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The Nuts & Bolts of Treating Articular Cartilage Defects

Narrator:
Welcome to **Medical Breakthroughs** from Penn Medicine, advancing medicine through precision diagnostics and novel therapies.

Dr. Caudle:
This is ReachMD and I'm your host, Dr. Jennifer Caudle, and with me today is Dr. James Carey, Assistant Professor of Orthopedic Surgery at the Perelman School of Medicine at the University of Pennsylvania. He is also the Director of the Penn Center for Advanced Cartilage Repair and Osteochondritis Dissecans Treatment. We will be discussing articular cartilage today. Dr. Carey, welcome to the program.

Dr. Carey:
Thank you. I appreciate the invitation.

Dr. Caudle:
Well, we're happy to have you here and I'm really interested in talking about this topic. Can you start out by telling us a little bit about what exactly articular cartilage is?

Dr. Carey:
Sure. Well, the articular cartilage is the shiny surface that coats our bones and allows them to glide at the joints. Interestingly, the cartilage is actually very slippery and if you actually compare the coefficient of friction of various surfaces, it's about a thousand times more slippery than ice on ice.

Dr. Caudle:
That's amazing. Can you talk to us then about what happens when the cartilage is damaged, and feel free to be specific with certain joints.

Dr. Carey:
The thickest articular cartilage in our body is about the knee. And while the articular cartilage issues can occur at many of our joints, we can focus a bit about the knee. Typically from the patient's perspective, they will note pain and swelling in the knee. And this cartilage damage, you can imagine, it's supposed to be very slippery and when it's injured, the knee can't bend or straighten completely, and during movement the patient may have catching or locking sensations. Catching is when the motion in the knee is temporarily inhibited and locking is when the motion in the knee is halted. X-rays and MRI are almost always performed prior to formulating the definitive plan. X-rays, as you know, they show the bone very well, but you can't directly visualize the articular cartilage. We get indirect information when it's missing and the bones can be touching in certain areas, but it's really the MRI that shows us the articular cartilage in 3 dimensions, and can allow us to map out where it's excellent and where it's missing or damaged.

Dr. Caudle:
Well, can you talk to us about what the difference is between focal cartilage defect and arthritis?

Dr. Carey:
That's really an excellent question. That's really the key to formulating the proper treatment plan. So, if we think, and broadly there's 2 types of cartilage injury. It could be a focal defect or regional defect. A focal defect would be like a small pothole on a good road, and those are things that we can perform cartilage repair on. In contrast, when the cartilage loss is regional, it's kind of like a bad road, that is what osteoarthritis is; the regional loss of the articular cartilage where it's thinned kind of more in a global sense in that compartment of the knee. They're really on a continuum because little potholes can turn into medium-sized, and then large potholes, and eventually into a bad road, but we tend to think of them differently because they have different treatment options.

Dr. Caudle:
So, why don't we talk about the treatment options? You just mentioned that they do have different treatment options. Can you talk about those treatment options for small defects, say those that are less than 2 cm2?

Dr. Carey:
Yes, and a patient's treatment options really depend on the size and location of the defect and when some of the studies – I mean, at this point, there's about 16 randomized controlled trials to look at different cartilage treatments with more than few years' followup, they're often dichotomized less than 2 cm2 or more than 2 cm2, or less than 2.5 cm2 or more than 2.5 cm2. I will typically use about 2 cm2 as a cut-off and the smaller defects get smaller treatments that are performed with smaller incisions, often arthroscopic incisions. And there's really 2 treatments for the small defects; one is, osteochondral autograft transfer, or O-A-T, OAT, and this procedure involves borrowing a small cylinder of cartilage and bone from a less critical part of the knee, and putting it into a more critical part of the knee, and, as you know, most of our cartilage is pretty critical already or it wouldn't be there, so there are limits to how much we can borrow. And that's why it's only used for these smaller defects. The other treatment option for small defects -- you've probably heard of microfracture -- and during microfracture, little holes are drilled into the bone to allow the marrow elements to leak out. These query*4:41 potential cells can go down different pathways: cartilage, bone, fibrous tissue, muscle, fat, but we want them to go down one pathway, cartilage, or maybe even the fibrocartilagenous pathway would be acceptable. And so, we want them to go down the cartilage pathway and so we often will simulate in the postoperative period like we're back in the womb again, kind of kicking and nonweightbearing for a period of about 6 weeks, but in that manner, microfracture can fill a defect and patch it when the defect is small.

