated with the Centeno-Schultz Clinic or any US Regenexx Network provider. The Regenexx-C procedure is not approved by the FDA for use in the United States.

So now that you know what's being offered, can research guide us as to which is better for orthopedic use—bone marrow or fat?



How about when the two stem cell types are compared head-to-head in the lab for producing new cartilage? Thirteen papers show that bone marrow stem cells are better at producing cartilage than fat stem cells, while none show that fat stem cells are better than bone marrow.



How about a comparison of how the cells are harvested? Bone marrow stem cells are taken from the patient using a bone marrow aspiration. This is where a small hole is poked through the bone with a special needle. Fat stem cells are harvested during liposuction where fat is collected through a cannula. As you can see from the graph to the right, the risk of liposuction is about 21 times more than that of a bone marrow aspirate. Again, on the safety of getting the cells from the patient, bone marrow stem cells win again.

In summary, the weak data I found in 2005 on fat stem cells hasn't really gotten much stronger. Bone marrow stem cells are still our first choice for orthopedic tissues. Might that change with time? It may, but for now, we'll go with what the data says is likely to be better for our patients.

A New Type of "Stem Cell" Emerges: Placental, Amniotic, or Umbilical Cord Tissue
Amniotic fluid and placental tissues surround a baby growing in the womb. When the mother's water breaks, this is the fluid that ends up on the floor. The placenta is the part of the baby's sac that attaches it to the mother's uterine wall through the umbilical cord. Cord Blood is located in the umbilical cord as is what's called Wharton's Jelly.

Amniotic and placental tissues from the birth sac have been used for a century or more as a filler for the damaged covering of the spinal cord and in eye procedures. Way back when, a surgeon would make a visit to the OB ward and pick up some of this stuff to sew into a defect. In the 1970s when FDA tissue regulations went into place, companies could make a little money selling these tissues to hospitals and surgeons.

About five years ago, some smart businessman got the bright idea to begin marketing placental tissues as an injectable regenerative medicine product. They took the birth sac and freeze dried it, chopped it up into very fine pieces, and put the powder in a bottle. I recall one of these companies who had incredibly aggressive sales reps and tactics. The companies then went to medical conferences to convince doctors to inject it for problems like tennis elbow.

Now there wasn't a shred of evidence that this stuff would help tendinitis or any other orthopedic condition, but that didn't matter— it was a "regenerative tissue." The sales were pretty good, but at some point, some smart sales rep got the idea that if he told doctors that this was a "stem cell" product, that would sell more vials of the stuff. Sure enough, sales went through the roof! Never mind that freeze drying, processing, and gamma irradiation sterilization of the living membrane made sure it had no living cells of any type, let alone stem cells.

Most doctors, who were new to the concept of stem cells anyway, bought this marketing "little white lie" hook, line, and sinker. Then came amniotic/placental fluid, which was marketed the same way. This was perhaps more believable as a stem cell product, and you can find research that when it surrounds the baby in the womb, this fluid does contain some stem cells. After I was told by a knowledgeable sales rep about the rich stem cell content of amniotic fluid, we decided to test these claims.

We check all manufacturers' and reps' claims before we use products. Unlike other medical groups who frequently take payments from outside companies to perform research or be paid representatives for products, we do this at our expense so there are no potential conflicts (e.g., a manufacturer that funds a study). Also, unlike any other medical group, we also have a research lab outfitted like any university research lab in the country, so we can run these tests and separate fact from fiction.

First, as discussed, the doctors hawking this stuff buy vials of product from sales reps. So, you need to determine which product the doctor is using. Second, if you go to the website of any company selling amniotic powder or fluid, you won't see a word about stem cells. Why? These website claims are heavily regulated, and a single claim that there are stem cells in this stuff would result in the tissue being classified as a drug product and taken off the market to undergo a decade of testing costing hundreds of millions of dollars. This contrasts with the inexpensive FDA tissue registration required if what's being sold has no living cells. However, what the sales reps tell physicians behind closed doors is another thing. In that world, reps meet physicians who would love to "get into stem cells" but don't want the hassle of buying equipment, learning and mastering a harvest procedure, and dedicating the staff to run the machine that isolates the stem cells. They want something that will sit on the shelf that contains stem cells that they can use when the need arises. The problem, as we found out, is that none of this stuff contains stem cells.

Once our lab found no living tissue in any "stem cell product" tested, the Interventional Orthopedics Foundation did an independent assessment of these amniotic products that was presented at the IOF 2015 conference. Their research also found that these products didn't contain any living tissue, let alone stem cells! Regenexx has since tested a cord blood product as well. Same thing—dead cells!

So the physicians offering this therapy are injecting dead tissue and hawking it as a live stem cell therapy. So is this deliberate fraud or just a physician who doesn't know what he or she doesn't know? Most of the doctors I've met and educated about this scam had no idea that what an orthopedic sales rep was selling them was dead tissue. Hence, it's likely a doctor who bought what he or she thinks are living stem cells and who doesn't know enough basic cell biology to understand the likelihood that the sales pitch he or she heard was fiction. In addition, the doctor has no way to independently test whether these tissues contain live cells, so the doctor is wholly dependent on the sales pitch.

If you see a clinic offering amniotic, fetal, cord, or placental stem cells, run! The doctor isn't educated enough in this field to know what he or she doesn't know, which is never a good thing for patients. If the doctor does know what he or she is injecting and is still calling it a stem cell therapy, then that's consumer fraud, which is also not a good thing for patients.

Does Where You Get Your Bone Marrow Matter?

If bone marrow is the way to go, does it matter how it's harvested? First, when most patients hear about a bone marrow procedure, they think of a different procedure than the one we perform (a bone marrow biopsy is the one you've heard about, while we perform a bone marrow aspiration [BMA]). A BMA is a simple procedure where the area is thoroughly numbed, and then a needle is gently worked through the bone to pull out what looks like thick blood. Is this really painful? In 2007, we polled our patients and found out that about 9 in 10 thought it was no big deal.

Second, where you take the marrow can make a big difference in the number of cells you get. For example, recently some doctors who aren't comfortable using more-advanced guidance techniques have begun taking it from below the knee rather than from the back of the hip. Others have begun to take it from the front of the hip. Regrettably, this knee site doesn't produce as many cells as the hip site; hence, we use the back of the hip procedure (at what's called the dimples of Venus or the PSIS) that yields more stem cells.

Different Orthopedic Stem Cell Procedures

As discussed above, there are two different bone marrow stem cell procedures—one is same day and the other is cultured. What's the difference? The same-day procedure is what it sounds like. The stem cells are isolated and used the same day. The cultured procedure grows the stem cells to bigger numbers over a few weeks.

Almost all same-day procedures being used today are performed in automatic bedside machines that remove one fraction of the bone marrow that is rich in stem cells—the buffy coat. The issue with these machines is that they often can't be very exact, so they also isolate a lot of junk cells with the stem cells. Thus, we only perform this process of extracting the stem cells by hand so it can be done with more precision.

The buffy coat has both the MSCs, discussed above, as well as hematopoietic stem cells (HSCs). While the MSCs are good for helping to repair orthopedic tissues, in our clinical experience, the HSCs are good at bringing in new blood supply and treating muscle. In fact, these cells are responsible for muscle repair in the body. This can be very important for tissues like the meniscus or rotator cuff where poor blood supply may be a cause for delayed healing. Both cell types make up the Regenexx-SD procedure, which we have used to successfully treat injured or arthritic joints; meniscus tears; labral tears; and tendon and ligament tears, like the anterior cruciate ligament (ACL).

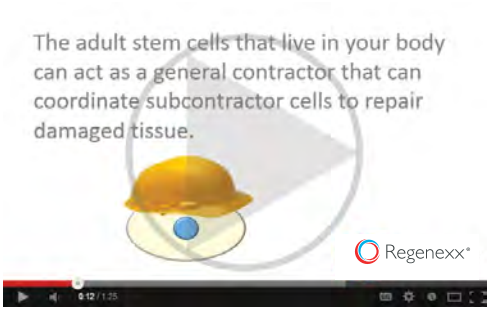
Our dedication to lab research has also allowed us to advance this same-day procedure way beyond where it has been. We discovered a second fraction in the bone marrow that's very rich in stem cells and is currently being discarded by everyone else. This layer has many more stem cells per unit volume than the buffy coat, and our lab research shows that they're fast growing and very useful for orthopedic purposes. Thus, we've increased the number of stem cells we can pull out of the bone marrow by a factor of five to seven by isolating this new fraction. When we compare how many stem cells we're able to isolate in the lab per unit volume to the number that automatic bedside machines can isolate, it's 15–20 times more! More recently, we have upgraded the isolation process we use a third time, again increasing stem cell yield.

Finally, we also have a cultured stem cell procedure offered through a licensed site in Grand Cayman (a British Commonwealth country with its own medical-practice laws). In this procedure, we can grow cells to bigger numbers over one to two weeks. In addition, for the spine, we can condition and select cells in culture using patent-pending methods

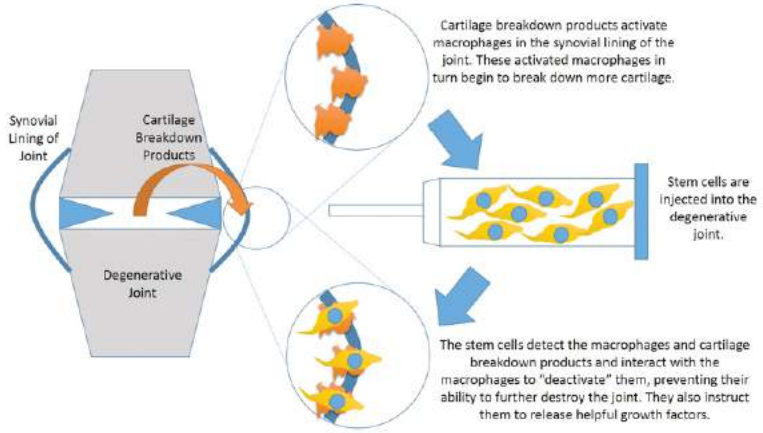
to allow cells to survive the rough environment of the low-back disc. As discussed above, this special process, in our clinical experience, makes the cells perfect to treat disc bulges pressing on nerves.

How Do Stem Cells Do Their Thing?

While you've likely heard that stem cells are blank-slate cells that can turn into another cell to replace a damaged cell, there's really a lot more to the stem cell story that just that neat little trick. Take, for example, the concept of exosomes. These tiny little packets are excreted by stem cells and can contain snippets of mRNA (an instruction sheet to make proteins). A stem cell can use these mRNA protein instruction sheets to task another cell to make proteins on its behalf. For a short one-minute video explanation on the topic, click on the video link to the right.



Stem cells can additionally work through what's called paracrine effects. This means that the stem cell excretes chemical messages called cytokines. Think of the stem cell as a general contractor who is involved in coordinating a repair of tissue. It barks out orders to hire subcontractor cells to do some of the work. While cells can't talk, their version is releasing very specific chemicals that can attract the types of cells it needs and then releasing other chemicals to give basic instructions to the other cells. For a short video that explains this, click on the video link above.



One interesting study also explained another mechanism for how stem cells may help arthritic joints. In the type of catabolic joints that I describe above, there are cells that act like Pac-Man by gobbling up normal, healthy cartilage (these cells are called *activated macrophages*). These cells are deactivated by mesenchymal stem cells and, as such, stop eating the good cartilage.

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I've also done a short one-minute video on how this Pac-Man cell inhibition works. For that, click here.

Can We Do More with Specially Cultured Stem Cells?

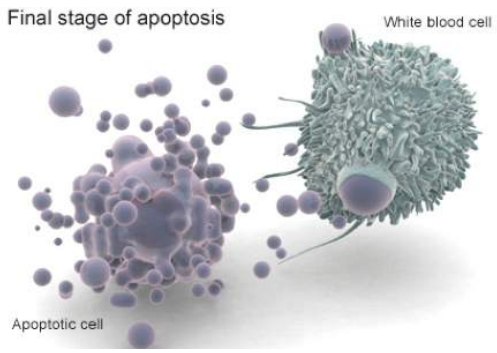
In 2006, our clinic pioneered a new approach to stem cells, culturing them to grow more. In this advanced procedure, we can obtain about 20–50 times more stem cells than in our same-day procedure. This Regenexx-C method has been the subject of several safety papers published in the US National Library of Medicine. The cultured stem cell injections were much safer than the more invasive surgical procedures they helped patients avoid.

For patients who have multiple joints to treat, culture-expanded cells can come in handy. Since each joint needs a certain number of stem cells from our same-day procedure, not all patients would have enough cells to treat many joints. This is usually not an issue when the cells are grown to larger numbers. Another big advantage to cultured cells is the ability to save them for future use in cryopreservation (deep freeze). In addition, since we have more cells, we can often save many treatments for the same area or other future injuries.

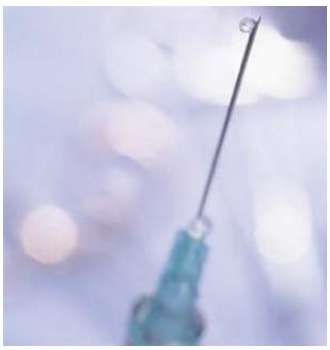
Beware of How Traditional Orthopedic Approaches Can Hurt Tissues

Let's explore some common traditional-treatment approaches that may adversely impact how you respond to the newer biologic therapies, like platelets and stem cells. For example, steroids are commonly injected into joints, and patients are often prescribed nonsteroidal anti-inflammatory drugs (NSAIDs). Is this a good idea? Regrettably, the research of the past decade is increasingly showing that not only are many of these approaches ineffective, but some actually make the problems worse. Let's explore these a bit.

The Opposite of Healing: Apoptosis (Steroid Shots are Bad News!)



What's the opposite of healing? Causing apoptosis, or preprogrammed cell death without any ability to heal. For many years, doctors have injected high-dose steroids because they quickly bring down swelling and make the area feel better. However, study after study continues to show that these drugs, when used at the high doses that physicians often inject (milligrams), cause local preprogrammed cell death (apoptosis). In the knee, this means that these drugs can kill cartilage cells. While causing a little cell injury is not necessarily a bad thing (as discussed above) and your joint will feel great from the high-dose steroids because the swelling will be less, these medications work by taking away the local repair response (inflammation and swelling). So when the pain returns it will often be worse because you're left with an injured area, with new dead cells, that can't repair itself. It's, therefore, no wonder why the pain is often worse once the steroids wear off.



Doesn't the body use steroids? Yes, your body can release natural steroids into an area where the inflammation dial may be turned up too high, which turns down that inflammation dial just a smidge. How much is too much steroid? While the milligrams of steroid commonly injected by doctors might not seem like much, it's about 100,000 to 1,000,000 times more steroid than your body would expect to see in the area. As an example, if the amount your body uses to control joint swelling is the height of a matchbook (nanogram range), the amount most doctors have been taught to inject is the height of the Empire State Building (milligram range)! Or, as I like to tell patients, if we inject the much smaller nanogram dose, we're putting in a thumbtack with a ball peen hammer, but if we inject the much larger milligram dose, it's like putting in the same thumbtack with a sledgehammer. If you use the ball peen hammer, there won't be much collateral damage, but using the sledgehammer is bound to create problems.

Why don't we see more doctors injecting the smaller physiologic doses? For one reason, they just aren't commercially available in those dose ranges. Steroids for injection bought from a medical supply company come only in the much bigger milligram ranges. Despite injecting the much smaller doses, we usually see the same results (decreased swelling). In addition, research has shown that these smaller doses can increase the good growth factors in a joint associated with repair.

Don't I Urgently Need to Get Rid of Inflammation?

The RICE approach in orthopedics has become widespread. The concept is to get rid of inflammation through rest, ice, compression, and elevation. But is getting rid of the inflammation always the best plan?

Inflammation—you've likely heard the term in a negative way. Inflammation means swelling. You've likely heard that too much inflammation in our arteries may be the cause of heart disease. You may have heard of a rare syndrome where too much inflammation after a leg or arm injury can cause serious problems (compartment syndrome), where out-of-control swelling in a confined space can lead to severe injury). All of this is true, but for this chapter, you have to understand that like anything, there is also a good side to inflammation. Without inflammation, we would never heal ourselves.

Maybe you've had a chronically swollen joint or seen people with joints that swell. The reaction from modern medicine has been to inject high-dose steroids into these joints. As stated above, since high-dose steroids are potent at reducing inflammation, this may at first seem to help. However, these ultra-high-dose drugs also destroy the natural repair response. So we now have a joint that no longer swells but also has no ability to heal itself.

