

Editorial

“In My Experience...Evolution to Osteochondral Allografts”

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The author writes about his experience in joint preservation and osteochondral allografts.

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When and how to address articular cartilage defects is an interesting topic. I have seen the evolution, controversies and conflicting opinions related to articular cartilage and optimal treatments for 30 years now. I'm entering my 27th year of practice, so I've seen things fall in and out of favor with a change in decision-making related to cartilage pathology and defects in younger patients who are not good arthroplasty candidates. Originally, when I started, we had minimal options. We had microfracture and debridement, and we just started doing autologous "OATS" procedures in the U.S. back in the mid-90s. To be honest with you, we didn't do that many fresh osteochondral allografts at that time. The original version of autologous cartilage implantation (ACI), was just coming out at that time as well. We were part of the STAR trial that came out in the late 90s and I still recall how tedious and painful (to me) it was to harvest periosteal patches in order to cover the defects at the time. Then there were the treatment options often pushed by industry that unfortunately did not pan out over the years such as OBI and Chondrofix implants. And I'm sure there will be others to add to this list. So, most of us have evolved over the years in terms of how we think about and address with articular cartilage injuries.

Everybody typically develops their own personal algorithm over time and with experience when it comes to articular cartilage. Much like all aspects of treatment approaches across Orthopedics, and I often say, when you hear different surgeons talk about their preferred approaches—, it's very much like religion when young surgeons come out of training, especially in their first 5 to 7 years. Depending on what household you grew up in, you're much more likely to be Jewish, Catholic, Episcopalian, or whatever it may be. You're more likely to do what your parents did. Well, it's the same thing with articular cartilage. Most of us initially go out and mimic what your mentors taught you and how you were trained, and I think we're all like that. Again, it's not specific to articular cartilage procedures.

You see various opinions on the optimal treatment of articular cartilage pathology. We have very thoughtful friends and colleagues in this arena who have vastly different opinions and approaches. Some are still in the marrow stimulation camp which was pioneered by Dr. Steadman, others have gone almost exclusively to osteochondral grafts as their go to treatment for larger lesions while there is a group who feel cellular resurfacing options such as MACI is preferable to grafts. I think there is a role for both depend-

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ing on lesion and patient factors such as location. Anecdotally I remember back to when the first generation ACI was coming out in the 1990's. Everybody's enthusiasm, again somewhat driven by industry, "Oh, this is going to be the holy grail. We're finally able to grow articular cartilage." Then reality kicked in, and we realized that it certainly wasn't. Yes, ACI was a significant advancement, but unfortunately, the hyaline-like cartilage that was filling treated defects did not have nearly the same architecture as normal cartilage. So, this initial enthusiasm for growing cartilage really waned as we got into the 2000s. The now third generation option of MACI offers dramatic improvements over the first two generations, but it is still far from the holy grail.

Autologous osteoarticular transfer procedures (commonly termed "OATS"), where you take plugs of cartilage from one area and transfer them to another area, were common back in the late 90s and 2000s. Personally I did quite a number of them during that era. It was and still is an excellent option for small symptomatic lesions, especially in young athletes where you may need one or two plugs to address a focal defect. However, due to limited donor site real estate, its use is restricted to small lesions. There is potential donor-site morbidity that is real, and that can also be an issue with this robbing Peter to pay Paul approach. The reality is most of the lesions we are currently treating with a cartilage resurfacing or restorative procedure are too large to consider an autologous "OATS" procedure.

Over the past two to three decades many of us have evolved towards doing more and more fresh osteochondral allografts (OCA's). I really credit guys like Dr. Bill Bugbee and Dr. Brian Cole, who have done a tremendous amount of basic science and clinical research in this area. I think what we're all realizing is that osteochondral allografts have really become the workhorse for symptomatic cartilage or osteoarticular lesions when you have to operate and attempt to restore the articular surface because of their reliability, resilience and outcomes. With this technique we know we're putting in real, viable hyaline articular cartilage with normal architecture that survives the transplant procedure. Additionally, the subchondral bone can be pathologic and/or a source of pain with chondral lesions. So you can address that issue as well with a graft. You don't have donor-site morbidity but there are logistical issues to getting a graft-although this has become much easier over the past two decades. Additionally fresh osteochondral grafts are extremely safe when using a reputable tissue company that specializes in supplying OCA's. For all these reasons, we have seen the frequency of utilizing fresh osteochondral allografts going up and up.

