Why Foot and Ankle Strength Matters Transcript

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Introduction and fall risk overview

Hey everybody, Dr. Rob Silverman here of Proven Health Alternatives. I'm here with Dr Tom Mishore. He is, without question, the expert when it comes to the foot.

Well, I actually didn't meet him. But I first read his book when I was in chiropractic school and that book was a textbook being used in podiatry school.

That's how far back we go. Tom, thanks for taking some time out and coming on. It's great. No problem, Rob. Thanks for having me. I really appreciate it.

So that's nice of you. You're doing a great job with this site and everything. Keep up the good work. One in five of these falls results in a serious injury.

In the US, there's 36 million falls, eight million injuries, three million visits to the emergency room, one million hospitalizations, and over half a million fractured hips.

in addition, approximately 25% of people who fracture their hip will perish within the first year. And 50% will be unable to return to their prior level of function.

In your opinion, what's the number one reason for false? Well, I don't like using my opinion. I'd rather go by the research. A woman named Karen Mickle is a podiatrist down in Australia.

She was the first one to come up with this. So I always like to credit her because there hasn't been enough information on this, she published this 2009, 2010. She went into a senior center to over 300 people.

She evaluated everything from like loose rugs, body weight, every conceivable factor. And she found the number one predictor of falls was weak toes. As strange as that sounds, It's called the anterior fall envelope.

If you're listening to this and you are in a spot where you can just stand up, if you stand, put your arms at your side and then lean forward, the first thing you will notice is that your toes push down to protect you against a forward fall.

Most falls don't happen while they are walking. They happen at the initiation of gait. The initiation is not a simple process. You don't realize it, but when you're standing still, your medial gastroc in particular, you inner calf muscle is constantly going on and off.

Medial Gastroc is an interesting muscle. Are most of the people watching this technical or are they non-technical? They're listening more than they're watching.

Okay, so the main thing is that what you do when you lean forward, the medial gastroc has more vertical fibers to it. So when it contracts the inner calf muscle, it immediately pulls you back to a balance point.

What your body does when want to initiate a walk is it shifts weight to the opposite side. It then sends an inhibitory signal to that gastrocnemius, specifically the mediogastroc.

You start to fall forward then your toes protect you. she showed that toes in older people work weakened at an accelerated rate. The average person in their 70s has 35% less toe strength than the people in 40s and 50s.

And this is interesting because they don't lose strength in your quad or hips that much as they age. So this isn't whole body weakness. You lose the strength and your toes and feet much faster than you lose anywhere else.

In fact, getting out of fall prevention, but just getting into runners. Max Paquet is a researcher from the University of Memphis. He studies distance runners, what makes them fast.

And he showed that masters runners slow down not because of decreased force output in their hip or knee, But because a decreased forced output and their ankles, specifically their toes.

Toe strength as the key predictor of falls

And that weakness, when you're older, makes it so you can't protect against your anterior fall envelope. So I wrote a 45-page paper on preventing falls in the elderly.

A friend I've known for 30 years is Hilton Menz. He was the editor of Foot Ankle International. Really a smart guy. And he's written hundreds of papers on fall prevention.

I summarized a lot of his work, a lotta Karen Mickle's work. And there are a series of tests. There is one, for example, you have someone stand and then just lean forward like this with their arms at their side.

And I use a laser scanner. You just measure how far they can lean and maintain their balance. It has to be four and a half inches. If they cannot go four-and-a-half inches, they are significantly more likely to fall.

Karen Mickle showed that strength beneath the great toe was a huge predictor. I made a dynamometer, I think I sent you one to measure strength there. Should be 10% of your body weight.

So let's talk about strength, most precisely, big toe strength. So you have a device that measures the strength of the toe. If you didn't have it, wouldn't it be 60 to 70 degrees normal movement of a big toes in an extension to generate enough strength?

That's motion during the gait cycle, which is different than force output to prevent falls. Like if you had limited motion in the joints, you can get into problems with bunions and things like that.

But what you're talking about with fall prevention is how much force can you push the big toe down onto a surface? Several foot ankle researchers developed the paper grip test, which is what I based this project on.

While someone is sitting, you take a business card, put it under their second through fifth toes and tell them to push down. And then you pull it out.

if you have difficulty pulling it out, they're strong. If you can pull it with no effort, and as simple as that test is, it had good inter-rater reliability.

It just didn't quantify it, so I disliked it. So, I measured the coefficient of friction in a piece of paper against the ground, then I hooked it up to a scale, Then I cut it to go under the first metatarsal, you put it under a great toe and pull back, It's got to be 10% of their body weight.

They studied it at University of Virginia recently. It's got an inter-rater reliability of like 0.93, which is unbelievable. So it's very valid. You get consistent time-to-time measurements.

But I also then put it under the second through fifth metatarsal, it should be 7% body weight. And now recently, because peroneus longus and muscle on the outside leg is really important with athleticism, I put under to the first met head and I pull it out and it also should 10% of bodyweight.

Other people made up those numbers for strength. I made the one on pronies longest because it hasn't been studied enough. You know, we're trying to do studies now I've got a study going at UCLA and someone at University of Indiana is studying that foot strengthening device.

Because one prior study at Temple University got 35% increase in strength in just six weeks. And one reference

said, for every 1% increase in force generated beneath your big toe, you decrease your fall risk 7%. So toe strength is hugely important, not just for fall prevention, but for athleticism.

Several studies out of Japan showed that when you send someone on an agility drill and you see the best performers and then you measure their toe strengths, the athletes have the strongest toes.

And that's because when your pushing off and changing direction, All of your force is on your great toe. In fact, the paper just came out of France, a couple of foot ankle researchers, I think they're PTs, they created their own foot strengthening program that was very aggressive.

