

EMG Biofeedback: Lewis Lupowitz, DPT, CSCS, FRC Mobility Specialist

Intro

I am Lewis Lupowitz. I'm a physical therapist, Doctor of Physical Therapy, Certified Strength and Conditioning Specialist, Functional Range Conditioning Mobility Specialist, currently working out of Orlin & Cohen Orthopedic Group, which is the largest orthopedic group on Long Island. Right now, my role is to sort of oversee our sports in Nassau County. My responsibility is to ensure that, especially during the fall and spring seasons, that athletes are most taken care of and easily facilitated into our clinic. And the way I sort of transitioned into this role was having performed a fellowship down in Birmingham, Alabama at the American Sports Medicine Institute under the guidance and mentorship of Dr. Kevin Wilk.

Why is it important to know which muscles are activated?

Muscle activation is sort of the name of the game, especially in my field. I primarily treat a lot of individuals who are coming out of surgery. So in this post-operative phase, you've got to be somewhat cautious in terms of how active these individuals are. There's surgical repairs that are involved, and over-activity can actually lead to damage. And obviously under-activity can lead to a lack of progression in these individuals. So having a good foundation and understanding of what needs to be active to progress this individual back to their day-to-day function, as well as what can potentially alter or disrupt the surgery that was just involved is pretty imperative, especially in my realm.

How do you determine what techniques or equipment to use?

So I think the biggest thing for me is it's subjective- kind of talking to the individual. Again, like I said, post-operatively, an individual might say, "Hey, that doesn't feel the same as the side that wasn't worked on" and even later on in their rehab progression, we're getting someone back to running, cutting, and they might just tell me straight up, "I don't feel as explosive or powerful on this side." And you'd follow that up with "why, what feels different, what doesn't feel the same." And then from there I've got at least somewhat of an idea of where my assessment will be guided. So I think asking the right questions is the first and foremost in terms of how to determine what's activated. And then from there, performing the test that you're taught in terms of seeing what muscle is activated through which specific positions and then using the right devices to get an actual gauge on what it is you're looking for. Are you looking for strength? Are you looking for neuro-activation, are you looking for power output, speed output? So all of these little nuances to cater to what that individual tells you initially is lacking from their perspective.

How do you assess muscle activation?

Let's just say hypothetically, we have an individual who's postoperative after an ACL injury-- that's generally my primary population. So early on we just want to see can they even activate their muscle from a visual perspective? Does it look like the muscle is sort of working? Does it look contracted? From there, we'll start to use a biofeedback device that will actually tell me if it is or isn't, and if so or if not, what is its comparison to the unaffected side? And usually, I'll try to do this before the surgical intervention if I'm treating them prior, to get a baseline assessment, and then afterwards as well. So early on I like to use a biofeedback. As we progress through their rehab stages, I'll start to add in a handheld dynamometer for some isometric strength or positional strength measurements. And then before I return them to play, I'm fortunate that we use an isokinetic device which measures power and strength output by maintaining a constant speed. So the force curve will vary because the speed is set to a constant. So it'll

give us a nice reading in terms of a lot of different measurements that will allow us to determine sort of where this individual really is and if they are ready to return back to their sport.

When and why do you use EMG biofeedback devices?

Biofeedback is a device that's used to measure neural output or motor unit recruitment. We know that as you start to activate a muscle, we need to elicit a response from those muscles and sort of create this recruitment process. So it's not necessarily a strength measurement, but the way that I like to explain it to patients is sort of how light are we turning on the light bulb? Or how bright is it? Does it feel as strong or as active as the other side? So in my world, where I really use this is early on after a surgery when an individual may not be most fit to give a max effort contraction of their muscle because of the repairs that are involved. So what we'll do is we'll wear this device. And we'll see, are you even able to turn these muscles on before we start assessing your maximum strength output? So again, it's just a way for individuals to sort of see their ability to activate their muscles and start to re-learn how do they use those muscles if they aren't as active as they feel they should be.

I think that the visual component from the biofeedback is the biggest part of it all. So having the individual be able to self-assess and understand from their perspective if they're doing what the goal actually is, is extremely helpful. So now there's a lot of devices on the market. The original ones were sort of this pressure gauge that almost looks like a blood pressure cuff to sort of apply pressure into this air-filled bladder. And even then, it's still some sort of a visual feedback. But now there's some devices out there that have a Bluetooth configuration to an iPad or an iPhone. And it allows for a nicer visual effect. So the individual can actually see goals and you can set specific goal achievements. And it starts to incorporate not only a visual component, but a sound, an auditory component as well, where, when the goal is achieved, a specific sound is elicited versus if not, the sound doesn't elicit. So it just helps with engagement for that individual to sort of work towards their goals.

Which injury states benefit most from biofeedback EMG?

So in my specific realm, I personally use this on individuals following any sort of knee surgical procedure, primarily with ACLs. So in the recent literature in my world in terms of physical therapy, Dustin Grooms, who's an athletic trainer by trade out of Ohio University, has actually shown us that individuals following an ACL procedure tend to have cognitive or brain changes after this injury. So they don't necessarily know how to use this muscle the way that they once did. And what tends to happen is they now become more visually reliant. So the reason I like these devices is because of that visual feedback that they get from using the device. And sort of seeing what it takes to make this muscle work also helps rewire their brain to get it to work in general. On a secondary, I use it in a lot of shoulder patients or overhead athletes who tend to have sort of mismatch shoulders just because of their sport. So they sort of tend to overrecruit one area and underrecruit another, which leads to a little bit of pain or discomfort in their shoulder with increased activity. So helping them figure out what it takes to have a quote, unquote, normal shoulder versus the athletic one that they've sort of adapted to. And then lastly, there's a lot of literature out there indicating its benefits in core stabilization following lower back injury. So those three would probably be the top that I would use it in a clinical setting for.