Fifteen to twenty years ago osteoarticular allografts were utilized in my personal algorithm primarily for just large femoral condylar lesions or in the setting of subchondral bone loss or pathology. OCA's have really become the go-to treatment for most of my symptomatic lesions, even smaller defects, that I need to treat with a resurfacing or restorative procedure. Exceptions to this are for certain lesions in the patellofemoral compartment that I think are more amenable to a cellular approach such as MACI due

to technical issues. Smaller condylar lesions can actually even be implanted arthroscopically. Tissue companies are now selling procured plugs as opposed to buying the entire condyle which can be much more cost effective-especially in the ambulatory surgery center setting. It's much more viable than buying a hemicondyle which can run \$10-15,000. Since we can now get these smaller fresh procured plugs, for a much more reasonable price, that's also helped with using fresh osteochondral grafts as a primary treatment procedure for smaller symptomatic lesions.

I think that what we're all seeing is the number of osteochondral allografts is going up and up. The number of marrow stimulation procedures is gradually going down. The number of autologous OATS procedures has gradually gone down. If you look at the ABOS data, marrow stimulation and autologous OATS is going down while fresh OCA's are growing in popularity. The fact is that osteochondral allografts is a procedure that's growing because it's reliable, generally much more resilient, and you can restore fresh articular cartilage. The bottom line is that it works very well in the proper setting relative to our alternatives. In some cases, now we can do it arthroscopically. In other cases, you just have to make a small open arthrotomy if you need to, but it's a very reliable procedure that is quite gratifying to do. What we've seen happen over the last 25 years is that most of us have changed our cartilage treatment algorithms, and we've really seen fresh osteochondral allografts rise to the top due to the reliability, safety and availability. You're restoring defects with real articular cartilage with not only a chondrocyte phenotype but normal hyaline architecture. Now, not that there aren't problems with it.

You can have problems with anything. You could potentially have problems with incorporation. You can have fracture and collapse. You can have delamination of the cartilage. You can have cartilage breakdown. You can certainly have problems with osteochondral allografts, but all that being said, it's still probably the most reliable articular cartilage procedure that we have at our disposal at this point, at this time, other than perhaps autologous OATS procedures. But you're really limited in that you can only use that for small lesions. Autologous osteochondral grafts are very reliable. It works great, but you're really limited in terms of the donor-site real estate. So, you can really only harvest one, two, or maybe three plugs at the most. That's why the frequency of using autologous grafts has gone down, and again, why fresh osteochondral allograft usage has gone up and up and up. Also, from a technical standpoint, the instrumentation has gotten better over time. That's helped, and again, the utilization of arthroscopic equipment to basically deliver these grafts arthroscopically is available now.

In terms of fixation, most of these are press-fit without the need for fixation. For most of these, you core out a recipient site, and then procure the donor plug that's going to be placed into that recipient site is slightly larger. So, you can typically get a very nice press fit. There are rare or unusual cases where you feel you need to place fixation with headless screws, but I'll be very honest with you, I almost never do that. You can typically get a nice press-fit for most grafts. Now, there are some types of osteochondral

grafts where the technique is not press fit with coring reamers. For instance, for a patella, if you're going to resurface the entire patella, where you basically have to treat it almost like a fracture and fix it with screws. That's one example where you can't do a press-fit, but that's relatively less common versus the press-fit technique. I know there are some people that like to put screws in almost all of them which is fine, and if needed you should not hesitate if you feel the fixation is needed. I personally almost never use screws because the press-fit is so good.

Regarding post-op rehab you typically have to differentiate tibiofemoral lesions (most of these tend to be femoral defects that we treat), versus patellofemoral lesions because, in terms of weight bearing, there is obviously a difference in what you can allow. If you have a weight-bearing femoral condylar lesion, I will typically have them go toe touch weight-bearing for 6 weeks and then after 6 weeks, let them advance as tolerated. If I have, let's say, a trochlear defect that I resurface their trochlea with an osteochondral allograft and it's not weight-bearing in full extension, I'll let them bear full weight right away, but I'll limit their weight-bearing flexion. I'll put them in a brace and don't let them do squats and lunges for 6 weeks. But honestly, most of these grafts typically incorporate within 6 weeks in most cases. Now, it is an allograft, so sometimes biologically it can take a little bit longer to incorporate in some cases and we see that. But in most cases, they heal quite nicely within the first couple of months. Beyond that, honestly, it's really a matter of getting their strength back and how they feel.

One thing that we've noticed sometimes with fresh osteochondral allografts is they will sometimes get pain that takes a while to resolve, even after they are healed at the bone interface. So even though it may heal by 2 months, sometimes these patients can have this often mild chronic discomfort or pain for 6 or 9 months that gradually goes away.

If you look at MRIs after fresh osteochondral allografts, honestly they do not look very good in the first few months. So that's why a lot of us try to avoid even getting an MRI unless it's for research purposes or if you think you have a problem. Because a lot of times you can see that immunologic reaction around those grafts and sometimes it really lights up on T2 images. Other times it doesn't. But I do think that in that subset of patients that get pain for that 6 to 9 months to a year sometimes, it's my personal feeling it's probably because that immunologic reaction that gradually gets better and resolves. The good news is most of them it gradually resolves. The other good news is the pain usually goes away. That's one thing I've learned over the years is that an autologous plug versus an allograft plug, the autologous plugs heal quickly in people. As long as you don't get donor site morbidity, they tend to feel better quicker. With allograft plugs or implants, sometimes you'll see that patients will have more pain for a while. It gradually gets better. You just have to tell them, "Hang in there. It usually gets better and better and better." Sometimes it can take up to a year for that to get better.