Dr. Caudle:
If you're just tuning in, you're listening to Medical Breakthroughs from Penn Medicine on ReachMD. I'm your host, Dr. Jennifer Caudle, and I'm speaking with Dr. James Carey, Assistant Professor of Orthopedic Surgery at the Perelman School of Medicine at the University of Pennsylvania.

Dr. Caudle:
So, now let's go a little bit to some of the options for large defects, those that are more than 2 cm2. Can you talk to us about those a little bit?

Dr. Carey:
Larger defects may be treated using autologous chondrocyte implantation, or ACI, or osteochondral allograft transplantation, both of which require open incisions. The autologous chondrocyte implantation, ACI, is a 2-stage treatment. The first stage is done arthroscopically and a little biopsy of articular cartilage about the size of a Tic Tac is harvested and sent to the laboratory where they grow millions and millions of the patient's own cells. Then, about 3 to 5 weeks later, they can send back vials of the patient's own cells, typically about 12 million cells per vial, and even the smaller defects require about 2 vials' worth of cells, and then the second stage is an open procedure with incision long enough to access the injury site, and

during this procedure a collagen membrane is sewn around the surrounding cartilage and then the cells are injected underneath the membrane and sealed water-tight with fibrin sealant so that the cells don't leak out. The cells mature over time, as long as 18 months, and become cartilage ultimately.

The other treatment is osteochondral allograft transplantation and this procedure is similar to -- just like a heart or lung transplant, but for cartilage and bone. During the procedure the damaged cartilage and bone is replaced with the donor tissue. It has some advantages, though, you don't have to worry about matching the donors based on blood type, like you do with those other organ donations, because the tissue's not very immunogenic. Instead, it's important to match the bone and cartilage based on the size of the donor because you can imagine the radius of curvature of the femoral condyle is going to be different with a small girl compared to a large man, and so it's important to match that carefully. Another difference is these cartilage and bone cylinders can remain in storage for about 4 weeks and still be viable, whereas you know the heart, lung, kidney transplantations have to happen much more quickly.

Dr. Caudle:
Can you talk to us about what new techniques are available on the horizon?

Dr. Carey:
Here, the surgeons at the Penn Cartilage Center are involved in a few randomized controlled trials including 2 Phase III FDA trials. One involves the NeoCart which is an investigational cartilage tissue implant. It's derived from the patient's own cells, combined with collagen, and it forms a cartilage tissue implant which is then sculpted like a puzzle piece to fit the injury site and then glued into place with a special adhesive. And the second study involves Hyalofast which is a scaffold with autologous bone marrow aspirate concentrate and this will be a one-step, minimally invasive, arthroscopic procedure.

Dr. Caudle:
Wonderful. So, can you talk to us a little bit about education? Are there any innovative educational events that are related to cartilage and cartilage repair happening?

Dr. Carey:
The 5th Annual Penn Cartilage Symposium will occur in late April, April 29th and 30th, the same weekend as the Penn Relays, and speakers have come from around the globe. This year, Dr. Lars Peterson, who many consider to be the godfather of cartilage repair, is coming from Sweden, and last year we had 173 attendees and this year we anticipate more than 200 people to attend including physicians, scientists, engineers, nurses, physician assistants, physical therapists, athletic trainers, and students, and I learn a lot at this symposium. I think people really enjoy that.

Dr. Caudle:
Well, that sounds wonderful. Well this has been a very interesting and enlightening interview. Dr. Carey, thank you so much for being with us today and sharing your insights on articular cartilage.

Dr. Carey:
Thank you.

Dr. Caudle:
I am your host, Dr. Jennifer Caudle and thank you for listening.

Narrator:
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