

Dr. Justin Arner:

Welcome everyone. I'm Dr. Justin Arner from the University of Pittsburgh Medical Center in Pittsburgh, Pennsylvania. Today I have this pleasure of speaking with Dr. Aaron Krych, Professor of Orthopedic surgery at the Mayo Clinic in Rochester, Minnesota. Dr. Krych was the author of this paper titled "Platelet-Rich Plasma and Marrow Venting May Serve as a Cost-Effective Augmentation Technique for Isolated Meniscal Repair: A Decision-Analytical Markov Model-Based Analysis," which is in press in the Arthroscopy Journal. Welcome Dr. Krych, and thanks so much for joining me.

Dr. Aaron Krych:

Thanks very much Justin, for having us. I'd just like to really emphasize I'm presenting on behalf of our entire author team. To the listeners of Arthroscopy, I'd just like to recognize the outstanding work of our lead author Jake Oeding on this manuscript as well.

Dr. Justin Arner:

Great. Certainly this is a pretty complicated modeling technique that I'm not as familiar with and I'm sure it took a lot of legwork in reading the background. You guys really did it the right way, so congratulations on that and mentioning that, first thing I really wanted to ask you about is can you just tell us a little bit about the modeling and Markov modeling, what it is and what these modeling studies provide for us and how they work?

Dr. Aaron Krych:

Yeah, I think that's a good place to start. I would let people know that it's really about the goal of what the Markov model can do, and it's really about to add cost to an outcomes model to determine if really one treatment is cost-effective over another. So in general, the way this is set up is Markov models are decision trees. We just model clinical courses of treatment really as transition between discrete health states based on probability events over a specific period. So what it means in this meniscus repair study, as we take an event like an isolated meniscus repair, we then look at its outcome, either success or failure, failure leading to further surgery with partial mastectomy, and we look at the estimated probabilities based on papers and data and the literature. We really try to play this model out, and in this case we used two years as our time horizon to really determine was there a cost-effectiveness difference between different treatment options for an isolated meniscus repair.

Dr. Justin Arner:

It's definitely the future. I think it's a great opportunity to have kind of big data and set up the appropriate outcomes that we really want to boil down to. So tell us a little bit of how you got interested in meniscus repair and cost and this study and the biologics. What was the background of it?

Dr. Aaron Krych:

Yeah, so I think when we look at the landscape in recent years, it's definitely shifted to more focus on trying to save the meniscus, obviously trying to repair it if possible, particularly in an isolated setting in a younger patient, which is really the topic of this paper. We've talked about different strategies to improve healing rates with biologic augmentation such as PRP, marrow venting procedure, fiber clot, different things, and really to date, the data's been mixed on the treatment effect for these strategies. As you know third party payers aren't often reimbursing for PRP augmentation of isolated meniscus repairs. So what we really wanted to do is try to get something more definitive that not only looked at

cost, but also effectiveness of these biologic augmentation strategies a bit more closely. And hence, we thought the Markov model was the best way to look at this.

Dr. Justin Arner:

Yes, certainly the only way we can get them to pay for some of these things is studies like this. It's really important. Diving into some of the details about the model and the studies you guys used and everything, I wanted to just ask a few questions. How did you guys pick the age 25 to 35 years old, and then I noticed there were kind of three studies you guys utilized to help use this model and basically bring it to fruition. Just tell us a little bit about how that basically is set up.

Dr. Aaron Krych:

Yeah, so first you mentioned the age Justin. So we evaluated patients, again, this is a theoretical analysis, so we wanted to choose inputs that were clinically relevant and that obviously for us starts with a patient. So we would all agree, I think that a young adult age, like 25 to 35 that sustains a traumatic isolated meniscus repair would be best served with a meniscus preservation with repair if at all possible. The second factor to consider is when you perform Markov modeling, you need to have published data and estimates available.

So we needed to also choose a patient that was going to closely match the cohorts of outcomes that are currently published. You mentioned that we chose three studies, so we systematically looked at all of the data available and what we really wanted were decision trees and assumptions and estimates that really again, mimicked real life. So we wanted to include young patients as we mentioned, we wanted isolated meniscus repairs without ACL injuries and really no arthritis or cartilage injuries, and we kind of wanted to exclude degenerative tears, discoid meniscus type of tears. So while there were other systematic reviews available, really when you looked at the factors that we wanted above to really isolate the effect of biologic augmentation, we chose these three papers.

Dr. Justin Arner:

As you mentioned, I did a review for JAAOS, I guess maybe two years ago or so, and it's really surprising how few studies there are with these isolated meniscal repairs, and it's something we really struggle with. And as you mentioned as well before about the mixed literature with biologics, and I think some of us take for granted, some of these studies are less impressive than what we would hope. And I noticed you noted that your PRP augmented repairs, the failure rate was set at 10.8% and then 27% without PRP. Tell us a little bit about your kind of gestalt in your experience. Have you seen failure rates similar to that or what are your thoughts about failure rates in these isolated repairs?

