

Dr. Travis Dekker:

Welcome to the Arthroscopy Association's Arthroscopy Journal podcast. The views expressed in this podcast do not necessarily represent the views of the Arthroscopy Association nor the Arthroscopy Journal and are not meant to be used as treatment recommendations for patients. Welcome everyone, and welcome this evening. I'm Dr. Travis Dekker, coming from the United States Air Force Academy.

Today, I'm talking to both a friend and mentor of mine, Dr. Alison Toth. She's the ultimate team physician surgeon and mentor of mine, and she's been a staple on the sideline for Duke University Athletics and NCCU for decades. She continues to be an advocate for her trainees, pushing them to their potential, while also keeping patient care and outcomes as her top priority. She currently serves as the vice chair of orthopedics at Duke University and she'll be speaking to us today on one of her classic arthroscopy articles that remains heavily cited. We'll be speaking about hamstring autograft ACL reconstruction, reviewing her 2012 article entitled, Graft Size and Patient Age Are Predictors of Early Revision After Anterior Cruciate Ligament Reconstruction With Hamstring Autograft. Welcome to the podcast, Dr. Toth.

Dr. Alison Toth:

Hello. Thanks Travis. Really enjoy being here and thanks for the invitation. It's great to see you running the podcast series for a Journal of Arthroscopy and again, pleasure to be here and discuss this classic article.

Dr. Travis Dekker:

Well, let's get after it. Let's jump right in. Dr. Toth's paper is served as a landmark paper to many and it helps guide us as surgeons on graft size and its implications of failure, in what remains as one of the most commonly performed orthopedic surgeries worldwide, ACL reconstruction. In addition, just on my traveling fellowship, it still remains that hamstring autograft is one of the most commonly used grafts in the setting of an isolated ACL reconstruction. So can you give the audience some background on what led you and your co-authors to ask this question specifically on hamstring autograft for ACL reconstruction?

Dr. Alison Toth:

Oh, sure, Travis. I really appreciate you asking the question. This is a really interesting project that came up. The lead author on the article, Bob Magnussen, who's now at Ohio State, was a fellow with us at the time. And the senior author on the paper is my since deceased colleague, Dr. Bill Garrett, well known to so many people and a wonderful mentor and sinker in the field of sports medicine. Dr. Garrett was a big proponent of the hamstring graft I trained at Duke along with basically most of the co-authors on that paper. And we learned from Bill about doing hamstring grafts at the time. This what most everyone did, a classic four-strand graft and that was a doubled semitendinosus and gracillis graft for ACL. And Dr. Garrett had taught us to think about that smaller grafts may be problematic and the smaller the graft perhaps we would have worse outcomes.

But it was interesting to note that Bob Magnussen, the lead author on the paper, asked the question in 2011 when he was a fellow, whether we had any data on this matter. And we are surprised to look in the literature at that time and really not see any definitive work in this regard whether graft size really matters for ACL reconstruction, and again, specifically to the hamstring question. And of course, the reason Travis said the hamstring question is so important is that the size of the graft can be so variable, not only the diameter but even the lengths. And at the time, again, we were doing these four-strand

constructs. At the time, nobody was really making the semitendinosus into a tripled or even larger graft. So the really, the size was quite limited by the manner in which we were doing these cases.

So ultimately the question came up, does size really matter about these grafts? And we've been doing hamstring grafts, four-strand grafts at Duke for many years. And so we decided to look at this question with Dr. Magnussen. Our conclusions are, as you might have seen in the paper, and we can talk about those conclusions, Travis, but the main conclusion of the article was that grafts that are eight millimeters or less in diameter had a higher failure rate. But even more interesting here is I think what people don't remember about the article is that what it really showed more significantly is that patients under age 20 had a much higher failure rate with these hamstring grafts and that was far more significant, like an odds ratio of 18 times higher risk of failure if that graft was eight millimeters or less. And so I think that we really want to think about the age of the patient, but I think that was lost in the article a little bit. When people think about it, they think of the eight millimeter rule, as people call it.