Why does a joint stay swollen? Swelling is the result of your body marshaling the troops to heal an area. All of the cell types needed to build new tissue are in the swollen area: cells to clean up the damaged tissue (macrophages), cells to recognize any foreign material and deactivate invaders (white blood cells), and cells to act as general contractors in managing the repair response (mesenchymal stem cells). However, your body will keep throwing inflammation at the area (swelling) if the right signal isn't received from the newly formed repair tissue. As discussed above, if there aren't enough stem cells to complete the construction project, the "done" signal may never be received.

An easy way to think about swelling is that it's like the heat in the oven that's used to bake a cake. After all, the term inflammation incorporates the Greek for the word for flame. When an area stays swollen and chronically "inflamed," it's like low-level oven heat. If you place cake batter in a 200-degree oven, you don't end up with a baked cake but with dried-out mush. Why? The chemical reaction that "bakes" the cake needs higher heat, or said another way, to be more "inflamed." Turn up the oven to 400 degrees and you get a cake. The same holds true for a chronically swollen joint. The low heat of chronic inflammation isn't enough to repair the tissue, so the joint stays swollen. However, using the microinjury or platelet techniques above, we can "turn up the heat" and use much higher-level healing inflammation to heal the tissue (or bake the cake). The same can happen when we add stem cells, which can also help to complete the repair job.

So in summary, inflammation isn't usually a bad thing in orthopedic applications. Swelling is necessary to healing. Doing things to get rid of swelling (the rest, ice, compression, elevation [RICE] mantra) or using anti-inflammatory drugs may have their place in certain rare circumstances to prevent things like compartment syndromes. However, in Orthopedics 2.0, the use of drugs like high-dose steroids and NSAIDs (Motrin, ibuprofen, aspirin, Aleve, or other nonsteroidal anti-inflammatory drugs) to halt the healing inflammatory response is generally considered a bad idea.

Should I Take Anti-inflammatory Pills to Help My Knee Pain? Medications That Adversely Impact Regenerative Orthopedics

Anti-inflammatory drugs have become a mainstay of orthopedic and musculoskeletal care. While we have discussed steroid medications, what about nonsteroidal anti-inflammatory drugs (NSAIDs)? These are medications that block the pathways for inflammation—with most of them, the COX pathway (cyclooxygenase). COX drugs help control swelling, but they also cause stomach ulcers by inhibiting the enzyme that helps to protect the stomach wall. Just how dangerous are these drugs?

Moore, in 2002, published that the estimated risk of death due to bleeding stomach ulcer when taking NSAIDs for more than 60 days was 1 in 1,200! While this represents only a small number of people who are very sensitive to this drug class, the overall numbers are concerning. As a result of these inherent dangers, newer drugs were designed to work against COX-2 rather than COX-1 (the latter being more responsible for protection of the stomach wall), but these drugs had a new set of side effects. These drugs (like Vioxx, Bextra, and Celebrex) all come with an enhanced cardiovascular risk (risk of sudden death by heart attack).

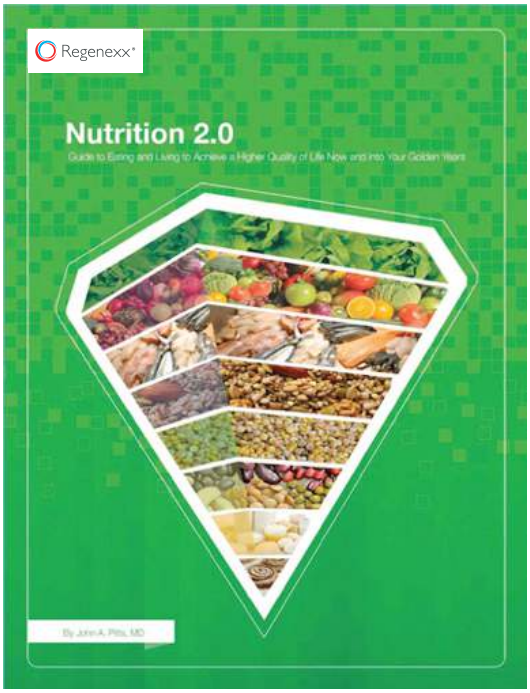
How do NSAIDs impact healing? Well, from a 50,000-foot view, inflammation is needed to heal, so blocking inflammation may inhibit healing. Sure enough, NSAID drugs, like Motrin and others, have been shown to delay healing. While most of this research has focused on fracture healing, we keep patients undergoing regenerative-medicine treatments off these drugs.

Other drugs are also notable for causing musculoskeletal problems. The antibiotic drug class that includes Cipro (quinalones) has been shown to lead to tendon ruptures. Heartburn drugs, like Nexium, have also been linked to hip-fracture risk. Cholesterol drugs have been known to cause pain and harm muscles. Many commonly used drugs can adversely impact regenerative-medicine healing. Our own cell-culture data implicates cholesterol and certain blood pressure drugs as causing problems with mesenchymal stem cell growth in culture.

If Most Drugs Are Bad News, What Else Can I Do?
Can you change your lifestyle to protect your knee and other joints? The answer is likely yes. I would break this down into a few different categories: diet, exercise, supplements, prescription medications, and hormones.

Diet
Could what you're eating impact your joints? We know that patients with metabolic syndrome get more arthritis, independent of their weight. What's a metabolic syndrome? This is when you gain weight (usually in middle age, but it can happen earlier), participate in limited exercise, and start to get high blood pressure. This happens because of a combination of genes, low activity levels, and a sugar/starch-based diet. Basically, excessive sugar and carbohydrate consumption leads to spikes in insulin, which eventually makes the pancreas less sensitive to insulin causing more to be produced. This "hyperinsulinism" leads to a state where insulin is always present, and this hormone is a potent blocker of fat breakdown and facilitator of fat production. All of this not only causes weight gain but also unstable blood sugar, which leads to bad chemicals that can break down cartilage.

How do you fix it? Well, since you can't change your genes, you need to change your diet. If you want an instruction manual on how to eat, get Dr. Pitts's book, *Nutrition 2.0.*



How do you know if you have better blood sugar control and, hence, are doing better protecting your cartilage? There are two tests, one that you can do at home and one that requires a doctor's visit. The first is what I call the "Dark-Chocolate Test." Before you start on this diet, you'll likely think that a 70% dark-chocolate bar tastes pretty bad or at least bitter. This is because you have set the level of sugar detection for your taste buds way too high by eating too much sugar and starch. However, once you are on a low-carb diet for a few months, the 70% should taste sweet. Next, try 80%. It should taste OK if you're a real low-carb superstar. If it doesn't, be stricter with your sugar intake. When you're done with your sugar transformation, an 85% bar will taste just fine, and that piece of birthday cake will be disgustingly sweet!

The doctor's office test is called an HbA1c serum level. This is a measure of changes to red blood cells in the presence of high blood sugar levels. It can take a few months to change, so get it tested a few months into a diet. While your doctor may tell you that anything below a 6.0 is fine, it's really not. You want yours well below 5.6, and for maximum protection, it should be below 5.1. Remember, tracking this number takes patience! As your blood sugar control improves as you eat fewer carbs, this number may take many months to drop all the way to its nadir.

Exercise

First, what are "normal" levels of exercise for cartilage protection? Second, does pounding exercise, like running, destroy joints?

We Americans and others who live in First World countries have become very accustomed to low exercise levels. My favorite candidacy review that I have ever performed was when I asked the personal physician of a Middle Eastern woman, who was a member of the royal family, whether the woman got much exercise. I was promptly told that the royal family took cars and a security detail to go around the block! While this is an extreme example, it gets the point across: we have lowered our expectations for exercise so much that we no longer know what our bodies were designed to do. Another example is the health club across the street from our office. I see people in there working out as if they are the walking dead, strolling along on an elliptical machine as if it were a Sunday stroll and not their half hour to work their body hard.

What our ancestors considered everyday activity, most of us would consider our toughest exercise day. Think about this for a moment. You wake up and haul 100 pounds of water a half mile from the river to your home. You then chop wood with a 30-pound iron axe for an hour. Then you get to walk/run 20 miles while you hunt the big game that will keep your family fed for the next week. You get the picture.

So what is "normal activity" for our conversation on "Living 2.0"? It's 30 to 60 minutes of exercise so intense that having a normal conversation is very hard. This is performed five to six days a week and combined with weight lifting. In addition, my definition of weight lifting is absolutely not what I see in the gym across the street. It's 6 to 12 reps of whatever weight causes your muscles to fail by the 6th to 12th repetition. So if its biceps curls, pick up the weight that will cause your biceps to stop working by the end of the set. Then do this twice more as a minimum biceps workout.

Why am I pushing the weights so hard? Because elderly weight lifters have muscles that at the cellular level look more like younger people than their old sedentary counterparts. In addition, exercise increases the stem cells in your muscles.

What if pain prevents you from getting to this level? Well, that's why you're reading this book. Our goal is to use regenerative therapies, diet, exercise, and specialized therapies to keep you this active well into your 70s and beyond.

How about pounding exercise, like running? Is this good or bad for your joints? Regrettably, this cartilage research is still all over the map. Some studies have shown that running is protective to knee cartilage while others have shown it's destructive. In the meantime, like anything else, everything in moderation, or get a good doctor! By this, I mean that the ideal workout mixes up lots of activities, which might include running.

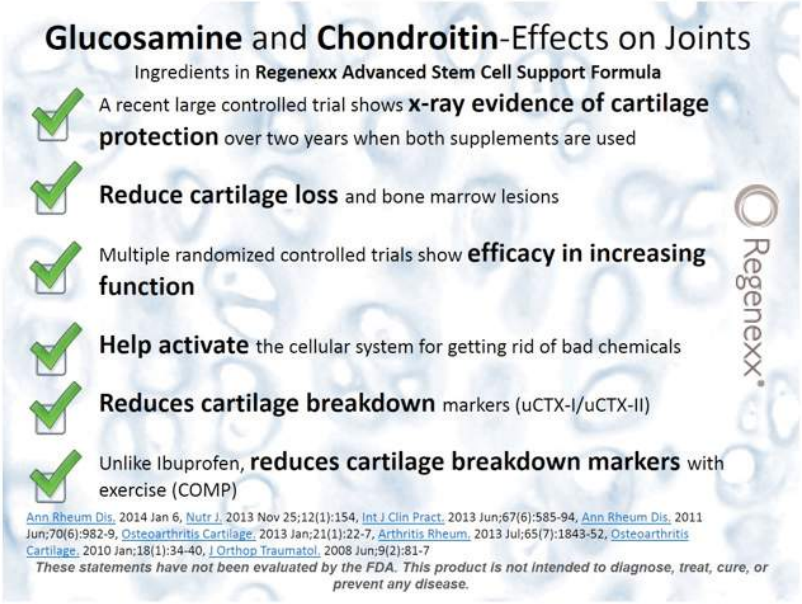
Supplements

One of the most frequent questions I get asked by prospective stem cell patients is what supplements they should take to help their chances of success. While from looking at the ads on the Internet, this would appear to be a very simple question, it's actually quite complex. The issue is that while some supplements have been tested with cartilage cells, we have very few that have been tested with stem cells.

What I can say is mostly from tests with either cartilage cells or early studies in patients where objective measures of cartilage health are used (not stem cells).

• **Glucosamine** is a very common supplement that can be derived from many sources. It's basically a cartilage building block, and there's a bunch of research showing it helps cartilage. See article 1, article 2, and article 3.

• **Chondroitin** is the cousin of glucosamine and another common cartilage-building-block supplement. Many studies also show it helps cartilage. See article 1, article 2, and article 3.



• **Fish oil** is a supplement that is taken widely, but poorly understood by most who take it. While this is an important source of omega-3 fatty acids that can help reduce swelling, and there's some evidence that it may help preserve cartilage, most people take way too little to see these effects. First, you need to make sure your fish oil isn't oxidized. So if your fish oil smells fishy, ditch it and get a better brand. Second, if you pop a few pills that you bought in a grocery store with the label "Fish Oil," you're taking way under the dosage associated with big health benefits (the amounts that Greenland Eskimos consume). Using that math, it would take 20 to 30 pills per day of these garden variety capsules to match this amount. An easier way to take more omega-3s is to buy concentrated EPA/EFA brands. This is about 3,000 to 6,000 mg of omega-3 fatty acids per day. More on all of this at this link.

• **Curcumin** is an extract of the Indian spice turmeric. The research looks promising that it's an anti-inflammatory and may help preserve cartilage. In fact, one study shows that it's as good as Motrin for pain and swelling. It also seems to work better when combined with other supplements like resveratrol.

• **Resveratrol** is a powerful antioxidant and activator of the SIRT1 gene which has been associated with longevity. It's found principally in the skin of grapes, and it's thought to be one reason the French suffer fewer cardiac events. Apparently, all of that red wine is loaded with resveratrol! It also seems to help poor blood sugar control. That middle-aged paunch caused by declining insulin control can also eat up cartilage, so resveratrol may protect joints.

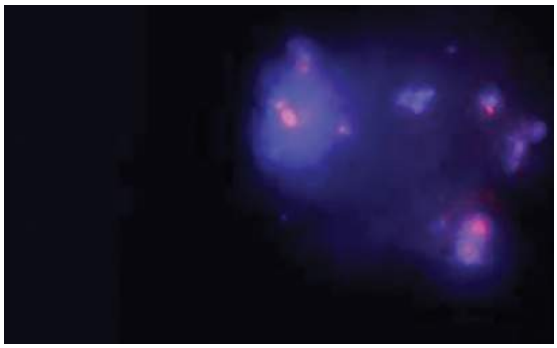
There are literally a hundred other supplements touted as good for arthritis. However, our patients also want supplements that will help their stem cells, yet little stem cell research exists with supplements, which is why we had to create our own.

At first, I thought this would be a quick two- to three-month project of testing stem cells with supplements to see how they grew. As we got further into this project of determining which supplements were the best at stimulating stem cells to grow more cartilage, the science got more and more complex. We learned we needed to look at the following:

• How the stem cells from the bone marrow of different ages of donors responded to different supplements. Most studies in this area choose young stem cells by default since samples are often bought through a science company or taken from grad students. Yet older stem cells are different and need to be tested alongside younger cells. In addition, the stem cells from arthritis patients are likely different, and few twentysomething grad students have arthritis. As a result, we took all of our cells from real arthritis patients.

• How the stem cells grew when exposed to supplements. This is not so easy, as many supplements are digested into different forms before they reach the bloodstream, so we tested these forms as well.

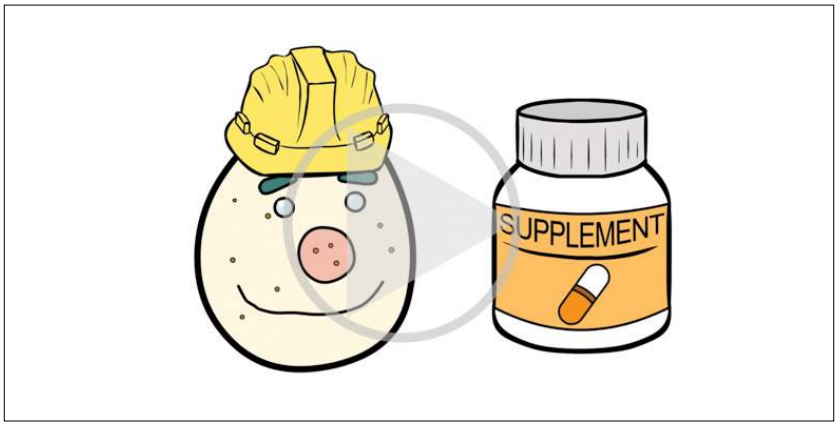
• How well the stem cells produced cartilage components when exposed to various supplements. To do this, we needed to look at the cells as they produced these cartilage-building blocks with quantitative fluorescent microscopy. To the right is an example of what this looks like, with the bright areas representing the amount of cartilage components—collagen 2, aggrecan, and SOX9—being produced by the cells.



• How well these supplements were able to support the overall robustness of the cells. A cell can look great in culture, grow well, and produce cartilage, but how healthy is it when stressed? In medicine, an example is the stress test for the heart. While someone might appear healthy, when they're pushed to the limit on a treadmill, their heart can show signs of trouble. We did the same thing for cells by adding in common bad chemicals found in arthritic joints that beat up cells like IL-6 and then seeing if the supplements helped the cells recover better.