Dr. Aaron Krych:

Yeah, I would say it's important to mention here that these failure rates were representative of two year outcomes after an isolated meniscus repair. So if you look at the inverse of this, that means the success rate would be 73 to 90% for an isolated meniscus repair, which I think honestly reflects the outcomes of my practice. I think we have to keep in mind though that we are repairing more and more complex tears in younger and younger patients. Both variables, both young age and complexity of tear are going to drive up the failure rate of our repairs. So I think when you discuss this with patients, I mean clearly there's a zero chance of saving a meniscus if it's in your shaver tubing, but I feel that these success rates would be valued by most patients when you have a discussion with them.

Dr. Justin Arner:

Yeah. Right. That's for sure. Just when people have discussions about rotator cuff tears, they say 50% of them are going to get worse, but 50% of them aren't going to get worse. So if you're looking at the, I know it's pretty obvious, but we certainly want to get better. Tell us some of the main takeaways from your study, and has this changed your practice at all, the findings that you guys came up with from this Markov model?

Dr. Aaron Krych:

Yeah, so I'll try to simplify it for the listeners out there and certainly they can dive into paper a little bit more depth. So with isolated meniscus repair, we definitely saw that biologic augmentation resulted in higher number of qualities or quality adjusted life years and overall costs when you compared it to non-augmented isolated meniscus repair, really suggesting that biologic augmentation was cost-effective. Specifically, we looked at the number of qualities was the highest with PRP augmentation, which we found was very interesting. When you looked at total costs however, the marrow venting were actually the lowest in the three groups. Therefore, when you looked at these two biologic treatments, one really didn't dominate over another.

Typically, when you look at dominance in a Markov model, you want both clinical superiority, i.e. higher effectiveness and cost savings with overall lower costs, and this was kind of a split decision if we will. We did determine that the cost savings of PRP application over the two-year time horizon of the study did not fall below what we call the willingness to pay threshold. So typically, \$50,000 is used as the willingness to pay threshold that's been established in other studies, so it did not reach that threshold. So really based on the current published failure rates, we found that marrow venting was actually the lowest cost-effective strategy in treating young patients with isolated repairs in this study.

Dr. Justin Arner:

That's an awesome summary. One thing that I noticed in the study, which I'm sure is based on the Markov model they mentioned or you guys mentioned that there was a \$5,000 difference with marrow venting. Tell us, I'm just more curious, what's the background with that?

Dr. Aaron Krych:

Yeah, I appreciate you bringing this point up because here is where it gets a little bit more complicated. So when you report costs of a Markov model study, these are reflective of the overall treatment cost for that time horizon, which again is two years in this study. So for example, the upfront cost of PRP, we estimated about a \$1000 in this study, which is clearly more expensive than marrow venting procedure or obviously no augmentation at the time of surgery. However, when we looked at the probability of failure, this was the smallest in the PRP group, so there was less cost accrued for the recurrent valuation if you have a failure, a MRI, office visits, subsequent partial mastectomy. So this explains how a less expensive treatment option, just talking about the cost of the initial procedure, may actually end up resulting in higher total costs than a treatment option that was a slightly more expensive upfront, which is what we saw in this study. The non augmented procedures actually cost the most in terms of a two-year timeline.

Dr. Justin Arner:

Yeah, that's a great explanation. It's a lot easier to hear from you than just from the paper directly. I've tried a few different personally marrow venting techniques. Not to jump ahead too far, but what are your thoughts about marrow venting and are you doing it and how are you doing it versus some of these

drill techniques with a shaver or an all or more of a longer nitinol wire type drill? Do you have any thoughts about that?

Dr. Aaron Krych:

Yes, I think as we're recognizing it provides value, different types of techniques have really emerged. And I think the goal remains, you want to deliver cellular elements from the bone marrow, and this hopefully will provide a fibrin clot at the repair site, and we want delivery of growth factors ultimately over initial healing. So really the goal is to get bleeding in the notch, and certainly you can use a microfracture all, but sometimes this impacts the bone, which doesn't cause a lot of visualized bleeding. So what you mentioned, you could consider a wire, a cannulated drill bit actually works the best because it actually removes bone and keeps the channel open. So you really see a lot of bleeding there. Regardless, what I would tell people is to stay away from the PCL. I did have a case where a patient developed a symptomatic cyclops lesion, and I think I was too close to the PCL, so I used more of the lateral wall distal to the ACL, just to avoid any sort of heterotopic site blocks lesion that might form.