Dr. Travis Dekker:

When I was a resident under you, it was always awesome to hear how everyone encouraged the fellows to ask questions and to always question the dogma of what we did. And so it's amazing that even at that time, that size really hadn't been discovered as an independent variable of what could have led to failure. And I think once again, your results with, like you said, importantly that young patients have higher risk for failure. And the reason for that, I'm sure we could go above and beyond trying to figure that out and we're still trying to discover exactly why that is. But hamstring grafts, we have definitely have seen through time that in certain athlete and certain subpopulations, and maybe it's not the ideal graft choice, but if there's anything that we can modify, I think your article is showing that maybe there are some components that we can at least do to try and help mitigate that.

And so yeah, thanks for going into your findings a little bit and the takeaways that you got from it and also kind of reemphasizing maybe a little bit of the lost findings of that predictor of age. One thing I did notice is that of course, we've modified our techniques even in the last 10 years of how we do ACL reconstruction. The senior authors at the time with the, how you collected it, they essentially performed three of the most commonly used techniques at the time with an accessory AM portal, transtibial and then retrograde drilling or outside in drilling. Do you think this could have affected your results at all? And if so, how has that modified how you even do ACL reconstruction now?

Dr. Alison Toth:

Yeah, that's a great question, Travis. I'm glad you picked that up in the article that there were these different methods of performing or making the femoral tunnel, even the tibial tunnel at the time. But I do think it does matter how the anatomic location of the ACL femoral tunnel, we know that that's one of the most common errors made is that that femoral tunnel is malpositioned and frequently it's too anterior as you know. But I think it definitely could have affected the results, Travis, because if that's not an anatomic tunnel, which it probably wasn't, certainly for some of the tibial tunnel based femoral tunnels, I think we would all worry a little bit that could have skewed the results to increase in failure due to perhaps impingement of the graft. And so I think, and this is a retrospective study of course, and again, it was really important because it got people thinking about this question about hamstring size or ACL graft size.

But if we were going to do this study, well Travis, obviously, we should've controlled for performing the ACL, the tunnels, in a consistent manner because then that would've, at least, that would've more normalized that situation. And instead of having, as you can see, multiple senior authors here, it might have been better to have a multi-center trial.

I think the MOON Group, by the way, Travis followed us about a year later, 2013 and also studied graft size, hamstring size in particular and came to the same conclusion we did and even, the MOON Group was able to say based on 0.5 sizes and difference that, that could eventually lead you to increasing rates of failure per like 0.5 size smaller graft, increased failure. And so I think that the MOON Group being a multi-center trial was a better way to look at that. But still, even that group, they did have some different methods of performing some of the tunnel placement. So yeah, again, a more clean study would've been or will be the best way to study this. But I think at the time, I'm sure glad we got the information out and got other authors thinking about graft size as that independent predictor.

Dr. Travis Dekker:

Well, I think it's important to set in the scene at that time too, that those were the most commonly used techniques and hard to control for that. And we're going to continue to modify and hopefully advance our techniques as research continues to advance and the findings from these groups continues to advance. So size matters, age matters. And when you discovered that size did have an important role in graft failure, did you modify your practice and how you utilized hamstring autograft?

Dr. Alison Toth:

Yeah, another excellent question because another reason that we studied this at the time is that a couple of us in this group of authors already felt like size was something important and if a graft was seven millimeters or less. We were augmenting with allograft, semitendinosus. So what we would tend to do there is we would use the patient's own semi-t doubled and then an allograft semi-t doubled. So you still had a four-strand graft, but now one out of the two limbs of the graft was allograft. And so we would often use a seven or eight millimeter of the semitendinosus, which that just means it's doubled size, seven or eight millimeters. And so you would end up with a graft that was often nine millimeters and most of us felt like that was providing more collagen and so a larger graft and was probably better. But Travis, we didn't know that. And so part of when Bob Magnussen, the lead author here, came to us and said he'd like to study this, we also thought that was going to be an important question is whether you could also augment. So this was one study, but then what about augmenting size? If it was small, would it be better to do what we were doing at the time, which is to augment with allograft? And that wasn't the point of this study, but that was along the lines that we were thinking that maybe adding collagen was better.