• Determining the sourcing. Most supplements come from many different sources. As an example, glucosamine can be extracted from any number of shellfish sources, pig parts, or cow parts. Is one of these better than the other at helping human stem cells?

In the end, after a year of testing, we produced a supplement we could hang our hat on: Regenexx Supplement. One that was based on basic research that we felt represented what we were trying to accomplish in patients. While every other supplement you can buy is merely put together based on snippets of data taken from unrelated lab research done by others, ours was a coordinated and costly plan to find the best ingredients for our patients. Click on the video link below to see a short animation on the Regenexx Supplement.



Prescription Medications

When we first began culturing cells in 2006, we were surprised to find that some patients' stem cells wouldn't grow well. After a few culture failures, we decided to try and isolate the problem, and after much trial and error, we were surprised to learn that the culprit was usually a prescription medication. For example, when we would stop the patient's medication and take new cells and reculture them, the stem cells would grow fine. We could also get the cells to grow fine when we exposed them to the serum of another person who wasn't on the drug (for research purposes only). This convinced us that many prescription medications are toxic to stem cells.

What should you avoid? Likely, the most surprising thing we encountered was that America's wonder drugs, cholesterol medications known as statins, seemed toxic to stem cells. I would take a minute to read about the limited efficacy of these drugs if you're on them, but only make any decisions to stop the drug after consulting your primary care physician. Other drugs that were problems included NSAIDs, like ibuprofen, Motrin, Aleve, and Celebrex. Given that NSAID drugs carry significant cardiac risks, not taking these drugs makes sense. We have found fish oil makes a great alternative anti-inflammatory, and research supports this effect. Other problem drugs include ACE inhibitor blood pressure medications that are usually taken to combat hypertension due to metabolic syndrome. Rather than take these drugs, increase activities and cut the carbs to control your blood pressure. Finally, steroid anti-inflammatories are also a big concern, as they are toxic to many different cell types, including stem cells.

Hormones

We take our hormonal mix for granted, a little like the fact that our heart beats more than 100,000 times a day. Yet if you're trying to control your weight and stem cells, these hormones can play a critical role as you age. For example, serum taken from women after menopause (when many hormones are no longer produced) directs stem cells that should turn to bone to turn into fat instead. For men, testosterone levels decline as we age. Yet testosterone can activate stem cells to produce more muscle and less fat. While the jury is still out on the effects of sex hormones on stem cells, in men it's pretty clear that supplementing these hormones in middle-aged and elderly patients can help overall body composition, reducing fat and increasing lean muscle mass and likely improving heart health. The same has been shown for women. On the other hand, the willy-nilly prescribing of testosterone in men, without strict monitoring, may be linked to an increase in heart attacks.

Should you supplement your hormones? This is a personal decision. In my experience, it makes it much easier to keep the pounds off and activity levels high as we age. On the flip side, for men, urologists have been concerned that testosterone may cause prostate cancer. However, newer research suggests this likely isn't the case. In addition, without strict monitoring, the excess production of blood cells may be the cause of blood clots that can cause heart attacks. For women, the Women's Health Initiative study suggested

that estrogen pills could cause cancer, yet the study authors have since stated that the press misinterpreted their results. They now recommend hormone therapy for younger women just after menopause.

My Own Living 2.0 Story

At the age of 37, I was at the low point of my personal health. My wife and I had just gone through the trauma of having premature twins, and my exercise was sparse while my sleep was nonexistent. My weight had ballooned such that my waist had gone from a 32 while in residency to a 42. Just jumping onto our high bed made my heart race. I was an early heart attack waiting to happen. It took over a decade to completely climb out of the hole I dug, and I learned quite a few things. Had I known these at 37, I could have been in perfect shape by 40!

What did I learn along the way?

• **Carbs are key.** While for my wife's genetics, carbs aren't important, for me they are everything. I spent years on fad diets, trying to prevent my waist from ballooning and avoiding any type of shopping for pants (as that meant admitting that I could no longer fit into a size 40), none of which worked. In the end, it was understanding that limiting my sugars and starchy carbs was the answer. However, that got me only part of the way there.

• **Understanding what the term "workout" means.** Like I have said, I see people working out at the gym like they're the walking dead, and I understand that once that was me. It wasn't until I got a personal trainer that I finally understood what working out was all about. My trainer worked me like a dog, and the harder he pushed, the more I wanted. It took a few years with a trainer to understand that to stay in good shape in middle age for most of us requires working very hard. An example is the *INSANITY* workouts. For most of those 30 to 40 minutes, the exercise is tough enough that holding a conversation is difficult—you're simply pushing too hard. A kinder and gentler approach that starts slow and builds (by the same trainer) is *FOCUS T25*. The same applies with weights, which should be a cardio workout as well. If you're not huffing and puffing while you quickly move from one weight station to the next, you're not hitting it hard enough.

When I finally figured this out, my weight went down again. But there were still two more pieces.

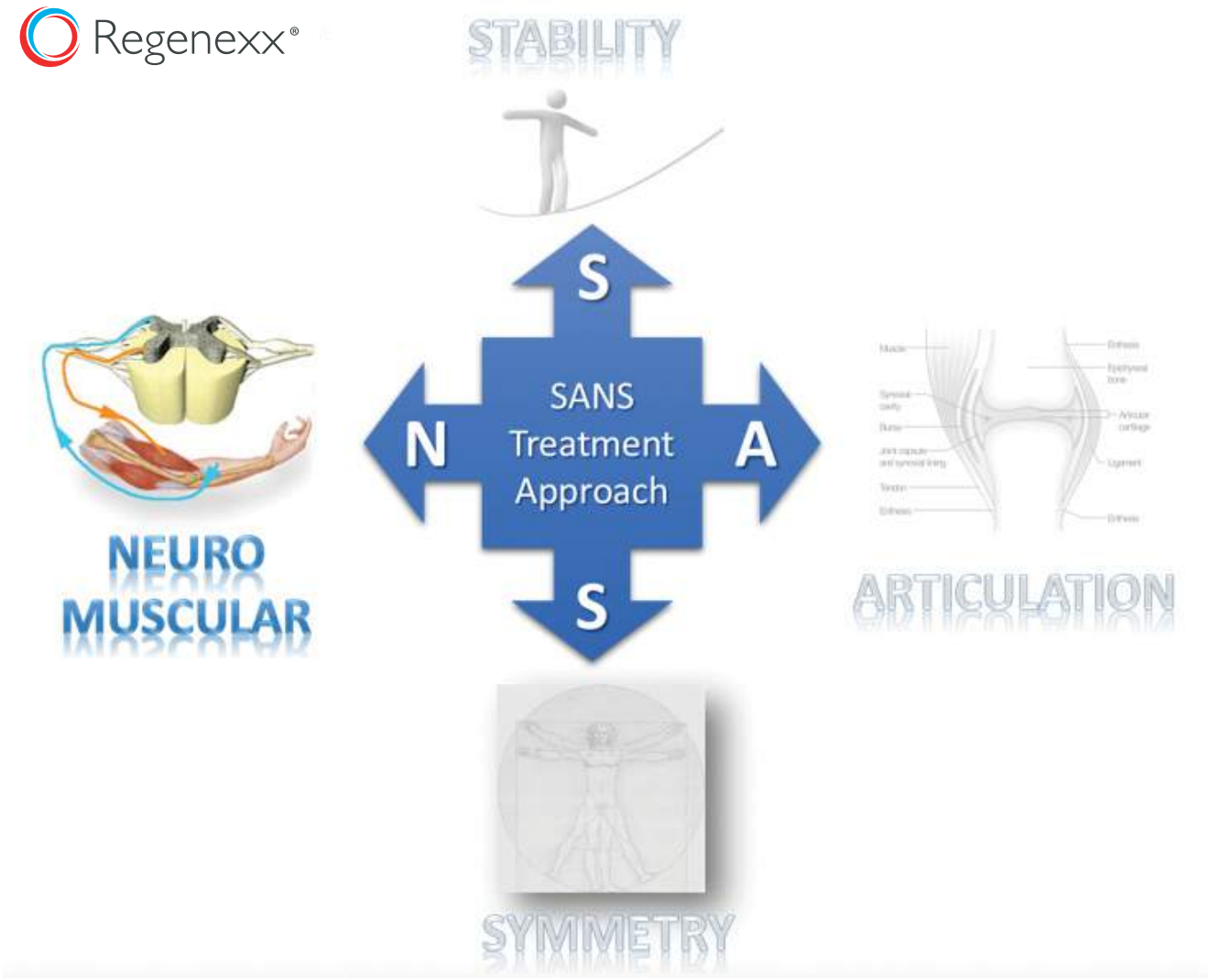
• **Hormonal control** is a problem for middle-aged men and women. I spent many years being asked to lecture to doctors involved in age-management medicine as many are very interested in stem cells. I would sit through the lectures before and after mine, which were about supplementing hormones in middle-aged and elderly men and women. I have to say that at first I thought these doctors were a bit nuts. Was this really necessary? After a few years of seeing countless lecturers review the science, I was convinced that I had to be my own guinea pig. In 2010, I worked with a Denver-based age-management specialist to check my testosterone levels. They were dismally low, so I started testosterone therapy. The final piece of the puzzle clicked into place for me. Much of the extra weight that I had

been carrying melted off as I already had the diet and exercise piece under good control. Unlike the recent rush to prescribe testosterone to everyone with "Low T," this program is carefully monitored. Which brings me to the last part.

• **Proactive injury management is important.** You can't help but get injured from time to time if you're hitting exercise hard enough to stay active as you age. I constantly look at my joint stability, levels of nerve irritation, muscular firing, and body symmetry—just as I describe in this book. All of this is to try and prevent injuries or catch problems when they're early. Since supplementing testosterone pushes my blood hematocrit up (the number of red blood cells), I put those extra blood cells to good use. Once every two to three months, I have blood taken to reduce my hematocrit and to fuel the Regenexx-SCP and Regenexx-PL procedures. I proactively have small issues treated with these regenerative cocktails. As an example, my right knee, left shoulder AC joint, right elbow, and low back are common problem areas for me. These aren't disabling problems but are areas of constant irritation—all likely related to wear and tear and declining stem cell activity as I age. So I have my colleagues give these areas an "espresso shot" of my own healing blood platelets.

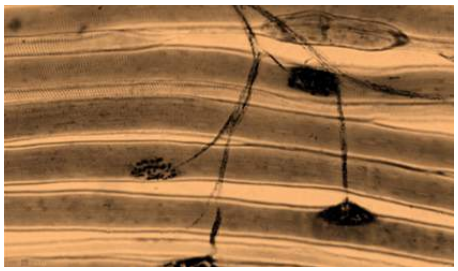
The conclusion? For me, controlling my weight, staying off prescription drugs, and staying active requires four key elements: diet, exercise, hormones, and early injury detection and management.

Chapter 4: Neuromuscular



"My countrymen should have nerves of steel, muscles of iron, and minds like thunderbolt."
Swami Vivekanda

For many readers, the term “neuromuscular” is a new term. To clarify, as it’s used here, it means both nerves and muscles and is often used to refer to the connection between the two. While the nerves in various parts of the body tell many different organs what to do, the most visible organ they direct is muscle. Your nerve says, jump, and your muscle says, how high?



Think of the nerves as the wires that connect the main computer (the brain) with the muscles. You think of a movement, and the brain generates a nerve impulse that drives muscles. Information also goes the other way, from the skin, muscles, joints, ligaments, and tendons up to the brain. This information is called “proprioceptive” and allows you to finely adjust your movements to what’s going on in your environment. For example, if you step on something unstable, you might fall. However, that information is quickly relayed to the spinal cord where reflex patterns stored there instantly adjust your stance.

As discussed above, this type of stability during movement is made possible by proprioception, which is used to provide real-time feedback so that a moving joint stays in finely tuned alignment. For example, if the joint experiences forces that might cause it to translate or shift too much, small joint sensors detect this motion and instantly tighten muscles to counteract that abnormal motion and keep the two joint surfaces aligned (keep the joint in the neutral zone). If this didn’t happen thousands of time each day, the joint would wear out much more quickly.

What happens when this system of sensors, nerve impulses, and finely tuned muscle firing goes off-line? As discussed earlier in the “Stability” chapter, all heck breaks loose. In this chapter you’ll learn that when spinal nerve irritation or compression occurs, the muscular stability system for the spine goes off-line, and the spine becomes unstable. I believe the same happens in peripheral joints, like the knee. If spinal nerves are irritated in the back (note: you may not feel any back pain), the muscles that help stabilize the knee in movement can go off-line or have reduced efficiency, and thus, the knee joint becomes unstable. So now, when the knee experiences abnormal forces like a shift, the wiring loop through the spine between the joint sensors and the muscles that protect the spine is impacted, causing an ever so slight delay. This delay leads to a joint that gets out of alignment more easily during motion and as a result, a joint that is more likely to become arthritic. Since this concept of muscular activation delay has already been very well documented for spinal stability (here the delay causes the vertebrae to become unstable in movement), there is no reason to believe it only applies to the spine.

One of the problems we’ve had as a medical community is our main and most widely available test for diagnosing nerve pathology (electromyogram [EMG]/nerve conduction study [NCS]) is very specific for certain types of nerve injuries (such as when a nerve is

wholly or partially destroyed by trauma) but not very sensitive for other types of nerve problems. In particular, many significant problems with the nerves involve small fibers (small-fiber neuropathy), whereas the EMG/NCS test can't detect this type of pathology. In addition, the test has very poor sensitivity in detecting nerve irritation. While other more sensitive nerve tests (in particular, quantitative somatosensory tests [QST]) are commonly used in research, they are not yet widely used by physicians. So in a real way, physicians are often "flying blind" from a diagnostic testing standpoint in figuring out when nerves are sick.

So in summary, even small amounts of spinal nerve irritation may not cause any noticeable back or neck pain, but it can wreak havoc with the muscular stability system either in the spine itself or in your joints. Since this system protects your joints during activity, when this type of nerve problem takes muscles off-line or reduces their efficiency, this will eventually lead to less protection for the joints and an earlier onset of arthritis. In addition, the diagnostic-test toolbox we have available to us today doesn't include tests that are capable of detecting this type of nerve problem, hence the reason this problem often goes undiagnosed. In addition, I believe that treating this problem is a key component of long-term joint preservation.

Take This Simple 10-Item Test for Nerve Problems

1. I have numbness, tingling, burning, or electrical sensations.
   Yes / No
2. I have chronic tightness that feels like pressure in my arm or leg with certain activities.
   Yes / No
3. I have a chronically tight muscle that just won't "let go" no matter how hard I stretch.
   Yes / No
4. I have pain in my wrist area whenever I reach for something.
   Yes / No
5. I have pain in the back or bottom of my heel that won't go away.
   Yes / No
6. One arm or leg always seems to be significantly weaker or smaller than the other, no matter how hard I try to strengthen it.
   Yes/No
7. My arm or leg feels a bit "goofy" or uncoordinated after I do certain things.
   Yes/No
8. I have an area of chronic pain that just won't go away no matter what I try.
   Yes/No
9. I have chronic neck or back pain.
   Yes/No
10. I had a back or neck problem years ago, but it seems to be fine now.
    Yes/No

If you answered yes to any of the above, you may have a nerve/muscle problem and not know it.

Questions 1 about numbness is more obvious. Most people associate these symptoms with nerve problems.

Question 2 isn't so obvious. When there's pressure on a nerve in the neck or back, many patients don't necessarily feel neck or back pain, but instead feel pressure in the muscle that is supplied by that nerve. Some patients describe it as feeling like a blood-pressure cuff is pressing on the muscle.

Question 3 is also not obvious. That chronic hamstrings or groin tightness you've been blaming on being out of shape could actually be caused by a pinched or irritated nerve.

Question 4 is really interesting. We commonly see this when there's scarring around the median and/or ulnar nerve. Reaching out to get something places the nerve on stretch, and since it's scarred, it can't move with the arm, which causes pain where the nerve is scarred down.

How about question 5, the heel pain? Most patients with plantar fasciitis would think it must be caused by something in the arch of their foot. However, we see patients every day who have S1 nerve problems in their back or a pinched tibial nerve at the ankle who have this problem caused by an irritated nerve.

Question 6 may seem more like something associated with a nerve, but the weakness or atrophy (smaller muscles) I'm talking about is where one arm or leg is notably smaller, not the kind you see in paralysis.