They used all professional athletes and they had huge increases in medial lateral cutting changes in direction with strengthening the great toe and medio forefoot.

they did a lot of peroneal exercises, lot a great to exercises. A lot them like the toe pro, They just had people on a slant board and then raise up But simple to do, and it really all comes back, you were talking about strength.

People say, what's the best way to strengthen your arch, is strengthen the intrinsic muscles. And there are short foot exercises, there were band exercises.

There are curl exercises there, are towel curl exercise. They were marble pickup exercises that is what 99% of healthcare practitioners prescribed to strength and feet.

For 20 years, I have hated those exercises There's no research that has ever shown that alternate ways are better until recently. A guy named Goldman, and this wasn't in this region, this was 10 years ago, he had people do toe exercises while they were in a position of function.

So the toes were dorsiflex 45 degrees and he just had them do a series of isometric contractions. He got four times the strength gains compared to conventional foot exercises.

That translated into increased horizontal jump distance, increased athleticism, increase cutting. And it's the reason I made that top road to Brad falls in the elderly.

In the first, I mean, in 2016, when that first paper came out, and it was sold primarily to people in NBA and professional athletes, because they discovered early on, it increases horizontal jumped distance.

To this day, it's used more to improve athleticism than to prevent falls. And I did it, and I still want it to be used for fall prevention because Karen Mickle, who came up with this early research and is an amazing, really bright person, she came with a home protocol of therabands going back and forth like this, going like that.

I recommended that for four years. If I saw patient compliance of more than 30% at the two-month mark, that was a lot. It was difficult to do, it was time consuming, you had to wrap bands around.

So I made this product, that Toe Pro, which is just a piece of foam where when you press on it, your toes are in a lengthened position, and your peroneals are lengthen position.

And it's just you work every muscle all at once, so you don't have to different things. Compliance is key, if you do not have good compliance. This is interesting, we were talking about short foot and marble pickup.

Hilton Menz, the guy I talked about before, just teamed up with Karl Lansdorf and a guy named Osborne, who just got a PhD in biomechanics. They took 16 common foot ankle exercises and then did EMG studies on them.

And then they used devices to measure force output at the MTP at four foot. and they showed the short foot exercise, which is the most frequently prescribed one, had huge levels of EMJ activity, but didn't alter force at at toes.

And it's because they are working the muscles in a shortened position. When you work a muscle in shortened positions, like with TheraBand or anything else, the actinomycin filaments are in position where they have hardly any contact, and they've shown repeatedly, not just with the feet, but with hamstrings, with everything.

If you work a muscle in a lengthened position, it stimulates satellite cells in the muscle to increase muscle protein synthesis, and it accelerates remodeling.

And the key to strengthening is to also exercise in position of function. If the toes are working while their dorsiflexion, why on earth would you exercise them in shortened position?

The marble pickup was the exercise I hated the most.

Testing toe force and foot strength

Like, if you're going to grab a branch, marble pickups will come in handy with your foot. But if you're going to run and achieve the level you said before, 55 degrees of dorsiflexion, you have to strengthen them at 55°. Exercises are angle-specific.

In fact, if measure toe strength in a neutral position and then measure it when it's dorseflexed, toe-strength in neutral positions does not predict athleticism.

It only is predictive if they're strong when they are dorsaflected. So I'm going to revert back to the idea of toe flexor strength because if it's disproportionately important because the toes act as the last line of defense when balance is perturbed.

So if your toes can't grab the ground, your nervous system loses a major stabilizing input right when it needs it most. Would that be a fair podcast statement?

Yeah. If you are having difficulty generating force, then you're going to continue along a movement pathway that you've established previously. So, like, I wouldn't look at it so much as a proprioceptive cue, Because for proprioception I made those balance buttons.

I don't know if you saw anything about that. Yeah, I did. So you know the four cutaneous receptors, low adapting, fast adapting in the bottom of the foot.

They're the cutuous receptors that produce what researchers call a sensory steering that guides you through. The muscles just react to what thecutaneousreceptors and whatthe spindles are telling them from above.

Right. So as you get older, it can take up to 80% more pressure to stimulate those receptors. And we had talked earlier when you started the intro about falls, ending up in hospitalizations.

The most lethal fall is a lateral fall. Wow. When you fall laterally, If you fall forward, your opposite foot is there to protect you. If say I'm on my right side, I fall to the left, my left foot goes.

But if I fell to my the right, right foot's weight-bearing, and my foot can't cross over. So you tend to go down at a high rate. And the problem with that is that our femoral necks have an angle to them of about 120 degrees.

When you fell straight sideways on your femural neck, the femeral neck just breaks because it doesn't have any protective cushion over it. So this is interesting and it gets back to your question.

If when you have sensory steering, it's driven by your cutaneous receptors primarily. So these researchers did a process called micro neurography and I love them because they just meticulously dissected and they counted the number of sensory nerves in the skin of cadavers and then they located their path.

Almost all sensory cutaneous receptors are located lateral side of the foot. And the reason for that is that if you lose

a sense of where your foot is laterally, you're going to go down.

That's hugely important. If you fall medially, joints move, all this other stuff. You get your joint probe receptors tell you where you are, your muscle spindles tell, but when you follow lateraly, so your body puts a ton of them there, the problem is as we get old, it takes 80% more pressure to stimulate them.

So I had previously, someone who owns an orthotic lab, wanted me to make an insole to improve balance. I looked at the research years ago, I didn't really like it.

Nothing really seemed to work that well because people adapt and that's huge. So the theory is they put irritating surfaces under there and say, well, now you'll feel it because it's irritating.

The problem is even if it's irritating, your central nervous system is incredibly skilled at telling this information is valid, this is information isn't.