In terms of availability because that has been a problem in the past. I think where we're going with this, it's going

to become more and more popular because it's relatively not a difficult operation to do. For most surgeons, it's very easy to become proficient with doing osteochondral grafts. Honestly, it's very satisfying. You do an OCA and you think you're doing a good thing for the patient, you have this beautiful cartilage where half an hour earlier, you had this bad ugly defect. So, it's a cool procedure. It really is, and it's a lot of fun. You get the sense you're really doing the right thing versus, quite frankly, some other cartilage procedures where sometimes I finish and I'm like, "I hope this works," and you're not always sure.

Now let's have a reality check here for a second, okay? I joke with my total joint partners and colleagues sometimes. I say, "Listen, if you want to get the most holiday from your patients, do hip replacements-not cartilage surgery." Cartilage surgery outcomes are just not as good as joint replacements-even in the best of hands. Let's face it, from a patient outcomes perspective, in orthopedics, nothing beats a hip replacement as you know.

In cartilage surgery, we have 20 to 35% failure rates in some scenarios. Our results are dismal compared to the results doing hip replacements. But it's just part of the deal. If you're going to do cartilage surgery, you have to realize that your results are not as good and we have a lot of room to improve. But I also think that these can be complicated patients. Traumatic small lesions in a previously normal knee are fairly straightforward-but that is the minority. Very often that medial compartment that eventually turns into bone on bone starts off as a small focal chondral defect. And that small defect that you see when someone is 30 years old really, that's often the phenotype of early osteoarthritis-for which we do not have a cure. So, we're really not changing the natural history of osteoarthritis and progression in most of these patients. We're trying to treat symptomatic lesions in younger patients. We're trying to fill that pothole, that hopefully will make them feel better for a period of time until they are older. These patients are often not easy, and the development of their cartilage pathology is often multifactorial.

We have a long way to go in treating cartilage defects. I think part of it is understanding what's going on in that patient's knee and the fact that in a lot of cases, it's really osteoarthritis that is the underlying etiology-we are just seeing them early. We're just seeing it as a sports surgeon because they're not bad enough to get into the knee replacement doctor's office yet. So, they're seeing the sports surgeon who says, "Oh you have an articular cartilage defect," versus really what they have is early osteoarthritis that we're trying to treat. We may treat that symptomatic defect that really is just, again, the early stages of osteoarthritis. We have a long way to go and our results are not perfect by any means. We have relatively high failure rates and dissatisfaction relative to joint replacement patients. We always have to remember that, especially as patients get a little bit older. They'll come in and say, "Well I don't want a joint replacement. I want you to do some sort of cartilage procedure." I think we as sports and cartilage surgeons have to realize that the alternative of doing

an arthroplasty sometimes may just be a better option for some patients.

I think that is part of the challenge, that to be from a patient satisfaction standpoint, part of this is what's very important. I think where a lot of sports surgeons have evolved over the last 25 years is we've realized the fact that our results are not perfect and that from a patient satisfaction standpoint, our results are not nearly as good as someone who does hip replacements, for instance. It's very important to talk to the patients beforehand about the fact that, "Listen, we're going into this, but you may have a home run type of lesion on the medial condyle that's small that there's probably a 95% chance that I'm going to make you better for a while. But in a lot of cases, it's a bridging procedure, and you're not going to be better forever. That knee is probably going to eventually still break down in a lot of cases. We're just trying to buy you time, and it's a bridging procedure."

One final point I would like to make is the fact that I've personally become much more conservative taking care of cartilage lesions, and I know a lot of my colleagues feel the same way. Whereas 25 years ago if there was a chondral lesion that we picked up on an MRI, even ones that may

be minimally symptomatic or asymptomatic, sometimes we were like, "Oh, we should probably address that lesion, otherwise that patient's going to get osteoarthritis at an early age." I think that thinking was completely wrong and in most cases we are not changing the natural history of arthritis. I think that we were overaggressive in a lot of cases back in the 90s and 2000s and that a lot of us have gotten much more conservative realizing that less is better and less can be more. Now, if somebody has a cartilage lesion, we are not going to be jumping into doing a MACI procedure or even osteochondral graft. A lot of us will start with a simple scope debridement, and patients can do well with that. This is especially true in high level athletes. So despite this being primarily a discussion related to surgical options and OCA grafts, I wanted to stress I have gotten much more conservative over the years when it comes to surgical decision-making and just decision-making in general treating cartilage lesions in the knee.

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