To take that a step further, Travis, we were doing that and other authors have found over time that allograft as an augment to size does not work so well. And I think that hasn't been totally abandoned as a technique, but what has developed, as you probably know, is instead of just doing these doubled grafts as we did back in the day, now the semitendinosus can be tripled, quadrupled itself and sometimes even with adding gracilis, you can have a five strand or even six strand graft, which is amazing. I think we've just evolved into using buttons and suturing the semi-t together and adding the gracilis to that at times where you have grafts that can be nine and 10 millimeters in diameter. And it certainly seems that those fail less, especially using the patient's own tissue. So I think what's evolved is that we've gotten away from maybe augmenting with allograft or accepting a small graft like a doubled graft and instead just added more collagen by using more of the patient's own semitendinosus in particular.

Dr. Travis Dekker:

Well, I think that you pointed out a lot of great technological advancements that we've had and how we are fixating the ACL different techniques authors are now doing and some surgeons are doing, all inside

techniques that take advantage of the suspensory fixation to really utilize that five, six-strand hamstring ACL that can be much beefier. I also think it's interesting to point out that like you said, I did a lit review and specifically in adolescent patients and those under the age of 20, which in your paper showed a higher risk of re-tear, that augmenting was worse for those patients.

So if authors and surgeons out there, which it still is one of the most commonly used grafts or still advocating for use of hamstring, I think utilizing the new advancements and techniques to where they can beef up the graft through an autograft technique without having to supplement it with a hybrid graft and allograft may be the best option for them, at least with the limited data that we have out there at this time. And so as I mentioned, hamstring autograft remains one of the most commonly used grafts. We obviously, have other options that have kind of taken off and have started to supplement our or add to our arsenal when we talk to patients and give them the risks and benefits and perks of different types of grafts. What are your indications for the use of a hamstring autograft ACL now at this time in your practice considering you work on Division One athletes across all spectrums, contact athletes, cutting, pivoting to swimming to everybody else?

Dr. Alison Toth:

Yeah, Travis, I think that most of us are aware of the literature, especially by the MOON Group and using some predictive models based on their experience looking at the risk of failure of hamstring grafts in these younger populations. So again, we're talking about under, well 25. But certainly in the under 20 group there seems to be a higher failure incidents, especially with a higher level of activity. So we're talking about these athletes that are playing contact sports, level one sports if you want to call it that. I think we know that there's a higher risk at least based on that cohort and a number of studies, especially in the younger population. And so as someone who takes care of a lot of Division One college athletes and high school athletes, certainly I've got a big under 25 crowd and a lot of women too.

I've gone away from using hamstring as my primary graft. And Travis, as you said, it's really some of the data we have there that I've just mentioned. But I think it's really also the rise of the quadriceps tendon autograft as a more viable graft for whatever reason it's been done for decades, but it's had a resurgence in popularity for a variety of reasons. Some of it's the sort of all soft tissue option, the suturing technique that is really makes the graft a little bit more stout or stable to less like stretching of suture and pullout. Some of our fixation techniques have improved as you mentioned.

So for me, the rise of the quad autograft as a more consistent size source even in a child Travis, even in young children, the ACL or the quadriceps autograft is often quite large enough and usually on the order, even in a younger child like seven millimeters in diameter. There's a nice study Travis out of CHOP, or the Children's Hospital of Pennsylvania group, lead author Ted Ganley, just here in 2021 looking at quadriceps tendon size in patients less than 18 years old. And about 82% of them, of those quad grafts, are greater or equal to eight millimeters. So you're really at that size where we think that that could be important.

And there's even some ability to predict that on MRI. If that graft of the MRI on sagittal thickness is a little over six and a half millimeters, then you, 97% of the time, you got an eight millimeter graft. So the predictability of having a good size graft for your quad was one of the things that led me to really change that. But again, it was more the failure incidence in that younger population is playing contact sports and especially in young women that I've mostly moved away from using hamstring.