Question 7 is an extension of 6, as sometimes patients with nerve problems note that their arm or leg seems uncoordinated.

Questions 8 and 9 are connected, in that a bad nerve can cause pain just as readily as it can cause numbness, tingling, or burning.

Finally, it's important to note in question 10 that many patients who no longer believe they have any back or neck problems because the pain has gone away still have bad nerves that cause problems in joints, muscles, and other areas.

Arthritis Doesn't Cause Pain; Pain Causes Arthritis

I saw this title come across a science news feed a few years back. It hit me like an unwelcome pie in the face, as I had often suspected that something like this had been happening in my patients. The concept is simple, yet it will change the face of orthopedics and rheumatology forever. What was discovered? That irritated nerves can cause bad chemicals to dump into joints, which leads to cartilage breakdown.

Since that time, many other articles have been published confirming this link between bad nerves and bad joints (see here, here, and here). This discovery is equivalent to when we doctors learned that stomach ulcers were caused by bacteria and not stress (I was taught in medical school ulcers were due to stress).

How can arthritis be caused by pain? The authors created an elegant animal model that showed that nerve activation in a joint leads to bad chemicals being dumped into the joint, which leads to pain and faster onset of joint arthritis. This is a reverse of what has traditionally been considered (i.e., that a joint is injured and begins to degrade and then causes pain). It's important to stop for a moment to consider how these scientists have turned orthopedics on its head. Again, our entire orthopedic care model is based on the concept that injury in a joint (or accumulated injuries over a long period of time) leads to arthritis in the joint, which leads to more joint breakdown and pain. This new model reverses the old paradigm so that now it's aggravated nerves that lead to arthritis. Sound familiar? I believe this is just an extension of what we've been discussing here: problems with spinal nerve irritation lead to bad chemicals being dumped into a joint and a "sloppy" joint with poor stability, which ultimately leads to arthritis.

I have had my own knee problems caused by my back. Using this new model, my knee problems were caused by spinal nerve irritation (which I never perceived as low-back pain) causing not only a sloppy knee joint (due to parts of the big stabilizer muscles being shut down by trigger points) but also bad catabolic (breakdown) chemicals dumping into the joint. This issue was quickly fixed not by operating on my knee or even injecting magic stem cells into the knee, but by bringing the spinal and joint stability systems back online by using IMS to get rid of the trigger points. What are trigger points? Read on.

Low-Level Arthritis Pain vs. Nerve Pain

Based upon my clinical experience and this new model of nerve-related joint pain and arthritis, I would place patients into two distinct categories: what I'll call "neuropathic arthritis" versus "classic arthritis." Early on in the degenerative process, and for some patients who have more of a spinal component to their joint pain, patients are firmly in the "neuropathic arthritis" (NA) camp. These patients have severe joint pain that is often disabling or can become disabling with certain types of activity. I see these patients in the clinic, often very desperate because their joint pain is very intrusive. They are either completely disabled by their pain or they are unable to exercise at high levels.

In this new model of joint pain, these patients have an active spinal nerve problem manifesting as joint pain. They are often unaware that this joint pain is linked to their spine, but if you dig enough, they will usually admit to a history of spinal problems that have either (in their mind) been successfully treated (perhaps with a surgery many years in the past) or are ongoing, but the pain is low level and (in their mind) under good control. They have usually had several unsuccessful joint surgeries, which didn't work because while they have issues in the joint, they also have active issues in the spine that were unaddressed by their joint surgeries. Treating the spine in these patients can often make a huge difference.

The second camp is the traditional "classic arthritis" (CA). The CA group no longer has an active spinal component, or if they do, their arthritic joint has long since degenerated. Their pain pattern is different and matches what we know of arthritis pain. You may remember your grandparents being stiff in the morning with low-level pain that became better with activity as the joint "warmed up." Just like gramps and granny, once these patients start moving, they generally feel better. Treating the spine in this group is often too little too late, as the joint damage is done.
It's important to note that there are other factors at play in many of these patients, so this is a simplified discussion. For example, patients with knees that are unstable from a ligament standpoint may also have more pain when they are active, and patients with bad knees due to severe trauma may have less pain as their joint warms up. Like anything in medicine, the body is a very complex machine, hence the SANS approach, which looks at all components of the musculoskeletal system.

So What Can Be Done to Fix the Spinal Nerve-Joint Connection?
Despite research showing that irritated spinal nerves may be associated with joint problems, most physicians have a hard time associating joint pain with a low-back nerve problem. The first step in identifying a spinal nerve component as a cause of knee pain is simply a thorough neurologic exam. When I say a complete exam, I don't mean the "Can you feel this?" type of neurologic exam. Instead, I mean a careful exam that's focused on comparing sensation from side to side and on the same side, testing multiple different types of sensation. This includes not only light touch (the can you feel this exam) but also pain sensation (pinprick) and perhaps hot/cold sensation. The exam also recognizes that there are multiple types of pain and nerve referral patterns, including those from spinal joints, nerve trauma, and muscle trigger points.

If the exam shows that spinal nerve irritation may be occurring, the next step is a spine MRI. Correlations between the exam findings and the MRI are important. In addition, this correlation acknowledges that while spinal nerves can be compressed by bone spurs and herniated/bulged spinal discs, they can also be irritated by sloppy stability in the spine. An MRI marker of this type of sloppy stability can be seen on MRI as multifidus muscle atrophy. So even though there may be no bulging disc on the spinal nerve, significant atrophy of the deep stabilizers at this level (multifidus) combined with sensation problems at the nerve in the leg means that the spinal segment is likely sloppy from a muscular stability standpoint.

Treatment for Irritated Spinal Nerves

Your spine has discs, which act as shock absorbers. The diagram to the left shows that the spinal discs can herniate their inner contents (nucleus pulposis), which can place pressure on spinal nerves. This is called radiculopathy (if more severe) or radiculitis (if less severe). This has also been called "sciatica," although this is not an accurate term. The traditional solution is to surgically remove the herniated portion of the disc sitting on the spinal nerve. In the 1940s, this was a great advance. Patients with numb and weak legs due to a bad back now had a treatment. On the other hand, it began our current move toward invasive spine treatment, a path that many have criticized.

If I have knee pain, why should I care if there's a problem in my low back? Again, the two issues may be very much linked together. If your doctor believes that there is a connection, he or she needs to treat your low back along with your knee.

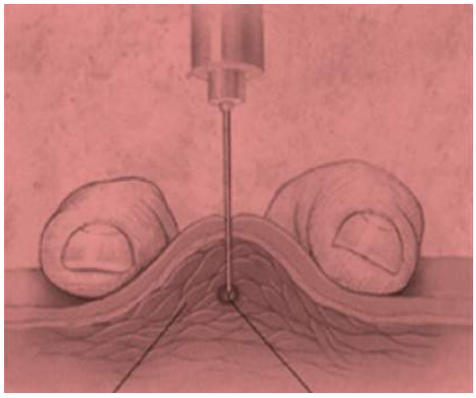
Can We Use Platelet Lysate Injections to Help Damaged Nerves?

In medical school, I was taught that while a damaged nerve might be able to regenerate a little bit over time, most nerve injures were permanent. Recently, we investigated whether nerves might be helped by injecting around the structure. The simplest form of this procedure is called nerve hydrodissection. Basically, fluid is injected around the nerve using very strict ultrasound-imaging injection protocols. This frees the nerve up from any scarring that may cause pain. Next, platelet lysate (a cocktail of growth factors isolated from your blood platelets) is injected to help the nerve heal. We've seen some very interesting results in select patients with everything from severe chronic nerve pain (complex regional pain syndrome [CRPS]) to more specific nerve damage. We remain cautiously optimistic and will continue to move forward trying to help these patients who have few good options.

Making the Transition from the Nerve to the Muscle

You've learned about the nerves. Now you must learn about where the nerves go—the muscle. We like to think of these as separate structures, yet one look at the former Superman actor Christopher Reeve in his wheelchair shows they are not. A spinal cord injury in his neck shut off all nerve input to the muscles. What happened? He went from being one generation's Superman to being shriveled up. Why? The nerve and the muscle are one continuous structure. What happens to your nerves directly and immediately impacts the muscles.

The Nerve-Muscle Hotspot: Trigger Points



Trigger point injections (TPIs) were first popularized by Janet Travell, MD, one of JFK's physicians. Janet's techniques made it into popular medical culture because JFK had a bad back that often responded well to her trigger point injections with numbing medicine.

Sometime later, Canadian neurologist Chan Gunn, MD added a significant piece to the trigger point puzzle. Travell had noted that just using a needle without injecting anesthetic (dry needling) seemed to work just as well. To the medical establishment of the day, this seemed like voodoo. At the time, Chinese acupuncture was largely unknown in the West, so Travell largely placed her emphasis on injecting anesthetic and anti-inflammatory medications. Gunn grew up in Korea, where a more aggressive form of Korean muscle acupuncture was common, so he moved forward with Travell's dry needling technique, substituting the much finer and less traumatic acupuncture needles for the more traumatic cutting-edge injection needles used by Travell. Gunn also theorized that the muscle trigger points that Travell thought were due to overuse were more likely caused by nerve irritation.

The science of the last 20 years supports Gunn's theory that nerve problems (autonomic and likely spinal nerve) and trigger points are closely related. By the early 1990s, while physicians who were experts at trigger point injections were few and far between, TPIs were used by a plurality of doctors treating musculoskeletal pain. Then something happened that often drives the course of medical care much more than efficacy or science—the reimbursement changed.

Prior to the mid-1990s, a physician could receive adequate compensation per site injected. After the mid-1990s, the average compensation for this procedure was reduced by about 70–90%! In addition, getting compensated by insurers became more difficult. This was all it took to relegate the art of trigger point injections to the history books. Today, because of this reimbursement collapse, finding a physician experienced in managing this type of muscle pain is like finding a needle in a haystack (pardon the pun).

I think my own personal story is important. In the late-1990s I attended a medical conference that involved days of sitting. For an unknown reason, my left knee began to ache and swell. There was no trauma to the knee. I was literally hobbling around the office, and all of my aerobic exercise came to a screeching halt. I underwent an MRI, convinced that I had somehow torn a meniscus or some cartilage. While the MRI showed the swelling and perhaps some questionable small tears in the meniscus, it didn't show a "smoking gun" cause for my severe pain.

I went to see an orthopedic surgeon who wanted to perform a diagnostic arthroscopy, likely chop out some meniscus and remove a "plica." I was desperate and convinced the MRI was missing the true cause, so I reluctantly signed on for surgery. A few days before the planned surgery, a visiting doctor from Canada was in our clinic and asked if I had tried trigger point therapy in my quadriceps muscle and low back? I said no, looking at him like he was some alien speaking in tongues. At this point, I had seen the best physical therapists in town and failed all of their exercises, so I was desperate. I told my Canadian colleague that I would try anything.

Turns out, this visiting physician was one of those "needles in a haystack" as he was experienced in the Gunn trigger point technique (called IMS, short for intramuscular stimulation). He examined my thigh muscle (quadriceps) and my low back, pulled out an acupuncture needle, and proceeded to stick this in my low back and thigh muscles. The muscles cramped suddenly as the needles hit the trigger points (more strange than painful). After a two-minute treatment, I got off the table and walked normally. That night, I went running for the first time in months, without a twinge. I canceled my surgery and have never looked back. I was so impressed, I learned the technique and began using it in patients. IMS has revolutionized our practice, providing relief to patients who would only otherwise be treated by much more invasive treatments. Because of reimbursement issues (insurers don't generally cover IMS, and the other form of trigger point therapy [TPI] is poorly reimbursed), the technique has remained obscure. There may be other reasons the technique has never moved to a wider physician audience, as it takes significant effort and dedication to learn how best to apply the procedure to get consistent results.

At a medical conference where both traditional Chinese acupuncture and IMS were being taught, I had insight into how my medical colleagues view this complexity. After Dr. Gunn lectured about IMS, I turned to the physician sitting to the left of me and asked, "Wow, isn't this IMS stuff great?" Her response was, "It's too complex. You have to learn where all the muscles are, what they do, where to put the needle for each one, what to avoid...With traditional Chinese acupuncture, I just look at a chart on the wall and put the needle at X marks the spot."

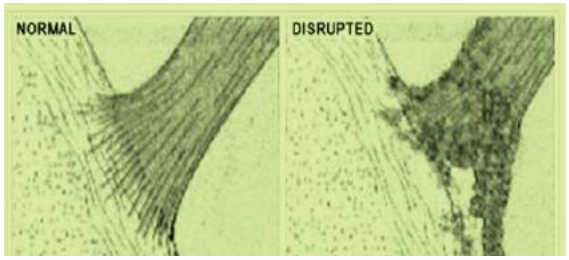
So while traditional Chinese acupuncture (placing a needle into the skin at specific Chinese chi points) has become popular, IMS has remained in obscurity. These past few years, IMS has finally taken a leap forward by being adopted by various Colorado physical therapists (PT). One of our former PTs who we had trained in IMS went through the red tape to allow physical therapists to widely practice the technique after very intense coursework. As a result, IMS is now gaining more acceptance, and more patients are getting more access to the technique through physical therapists.

How Can My Back Cause My Knee Problem if I Have No Back Pain?
Let me again use my own example. While I no longer had back pain when my knee went out, how did my low back cause a knee problem? How does that work?

On that fateful day at the end of the medical conference, muscle trigger points in my spine and thigh caused severe knee pain and swelling. Did I have a back issue? Turns out, I had fractured a few little bones in my back about 10 years before the day I had my knee pain. Other than a few bouts of mild stiffness, I had never had any ongoing back pain after the fractures, just a sudden and unexplained onset of knee pain. So what's the connection?

The low-back spinal nerves were irritated, which caused big trigger points to develop in my quadriceps thigh muscle. As this happened, large sections of that big muscle began to shut down, turning off the major stability system of the knee, which began to swell because of the extra wear and tear due to abnormal motion. Why didn't my back hurt? Pressing on spinal nerves generally doesn't give you back pain; it causes symptoms where the nerve innervates (the area the nerve supplies). So if I took magic fingers and pressed on the right-L5 spinal nerve in your back, you would feel it in your right leg and big toe, not your back.

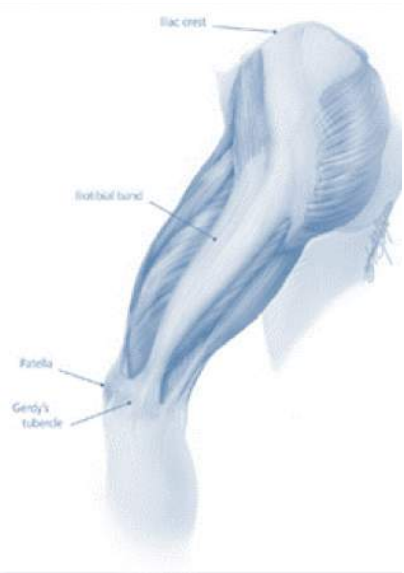
Enthesopathy
We take for granted that our muscles not only contract but also have a function as shock absorbers, letting go in a controlled fashion. As an example, when you jump from a fence at a height of just four feet, your femur bone should break. Why doesn't it? The big quadriceps muscle absorbs the shock by acting an eccentric contraction (controlled release). When a muscle has trigger points, the biomechanical properties of that muscle change. Large sections of the muscle can lose their ability to act as active shock absorbers. We believe this leads to extra pull on the areas where the muscles attach to the bone. This causes swelling and breakdown of these areas known as enthesopathy.

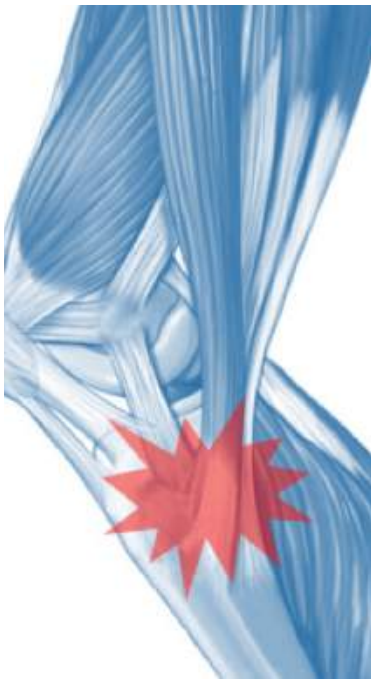


Enthesopathy means that where a tendon attaches to bone, the tendon is aggravated and swollen. If this goes on a long time, you may see small tears in the ligament. If it gets really severe, you may see bigger tears. All of this can cause pain.