So both the slow and the fast adapting receptors learn to ignore it. What I did, I made a little pad that had progressively larger buttons on them, elevations, so that they'd actually hung off the side of your insole so if you started to go laterally, you'd hit the small ones, probably wouldn't feel them at first, but if you went too far to the side, your fast-adapting cutaneous receptors, specifically the meissner's corpuscles, would say, hey, we're too farther to side.

And that produces a monosynaptic reflex loop that makes your pronius brevis muscle shift you inwardly. So I made those to help people with chemotherapy.

Because chemotherapy is notorious for producing problems with impaired sensations, specifically along the bottom of the foot. Did you know with peripheral neuropathy is that long nerves are affected the most?

That's why tall people are more prone to peripheral neuropathy, because the sciatic nerve is longer in tall. The longer the nerve, the more likely… Speaking of a size of person, I've read that if you have a longer big toe, it increases the lever size, You're going to be able to generate more power and you're not susceptible to falls.

So small people are more susceptible falls that said, what tests would you recommend that people do at home to really assess where they are? If they. Accessible to Falls and what exercises they should do within those tests.

Yeah, first I'll comment on the remark about the long toe being important for balance. It is. it's not just important to balance, but my favorite researcher has shown that if you have long, you can separate the world's fastest sprinters from second-rate sprinters by the length of their toes.

The world's best sprinter's have toes that are a quarter of an inch longer than college-level sprinters. They also have an Achilles tendon that is 25% closer to the ankle axis of motion, so they've got a short lever on one side, long lever the other.

Downside, and Hilton Men's proved this, a long, great toe generates so much force, they're more likely to get arthritis and metatarsal phalangeal joint.

So if you wanted to do a single test to see if your toe strength correlated with a fall, I would do that anterior fall test. You can just stand lean forward, you should be able to go four and a half inches forward.

Some people will measure, and you can take a tape measure and go to the wall, or just see with your arms straight. It's the first picture in that fall prevention article I wrote.

with your arms straight you lean forward four and a half inches or measure strength with that paper grip test super easy you sit down on the ground have someone put a business card under your second through fifth toe and pull it out so i'm going to give you a couple of tests what i mean i'll slow you down i will give a home test great let's talk about the timed up and go the tug test Yeah, timed up and go test is an important test for measuring speed, but my

preferred test from measuring speeds is the alternate step test.

And I say that because it's simple to do and it measures rate of force development. That test it really simple. You put a seven inch platform out and then you set it, get a stopwatch going and you say, go up, and down on that stuff as fast as you can.

So they go, up down, down. They have to eight steps in 10 seconds. If they can't do that, they have impaired rate of force development. So you're walking, you hit an uneven surface, and you and I or someone with good reflexes would immediately correct and catch themselves.

If you have an impaired, rate-of-force development, because this is important, I probably should have started out with it, is that strength is very important.

We talk about strength and fall prevention. But, and everybody's talking about sarcopenia, which is Latin for poverty of flesh, muscle wasting. Right.

A better predictor, sarcomenias is not the best predictors of falls. Dynopenia is, there's a difference. Which is strength deficits. And that's why foot strength is a better predictive longevity than hand grip strength.

Training the feet for athletic performance

Well, you, we've got to stop right there. Yeah. I'm in accordance with you. However, every influencer expert talks about grip strength versus foot strength.

And you're right, because we're more muscle fibers in your lower body, your upper body. So it's not just that it said you have a preferential weakening of the foot ankle much more so than the hand at an early stage.

So there, there are studies strongly showing that. It's a better predictor, but you know, I don't pay much attention to influencers. I never have. Can I make the statement that big toe strength is a longevity exam?

Yeah, go ahead. Okay. With that, you're good with that? Yes. And your reference is to back that up. I love it. I got to add that into my toolbox now. You do.

Big toe strength is huge, not just for longevity, but for athleticism, fall prevention. In the NBA, they test a lot of things. Wingspan, vertical… I just had a meeting with an NBA team a couple of days ago where they wanted to go over tests that they could do to predict calf injuries.

So they're going to start doing it. And this is an interesting paper, again, talking about the muscle that drives the big toe is primarily flexor hallus as long as it runs from the fibula and runs down.

A couple of people from a specific team said they are getting a ton of calf injuries and they don't know why. Beautiful paper came out that showed that when you get Achilles tendonopathy, over a three-month period of time, if they re-MRI you, you will have hypertrophy of your flexor hallucinus longus.

Flexor Hallus as long as by itself can produce a heel lift. I wrote an article on this from the Journal of Contemporary Chiropractic. If you have an Achilles tendonopathy or any tendon injury, You have to look to the synergist.

People say, let's focus on the tendon and make the tendons stronger. If you, and I call it variable load sharing, if you're going into your propulsive phase while walking or running, you are sharing force between a half of different muscles.

Peroneus longus is the most powerful stabilizer of the inner forefoot. Flexor hallusus longest, the more powerful stable of hallux, big toe. If they're weak, they are going to transfer their load to the Achilles tendon.

And I had no proof of that until I saw that paper. That three months after an Achille's injury you have hypertrophy of

flexor house as long as, and I personally feel if you had hypertrophy in advance you wouldn't be getting the achille injuries.

So strengthen the synergist. And if you're dealing tennis elbows, extensor carpe radialis brevis, strengthen extensor digitorum longus. Look to the synergy.

So it's a simple concept. I don't know why it is so missed and why people have not been. That's what Karen Mechel has written multiple papers on and where she said, I do not know what people are paying attention to it.

Here she does the research. She proves it and it falls on deaf ears. And like I said, I made this thing to prevent falls in the elderly, partly because of research I read by her and Goldman.

And it's fallen on deaf ears. I mean, it now, we sell a ton of them because it improves athletic performance. That's why there's podcasts. Now, let's get back to the NBA, because I'm a basketball and NBA guy.

