FAT STEM CELLS VS. BONE MARROW STEM CELLS

The Source of Your Stem Cells Makes a Big Difference

Christopher J. Centeno, MD
Which stem cell best treats arthritis? What is the better choice in bone and cartilage repair? Bone marrow aspiration harvests bone marrow stem cells while liposuction harvests fat stem cells; which procedure is less invasive and safer? You will see in this report that 99 percent of the studies being completed today are with bone marrow derived stem cells, while minimal research has been done on fat stem cells.

Why is using fat for stem cells a big deal? Legal and safety issues are two big reasons why it matters where your stem cells come from.

**Fat Stem Cells or Bone Marrow Stem Cells for Orthopedics?**

When Regenexx first started studies using stem cells in 2005, we looked at two possible sources—fat tissue (adipose) and bone marrow aspirate. After a quick search of the U.S. National Library of Medicine, we learned that there was very little, if anything, published in human or animal models that showed that fat stem cells would be effective for things like healing cartilage. There were, however, hundreds of publications on bone marrow stem cells healing cartilage. At that point there was simply no contest; bone marrow won hands down.

When we first began seeing fat stem cells (also known as stromal vascular fraction or SVF) being injected into knee and hip joints, we were confused, as we knew the literature was pretty clear. With the proliferation of clinics offering fat stem cells for whatever ails you—from arthritis to ALS to anti-aging—Regenexx wanted to revisit this topic. As an update on what's currently published, the graph below shows the number of citations listed in the U.S. National Library of Medicine under fat stem cells or bone marrow stem cells for cartilage repair as of May 5, 2012:
It’s not hard to see that under fat stem cells (adipose), there still isn’t much published showing that this is the source you would want to use to help cartilage heal. On the other hand, there’s a massive amount of data showing that bone marrow stem cells should be your first choice.

The conclusion? While we use fat as a structural graft containing stem cells as part of our Regenexx-AD procedure, we also add bone marrow stem cells to that procedure for the above reasons. So if you’re told that fat stem cells are the way to treat your knee, there isn’t much published data supporting that claim; however, there is a massive amount of data published that bone marrow stem cells may be your best bet.
Fat Stem Cell Injections and Arthritis: Reality Sets In

Fat stem cell injections and arthritis? When I first looked into treating patients with stem cells, in early 2005, I saw a few papers on fat stem cells and asked the university scientist I was working with what he thought. The scientist's team had tested both bone marrow and fat stem cells on athletic horses with arthritis and found that bone marrow was better for orthopedic conditions.

Recently, while performing PubMed (website for the National Library of Medicine) searches to provide input to the Regenexx Prometheus Project, I discovered three papers on fat stem cells that, in summary, stated that many of the notions on which the nascent fat stem cell industry is based may be seriously flawed.

Fat stem cells have a very seductive business plan. Most Americans have extra pounds they carry, and we'd all love to get rid of it the easy way, via liposuction. There are stem cells in that fat, so why not bank or use those stem cells elsewhere? Makes sense at face value, but is the science behind the proposition weak?

The first paper I found showed that the large-scale liposuction that surgeons perform to suck out fat doesn't produce good fat stem cells. This is a huge issue, as most fat stem cell biobanks rely on surgeons who collect fat during common liposuction to provide fat for stem cell isolation and banking. The researchers found that the common liposuction surgery produced cells that were less viable and less functional than a mini-liposuction designed to harvest stem cells. The second paper showed that fat stem cells obtained from obese patients were less capable of tissue repair than fat stem cells obtained from normal weight patients. This is a showstopper, as most of the patients seeking fat stem cell treatment for their arthritis are heavier patients. The authors believe the problem is metabolic, meaning heavier patients usually have a metabolic syndrome that involves insulin resistance, which likely causes their stem cells to be less capable of repair. This leads us to the third paper. In this research the authors found that patients with diabetes (which is the logical successor to a metabolic syndrome) have fat stem cells that are less capable of healing tissue.