While many physicians will recognize problems in joints, and fewer will recognize trigger points in muscles, in our experience, even fewer will recognize enthesopathy. This is a problem, as many patients suffer from this problem. The good news is, a new generation of physicians armed with PRP to treat tendons and ultrasound imaging to detect problems in those tendons is finally beginning to address this important problem.

What Are Common Areas of Enthesopathy Around the Knee?





Iliotibial Band (ITB): This is an area at the side of the hip and leg that begins from the top of your hip and extends down to the knee. Patients with chronic instability in the sacroiliac joint tend have problems here. The ligament is rarely torn, but can be irritated.

Pes Anersine: This area is a common insertion for many muscles that travel in the front of the thigh, including the sartorius, gracilis, and semitendinosus. These patients have pain on the inside of the knee that is below the joint and is often confused with meniscus tears. We see this problem in patients who have low-back issues leading to knee pain.

Hamstrings: The hamstrings are muscles that make up the back of the leg and attach to the back of the knee. They're responsible for helping to set the position of the bottom knee bone on the top thigh bone and for helping the knee meniscus position itself correctly. They can become painful at the back inside or outside of the knee. This pain is often confused with a torn meniscus. We frequently see this happen when the S1 nerve in the low back is fired up. Patients may not recognize that a back problem is causing the pain at the back of the knee as all they may feel is that their hamstrings are chronically tight.

Quadriceps: The quadriceps muscle attaches below the front of the knee at the patellar tendon. This area can become tender and swollen. In addition, the area above the kneecap can become swollen, which is called the quadriceps tendon. This often happens when the upper low-back nerves are irritated.

Achilles Tendon: This is the thick tendon at the back of your ankle and heel. It connects your calf muscle to your heel, so it's responsible for pushing you off as you walk. It can get torn in middle-aged and active elderly patients, usually during sports performed beyond current fitness level. It can have partial tears inside the tendon or can tear completely by snapping back like a rubber band. It's also very common in patients who have S1 nerve problems in the low back.

What Happens When Tendons Have Bigger Problems?
We've discussed what happens when tendons attached to bone are overloaded and aggravated. What happens when they fail? For partial tears, in our experience, platelet rich plasma (Regenexx-SCP) works well. For complete tears, where the pieces haven't retracted back like rubber bands, same-day stem cells tend to work well. For full-thickness retracted tears, where the ends have snapped back, surgery is likely needed (although we're working on nonsurgical options).

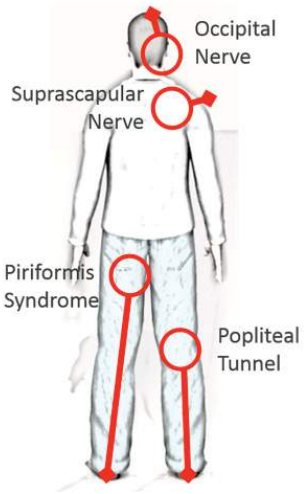
Peripheral Nerve Entrapment
A "peripheral nerve" is simply one that instead of living in your spine, lives in your torso, hips, arms, legs, hand, feet, and so on. So the nerves that live in and around the knee are peripheral nerves. The nerves that course through your body sometimes have to make it through some tight spots. The more common tight spots have lent their names to common medical maladies like "carpal tunnel syndrome" (the tight spot for the median nerve in your wrist). These common tight nerve areas are in all parts of your body.

Here are a couple of common areas where nerves get entrapped and cause symptoms in the knee:

Piriformis Syndrome: This is entrapment of the big sciatic nerve as it travels through the piriformis muscle at the back of the hip. This can cause leg pain, numbness/tingling, or weakness.

Popliteal Tunnel: This is an area at the back of the knee where the tibial nerve travels to the lower leg. It can become compressed when there is a Baker's cyst in the knee. The symptoms are leg and foot numbness, tingling, weakness, or pain.

There are many more places where nerves can become entrapped throughout the body.



Superficial Nerve Syndromes
There are many places where nerves pass through small tunnels in the fascia that covers your muscles. These small tunnels are all over your body, and, recently, a physician from New Zealand (Dr. John Lyftogt) developed a technique to treat this type of pain. Basically, the area is localized on exam or with ultrasound (the small nerve appears swollen at one of these common tunnels) and injected with a solution to reduce nerve pain (usually 5% dextrose in anesthetic). This procedure seems to work well in chronic-pain syndromes where the patient can localize certain areas on the skin or just below the skin that when pressed, re-create the pain pattern. For example, a patient with pain on the outside of the knee where the skin nerve exits the kneecap fascia (the covering tissue of the outside of the kneecap). This area can be pressed on, and this reproduces the pain. Another use of this technique can be in widespread pain where many injections are used at many nerve exit locations.

Central Sensitization

Let's say you're in your car and suddenly all of the warning lights start to go off. You take the car to the mechanic, and he or she says that there may be a few things wrong here and there with the car, but the real problem is that the wiring is bad. This is central sensitization (CS) also known as complex regional pain syndrome type II, fibromyalgia, neural sensitization, and so on. In all of these conditions, it's an injury to the pain-reporting wiring of the body (the nerves and microprocessors that control them) that causes the problem. The nerves become hypersensitive to pain. This phenomenon has been extensively published—most references are for whiplash or fibromyalgia. This problem is also now being discussed as related to joint pain (as discussed earlier).

Patients with CS simply have a nervous system that's on fire. At its early stages, it may cause arthritis (see above), but as this gets worse, large areas of the body can be impacted. In addition, these areas don't follow normal nerve pathways like dermatomes (skin areas associated with certain spinal nerves), so oftentimes many physicians without training in this area label these patients as having "nonanatomic" sensation problems. These patients, as they progress, can't tolerate physical therapy, massage, injections, acupuncture, IMS, and so forth. Our research group demonstrated that at an early stage, trigger points may make the sensitization problem worse. At later stages or when more severe nerve injury has occurred, cold sensitivity is common. For example, for patients with traumatic CS, a cold summer's night (about 60 degrees Fahrenheit) is actually painful, as that's all it takes to activate pain nerves.

Think about this for a second: How cold would it have to be for a normal person, you, to perceive cold as pain? Below freezing? Twenty below? These patients feel this at less than 60 degrees.

CS patients are generally the most difficult patients to treat. First, the pain sensitivity levels have to be brought down to a more normal level. One way to do this is medication. We have seen many medications for this type of nerve-related pain come and go—Neurontin, Tegretol, Elavil (amitriptyline), Doxepin, just to name a new. They all had the problem in that they didn't work for most patients. However, newer nerve-pain drugs are just coming to market, with many new ones in the pipeline. The most effective drug we have seen is the newer drug Lyrica. This works well in about 6 in 10 of these patients to reduce nerve pain and "put some water on the fire."

Once this is accomplished, the next step is usually to identify the problems that caused the fire. In many patients, there were specific musculoskeletal problems that led to others, which ultimately led to the fire getting out of control. Finding these specific problems and treating them can then start to provide relief. As an example, a patient labeled with "fibromyalgia" may note that his right neck and shoulder began hurting first, then his right low back, then his arm and leg. Tracing the issues back to the neck would be the way to approach this patient.

In addition, we are also encouraged with the results in using the nerve-hydrodissection technique with platelet lysate, as discussed earlier. This approach is to try and help the nerve function better by placing helpful platelet-derived growth factors near the nerve.

Neuromuscular Resources
Calming down nerves through injection often requires an expert trained in X-ray–guided procedures. Here are some resources:

• SIS (Spine Intervention Society)
• ASIPP (American Society for Interventional Pain Practitioners)

Realize that almost all of these physicians still use steroid epidurals as their primary injection type. **If you're interested in platelet lysate epidurals, see the** Regenexx Network physicians at this link.

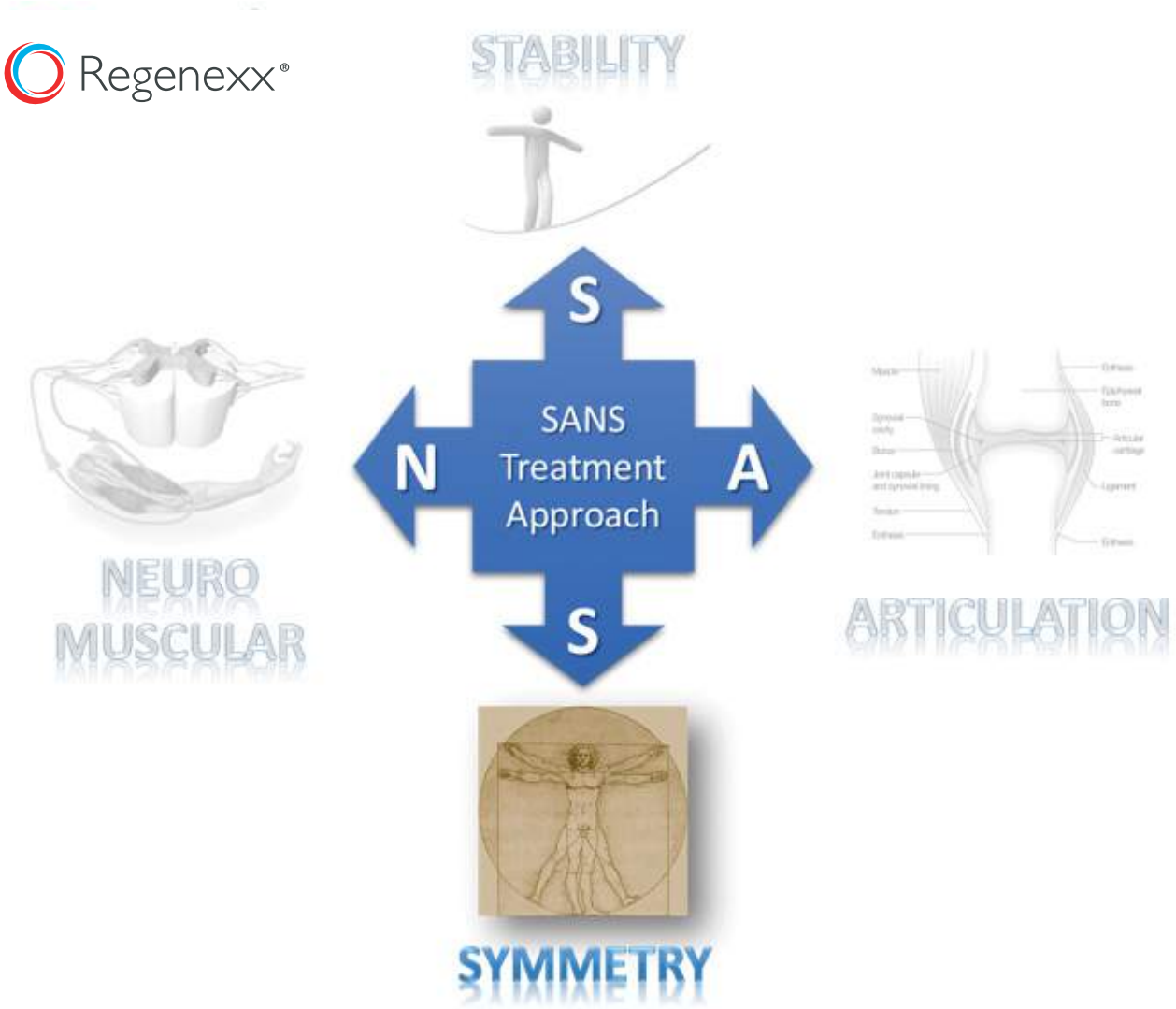
The most effective way we've seen to address chronic trigger points is either through IMS or trigger point injections. Here are some lists of where to find these "needle in the haystack" doctors and physical therapists:

• A list of Gunn IMS practitioners
• Trigger point educational group
• Physical therapists trained in IMS

Trigger points in muscles can be difficult to treat on your own, but we've seen some success with these approaches:
• Electro Therapeutic Point Stimulation (ETPS)
• Thera Cane

Enthesopathy: See level 1 prolotherapy and level 2 PRP resources discussed in the "Articulation" chapter.

Chapter 5: Symmetry



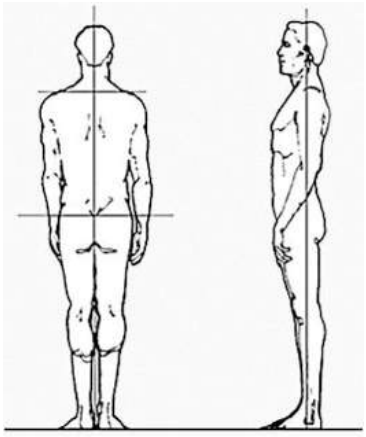
"True freedom is where an individual's thoughts and actions are in alignment with that which is true, correct, and of honor—no matter the personal price."
Bryant H. McGill

In most patients, there's usually more joint damage on one side than the other. Why? If someone has a genetic predisposition to arthritis and this is the only factor causing the joints to degenerate, shouldn't all joints be affected equally? In addition, osteoarthritis is more commonly seen first in the knees and hips and less often in the ankles and elbows. Why? Again, shouldn't we see all joints being impacted the same? The reason is clear: the wear and tear on our joints occurs unevenly, with some being impacted more than others or one side undergoing more wear than the other.

Why Should I Care About My Symmetry?

If you don't want to stay active and pain free as you age, then ignore this chapter. If you do want to stay active, then pay attention! Your body is designed to be symmetrical, and even slight amounts of extra force or motion, in any area, caused by an unbalanced body will cause problems. These may start small, but like a snowball rolling downhill, they become bigger and bigger with time.

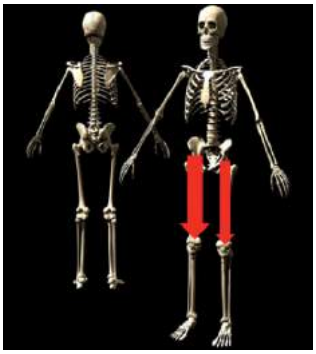
Reducing the Wear and Tear



As already discussed, increasing healing ability is only one part of the Orthopedics 2.0 equation. The other half of this coin is reducing the wear and tear forces that destroyed the joint in the first place. As an example, placing new tires on a car with bad alignment, without fixing the alignment, is guaranteed to quickly wear out the tires again. This issue is often ignored in our current quick-fix treatment methodology. I've seen hundreds of patients with a specific wear pattern, like on the right medial meniscus, where the most salient questions have never been asked: how did this knee get like this, and what are we going to do to ensure that it doesn't get this way again?

The reason the issue of specific wear-and-tear patterns is mostly ignored is that it's complex. Most physicians aren't trained to understand the biomechanics of the body. The few physical therapists or other providers who have spent years of extra study learning biomechanics are often too heavily incentivized by insurance companies to take the time needed to figure out why a part keeps failing.

Let's use a simple example to illustrate this concept. The skeleton on the right has been drawn with red force arrows going down from the hips. Let's say that because the spine is slightly bent to the side that slightly more force is applied to the right side (the thicker arrow) than the left side (the thinner arrow). We take thousands of steps a day. What happens to the extra forces on the right, and how does the body handle them?



The right knee, hip, and ankle will all react. They will initially just shore up the bones, tendons, ligaments, cartilages, and muscles on that side. When this person is young, with many adult stem cells in these areas, he or she may not notice much. However, as the number of adult stem cells begins to decrease with aging, the damage due to wear and tear at some point will begin to overtake the repair ability of these tissues and react to the extra forces. These areas (the ones that are the most vulnerable) will begin to break down. If our only goal is to replace the right-sided knee, or any other right-sided joint, with an artificial joint, that prosthesis may wear out a bit faster on that side, but this is likely not a huge issue. However, if we want to preserve that right-sided knee with Orthopedic 2.0-type procedures, we had better figure out why that knee is getting so much more wear and tear and correct that problem.

Take Five Minutes to Understand Your Symmetry

Patients are often surprised to find out that their body is no longer symmetrical. Others have noticed that a certain area has been getting tight for years. Either way, going through an intensive five-minute test of all major body joints, checking for symmetry is well worth your time. Why? As discussed above, joints that are not equal in their side-to-side or front-to-back motion don't wear evenly. If you have any areas that are tight and not symmetrical and you don't figure out what's going on and fix these, you can bet arthritis is in your future if it's not already knocking at the door. In fact, symmetry is often the single biggest thing you can work to fix that may either allow you to have an active older age or one plagued by problems and inactivity.