Hypothetically, Let's take a player like Wim Bayama, Victor Wimbayama. Seven foot five. Athletic is a day is long. Gazelle. But everybody's concerned about one thing, a foot or a leg injury.

So I bring them into you hypothetically again. What are you going to test on them? Well, for starters, DG Iovani proved this years ago. If you have limited ankle dorsiflexion, when the knee is extended, you are three to five times more likely to get a metatarsal stress fracture.

And it is so easy to test. You have a person stand up straight, You can take your phone or any goniometer, they lean forward, They've got to 34 degrees before they hit limited motion.

D. G. Iavani showed this. you're more to likely get neuromas, more like to getting metartarsalgia, More likely you get hallux abductus valgus. So the reason for it is that if you have a tight medial gastroc in particular, the heel leaves the ground prematurely, exposing the metatarsal heads to a greater tensile strain.

And a guy named Ferris did a beautiful paper where he took cadaveric feet, he put strain gauges in their metatarcel bones, He lifted the foot on a force platform, and then he pushed down and measured bending of the meta-tarsals.

He then used a pneumatic actuator and pulled on flexor house as long as to make the big toe push down. It offloaded the metatarsals by 35% and decreased bending of the meta-tarsal.

Wow. And he said, perhaps the toe muscles, and this was published in a surgery journal. He said this might be appropriate in conservative care because the toll muscles might not be necessary for propulsion as much as protecting the meds, metatasals.

I read that, I was like, it's a surgical journal, so No one's going to read this. No rehab people will come across that. And I've written articles on that, I published something in lower extremity review on it, and it's starting to catch on a little.

But then, so they have a tight cap so that he leaves the ground, right? Then when they're there, what's protecting them? their flexor house as long as their abductor house, their four foot planter flexors.

And that's what that guy in France who did that study, they were professional athletes, like big guys. They were lifting huge amounts of weights. All he did was this, I think it was a 12 week program, Their improvement in performance was through the roof.

And you're talking about injury prevention. I spent my life treating runners. Oddly enough, I deal with the NBA fairly regularly. I know nothing about basketball.

Mm. Changeful. American journalist Sports Medicine just showed a simple home foot strengthening exercise program decreased running injuries by 240 percent.

Why isn't that catching on? Nothing has proven to prevent injuries all that well. It's changes in stride, switching your foot patterns, altering your gait, foot strengthening does.

And it's just the first of many.

Sensory receptors, balance, and lateral falls

There's a reason that so many research people are coming to me recently, because it starting to catch on. A guy I know from Belgium, whom I'm going to write a paper with, I've been going back and forth with him, Nicholas Haljuwon, He just got his PhD.

The guy's a genius. He took all these people with flat feet, right? And people who have flatfeet are more prone to falls, they're more proned to all different problems.

And no one's ever been able to figure out which people will flat-feets are prone injury because it's actually an argument. Some people say having a flat foot isn't a problem.

It depends on the study. He took a population that he used ultrasound and measured the volume of their flexor, digitorum, longus and quadratus plantae.

The people with symptomatic flat feet had thinner tendons than a thinner quadrature plant. So if you're strong, and that's my point, I just wrote an article for dynamic chiropractic on whether or not pronation correlates with injury.

It does. especially if you're weak. If you have a strong foot and you were a hyperpronator, you are no more likely to get injured than the general population.

And here's an interesting paper. They took people with low arches and then neutral arges and high arces and gave them foot strengthening programs. The people would the low archers had the best response.

they had biggest improvement in performance. People with the neutral and higher had hardly any improvement. So I'm writing a paper now with Nicholas where I want to say you should prescribe strengthening exercises depending on foot architecture.

People roll in a lot if they have a hypermobile first ray, if the have hyper mobile subtalar joint, they should strengthen their tibialis, posterior, pronius, longus, flexor, house, as long as people with high arches roll laterally.

and they have proven, McClay Davis was the first to prove it, foot type predicts the location of injury. People with low arches get medial injuries, so they get injured on the inside of their ankle, people with high arces get injury on outside.

So that's why exercise prescription should be based on foot architecture. Everybody's going to ask three concise exercises that they can do at home to improve their toe and their foot strength.

Well, it's the reason I made that toe pro strengthening exercise. It's tilted like this, so it works the peroneals. Its tilted, like, this so works gastroc soleus.

And then to match the Goldman paper, It has a ridge on the top, So the toes are dorsiflex. So you stand on this. it has lower density foam under the toe.

You stand out, you raise and drive in. Duplicates the protocol. you could do that three or four times a week. Takes four minutes. Temple University studied it.

They got 35% strength gains in six weeks. And then the lead author, Dr. Song, who's a really bright guy, when he took out three non-compliant patients, I think there were 30 people in it, they got increased force output beneath the medial floor flitter and gait, which has never happened with an exercise protocol before.

So that's my number one. I would have said, like, band exercises, but I'm down on them now after seeing the 16 exercises. You know, if you're pressed, you could just put towels under your toes and then push down into them with a forward lean.

That was one of the exercises that men's and Osborne said was really effective. Just a full lean pushing into your toe. And then the French researchers ramped it up by putting a wedge under the toes as you did a lean forward.

So that had the highest output in force production in both the intrinsics and the extrinsics. Because the problem with short foot exercises, which people aren't talking about enough, it only works the intrinsic muscles of your arch.

Explain the shortfoot. I don't think people understand the term short-foot You basically have someone stand and here's the metatarsal head, say, and then the arch is here.

So you say I want you to draw your first metatal towards your heel by using your intrinsic arch muscles to bring them together. You just basically tense the middle of your arch and you raise.

And there is research showing that that helps with certain conditions. Like I had never had a bad opinion of it because I thought it teaches you to do a functional movement.