The conclusion? Some of the basic foundations of the burgeoning fat stem cell industry are on shaky ground. The industrial strength liposuction that's used to feed fat stem cell biobanks doesn't produce good fat stem cells. Heavier patients who might want to undergo liposuction and who have more arthritis have cells that are less capable of healing tissue. Finally, heavier patients with diabetes also take another hit to the repair abilities of their cells. To be fair, heavier patients with metabolic syndrome also have less bone marrow stem cell activity. Having said that, the adipose tissue in humans is a reservoir of bad chemicals where many of the fat soluble industrial pollutants live and where many pro-inflammatory cytokines take residence. In addition, while we use fat stem cells from time to time, we always make sure that the more potent bone marrow stem cells (if possible) are used in conjunction with these cells.
Fat Stem Cells to Treat Arthritis? The Data is Weak

In 2012, I created an infographic on the different stem cell types used in orthopedic stem cell procedures. Several searches of the U.S. National Library of Medicine were made to give readers an understanding of what was published on cartilage repair. At that point there was a massive amount published on bone marrow stem cells used to treat arthritis and very little published on fat stem cells. Since this is still a question frequently asked by patients and doctors, I downloaded more research on bone marrow versus fat stem cells a year later.

So did a year make a huge difference? Did fat stem cells begin to catch up and close the gap on their huge orthopedic research deficit? Not so much. The graph above shows the results. While there were more than 1,100 research articles published on using bone marrow stem cells in cartilage repair, during the same time frame, there were a paltry 17 on using fat stem cells for the same purpose.

The conclusion? There simply isn’t enough research to support using fat stem cells as a primary source to treat arthritis. Comedian John Lovett used to make up a bunch of silly facts on Saturday Night Live and then end it with his famous catch phrase, “Yeaaaah, that’s the ticket.” When it comes to the statement that we have enough research to be using fat stem cells as a primary source of cells to treat arthritis, I’d have to say, “Yeaaaah, that’s the ticket.” If you believe that fat stem cells are the way to go for treating arthritis, I’ve got some deeds in my trunk to land in Florida to sell you…waterfront and very moist…oh, wait, I guess that’s swampland….Stay tuned…

What’s More Risky? Bone Marrow Aspiration or Liposuction

There are numerous research articles and websites suggesting that a bone marrow aspiration used to obtain stem cells has a high complication rate when compared to liposuction. While we use fat for structural grafts in our Regenexx-AD procedure, we’ve never considered liposuction safer or more comfortable than a bone marrow aspiration (BMA) procedure. We’ve studied the discomfort of a properly anesthetized bone marrow procedure used to obtain stem cells in our own patients and found it to be very comfortable for the vast majority of people. We feel discomfort during liposuction is similar.

On the complications side, while we’ve seen very few issues with both procedures, they have different levels of invasiveness. Since liposuction involves placing a larger needle or probe into the fatty area under the skin and moving that probe about to break up the fatty tissue (which can potentially harm arteries, nerves, and other structures), we consider liposuction more invasive than a BMA. This is because a bone marrow aspiration involves placing a needle through the skin in a direct route into the bone (more similar to a complex blood draw). However, what does the research say about the safety of these two procedures?

Our analysis of papers published in the National Library of Medicine on both techniques revealed that the complication rate of a bone marrow aspiration is actually far less than liposuction. Depending on the study, liposuction is approximately 4–100 times more risky in terms of reported complications than a bone marrow aspirate. While serious complications like death, skin necrosis, permanent scarring, and blood clots are reported for liposuction, none are reported for bone marrow aspiration. To be completely fair, the type of limited liposuction performed for an orthopedic procedure is much less invasive than the types reported in many of the studies below. However, the statement that a bone marrow aspirate used to obtain stem cells is more invasive than liposuction is not at all supported by the medical research.

Review of Research in Bone Marrow Aspiration and Liposuction

In a study of 700 patients undergoing bone marrow aspiration, no complications were reported. In another study, 49 patients were studied who underwent large-volume bone marrow aspiration (>1,000 ml versus the 70 ml we usually harvest), and there were no complications. In one United Kingdom study, out of 20,323 bone marrow aspirations, only 15 adverse events were reported (complication rate of less 0.01 percent or less than 1 in 1,000). These aspirates were much more aggressive than we would perform for stem cell harvest.

Out of 2,398 superficial liposuction cases, overall complication rate was 8.6 percent (208 patients). There were 4 cases of skin necrosis (the skin died off) and 2 infections. The safety of tumescent local anesthesia liposuction in 3,240 patients was studied and complications were found to occur in 9 patients, or 1 in 360. In another study of 609 consecutive patients undergoing ultrasound-assisted liposuction the complication rate was 1.36 percent. There were 2 cases of low blood pressure and 7 local complications (3 fluid collections—seroma, 3 cases of dermatitis, 1 case of excessive bleeding). There are various single-case reports found including death, blindness, severe scarring, and serious blood clots due to liposuction.
**Bone Marrow Stem Cells Better for Cartilage Repair**

Here is another study that shows that bone marrow derived stem cells are more cartilage producing than adipose (fat) derived stem cells. This study also shows bone marrow cells were better than those obtained from periosteum (covering of a bone), synovium (the lining of a joint), adipose (fat), and muscle.