This is an 11-step test. You need to focus on whether you can attain the movement to the degree asked, whether the right and left are identical or different, whether the front/back is the same or different, and whether the tightness in the lettered areas is different on one side or the other. Realize the differences may be subtle but important. In addition, pay attention to which movements cause pain and where. I**f you're a patient of our clinic or a Regenexx Network physician, fill out the form in appendix A and bring it to your visit.**

If any movement causes significant pain, stop immediately and see a doctor. **If you think any of these motions may injure you, or you are prone to injuries with common or unusual movement, don't do this test, and, instead, see a physician.**

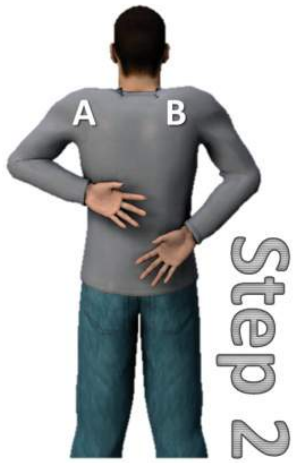
Step 1: Protracted Shoulder Check

Stand normally and place your hands together. Raise them over your head as shown. Move the hands as far back as they will go. Pay attention to whether the shoulders go back equally (you may want to have someone check, or do this in a mirror). Also pay attention to whether the front of the shoulders at points A and B are equally tight or if one of them is painful. You can also do this same maneuver lying flat on your back on a firm surface. In that case, your hands should touch the floor. If they don't, then both sides of your chest are too tight, or you may have problems with

the range of motion of the large shoulder joint. This step checks your ability to abduct the shoulder and also checks the tightness in the pectoralis major and minor muscles along with the front and bottom of the shoulder capsule. If this causes shoulder pain, you may have a shoulder impingement, a problem where the structures of the shoulder are getting pinched by poor movement patterns.

Step 2: Posterior Shoulder Check

Stand normally and place one hand behind your back. Raise it up as high as it will go. Both hands should be able to go at least to the middle of your upper back with the thumb just below the shoulder blades. Notice whether both sides can go equally as high and whether you have tightness in the back of the shoulder at points A and B. Is one side tighter than the other? This movement measures the tightness in the infraspinatus muscle as well as the back of the shoulder capsule. Patients that can't do this tend to develop overload on the back of the shoulder joint where they can develop labral tears. While many surgeons would just focus on the labral tear, the real focus should be on why this shoulder can't internally rotate!



Step 3: Neck Check

Very slowly and carefully roll your neck 360 degrees (only 180 is shown). Does this cause any pain at any point? Does it roll equally well to the front, side, and back? Is one side tighter than the other? Patients who don't do well with going straight back or back and to the sides may have an arthritic or injured facet joint in the neck or a problem with lordosis (discussed later in this chapter). If bending to the side or forward is tough, you may have tightness in the postural muscles of the neck that hold the head up, like the levator scapula, upper trapezius, or cervical extensors. Finally, if one of the front muscles is tight, it could be the stenocleidomastoid, an important muscle that helps to turn the head. You may also notice that you can't hold your head back like this or that if feels out of control if you do. This is often caused by weakness in the deep neck flexors, like longus colli or longus capitis. Weakness in these deep neck flexor muscles can lead to chronic headaches. In the "Neuromuscular" chapter (next chapter), there's a strength-and-endurance test that also covers this issue.

Step 4: Cervical and Thoracic Rotation Check

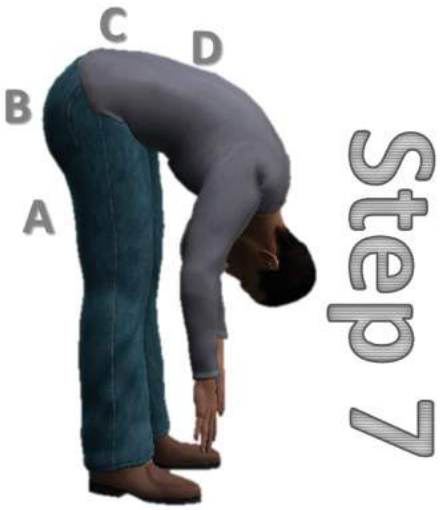
While standing, place your hands on your chest, and turn your head all the way over your shoulder as far as it will go. Then follow through with a rotation of your upper back as far as it will go with your feet firmly planted (they shouldn't move). Do this on both sides. Can you turn as far with your neck and your upper back on the left as on the right? Is there more tightness on one side of the neck, upper back, or lower back than on the other? Patients who can't turn their neck may have a problem with the facet joints, whereas patients who can't turn their upper back may have that issue or a problem with the normal motion of the rib cage, the rib attachments at the spine (called rib facets), or the thoracic spinal facet joints. In addition, chronic chest wall tightness on one or both sides may also limit the rotation of the upper back.

Step 5: Hip Rotation Check

Stand normally and place the toes of your feet together as shown. Make sure your feet are aligned and symmetrical—it's easy to cheat by placing one foot forward or back. Note whether both feet move inward equally (the motion is mostly coming from your hips). Also note the A and B points listed in the front and back of the hips. Are these areas equally tight? Is one tighter than the other? Also note the C and D points—does any of this stress or hurt your knees or one knee? Now take your toes and rotate them out all the way. Again, be careful to make sure your feet are symmetrical (heels are together) as otherwise it's cheating. If one hip has a very different range of motion (toes don't move as far in or out, and this seems to be due to tightness in the hip), this is very concerning. The hips tend to lose range of motion quickly and almost always after the onset of moderate or severe arthritis. I would advise you to get your hip checked immediately by your physician. If you already know you have a hip problem, this means that you have serious work to do. Unlike other joints, the hip has a very limited weight-bearing area (the part of the joint where it gets the most force). When the hip loses range of motion, and when arthritis is already present, the joint will put much more pressure on already worn areas, hastening cartilage loss. Getting hip range of motion back can be a challenge. In addition, patients with poor hip range of motion tend to have a less robust response to stem cell injections. As a result, there are procedures we can use to try and improve the hip range of motion through an injection that stretches the joint capsule.

Step 6: Lateral Hip and Back Check

Stand normally and reach to the side as shown. Go as far as you can, and note points A and B. Can you go as far on the right as you can on the left? Does one side of the lower back and/or outside hip feel tighter (point A or B)? Does that tightness extend down the side of the leg to the knee (points C and D)? This step measures the tightness in the opposite lateral lower and upper back muscles, like the quadratus lumborum and iliocostalis lumborum. It also measures the tightness of the opposite lateral hip muscles, like the tensor fascia latae and iliotibial band. If you can't bend as much to one side, there may be tightness in these muscles or the spine. If you have pain that goes down the side of the hip and leg, you may have an SI joint problem with tightness in the iliotibial band or an S1 nerve problem in your back.



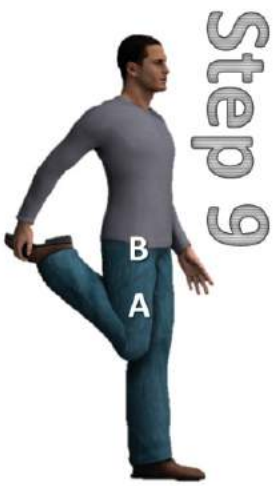
Step 7: Gluteal, Lumbar, and Thoracic Extensor Check

Bend forward all the way, and try and touch your toes. Do you get pain or severe tightness in one or both hamstrings (point A)? Is one side of your buttocks tighter than the other (point B)? Is your lower or upper back tight (points C and D)? Can you get within 6 inches of the floor? Does this cause pain or perhaps tightness, numbness, or tingling in one or both legs? Is your belly in the way? Patients who have difficulty getting close to the floor have significant tightness in hip flexion (which could be arthritis) or lower/upper back flexion (which could be disc disease or extensor muscle tightness). If one hamstring is always tight despite your best efforts to stretch it, it could actually be an irritated S1 nerve in your back despite the fact that your back doesn't hurt that much. Irritated nerves in your back can also cause one or both legs to get tingly in this position.

Step 8: Hip Flexor, Ankle Dorsiflexion, and Forefoot Check

Perform a lunge as shown, getting as far down as you can, making sure you feel a good stretch in the front of the hip on the back leg. On that leg, bend your toes so that they meet the floor flat. On the other leg, flex the ankle as much as possible. For some people, getting a good stretch may involve placing the hands all the way down to the floor. Notice the front of the ankle of the forward leg, and compare that to the other side when you perform the opposite stretch (point A). Does the buttock on the front leg have the same side to side tightness? On the back leg, can you flex your toes (point B), or is this restricted on one side or painful? On the same leg, is the front of the hip (point D) equally tight on both sides, or is one side tighter? Can you get as low on each side? Patients who have difficulty at point A (front of the ankle) may have ankle arthritis or a bone spur in the front of the tibiotalar joint, restricting dorsiflexion of the ankle. Patients with problems at B (toes) may have arthritis at the metatarsophalangeal (MTP) joints in the foot. For the big and 2nd toe, this can sometimes be related to long-standing low-back problems (even though you think your back is fine). Patients with problems at C (buttocks) may have problems with hip flexion, indicating tight gluteal muscles or arthritis in the hip. Pain with this maneuver could also mean a labral tear in the front of the hip. Finally, if you have an issue at D (front of the hip), this could indicate a tight psoas muscle. This muscle goes from the front of the lumbar spine to the hip, so tightness here can be due to chronic low-back issues or trigger points in this muscle. Sometimes patients with psoas issues have trouble getting in and out of a low car.

Step 9: Knee-Extensor Mechanism Check



Stand normally and grab one foot with the same hand while bending the knee as shown. You may need to hold onto something. That's actually your first observation. If you can't easily balance like this (after a practice run), then you have significant low-back and hip-stability problems on the opposite side of the knee bend (see the "Stability" chapter). For the symmetry check, do the right and left knees bend equally? To really check this, make sure you stand straight while checking both sides. Does point A (quadriceps) feel the same on each side? How about the front of the hip (point B). Does either knee hurt in this position? If you have less knee bending on either

side, the simplest explanation is that you have trigger points in the quadriceps muscle (see next chapter). If the front of the hip is tight, you may have issues with the rectus femoris muscle. If the knee hurts, you may have a patellofemoral problem (an issue with the kneecap in its groove). Another common cause of asymmetry here is swelling in the knee joint due to chronic arthritis, which reduces the ability of the knee to flex.

Step 10: Adductor, Sartorius, and Gracilis Check

Lie on the floor and place one ankle over the opposite knee as shown. Next, try to get the bent knee as low to the floor as possible. Check both sides and see if they are equal in your ability to get the ankle high up on the opposite knee. See if point A (inside of the thigh) feels the same degree of tightness side to side? Can you get one bent knee farther toward the floor than the other? Tightness in these muscles of the inside of the thigh are common in patients with chronic low-back conditions and sometimes can cause hip or inside-of-knee pain. In addition, patients with hip arthritis may notice a difference in flexibility from side to side.

Step 11: Lumbar and Thoracic Extension Check

Lie face down and prop up on your elbows, arching your back by lifting your head as high as possible and pushing your hips into the floor. Can you do this without pain? Does your lower back (point A) or upper back (point B) feel tight or hurt? Do you have pain or tightness at the back of the shoulder blades? Patients who have tightness in the front of the hip and low back may have tight psoas muscles. Patients who have pain in their low back with this maneuver may have injured or arthritic low-back facet joints. If you have pain in one shoulder blade, there could be a problem in the joint between the shoulder blade and ribs or in the rib cage itself.

What do you do now with this information? If you have an area where your movement isn't normal, or there's a noticeable side-to-side difference in motion or tightness, there may be a few different causes. First, this needs to be looked at by a physician, physical therapist, or other musculoskeletal provider. Why? In our experience, asymmetrical motion is a leading cause of excessive wear-and-tear arthritis, so getting symmetrical and balanced motion back is critical. Second, the lack of motion may indicate problems in that joint that have yet to be addressed.

What are some common ways to treat these tight areas?
1. Do simple stretches. The longest-running stretching book on the market is Bob Anderson's. See this link for Amazon or this one for the basic stretches.

2. Clear trigger points. When I discuss specific muscles above, these are your areas to target. Many times, there are knots in the muscles that when cleared will allow normal movement. The next chapter will focus more on ways to get rid of these trigger points.

3. Repair irritated nerves. Sometimes an irritated nerve won't allow normal motion in an area, as a protective response for the nerve. This topic is dealt with in the next chapter.

4. Treat joint arthritis. Sometimes an arthritic joint won't allow motion because bone spurs within the joint are blocking motion or the covering of the joint (the capsule) is too tight. For information on these issues, see the "Articulation" chapter.

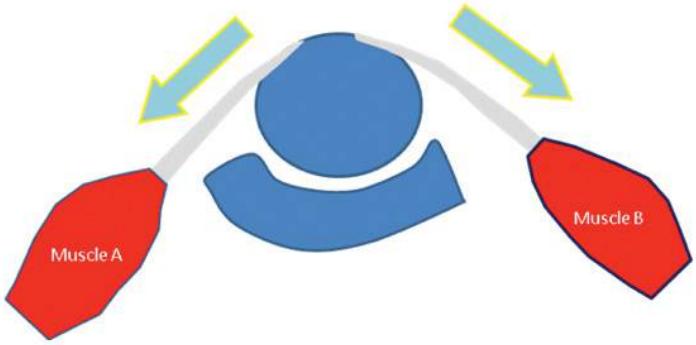
Now That You Know You Have Problems, Let's Learn More About Symmetry
Everything starts with the spine, as your arms, legs, and head would be useless without an anchor point. This anchor is your spinal column. You might be saying, But I have a knee problem. Why should I care about the spine? Because regardless of where you feel the pain, it's almost impossible for your spine not to be involved in some way.

A documentary on the tragedy of 9/11 provides a vivid example that may help bring this concept home. On one of the upper floors, many workers were trapped by a door to the stairs that wouldn't open. No matter how many large guys tried to ram it open, it wouldn't budge. It turns out that the violence of the airplane strike had twisted the spine of the building ever so slightly, and this compressed the doorframe against the door. These workers were eventually saved by a heroic building superintendent who guessed accurately that kicking a hole in the drywall next to the doorframe might release the pressure on the door. Your spine is the same. Small issues here can cause large problems in your shoulders, arms, hands, hips, legs, ankles, or feet.

What Did I Self-Diagnose in the Symmetry Screen?
Poor stability caused by too much movement is hypermobility. Equally important is hypomobility, or where a joint or spinal segment doesn't move enough in all directions or certain directions. This is what you self-diagnosed in the five-minute symmetry screen.

Chiropractors and osteopaths have been focusing on hypomobility for more than a century. The reason we medical doctors have given them a hard time is that hypomobility has been traditionally hard to measure. However, there is good evidence now that this does occur. In fact, studies that specifically apply this concept (hypermobility versus hypomobility) show that patients with spinal hypermobility treated with exercise do better than patients with hypomobility. This makes sense because if you have too much

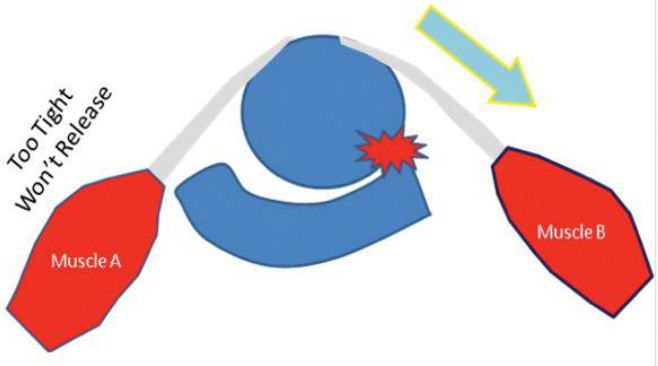
mobility you need to get the muscular stability system back online with exercise or other treatments to restore muscle function. However, patients with hypomobility did poorly with stability exercise. Why? They need more mobility, not more stability. This group did better with manipulation to force these segments to move.



Hypomobility can be as damaging as hypermobility. The take-home message is that if your joints don't move normally in all directions, you have to get them to move normally or this will place more wear and tear on the certain parts of the joint. What are some examples? If your knee won't straighten all the way, the front of the joint cartilage will wear more than the back. How about a hip that won't turn out all the way? The inner part of the hip will wear more than the outer.