I was surprised when Osborne got like zero output with it. So you basically just draw your arch in like this. The exercise that I'm talking about that Osborn and Men's and Lansdorf, they just had people.

That short foot exercise did not get a lot of force output in the MTPs and the toes. It had lots of muscle activity when they measured EMG. but that doesn't correlate with anything.

So then they just had people lean forward doing that lean test that I talked about. That had high EMG, but it also had really high force output beneath the metatarsal heads and the toes.

He prioritized and put that as a number one exercise for strengthening not just the intrinsics but the extrinsic muscles. that's why the short foot doesn' t work.

The extrinsic muscles are the muscles of your calf that go to your toes. Flexor digitorum longus, peroneus longas, flexor halusus longest. Those are long muscles that come down the back of the calf.

And when people start doing that toe pro exercise, they wake up at night with cramps because a lot of them have never used their flexors, their digiorum longest before.

So they think it's easy when they're doing it. Everybody feels it in a different spot depending upon where their weakness is. So the number one thing you want to do is recruit the extrinsic muscles and some intrinsic muscles.

Okay, rapid fire. You ready? We're going to make it New York style. I know you're from Mass, but we'll speed you up a little. Well, I'm a fourth generation New Yorker, so I happen to live in Massachusetts.

Okay. Bagels and lox. Here we go. Are you ready. Ready. Most important muscle in the foot. Proneus longus. That's the ankle. All right. The most important muscles in a toe or affects the toe.

Home tests and exercises for balance

Abductor calluses. What's important in muscle that affects a calf? medial gastrocnemius. What's so important about the soleus? Soleus is an unbelievable muscle in that it is comprised almost exclusively of slow twitch muscle fibers and several studies have been done on it.

It is completely overlooked. So, for example, anterior cruciate ligament injuries when people hit the ground if their knees go into valgus. It's a terrible condition.

It takes them a year before they get back to sport. Everybody focuses on strengthening the hamstrings, strengthening quads. And several papers have come out recently saying that the soleus, because it attaches just to the tibia, stops valgus collapse more than any other muscle in the body, more the the Hamstring, and that people who get ACL injuries are more likely to have weak soleous muscles.

This is important. The return to sports with ACL injury is determined by the triple hop test. which is a combination of your hamstrings, your quads, it never predicted who was going to do well with return to sport.

So this one researcher had people do single leg hops, where they measured vertical jump height, and that predicted return the sport, people who could do a vertical hop, who couldn't do it, weren't ready to go back to sports.

He then calculated mathematically which muscles contributed most to a single-leg hop and it was soleus. Solius is a primary protector against it exceeded the force that all of all the hamstrings combined.

So no one's looking at it. No one is using the single leg hop and it's an easy test to do. And this is important as we get older, the soleus acts as a second heart.

They did a beautiful study where they measured cognitive skills in older adults and they showed that when older adult are hypotensive, which is common between congestive heart failure and other things, If you give them what's called a solely is push up where they just tense their need to just raise their knee up like this.

That that increases perfusion in the cortex and improves cognitive performance and i'll send you the paper i wrote a paper on that so if you just go to the human locomotion site and then look up so is.

And then the last thing about soleus that I find so interesting, and it's what you were talking about before, is that it doesn't just break down glycogen, it breaks down glucose, but it also breaks VLDL particles.

That shocked everybody. They did a study where they gave a bolus of glucose and then had people do what were called soleous push-ups, just heel raises while seated.

And that lowered glucose to a normal level like 90 in like no time at all. And they said it acts as a second liver. It's a, it's amazing muscle. That's also loaded with proprioceptors because people don't know it, but muscle spindles are the sensory organs that tell you where you are in space.

They exist primarily in slow. So when you tap someone's patella reflex, It causes a twitch. Wait a minute, I'm going to hit you on a break again. So proprioception, your sense and ability to ascertain where you are in space.

It's coming from slow twitch fibers or slow-twitch muscle fibers. it's Coming from the extremity, as we talked about, most predominantly in the legs, correct?

And it is communicating with the brain. all sections of the brain. The cutaneous receptors interact with the vestibular system, they interact the cerebellum.

They've got widespread signaling through the entire central nervous system. And the muscle spindles, They take information from the cutaneus receptors and then they tell you information form the muscles.

So they tell you acceleration. They tell rate of force development. In fact, one person wrote a paper where he looked at every muscle in the body and counted the spindles.

Solius was really high. And he said they function as tone regulators. So it's possible to suppress spindle activity. After an injury, you have increased tone in a muscle.

Francois Hugg and several other researchers from Europe are showing that increased tension increases spindle activation, which can cause tightness of the antagonist.

It can caused overreaction of muscle. So these researchers from Belgium have shown that if you oscillate a muscle at 60 cycles per second with a 0.5 millimeter displacement with small little vibrating motor, you temporarily suppress spindel activity.

So if someone, say for example, was having problems with bounds because they had a tight peroneal muscle, research shows you put this little thing on their muscle and it relaxes it and then you can do other things to improve function.

And now there's a series of papers that have come out showing that if you do isometric contractions while vibrating a muscle it rewires the central nervous system to ignore an overactive spindle.

It has huge implications for fall prevention, huge applications for the sporting community. And it's all new.

Soleus, proprioception, and vibration therapy

UC Irvine had some researchers get in touch with me because I got in touched with the researchers from Belgium when I first saw that original paper because i wanted them to make these available to people and they just connected me with their engineer because they're researchers.

So I couldn't, they're not commercially available. There's a place in Italy that sells them for $14,000. So, I saw the displacements, and I made them.

I've made a motor that displays 0.5 millimeters, fluctuated the current going through it, got it to 60 cycles per second. We're going to make one now that goes to 100 cycles a second, like $80. You put it on a muscle, you isometrically tense it and it can break a pain cycle.