The authors concluded: “The bone-marrow-MSCs produced much more cartilage matrix than that of other groups. Gross and histological grading scale indicates that the defects repaired by MSCs isolated from bone marrow are superior to that repaired by MSCs isolated from periosteum, synovium, adipose tissue, and muscle (p < 0.05).”

There are a few common sources of stem cells for regenerative medicine. These are blood, fat, and bone marrow. We’re not wed to one stem cell source, but try to match the source of stem cells to the patient’s problem. For example, we’ve noted that adipose tissue is great for a structural graft that happens to contain stem cells (for example to buttress a failing knee meniscus). Bone marrow stem cells are best to help joints heal or to use in areas where you need to establish new blood supply. Finally, blood derived stem cells work great for things like rotator cuff injuries, meniscus tears, and ligament/tendon injuries. Again, having lot’s of tools in the tool box always benefits the patient more than having only one!

**Getting Fat Stem Cells to Repair Cartilage is Still a Problem**

Adipose (fat) stem cells don’t like to become cartilage, and fat stem cells knee injections are, therefore, not very effective. All stem cells can become other tissue or orchestrate its repair. While bone marrow stem cells just need a little nudge to head in the direction of cartilage repair, fat stem cells need a sledgehammer to get there. Case in point is this research paper showing that the researchers had to go through great machinations to get fat stem cells to repair cartilage. In this study the researchers found that stem cells from fat release certain chemicals that can inhibit cartilage formation.

Their solution? Use antibodies against the bad chemicals to neutralize them. You might be asking yourself the very obvious question: why not just use bone marrow stem cells to repair cartilage? Your guess is as good as mine.
**Bone Marrow Stem Cells Better for Bone Repair**

We don’t much care where you get your stem cells, as long as the source of the stem cells matches the tissue you’re trying to repair. The problem with stem cells is that certain sources produce stem cells more capable of repairing certain tissues, and stem cells from other sources are less capable. The general rule of thumb is, the closer the stem cells are to the structure in need or repair, the better they are at repairing that area. This makes sense at face value, as these resident stem cells in all of our tissues have a role in maintaining and repairing that local organ or tissue.

As an example, fat stem cells from your belly or thigh would be good at repairing the local tissues like skin, nerves, and blood vessels. So it wasn’t surprising to see yet another study showing that bone marrow stem cells are better at repairing bone than fat-based stem cells. This fits with many other studies showing that bone marrow stem cells are much better at repairing orthopedic tissues than fat derived stem cells. This again makes sense, as why would stem cells from belly fat have any role in repairing bone?

At the end of the day, rooting for one type of stem cell because that’s all the doctor knows how to harvest is like rooting for only one stem cell sports team and not recognizing that all stem cell teams have their positives and negatives. For example, stem cells derived from fat are much better for cosmetic work and structural fat grafts than stem cells derived from bone marrow. So why fit a square peg into a round hole or use a hammer when a wrench is needed? Use the stem cell source that fits the job!

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**Fat Stem Cells Poor at Repairing and Producing Bone**

Can fat stem cells help bone inside a bad arthritic knee? Fat stem cells have exploded in use the past several years. There are now hundreds of clinics around the United States where you can find these procedures being used to treat arthritis. While fat stem cells have some amazing anti-inflammatory properties that have been shown to be a godsend for patients with chronic neuro-inflammatory diseases like multiple sclerosis (MS), they have been less convincing in their effects on orthopedic problems like arthritis.
For orthopedic injuries one of the things that you want fat stem cells to accomplish is healing, or turning into bone tissue. Many severe arthritis patients need bone as well as cartilage, and other diseases like non-healing fractures and osteonecrosis would benefit greatly from stem cells that could help repair or become bone.

In one study, the investigators took both bone marrow and fat stem cells and gave them a stimulus to turn into bone. While they got bone progenitor cells and bone formation out of bone marrow stem cells, they were unable to get the same thing to happen with the fat stem cells. In essence, they couldn’t get the fat stem cells to produce bone without some very heavy handed tricks.

The conclusion? All of this is consistent with many other studies out there. In the world of cell therapy, the tail wagging the dog happens when physicians experienced in liposuction use fat stem cells to treat arthritis because that’s the weekend course they took, not because they are the best cells for the job!