Dr. Justin Arner:

Oh, very good advice. I'm glad we chatted about that. That's good to learn from others. So you mentioned before about the PRP \$1000, I saw your average cost. You saw between 500 and \$1,500. Do you think those prices have gone down anymore since these studies have been published, or tell us a little bit about how you use biologics in your practice? It's certainly difficult, like you alluded to with payers being difficult and or just your overall thought process with using those just in real practice in our own practices.

Dr. Aaron Krych:

Yeah, I think like any technology, certainly costs have come down over time. The challenge remains, there's so much variability and heterogeneity in the final product being delivered. So for example, some lesser expensive kits may not concentrate platelets as much as more expensive kits. And I think ultimately as a surgeon, as a clinician, we need to be familiar with the intricacies of the system that we're using. For this study in particular, what I'll just mention is we did perform a sensitivity analysis to determine if the cost of biologic augmentation would affect the overall success of this model, and from that analysis, what we determine is actually the success rate variable that has the greatest impact on outcome in the decision tree analysis is the success rate of the meniscus repair. So specifically if PRP augmentation really causes like 33% less failure than the currently published success rates, then it would become the dominant treatment strategy in terms of higher effectiveness and overall lower cost. So it wasn't the upfront cost of the PRP, it was more on how that affected the success rate of the outcome of the isolated meniscus repair.

Dr. Justin Arner:

A great summary and it certainly gets more complicated than just using PRP or not PRP. There's so many different systems and we learn so much every day about the additives and we could talk for hours about that as well. Another topic that we could talk about for a long time and is certainly not well established is just approach to meniscus repair. You alluded to saving the meniscus, which we all are trying to do. Tell us us about your kind of thought process regarding age and patients and your repair technique. How do you approach these menisci that are in these more younger age groups and your repair strategies and thought processes?

Dr. Aaron Krych:

Yeah, so what I would say, Justin, it's a great time to be a meniscus surgeon. We have a lot more tools. I think we have a better understanding overall of meniscus repair. And that being said, we have to realize that not all meniscus tears are repairable. Certainly there are some selective tear patterns that can do quite well. Partial mastectomy primarily where you have a good functioning healthy rim of meniscus left. Just like you mentioned, where we need to push the envelope is really in those meniscus tear types where the meniscus biomechanically is no longer functioning. So whether that's a root tear, a radial, a radial oblique tear. For me, I do that in settings, particularly in the lateral compartment. We know the lateral compartment is much more sensitive to any meniscus loss and in really that young patient. So for me it's that young patient lateral meniscus tears where we really have to do a better job of trying to get the meniscus to heal. Just recognizing again that we won't be 100% successful in all cases.

Dr. Justin Arner:

Certainly it's tricky depending on the patient and pressures from parents and patients about playing sports. And I was curious, there's been some more interest, and I've done it a few times of some of these horizontal type tears where the meniscus looks fairly healthy, not necessarily a 65-year-old arthritic person, but have you done many of the haybale type suture techniques for horizontal tears and do you prefer inside out versus all inside? I know the literature kind of can say we can do both.

Dr. Aaron Krych:

Yeah, I think it's really a great topic and I do perform repair of horizontal cleavage tears. I think when you look at the biomechanics, when you remove a single leaflet, it profoundly impacts the lateral side more particularly it happens at the popliteus hiatus. When you resect a single leaflet, really you're increasing contact pressure substantially. So I think we need to repair them if possible. In terms of all inside versus inside out, I think a meniscus surgeon really needs to be familiar with all techniques and have really all the tools in your toolbox. On the lateral side, I try to maintain the normal mobility of the meniscus. So in regard to a horizontal cleavage tear, that means maybe an all inside kind of knot tying technique where we're not tethering it to the capsule perhaps, but as soon as that tear pattern starts to come a little bit more anterior into the body anterior horn, certainly that's not possible. And that's again, I think where it's important just to have the entire toolbox as a meniscus surgeon.

Dr. Justin Arner:

That's certainly a good point. I know one study that was done here in Pittsburgh with Volker Musahl, he was a big kind of ramp fixer and his lab really give it to him, his lab, he looked at the normal motion of the meniscus, and maybe it's worse if we're plastering these menisci back to the capsule, making them too tight. Some of the data with more posterior lateral tears with ACLS certainly is off-topic here, but it's not as simple as just stitching it back as tight as you can. So that's a great point about the more all inside situation with knot tying, even though we don't love the knots there, maybe that's better. So to talk about, more about your practice specifically, tell us what you do in your practice. Do you use PRP or fibrin clot or have you ever tried BMAC in some of these and are you a believer in some of these biologic augmentations to use in your own practice in our practices with isolated meniscal tears?

Dr. Aaron Krych:

Yeah, I would say yes. Our paper supports certainly their use and certainly there have been other authors demonstrating the positive benefits. I think before you get into kind of the biologic augments to me are kind of the cherry on top if you will, but we really need to focus on the basics. We need an

anatomic reduction, we need a good biologic preparation. So spending some time rasping the meniscus tear the synovium, the surrounding tissue, and then really getting a good circumferential compression. So I think those basics are important.