Take, for example, this simple model of a joint and the muscles that help control that joint's movement. We have a ball-and-socket-type joint with a ball sitting in a shallow socket (like the shoulder). Here we'll call them muscle A and muscle B. Both muscle A and B pull equally on the joint. When one pulls harder, the opposite muscle lengthens equally to allow the joint to move.

So as this joint moves, the ball stays in the middle of the socket. In fact, keeping the joint aligned with millimeter precision as it moves is critical.

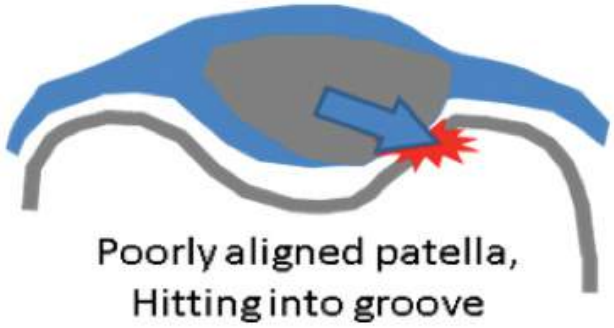


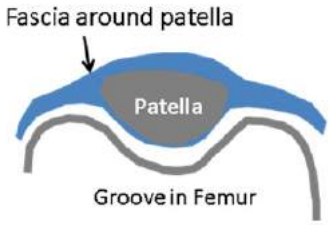
What happens if one muscle can't release as the other pulls? Now the joint moves too much to one side, banging into the side of the socket. This is an example of muscular hypomobility, where trigger points in one muscle make it tight and weak (more on this topic at this link). How do you fix this problem? You need to loosen up the tight muscle. This is discussed further in the neuromuscular section. The same thing can happen if one part of the joint capsule (the thick fibrous covering of the joint that helps to limit motion) is too tight or the ligaments that hold the joint together are too tight.

Realignment Surgery: If I'm Asymmetrical, Won't Surgery Help My Knee?

When I was in residency, one of my most and least favorite rotations was through pediatric rehabilitation. While it was always fun to be around the kids, these particular kids all had severe physical deformities. The surgeons on this rotation were great heroes, often allowing these kids to walk or function better by adding an inch here, taking away an inch there, or cutting this or that tendon. These kids were so severely disabled that it simply didn't matter that the accuracy of the surgical healing could be off by a few millimeters either way.

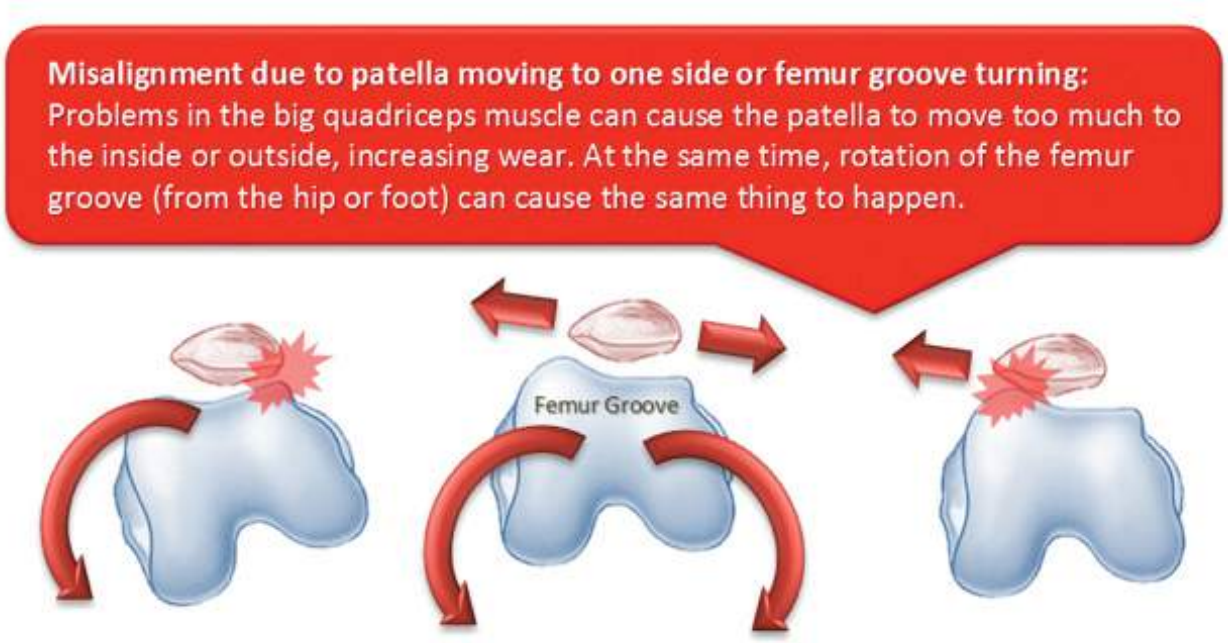
Fast forward 20 years, and I no longer see disabled kids for a living but patients with chronic joint and spine pain. I have seen hundreds of patients through the years who have undergone the same type of realignment surgeries, although they didn't do so well. What's the difference? The normal musculoskeletal system is tuned to submillimeter to millimeter precision. Human accuracy and surgical healing can be off, a few millimeters either way. So while it's possible that a surgically realigned tendon, muscle, ligament, or bone might be in the perfect anatomical position, it's more likely that it will heal "a little off."



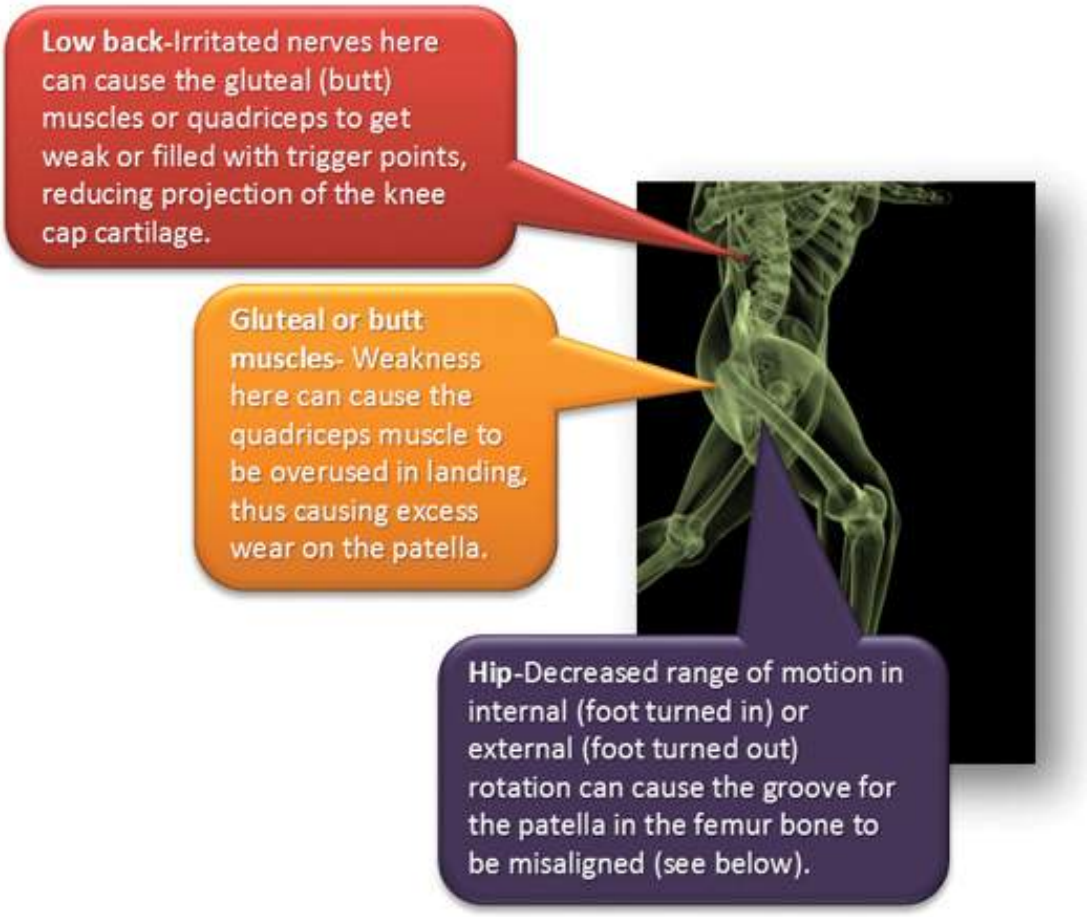


Also, many times these surgeries ignore the cause of the problem. Take the example of a knee lateral release. The concept is that the patella isn't tracking properly and is being pulled too far to the outside of its groove (or doesn't have enough pull toward the inside). Rather than asking what biomechanical forces have caused this to occur (issues in the hip, low back, etc.), we often try to take a quick-fix approach by cutting some of the quadriceps attachment and fascia on the outside. Since the patella is aligned to submillimeter precision, and the surgery can only have accurate healing to a few millimeters, I often see that the patella is misaligned after the surgery. For example, if the lateral side scars and heals too tight, the patella will be too far lateral, or if too much of the lateral side is cut, too far medial. Add in to that calculus that the same forces that were pulling the patella too far laterally are likely still there (say too little hip external rotation), and the surgery hasn't solved the cause. Since these are permanent realignments of the musculoskeletal system, rather than a quick decision, I tell patients to think long and hard before getting a procedure that can't easily be undone.

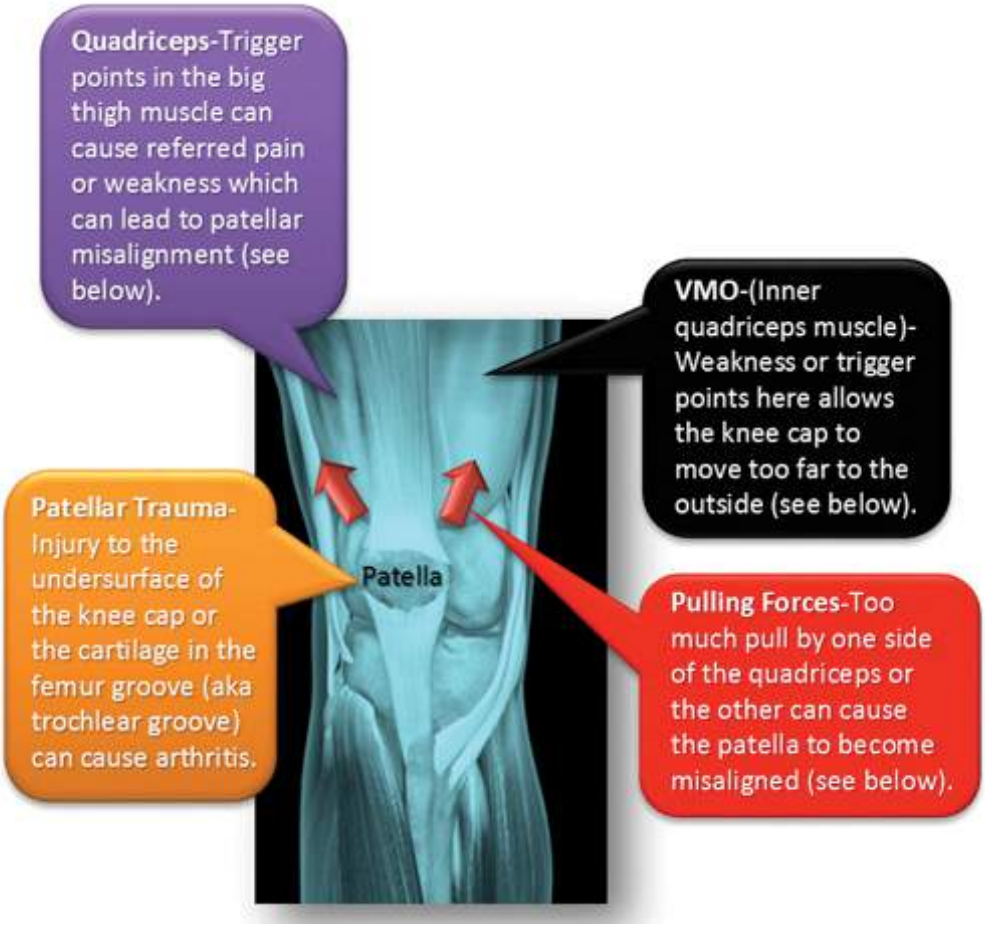
Learning More About How the Knee Is One Part of the Whole: Nonsurgical Solutions
So we just learned that trying to fix small alignment errors that can lead to big problems over time with surgery isn't such a good idea. Is there a better way to approach this problem? Yes, but it requires more thought. You know the song: "The hip bone's connected to the leg bone…" The same applies here.



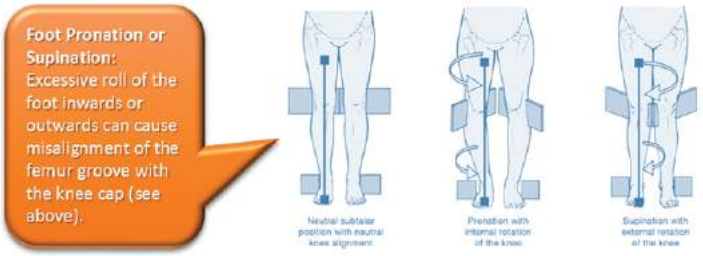
We'll start by breaking down the patellofemoral problem above. The kneecap sits in a groove and is controlled by the surrounding structures (see below). There are two ways the kneecap can rub against the side of the groove. The first is that the kneecap moves out of position and bangs against the side walls of the groove (straight arrows). The second is if the groove itself moves (curved arrows). The groove sits in the femur bone and that bone's motion isn't controlled at the knee but at the hip. So to fully understand kneecap problems, we must first start with the hip and work down.



The femur bone, where the kneecap groove lives (trochlear groove), can move out of place if the hip doesn't have normal motion. The hip range of motion can be controlled by many things, not the least of which is arthritis at the hip. Irritated nerves in the low back can also lead to muscle firing issues in the hip or thigh muscles, which can also impact both the way the hip and kneecap move. Finally, weak muscles due to trigger points can also cause abnormal hip motion. In summary, what happens at your hip impacts your kneecap.



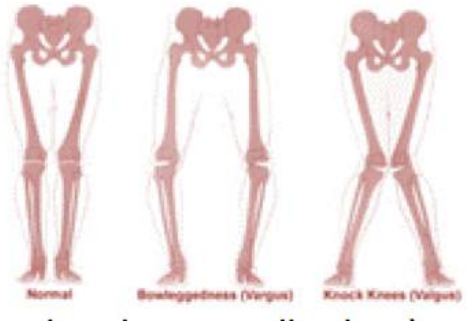
Now let's look at the knee area. The kneecap is a just a small bone that lives at the end of one of the most powerful muscles in the human body: the quadriceps (aka "the quad"). What happens to these four muscles that make up the quadriceps determines what happens to the kneecap. I'm always dumbfounded when patients show up and are more concerned about the cartilage loss under their kneecap than the status of the main muscle that controls it. The problem is that outside of a short stint in physical therapy, nobody has ever told them that they should be concerned about the muscle. What can happen to the quad? Trigger points in the muscle can lead to parts of it being shut down, so this means that one part of the muscle pulls more than the other on the kneecap. Obviously, trauma to the kneecap can knock off cartilage, leading to arthritis. Finally, weakness in one of the muscles that make up the quadriceps (the VMO, or vastus medialis oblique) can also cause more outside pulling on the kneecap than inside pulling, leading to alignment problems.



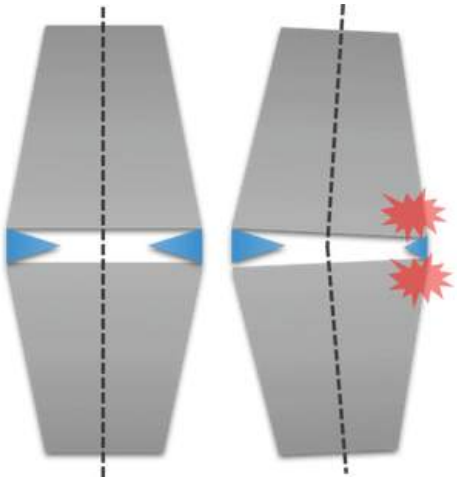
Finally, we have to look below the kneecap to see if anything in the foot and ankle can also lead to problems. The angle of how the foot strikes the ground can impact how the femur groove is rotated at the hip. This will impact the knee as well.