You know, a woman who won a gold medal in the Pan Am games had a hamstring injury that wasn't getting better. She got in touch with me. Her chiropractor, who was a great chiopracter down in North Carolina, did everything he could to help her.

And she wasn t getting any better, she did this protocol and she was running full speed in four weeks. It s a new program. works incredibly well, but it's complicated.

It can also identify patients who are going to get back pain in the future. The researchers from Belgium took 100 people, they put the most asymptomatic people.

They put them orders on them. Because when you stand, your muscles, when your shift forward and backwards during static stance, the spindles tell you where you are.

And then your core muscles tell where are in three dimensions of the spindles. So these researchers said, if we could shut off the calf muscles we could just evaluate proprioception in the core.

So they put those motors on the soleus muscle, you turn it on, and then if you have good core proprioception, You're going to get a signal from those motor on your calf saying, hey, your falling forward because they think the muscle is relaxed because the spindle is not giving information.

Now you're talking about, I love it, core proproseception. Let me interject. Yeah. Lets talk since we're really emphasizing the foot. Is it foot to brain?

Is the brain to foot? Because the body is all interconnected. Can't you make a case that the first impulse to the Brain comes from the foot because we make contact with the floor first before anything else?

That is such a complicated issue because you have anticipation of where you're going to strike. Your vestibular ocular reflex is giving you information.

Vestibulocular and cervical reflexes are the fastest reflex in the body. But I would say that once your foot hits the ground, There is a barrage of information that is prioritized to not just one segment, but to the entire central nervous system.

It goes to vestibular system, it goes the cerebellum. it's complicated and everything works together in my opinion. I just wrote an article on vesticular ocular gaze stabilization exercises.

because if people have impaired gaze, you turn your head fast, and if your eyes can't focus, your going to fall, I don't think that has much to do with the foot.

I think it has more to with what's going on with your neck proprioceptors, or suboccipital muscles. Strongest muscle in the whole body. Subocciptal muscles have one motor nerve to every four muscle fibers.

Wow. Yeah, it's 2,000 muscle fiber. Your bicep is 600. You're eyes, that's one to four. So your suboccipital muscles work with your eyes to tell you about your surroundings.

And there's a simple test you could do. You set a metronome and you turn your head while you look at a cellular eye chart. If you lose your field of view at certain number and then you stop moving and read it, if you have a three-line difference, then need to do gaze stabilization exercises.

Tell me a little bit about this article that I read that you wrote about Parkinson's and temple-like. Now, Parkinson is interesting. I wrote that paper because my mom suffered with Parkinson.

A lot of my family members have it. And whenever patients come in with it, I just always try to keep up with the literature because it's such a frustrating condition.

There was a researcher who went on, and I don't know if you know the story of it This researcher doctor Albert is a parkinsonian researcher. He went on a bike ride to benefit Parkinson's patients and it was a tandem bike, ride and the person who he did the bike right with was the woman who was just diagnosed with Parkinson.

And they did this like 12 hour bike ride. He's very fit. he was going at a cadence of 85 pedals per minute. She's not quite as fit, so she was having a hard time keeping up.

So she tried to match his cadence. Her natural cadence was 60 and she noticed that when she got off the bike, her tremors were less, her handwriting improved, she felt better.

So he studied the effect of metronome training, where you pedal to a variable beat of a metromome. And apparently, when you set a Metronom at a high level, randomly, or you don't know what it is, and your central nervous system has to adapt, then it shuts down and you tell the person, you peddle to match that beat.

They showed that when they did this for 20 minutes, It improves symptoms and improved step length while walking. It also improved rate of force development, not just in lower limbs, but in the upper extremities as well, because it's the central nervous system.

And they said there's something about alternating limb movements at an unpredictable rhythm. that either rewires the system slightly or improves the neural connections.

They don't know. So he then teamed with a guy named Balmori and they did a paper showing that training where you have 20 seconds at a high intensity metronome.

You just sit on a recumbent bike and you go, as this thing's going beep, beep. I made a 20 minute MP4 sound video that duplicated that study where it went up to 90 cycles per second in 95 and then down to 60. So you just get someone on a recumbent bike and you have them pedal to this every day.

It takes 20 minutes. And it's a really nice way to just, especially early in the disease, improve the rate of force

development, improved balance a little bit.

That's easy to do and it is oddly enjoyable. I mean, I like it. I do it for, I'm getting older. I play tennis every day. Do it to improve my rate of force development.

When I played tennis, it's helped me with that. Uh, can change directions a little bit quicker. And I just, set the metronome up to the 120 to a point where I can barely keep up with it and drop it down.

Okay. As I get better, ramp, make it go higher. A lot of my patients are training on the treadmill for Parkinson's because they find the treadmills stimulates or at least balances the cerebellum because there's a basal ganglia to cerebelom issue in Parkinson.

So what you're doing is different but effective which really goes to talk about the idea of exercise for Parkinsons in addition to the drug therapy and exercise where you are doing lower limb with upper body movement especially because It's cross walk and cross crawl on a treadmill and you've got upper and lower body movement again in the bike.

So I think we're tipping the iceberg because Parkinson's is raging now and they don't have anything other than the Aldopa. But the natural alternatives are coming.

One of the biggest studies that was ever done on it came out a little while ago, a meta analysis of use of exercise and managing Parkinson's. And they, I don't think the metronome program was out then.

Parkinson's, metronomes, and rhythm training

They talked about how doing tango and they specifically mentioned dancing, which my relatives used to do. as a great way to improve performance and motor function in people with Parkinson's.

And it's moving to a beat. Apparently, when you have to time movement to beat, it does things to the central nervous system that people do not understand.