And then beyond that, when it's an isolated tear, clearly biologic augmentation seems to work better than no augmentation. For me, bone marrow aspirate concentrate, there's really not enough data for me to use it in patients. At the minimum, I think everybody should be using marrow venting. I mean clearly that's been showing a benefit. And then the question is really PRP, when do we use PRP? And I do use it when we have an isolated tear, maybe a more complex tear. I think it comes down to doing what's right for the patient and for me, there's enough data out there to support its use and I'll advocate for reimbursement in those settings where we really need that meniscus to heal.

Dr. Justin Arner:

Yeah, it's a great point. And again, maybe a little off-topic, but do you have any advice about working with your system or do you discuss ahead of time? Does the patient get billed or how does that work in your system? It really probably depends on your hospital and how that cost really gets dispersed.

Dr. Aaron Krych:

Yep. The advice I'd give for you as a surgeon is get to know the resources at your own place. For example, there might be billers, coders, administrators that would be very helpful. It's always better to have those discussions upfront with them because make them your ally. And I think if you can arm yourself with data in the best interest of the patient, I think you can have some productive conversations. The other part of it's, I would have a heads-up conversation with the patient. Sometimes these things do require additional information for approval such as a letter, medical necessity or a peer to peer review or something. But again, if you feel that that is clearly best for your patient, then I think it pays to go the extra mile and advocate for them.

Dr. Justin Arner:

Yeah. Really spending the time with your hospital or present or whatever may make a lot of dividends in the end. So wrapping up here, I was just curious, we still feel like have some ways to go with improving meniscal healing. Certainly you mentioned come a long way versus the old darts people used to use or just mastectomies. But tell us where you think the future is. Is it continued biologic evaluation? Is it better repair techniques? I totally agree with you with being competent and feeling comfortable with inside out and all the different repair techniques. Certainly it starts with a stable fixation, but where do you think the future is with meniscus repair and healing?

Dr. Aaron Krych:

Yeah, I think Justin it's going to be a little bit of everything. I think from an education standpoint, when I look at the last 10 to 15 years, Arthroscopy and arthroscopy have really been leaders in teaching the next generation of a surgeon excellent repair techniques. Second is I think we as a surgeon are ultimately responsible for our repair technique and making sure we're performing the best repair possible. And then really on the biology, I think that's where we're going to see the gains and the breakthroughs. We really need to have a better understanding of the mechanism of meniscus healing. We know that MSC are involved, they're coming from the perivascular cells and the synovium, in the meniscus. So I think really strategies, old strategies, [inaudible 00:22:49], et cetera, are very important. But maybe looking for new ways to ramp up healing mechanisms that I think will be determined.

I think there's groups looking now at can we somehow isolate meniscus cells, combine them with MSCs, try to enhance healing, or when we can't repair the meniscus, maybe trying to improve our meniscus transplant biology. I think there's a lot of room to work there, but it's a great time again to be a meniscus surgeon. I think we're having enough success where it makes it fun and worthwhile, but enough failure is where I think we can really go back to the science and try to do better for our patients.

Dr. Justin Arner:

Hey, you're right. It is, it's exciting time, just like hip arthroscopy and some of these other types of procedures that we're making a lot of improvements with techniques and it's an exciting time and exciting to see what'll happen in the next 10, 20 years. So I really appreciate you taking your time and sharing your results with us today. And this is pretty complicated modeling technique and I think it's really interesting to speak about it and how you came to come to your results and everything. So we, as you mentioned, need to continue to improve this and this is a great way to start that off. So thanks for your time and really appreciate it.

Dr. Aaron Krych:

Thanks Justin.

Dr. Justin Arner:

Dr. Krych article titled "Platelet-Rich Plasma and Marrow Venting May Serve as a Cost-Effective Augmentation Technique for Isolated Meniscal Repair: A Decision-Analytical Markov Model-Based Analysis" is in press in the Arthroscopy Journal and is available online at arthroscopyjournal.org. Thanks so much for joining us.

Medical Disclaimer:

The information and opinions discussed herein, including but not limited to text, graphics, images, and other material contained in this podcast and its referenced paper are for informational and educational purposes only. No material in this podcast or its referenced paper is intended to be a substitute for professional medical advice, diagnosis or treatment. Specifically, all content and information in this podcast and its referenced paper does not constitute medical advice. Always seek the advice of your physician and/or other qualified health care provider with any questions you may have regarding a medical condition or treatment and before undertaking a new health care regimen, and never disregard professional medical advice or delay in seeking it because of something you were exposed to from this podcast or its referenced paper. The information discussed in this podcast and its referenced paper may not apply to every individual and may cause harm.