Dr. Travis Dekker:

Now, follow-on question that I've been curious about and I've been able to briefly look through the literature and haven't seen it reproduced, is I have seen size studies for hamstring clearly across the

board. And using paper like yours as a landmark study to have the eight millimeter rule has been really important about how we evaluate and look at ACL autograft choices. Do you use and apply that same rule for other graft options, bone-tendon-bone quadriceps?

Dr. Alison Toth:

Yeah, Travis, it's interesting that you point out, I agree with you that we really don't have studies of size of patellar tendon grafts and quadriceps grafts. And I think for patellar tendon, I think most people take a nine to 10 millimeter wide graft. The patellar tendon as we know it's the thickness is much different than the say the quad. But you've got bone on either end. I think that makes the size because the plugs you're making are often 10 millimeters by 22, 25. So that's pretty consistent. I know that patellar tendon is a more [inaudible 00:18:04] substance, but it's usually nine to 10 millimeters wide. I don't think people tend to study that for that reason. Travis, there's not a lot of variability there and the bone plugs kind of make it a little bit different about size of the graft that you're studying because I think that's fairly consistent.

I think the quad is an area that probably would be more right for studying that. And with the quad, most of the grafts, I don't think I've ever taken a quad graft that's been less than eight millimeters in size. But it might be interesting to look at failure rates, especially in a large and a multi-center study to see if an eight millimeter graft versus some of these quads or even 11 millimeters to see if there really is any difference in size with quad. And I don't think we know that.

There's only one study I've come across that was more of a systematic review in 2019 looking at partial versus full thickness quad grafts. And so there's also been quad with bone plug versus quad, all soft tissue and the all soft tissue can come out ahead, which was interesting. But I think it just tells us that we probably don't know enough yet about the quad tendon in terms of very large studies and particularly multi-center about whether size, age and other factors matter. But we really need to do that because I think the quad has now become one of the more popular choices and we need to understand that really well.

Dr. Travis Dekker:

Outside of patients coming in and making specific requests for graft, is there a role for a hamstring autograft and an ACL reconstruction in your hands at this point?

Dr. Alison Toth:

I think that the older patients, and when I say older that's sort of relative, Travis. I'm sure you'd love to tease me even on a podcast about age, but I think it's harder for you to do so on a formal venue like this. So that's probably an advantage for me. But I will say in patients that are like 40 years and older that are not playing contact sports, so they're not doing a lot of twisting and pivoting, they may do some fitness classes, et cetera, but they don't claim to want to go back to jumping and pivoting activity. That could be a very good choice.

And if I do a hamstring then I certainly do what we've just talked about is I don't really do the old four-strand like doubled semitendinosus or gracilis. I would make a more of often a four-strand semi-t or five strand even. So adding more collagen in that manner and would not use allograft tissue. So I know some like to use allograft tissue for older patients. I still like to use the patient's own tissue. So in my hands, hamstring is really going to be more for the patient that's less active, probably a little bit older. And I don't think we see a difference in data in that group, Travis when you look across many papers, patients that are in an older group, even older than 25, seem to have a lot less failures in general. And it seems less important which graft you use as long as it's an autograft.

Dr. Travis Dekker:

I totally agree with you in terms of activity levels, age and continuing to use their own tissue. One of the surveys we've done and we looked at it in our military society, is looking at grafts choice and how it's kind of changed over the years. I think I was barely out of diapers in 2012 when you were at the peak of your practice. Dr. Toth in 2012, graft choices were obviously different than the way we're indicating grafts now. I would say that currently, I use hamstring autograft basically for the older patient or patient request only. And after I thoroughly discuss the risk of stretching and re-tear of that graft. So my practice has transformed to where I'm about 75, 70% bone-tendon-bone just based off of my population with the other 30% being quad, and very, very rare instances of using hamstring autograft. How would you say your practice has transformed in terms of how you indicate and use grafts from 2012 roughly estimate your percentages to what they are now?