In summary, looking at a kneecap problem as only being caused by this bone is a bad idea. It's also related to what happens in the low back, hip, and foot and ankle. So if you see a physician for a kneecap problem, and he or she only focuses on the knee, other possible causes of your problem are being ignored. Why wouldn't all physicians look at a problem this way? Many times its lack of training, but sometimes it's because our medical care system rewards more for procedures on a joint than it does for diagnosing how the joint got that way.

More Specific Joint-Alignment Issues That Affect the Knees

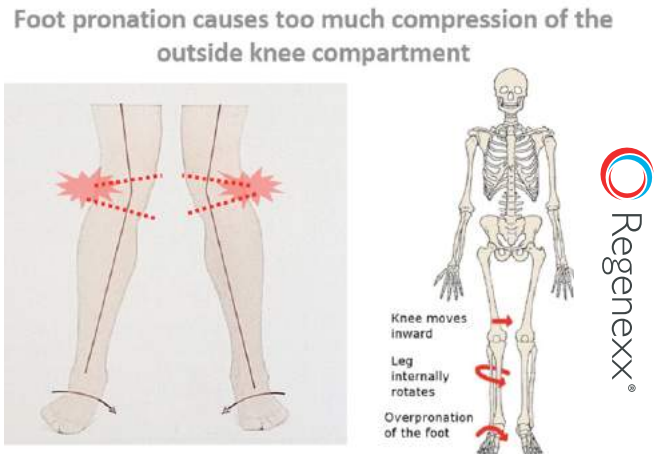


Now that we've learned about the complex alignment of something as simple as a kneecap, let's look at some more obvious ones. First, the knee can be side bent just like the spine can. You've likely heard the term knock-kneed or bowlegged. These are conditions where the knees can be bent so that they touch (knock-kneed, or what doctors call valgus) or are too far apart (bowlegged, or what doctors call varus).



While people can be born this way, the leading cause of one knee going side bent is the removal of all or part of one meniscus surgically, which causes that one side to lose its spacer. The knee then collapses toward that side, putting much more pressure on the cartilage, which can lead to more arthritis. One solution often proposed is a high tibial osteotomy (HTO). This is a surgery where a wedge of bone is removed from the lower bone of the knee on the high side to even out the forces. The good news is that it does seem to help. The bad news is that it's a big surgery, and one way to prevent ever having to do this is to not remove pieces of the meniscus in the first place.

Foot Pronation



When your foot rolls inward, this is called pronation. This can cause knee and hip alignment issues, such as knock-knees. This can also cause the hip to internally rotate, overloading different parts of both of those joints. So sometimes, correcting a knee issue means correcting what's going on at the foot. Pronation can also be caused by irritated nerves in the back making the supporting leg muscles weaker.

The Great Adaptation Machine

Our bodies were designed to keep moving at all costs and are great at adapting to problems that may develop in the human machinery. In a preindustrial society, the amount of physical prowess it took to collect, hunt, process, and consume food was great. In such a society, the potential for injury from a runaway animal or even a rockslide was also great. The only way for us to be able to get injured and keep going was to design the musculoskeletal system to be an adaptation machine. What does this mean?

At its simplest, let's take a left-knee injury. With an injured left knee, you instinctively limp on the left and transfer more weight to the right. This takes weight off the left so it can heal. This strategy works, because we were meant to heal on the run. For example, studies where patients are asked to bear more weight on an injured or operated area (different from the current nonweight-bearing orthopedic healing paradigm) show that healing with weight bearing is better than extended periods without weight on the joint.

The great adaptation machine also gets a good deal more complex. I have noticed that in chronically injured patients, the system is constantly rearranging forces to be able to off-load certain areas. An example is my own minor chronic neck, upper back, low-back, and leg symptoms. At times, my left scapula will hurt; at other times, my biceps tendon; and at others, my low back. I can feel my body rerouting forces through adaptation, from one site to the next. When the neck stabilizers go off-line, or when they are too taxed from my heavy-weight-lifting routine, the big neck muscles take over, and the upper trapezius, levator scapula, scalenes, and SCM fire up. What happens when these muscles complain too much? My body reroutes the forces to the front of the shoulder by moving the scapula forward, but this aggravates the biceps tendon. If this causes the biceps too much pain, my body reroutes those forces by turning the rib cage, which causes the low back to get torqued, and so on. This complex neuromuscular response has allowed us for millennia to continue to function with injury.

For patients and medical practitioners, this adaptation process can often be like peeling back layers of an onion. Again, at its simplest (the injured left-knee analogy), since the left knee is causing a limp, it may come as no surprise to the patient that the right knee begins to hurt as a result of excessive use. However, most patients fail to recognize the more complex adaptations. This means that they are completely unaware that the problems in all of these areas are related. In addition, physicians will often only go for the "low hanging fruit" of where it hurts today. This approach again avoids the salient question, How did all of this get this way? In addition, just treating the part that hurts will only be a temporary fix as this part will soon be overloaded again!

How Do I Know if I Have an Alignment Problem That Could Be Affecting My Knee?
First, I've only scratched the surface here concerning common problems with alignment. The goal was to introduce the concept, not list all things that an experienced musculoskeletal expert would see in daily practice.

At its simplest, patients with alignment problems have one-sided pain or arthritis in the absence of specific trauma. For example, while they may have both knees that hurt, the right hurts much worse than the left. In addition, an MRI or X-ray of both knees shows one has much more severe arthritis than the other. Examples of alignment issues can often be seen when looking in a mirror or asking your friends. You may notice that one shoulder is higher than the other, or the head is slightly tilted to the right or left, or that one hip is higher. Looking at wear patterns on clothing and shoes can give more clues. For example, does one shoe wear more than the other? Does one part of the sole of one shoe wear more than the other parts? Does one part of your pants wear out faster than another? Is it easier to hold a handbag or backpack on one shoulder or the other? When you're active, are you dramatically stronger on one side versus the other (more than you would expect based on being right or left handed)?

If I Have an Alignment Problem, What Else Can I Do About It?
The good news is that there are many therapists and practitioners who specialize in alignment. These concepts really began shortly after the turn of the century, when traditional allopathic medicine was in its infancy and unable to address what seemed like obvious problems to nonphysicians. The pioneers were Moshe Feldenkrais, Ida Rolf, and Matthias Alexander. I was introduced to these geniuses when I realized that by the early 1990s (just out of residency) these issues were still not being addressed by physicians. The concepts I've discussed here were not part of my training in physical medicine and rehabilitation. To remedy this deficit, I took to reading the old works of these masters to try and learn what I had never been taught as a physician.
Newer systems such as Pilates, Muscle Activation Technique, Myofascial Release Approach, and Egoscue have added to the diversity of treatment methodologies that address various aspects of posture and alignment. In addition, curve restoration has now become a scientifically vetted medical art.

A caution, while some physical therapists have spent years learning advanced biomechanics, *they are few and far between*. The standard course of physical therapy education contains very little about how to identify and address common alignment problems. This is despite one of the early geniuses of muscle function actually being a physical therapist (Florence Kendall). So if you've tried and failed physical therapy, it's unlikely that you actually saw a physical therapist with proper training in the art of biomechanical and alignment analysis and treatment.

Brief descriptions of the alignment concepts follow. Click on the links to learn more.

• Rolfing: Sounds a bit like the vernacular for vomiting, but it's actually named after the founder of the method, Ida Rolf. The focus is on very rigorous deep-massage techniques to free up areas of muscle and fascial tightness with the goal being to restore normal posture and alignment. This is generally accomplished in 10 sessions.

• Alexander: Matthias Alexander was a turn of the century orator in a time before the electric amplification of voice. He figured out that certain head and neck positions allowed the speaker to project his or her voice better in an auditorium. This was later applied to "sick" performers to improve their performances. This is now a system of treatment focused on head and neck alignment popular with stage and theater performers.

• Muscle Activation Technique: Developed by athletic trainer Greg Roskoph and based on the concept that certain muscles can become less active based on injury and certain patterns of movement, the focus is on balancing the moving biomechanics of the body by "turning on" these inhibited muscles.

• Myofascial Release: Pioneered by Arizona massage therapist John Barnes, the focus is on trigger point massage to release or free up tight muscles leading to poor body alignment. There is less focus on overall body posture than in Rolfing.

• Egoscue: Begun by Pete Egoscue, this system focuses on activating and strengthening specific muscles with specific exercises to restore normal body alignment and posture. This system has become popular with physical therapists wanting to increase their knowledge about biomechanics.

• Feldenkrais: Developed by Israeli physicist Moshe Feldenkrais, the focus is on alignment in simple movements.

• Curve Restoration: The gurus of this now scientifically vetted field are the Harrisons, chiropractors who have been publishing their results in peer-reviewed medical journals for years. They use very specifically designed forms of specialized traction to restore the normal curvature. They have also designed home units so that patients can try to deal with this problem in a do-it-yourself program.

Getting Out of the Hole

The goal of this book is to provide additional information for those patients who want to go further in their understanding of their problems. To go from an educated participant in their own recovery to a leader of that recovery. I've only had a few patients make it this far in their understanding. One gentleman who comes to mind was an engineer from Canada who moved to Colorado to get care from our clinic. Over time, our office visits became more of me providing advice about his next steps and what might be wrong rather than the doctor leading the patient. At first it was a bit disorienting, but later it became fun.

If you're a patient who can't do much without things badly flaring up, this section is for you. First, you need to have read this whole book to understand what's wrong. Next, you'll likely need to make some hard choices and follow the process diligently. I call this "digging out of the hole."

What is "the hole"? Your body has all or most of these systems we've talked about seriously involved. Your stability is fried, your joints are beginning to or have already given out, your nerves and muscles are shut down and on fire, and your symmetry is all catawampus. It may take you one to two years to get all of this addressed and to "climb out of the hole."

Where Do You Start?

1. **You must get "off the sauce."** We've seen an explosion in the prescription of narcotics by doctors after pharmaceutical companies claimed that newer long-acting and very addictive narcotics weren't addictive. Narcotics also take away your natural ability to control pain. So while they may take away the pain in the short run, they make the pain signals magnified in the long run. As a result, you have to decrease and eventually eliminate your use of narcotics.

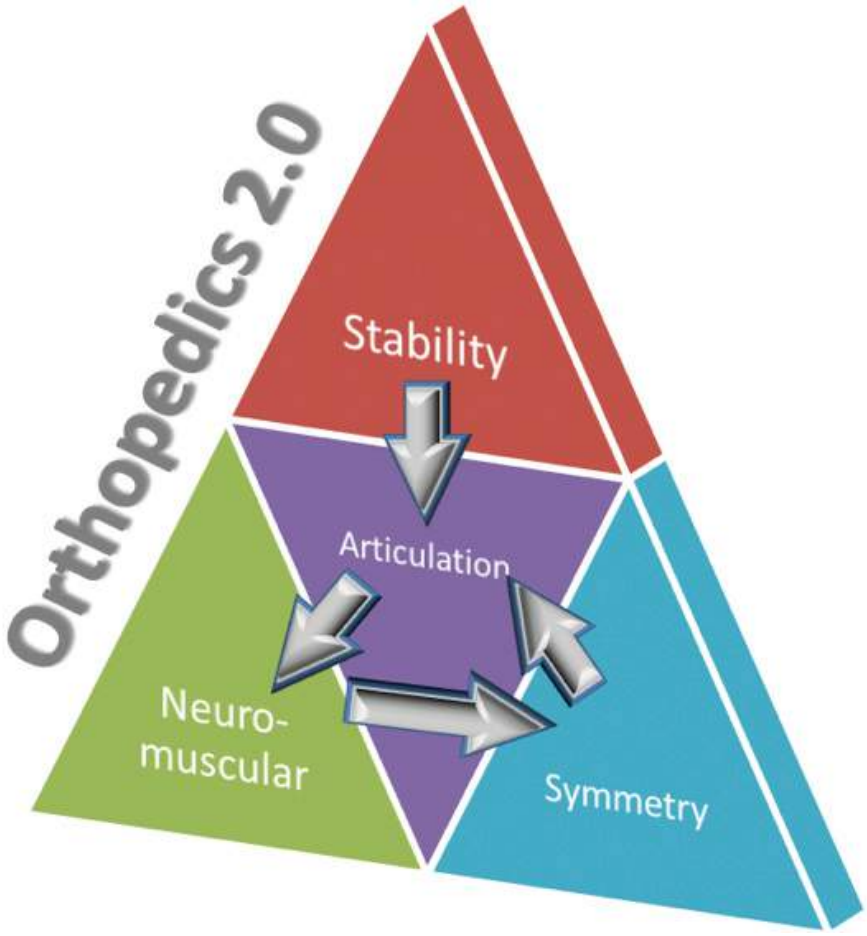
2. **Reduce the pain** coming from various joints, tendons, muscles, and nerves. These problem areas must be first carefully identified. Often this will take an hour or more of hands-on exam, combining many different types of imaging, including ultrasound, MRI, and movement-based studies. Once the areas are identified, then the focus should be on precise biologic injections to ramp up the healing response in these areas.

3. **Get rid of muscle trigger points** caused by irritated nerves using once or twice a week IMS. This will allow your muscles to begin to participate in providing stability.

4. **Slowly work on getting more stable and stronger.** This may at first be at very low levels. For example, some patients may have to begin in the pool and then take a few months to graduate to simple and gentle land strengthening. It may take one to two years to work back up to anything resembling a big workout.

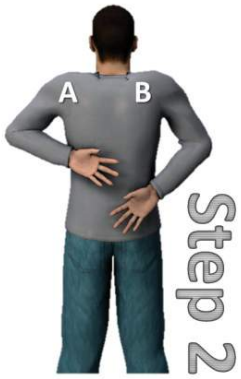
5. **Fix the bad symmetry** that likely got you here in the first place.

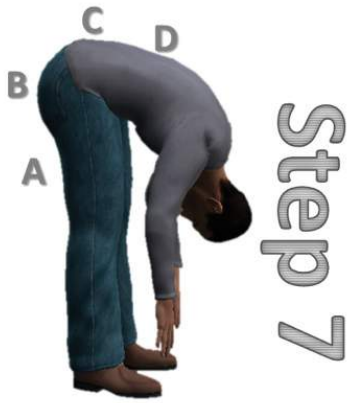
Chapter 6: Putting it all together

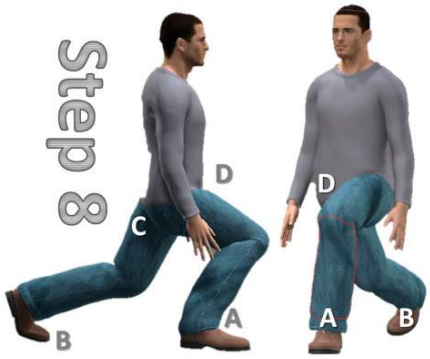


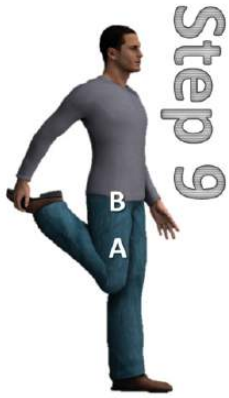
"The physician can bury his mistakes, but the architect can only advise his client to plant vines—so they should go as far as possible from home to build their first buildings."
Frank Lloyd Wright

Appendix A—Worksheets









About the Author

Christopher J. Centeno, MD, is a specialist in regenerative medicine and the new field of interventional orthopedics. He is board certified in physical medicine/rehabilitation and in pain management through the American Board of Anesthesia.

Dr. Centeno is one of the few physicians in the world with extensive experience in the culture expansion of and clinical use of adult stem cells to treat orthopedic injuries. He is a founding member of the International Cellular Medicine Society. His clinic incorporates a variety of pain-management techniques, and he treats patients from all over the United States and the world who travel to Colorado to undergo innovative, nonsurgical treatments. Dr. Centeno's clinical practice in Colorado (The Centeno-Schultz Clinic) has a state-of-the-art cell biology research lab, a bioengineering department, and a clinical-research arm.

Dr. Centeno has chaired multiple international research-based conferences. He also maintains an active research-based practice, with multiple publications listed in the US National Library of Medicine. Dr. Centeno has also served as editor in chief of a medical research journal dedicated to traumatic injury. He has lectured all over the world on regenerative therapies, including at the Vatican in Rome.

Dr. Centeno trained at the Baylor College of Medicine, Texas Medical Center, and the Institute for Rehabilitation Research. He hails from both Florida and New York and currently resides in Boulder, Colorado, with his wife and three children.

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