It feels good. They even have people on Instagram who are shuffling Fenestrated Gate, and they get them to exercise and have a constant beat And they could not only walk, but they can run because they'll rewire certain parts of the brain to overlap what they're losing in the dopamine for the basal ganglia.

Again, dopamine is your coordination neurotransmitter, if you will. Really interesting stuff, more to come on that. Let's talk about a weak diaphragm and which exercises are most effective for strengthening diaphragms.

Remember the diaphragme is innervated by the phrenic nerve and in chiropractic school, C3, 4, 5. Keep the Diaphragm Alive. There you go. I thought I was the only one who had to learn that.

No, I though we were the two only guys who remembered it. For now. Yeah, that was an article I wrote after I read an articles by Paul Hodges, who's a famous researcher.

They used infrared spectroscopy. to measure blood flow in the lower extremity, in low back, and then they pushed people to fatigue and they measured blood-flow inside the diaphragm.

And then, they exhausted people with exercise and showed that when athletes became exhausted, that the central nervous system drew blood away from the erector spinae and the and lower-extremity muscles and shuttled it to the diagram.

And they do it because your body prioritizes the delivery of oxygen in order to survive. The problem when you draw blood, even a small amount away from the lower extremity or the low back extensors, is that probe receptors, your spindles, need blood to give information.

So you're going to impair probe reception, and then that's going impair balance. These authors said it's the reason that athletes get hurt in the last few minutes of a game.

Their diaphragm is fatigued and they start drawing blood away and have an impaired sense of position. They have different ways of strengthening the diaphragms.

Some people say you should strengthen the diaphram doing deep breathing exercises with yoga. And those researchers that I talked about who use the muscle spindles, the focal muscle vibration, to evaluate core proprioception, they rehab that with diaphragme strengthening.

Because they showed that after you've been immobilized for a while, your diaphragm is fatigued. People with chronic low back pain have weak diaphragms.

So they looked at different ways to strengthen the diaphragme. And there's this inexpensive device that you can get on Amazon, a power breather. There's a smaller one that just has like a screw on it.

They looked at different ways to strengthen and only found that moderate resistance, two sets of 30 repetitions of near max inhales, that was necessary to strength the diaphragm.

Anything less than that, like the deep breathing in Pilates and yoga, did not work. It's like you're not going to straighten your grip if all you are doing is squeezing one or two pounds.

You've got to go near full effort. So you just put this in and you go… And you do that 30 times, you rest a minute or two, and you repeat it again. You do have five times a week, your diaphragm will be strong in six weeks.

That reminds me of a chiropractor, but known as a bodybuilder, Franco Colombo, when he used to blow up the, I think they were the water balloons, if you will.

Yeah, that's exhalation. So he was working on the secondary muscles of exhaling, he wasn't doing inhales. He was workin' on like the deep neck flexors on intercostals.

But yeah, remember that, It has to be inhalation only. It doesn't matter if you're exhaling because the diaphragm is relaxed during an exhale. British Medical Journal, 2022. In a 12-year study of more than 1700 older adults, The ability to successfully balance on one foot with eyes open was strongly correlated with longevity.

I loved that paper. And again, it got a little bit of attention when it came out, but not since then. So they followed people. It was a 12-year study.

All they did was had you take off your shoes, because everybody's got different shoes. So you had to be barefoot. You stand with your arms at your side, your eyes open, you get a practice.

Diaphragm strength and breathing exercises

Take one foot off the ground and touch it to your leg because it gives you a little more proprioception when you're touching the leg. And you got three chances to see if you can stand for 10 seconds.

People in the study were over 65, which is young to me. 20% of the people could not do it. Of that 20%, they factored out obesity, hyperlipidemia, cigarettes, smoking alcohol.

It was a massive independent risk factor for death, like 84% more likely to die in a seven-year follow-up. And the authors of this study said, unlike strength, and other factors associated with age, balance seems to deteriorate very quickly starting at 60. So most people up to around 50 years old, they keep most of their muscle mass and then they lose one to two percent per year after that until they die.

But balance is like a cliff. You've got good balance up until around 60, and then you lose it quickly. And it's because

of what you were talking about before.

It's the complexity of the system. There's so many things involved with it. The cutaneous receptors are involved, the muscle spindles are involve. Remember, spindle live next to blood vessels because they need circulation.

When you're deconditioned, you'll lose capillaries. That's why strengthening exercises, I've got a study going on where, and Karen Mickle, the woman with foot stuff, did a pilot study where she showed that simple foot strengthening exercise improved balance and improved peripheral neuropathy function even because it grew blood vessels next to the nerves.

So if you want to improve balance, get some blood into your spindles. And strengthening exercises are usually important for a lot of different reasons.

And a guy named Herbman-Ponser showed that human beings, we're not like the great apes. The great apes can sit around all day, do nothing. Their cholesterol is fine.

They don't lose muscle mass. If we dont exercise all the time, not all of the times, but walk a minimum of 4500 steps a day. So exercise like 40 minutes a days.

Our system starts to break down. all the other primates are not like that. They can sit all day and the great apes, if they move like a quarter of a mile a day, it's a lot.

Our ancestors always moved up to seven or eight miles a it's essential for our survival. And one of the reasons it is, those blood vessels that come in, they supply spindles, They do all these other wonderful things, which can enhance balance.

So when it comes to balance, strengthening exercises are incredibly important, and this is really important. I call it the McHugh protocol. Everybody knows the balance stuff where you stand on one foot and they also so if you strengthen your right arm, your left arm and only your Right arm.

Your left Arm will get 1412 to 14% stronger in the next week because 15% of the fibers don't cross over. It's called neurological conditioning. So most people know that.

You get an athlete who has an injury in their cast. And you exercise the opposite arm to keep some of that strength. Proprioception. So there's a small crossover there.