Hanging Your Hat on Seven Patients

In the published research or published FDA trials, how many patients have been treated for arthritis or bone diseases?
Fat stem cells for arthritis? The graph above compares the numbers of patients treated and published for bone marrow versus fat stem cells for the treatment of arthritis and bone diseases. Focus for a moment on the number 7. That’s the number of patients in the world who have been reported as having received fat stem cells for arthritis or bone issues. I lectured at a medical conference where the issue of bone marrow stem cells versus fat stem cells came up. Some of my colleagues who are using fat stem cells to treat these problems were hanging their hats and touting miracle benefits with a total world head count of 7 patients. No thanks.

The graph above is the total cumulative patient count by year (2012 and 2013) for cultured and same-day bone marrow stem cells (the latter being defined by “nucleated cells”) and fat stem cells (same-day stromal vascular fraction or SVF). As you can see, the numbers for bone marrow stem cells have grown steadily. We now have 1,293 patients who have been treated and had their results published in the peer-reviewed literature with bone marrow stem cells.

The conclusion? Never hang your hat (or medical license) on a grand total of 7 patients. The fat-stem-cell community has a lot of work to do, and anybody routinely using fat stem cells to treat orthopedic conditions had better be meticulously collecting this data for publication, as the research on fat in orthopedics (or lack thereof) is downright embarrassing.

A Clinician’s Perspective
This section offers a clinician’s eye view of the harvest procedures for both stem cell types that you won’t see elsewhere. In summary, harvesting fat in a mini-liposuction is a violent affair, harvesting stem cells from a bone marrow aspirate is like an advanced blood draw. Let me explain.

In order to get fat through a mini-liposuction, you need to first use a scalpel to open a small incision in the skin. This isn’t at all required for a bone marrow aspiration as the needle is just inserted into the skin like any other needle. In the liposuction the whole goal is to disrupt large amounts of normal tissue. In fact, the stem cells live around the blood vessels, so you have to chew up as many blood vessels in the fat as possible to get a good stem cell yield. This involves placing a small wand-like device under the skin and into the fat and moving it back and forth (through much resistance) to break apart large sections of tissue.

The bone marrow aspiration simply involves directing the needle under x-ray to the desired area of bone. The needle is then turned back and forth a few times to enter the bone (which is like hard plastic). At this point in the liposuction, the doctor must continue to break up large swaths of tissue with suction, sucking the broken tissue and blood vessels into a syringe. On the other hand, in the bone marrow aspiration, the doctor simply draws the bone marrow aspirate (which looks like blood) into the syringe like a common blood draw.

The complication rates (listed earlier) for these two procedures tell the rest of the story.

The conclusion? Don’t believe fat-stem-cell advocates when they claim that a bone marrow aspiration procedure is so invasive. You haven’t seen invasive until you’ve seen a liposuction!
About Regenexx

Regenexx is considered the world leader in orthopedic stem cell procedures. We were the first musculoskeletal stem cell clinic in the United States. Since our beginning in 2005, more than 5,500 Regenexx procedures have been performed across the United States and in two other countries. We track the largest number of patient’s results in the Regenexx professional research quality Registry. Our work is backed by research and we continue to lead the field in physician driven published studies and ongoing laboratory research. These facts set us apart from others offering similar procedures.

Disclaimer: Any case reports or patient results presented on this website are not indicative of all patient results. Like any medical procedure, all Regenexx procedures have a success and failure rate.

Fat Stem Cells for Knees? Regenexx-AD 2013 Data
The infographic above covers knee outcome data for the Regenexx-AD procedure. The procedure is only performed on patients who have a displaced meniscus with moderate to severe arthritis, so this is a select group of >200 patients we tracked who aren’t included in the last group of >500 SD knee patients. The procedure adds both bone marrow stem cells and fat stem cells to the joint to buttress the meniscus.

The numbers look good in this difficult-to-treat population. They are similar but slightly less robust than the SD data. This makes sense, as these patients have lost the ability to use the meniscus as a shock absorber and have bigger biomechanical problems, usually due to a prior meniscus surgery.

What’s also interesting is what these numbers don’t say. There are many advocates for fat stem cells. We have doctors processing fat at the bedside to enrich the stem cells, we have doctors injecting just the fat itself into joints, and we have new bedside machines that will minimally process the fat and bone marrow for re-injection. All of these techniques lay claim to the miracle of fat stem cells—there are many more of them, they are magic, they can help the crippled walk.

Regrettably, this data doesn’t show a huge advantage to adding fat into the knee joint and in a head-to-head comparison with adding just bone marrow stem cells. Having said that, it certainly looks like this procedure accomplishes what it needs to for many of these patients, all of whom were either knee replacement candidates at the time of the procedure or would soon be.