Dr. Alison Toth:

Yeah, great question. So I would say in 2012 I was probably more 75% hamstring and 25% BTB. Who is getting a BTB? Certainly the contact athlete I feel like, or the patient that had excessive collagen laxity and you could call that hyperextension of the knees or elevated Beighton score. If I thought the patient needed a graft that had less ability to stretch at all and going back to contact sports or something, then I was choosing BTB. So most of our college football players, college basketball, soccer were all BTB. There's always that risk of patella fracture that we all worry a little bit about in that population. But I felt like the re-tear, I think most of us felt like BTB at that time was still gold standard, especially in that population. But still hamstring for most patients, it was very popular. It was really what we were all doing.

And so I'd say today I do very little hamstring grafts. And for me, Travis, a little different than you, I've gone almost exclusively toward the quad tendon graft, soft tissue graft by the way, not a bone quad graft. But soft tissue graft. And I think that's really because the size predictability. And one of the interesting things we haven't talked about was that if we think about advantages and disadvantages of grafts, one of the most interesting or compelling reasons to use quad in addition to what we've talked about with the predictable size of the graft is that you know really, with a soft tissue quad graft, you don't have any of the risk of any kind of patella fracture. You really don't get anterior knee pain because you haven't harvested patella, you don't have any of that risk of fracture. You have very little of the sensory deficits, you can still get some of that from your tibial tunnel. But patients that have hamstring harvest or certainly BTB, often have that numbness of the anterior knee and sometimes pain associated with that, which you really don't with quad.

As I said, you can get a little bit of your tibial tunnel but your quad harvest site, there's often very little morbidity there and patients seem to do very well recovering their quad strength despite that harvest. So I think there's several advantages there. And so I've switched mainly to that. I'll still use a BTB in some of the contact athletes as we discussed before, and sometimes there's a preference that patients come in with based on what they've heard, especially some of our professional athletes I'll hear them desire BTB or something. But I do think that even the pendulum is swinging in that population toward quad a little bit. So definitely an evolution of practice, Travis, and I think one of the reasons looking at data, the MOON Group's work on some of the hamstring failures and certainly their work on allograft failures and younger populations has been compelling. And I think if you're in academics, Travis, it was hard not to look at some of that work and not think about changing your practice.

Dr. Travis Dekker:

Well, Dr. Toth, I have as always, thoroughly enjoyed our conversation today for this podcast and appreciate you discussing how your practice has changed the background of the study and kind of its implications on how we practice sports medicine today. Do you have any parting words of wisdom for us and maybe future directions of research as it pertains to ACL reconstruction?

Dr. Alison Toth:

Yeah, Travis. I think as you pointed out, some work on understanding a little better like the implications of quad graft size and looking at our patients not only for size of the graft but its fixation techniques and looking at age and trying to understand what are the best options.

So I think what I'll leave you with is that I think like all of orthopedics and perhaps medicine personalizing that doing what you think is the best thing for an individual patient is often the best thing to do and having a bag of tricks. So being able to use a multitude of grafts and being technically able to use the different graft choices, I think is a wise thing to do in your training is really pay attention and learn about all the techniques. And what I'm hoping is that someday we have even more data driven work to show us in a sort of an analytic way that a patient of this age, this sex, this level of activity, a little bit of plug and play, we can say that this graft has the lowest failure rate in that population and will help guide us over time.

And that's going to require good work of young people like yourself and some of the continued work by some great authors out there, helping us figure out the best way to take care of our patients.

Dr. Travis Dekker:

Well, as a very junior mentee of yours, I appreciate you offering your words of wisdom and really appreciate you taking the time this evening. Dr. Toth's Arthroscopy article published in April, 2012 when entitled, Graft Size and Patient Age Are Predictors of Early Revision After Anterior Cruciate Ligament Reconstruction With Hamstring Autograft can currently be accessed at www.arthroscopyjournal.org.

The views expressed in this podcast do not represent the views of the Arthroscopy Association nor the arthroscopy journal, nor are they meant to be used as treatment recommendations for patients. Thank you all for joining us this evening and I hope you all have a great, great evening, and Happy New Year.

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