Propioceptive exercises have almost 100% crossover. If you have someone in a cast on their right foot or an injured, I have them do proprioceptiv exercises on the good foot.

It's almost a 100 percent crossover, and McHugh et al. did a study on football players Overweight football players have the highest rate of re-injuries when it comes to ankle sprains, like 80%. So they were frustrated with it.

He is an orthopedic surgeon. And he knew they wouldn't do a hard protocol because they do all this other stuff. So before they could work out on a gym, he just had them stand on the balance pad.

Just stand down for five minutes on one foot. That was all he did. Eyes open. They had to do that before he worked out. It decreased injury rates over 75%. So what I do with people, because it enhanced pro-perception through the whole system.

So I always tell people if they fail that test, I'll just have them get a balance pad. I actually, the one they used in that paper in the American General Sports Medicine, it's not around anymore, so you gotta buy the expensive balance pads.

But I bought them from a manufacturer. You saw them on the site for like 20 bucks. And I got the same one that they use in this study.

Balance longevity, squats, and closing advice

Just stand on it and before you do your workout, balance for two to three minutes a day one day do one foot one they do the other foot and it improves balance markedly i just love it so anybody who fails that test i have them do that in fact the authors of that paper said this balance should be tested before cholesterol before blood pressure because it is a better predictor than any other measurement that you do in office and i saw that and I thought that will never happen Yeah, that may go against Western medicine.

So very quickly, rapid fire number two. Squats, yay or nay. People will hate me for saying this. I hate them with a passion. And I do that based on one paper that came out in the Journal of Orthopedic and Sports Physical Therapy that no one paid attention to.

They measured pressure on the back of the patella and that as people went down into a squat, when they went past 45 or 50 degrees, pressure the on back on patellar skyrocketed because the quad is pulling it into the femoral condyles to the point it could damage it in older people.

I just pulled up a paper today and I can send it to you. They're making a switch now because Dynapenia correlates with falls. And they're getting back into the squat stuff.

25% of the high force people dropped out of this study because they got injured. I have another paper that showed people over 60, if they do high-force stuff, they're 10 times more likely to be injured, and if you have retro patella arthritis, so if have any erosion on the back of your kneecap and you go past 60 or 70 degrees, you're going to get hurt.

And here, this is important and it's what I say to the people who say, well, how are you going get off the toilet when you get older? you angle specificity.

They have multiple papers that show this. If you do a partial squat and then come back up, you will be strong through that full range of motion. So I recommend based on another paper in Journal of Orthopedic and Sports Physical Therapy, when you lateral step-ups, if you hold a weight in one hand, and you get on a four-inch platform and step up.

Huge increase activity in the BMO, huge increase in activity of the quad, no pressure on the kneecap. It's reward return. You've got to take the risk versus the improvement.

And a squat on most people will cause an injury and a retro patellar injury. It is not necessary. Because when they said 25% got injured in that group, those injuries don't go away overnight.

you can get an injury that lasts four months before you get back. And then you want to make it so people do the exercise. I mean, exercise is difficult enough to do by itself.

So that's why I made up a protocol, five exercises to prevent age-related muscle loss. I put the reference in there about squats. I made a video of it on YouTube and I got all sorts of nasty comments because some people love squats, which I have friends who love them, and they've got huge quads, they got short femurs, had no injury to their patella.

Older people, like my age and older, should be really cautious about doing squats I haven't done a squat, I play tennis an hour a day every day and do all sort of…

I havent done squat in 30 years. Yes or no? Deadlifts? I love that list. Yes. Farmer's carries, farmer's walks. Good for handgrip strength. I mean, I don't know if I'd have an 80-year-old do it.

And I read a paper years ago that if you do one three-second maximum isometric contraction per day, you keep your strength, so I've read that 20 years.

ago I have a 100-pound dumbbell in my basement. Every day I go down and lift it for three seconds, and I put it down. So I'll say yes on that. Standing calf raises.

It works within a shortened position. In standing calf raise, it has to be lengthened to neutral? Yes. Neutral to short? No. So a seated calf raise is a no bueno for you?

As long as they fully stretch it. And some people say you can't get soleus with a seat calf raised, and they always reference this one paper where they did MRI studies.

That paper, to keep everybody consistent, they had people go to 20 degrees dorsiflexion. Whether they do the straight one or the seated one, there were 20. When your knee is bent, you should be able to go to 38. So they got a good outcome in the gastroc, because it was fully lengthened to 20. But people, when they did the bendy, they didn't push them.

In order for a muscle to respond, it has to be in a fully-lengthened position. I like seated calf raises, but it had to from full-dorsiflexion to neutral.

That is the key to all of these exercises and your outcomes. Fourfold differences in strength. Not one or two, fourfold. That's massive. And they don't know why, but when you get active in myosin filaments so they're just on their edge, the muscle filiments because it's lengthened, The satellite cells, which they call the stem cells of the body because they morph into myoblasts, they rebuild.

So they rebuild the muscle so you have to and that's what men's and osborne showed with that study of 16 exercises You put it in a shortened position.

You're going nowhere So if you're doing a heel raise and your calf is short You could walk around on your tippy toes with 500 pounds on Your back and Your calf would not get strong Well, I think we may have just scratched the surface with all the research that you decided the information that You shared with us today.

I greatly appreciate it Just before we end One thing for everybody to do differently on Monday, what do you want them to? Check their balance. I mean, super simple, easy peasy and quick to fix.

You can practice it just by practicing open eye balance and then progress to occasional closed eye. It would be the best thing you do. More important than checking your blood pressure and your cholesterol.

Well, there you have it. The key takeaway, I love it, Dr. Tom Mishaw. My pledge, we got to this again. Beautiful. Yeah, it was the first time I kept something short.

Sorry about that. We're not going there. It was great. Thanks so much.