The conclusion? The 2013 Regenexx-AD data is out, and it looks like the procedure is accomplishing its goal in a difficult-to-treat population. But what it doesn’t show is that adding fat stem cells to knee joints produces magical additional effects.

The full PDF of this fat stem cell research infographic is also accessible via this link or by clicking the thumbnail above.
What Regenexx Stem Cell Patients Say

Helping a Hiker’s Knee without Stem Cells

Dear Dr. Hanson,

Thirty miles 5200 feet in elevation gain 30 pound pack three days on the Continental Divide Trail at elevations up to 12,500 feet. It’s hard to believe that six months ago before I walked into your office I couldn’t walk a mile around my block without turning back because of the pain and couldn’t sleep through the night. I never thought I would ever be able do anything like this again.

Thanks so much for giving me my life back!

Ten-Month Follow-up on Knee Stem Cell Injections

Before the Regenexx injection, I had extreme difficulty standing and walking on cement for any length of time, plus I experienced a great deal of pain on a daily basis. I did have a lateral release surgery before coming to see you, but I wish today I had never done it as I whole heartedly believe the Regenexx procedure would have reversed the damage all on it own.

I navigate ships for a living and therefore, deal a lot with vibration and steal decks, both of which stimulate my knee pain. I was afraid until now I would have had to give up my career because of the damage to my knees. I am too young, ambitious and playful to be stopped by bad knees.

Within only a couple of weeks following the Regenexx injection to my right knee, I could tell I was experiencing significant improvement. I had only one knee injected, so the comparison was obvious.

Tremendous Results from Regenexx Procedure

Dr. Centeno,

I want to express my sincere thanks to Dr. Schultz and your organization. Dr. Schultz and his team did an excellent job with the Regenexx procedure on the torn meniscus and ACL on my right knee in October 2012. I could not have asked for any step along the way to be better! Before the procedure, Mark Reilly completed a functional analysis of my body. He made a number of suggestions of exercises that would be beneficial to my progress with my knee after the procedure and for my overall conditioning. I returned to see Mark after 6 months to assess my progress/improvements. I have had tremendous results from the Regenexx procedure. I feel that the exercise suggestions Mark made and his comparative follow-up analysis were very beneficial in helping me to objectively and subjectively assess my progress. I would highly recommend this follow-up analysis with Mark for anyone having the Regenexx procedure in the future.

Thank You to Your Entire Organization!

Jamie Costello
Las Vegas, Nevada
**Skiing in Aspen**

The top of the lift is just off to the right of the picture below. Then you hike up the ridge for about 30 minutes to get to the peak (12,392 ft). Then it’s a wonderful 15 minute ski down to the bottom. I’ve been wanting to do this since I first started going to Aspen 6 years ago. My knee felt good all the way up and all the way down!

His picture at the top is below! DW will be coming back for a second treatment of his knee, and hopefully we can keep him skiing 50-plus days a season over the next decade!
How the Centeno Schultz Clinic and Dr. Ron Hanson Have Helped Me Get Back to Teaching and Presenting in the Fitness Industry
By Leslee Bender Creator of the Bender method and Bender Ball

Approximately 2 years ago I tore my meniscus in my left knee due to 25 years of overuse training and lack of knowledge of what can happen with high intensity exercise. I sought out a method of healing that would be more permanent than surgery. I discovered Dr Hanson from research on the web and how high the recommendation was! The healing process was not easy as I have very degenerative knees however the results are amazing! My range of motion is nearly what it was years ago and above all the strength has returned.

My job is demanding as I am on feet teaching or on an airplane to the next conference which again takes its toll. However the pain is gone. If you are willing to take the time to go through the process I recommend it whole heartedly as your body is a magnificent machine and will heal when you treat it correctly with the right therapy and diet! Physical therapy is a must to train the muscles and nerves to work correctly so you can do what you love in life! I will keep the process so that I have healthy joints for the rest of my life! And, being athletic it is who I am so water and snow skiing has been experienced!

Leslie was first seen by our clinic in March of 2011. She was treated at that time with the Regenexx-AD stem cell procedure with a highly accurate injection of her own stem cells under ultrasound guidance directly into the knee meniscus tears as well as buttressing the displaced meniscus with a stem cell containing fat graft. She had a second knee stem cell procedure in June of 2011.

Appendix
Regenexx Procedure Network- Find a Physician
Regenexx Advanced Stem Cell Support Formula
Free Gift
Orthopedics 2.0 book

DOWNLOAD IT NOW
For more information or to schedule an appointment call 888-525-3005

Regenexx.com