When is biofeedback EMG not useful?

I think it could definitely be a little bit more difficult to target smaller muscle groups or the underlying stabilizing muscles per se. However, I think that if you're sort of able to put the pads in the right placement and pick the specific activity that you think targets those underlying muscles through the larger, more superficial ones. We know that based on this motor unit recruitment principle that there is this sort of building block effect where smaller muscles have to recruit in order for larger ones to do so as

well. And while there could be underlying issues that may not be picked up as well on the biofeedback, I still think that there's some benefit there.

Which features of the mTrigger do you find most beneficial?

So in terms of what I feel is most beneficial, I think that-- at least the specific device I use, which is the mTrigger, it's a small little portable device and connects really easily to, again, like we said, an iPad or an iPhone and sort of has this interface technology. So the best thing that I've noticed with that is there's multiple settings. So there's a training setting where we can simply set up pads side-to-side or even agonist-antagonistic muscles. So I can put two pads on someone's right quad and two pads on someone's left quad. And simply say, you know, turn this one on, turn that one on, and alternate and sort of get a visual in terms of which one is doing more. Or I can do it on two on the quad, two on the hamstring if I notice that they're using their hamstring more so. So I will say keep this one super, super high while this one stays super, super low. So I like using the training module for a visual feedback. In terms of another setting that they have on there-- there's a game setting. So I treat a lot of younger individuals, so kids. So once we kind of have a good idea of what it takes to activate their quad and they've got a pretty good understanding, we can actually put a game on where let's say there's a car driving on the left side of the road and they've got to avoid an obstacle. They tighten up their quad and the car slowly moves over towards the right side of the road. So, it just keeps them sort of engaged during this activity instead of just sitting on the plinth sort of squeeze, squeeze, squeeze my quad. At least now there's some sort of engagement there for them. And then the biggest one for me is the neuromuscular assessment test. So there's a setting where you put two pads on one area or the affected area and two pads on the unaffected area on the exact same side. And we go three maximum effort squeezes on the affected, three maximum efforts squeezes on the unaffected. It'll pick up the motor unit recruitment one side to the other and give me an automatically calibrated percentage of what their deficit is. And this also helps patient engagement, especially with the population I'm in-- I treat a lot of athletes and they're super competitive and they see a deficit of even 20% and they freak out, they're like, I'm not perfect, I'm not 100%? What the heck? We've got to train this more. So I think the engagement piece is the biggest thing for me. And then the only cons would be sometimes pad placement is a little difficult, sometimes getting the setup is a little tough. Sometimes convincing the person right off the bat that this is the best option for them- it can be tough as well. But it's something that I definitely use early, early on. And then if someone's sort of unable to figure out their body, I've really seen more success than lack thereof with these products.

What improvements do you suggest?

First and foremost, I think awareness, sort of like what we're doing here- sort of the educational component on why these things have benefit and where they have benefit in different avenues of the profession that I'm in, in particular, and other professions. And then from there if we can make some devices like you'd say, that can target some of these deeper structures or are maybe a little bit more specific to certain areas, would also be another avenue that would be, I think, beneficial moving forward.

Do you have recommendations to improve pad placement?

In terms of pad placement, I think what's important to note is that, again, you're not assessing strength, you're assessing motor output. So in terms of motor output, you have to follow the nerve root that travels through that muscle. So what I often find a lot of times in students that are shadowing me or aids in my clinic that are helping assist with these pad placements is that they'll place it right on the center of the quad muscle belly. However, we know that the nerve root that innervates the quad is a little bit lateral to the actual midline of the quadriceps. So maybe if they offered out a little pamphlet that-- kind of like a muscle trigger point book, where you sort of have the x's on where common spots are for trigger points-- something of that similar nature on common spots where pad placement should be based on nerve root versus muscle bulk.

How long does it take to set up and use the mTrigger?

The time it takes to set up the device in terms of pad placement and wiring is 2 seconds. In terms of calibration, it's about a 40 second calibration to the iPad just for the device to get connected. So I'll turn the device on, get it calibrating. And as it's calibrating, I'm sort of putting the pad placement on so that it's all this one-shot of about 45 to 60 seconds. And then depending on the day, if we're using it just as a training method, there's a setting on train mode where it'll be about a two-and-a-half minute timeframe of sort of 5 seconds on, 5 seconds off. I'll generally do that for two rounds, more as an active warm-up. Get the patient primed and ready, and then we'll go into a training mode of about two, two-and-a-half minutes for two rounds, so about a five-to-seven-minute total with rest time in-between. And then on a test day, we'll do one round of training, and then whatever the individual needs for their specific warm-up, and then the actual neurocognitive assessment or the neuromuscular assessment is three max effort contractions on one side and three on the other over the course of a total of 60 seconds. So nothing too long.

In terms of a post-operative patient, we'll probably use the training module after about the first ten days. We sort of just want the knee or affected area to sort of calm down. And then we'll start to implement it so that the individual understands what it takes to use the affected limb. I'll continue to periodically do that neural modular assessment every two weeks with that individual until they're within a 10% deficit, one side to the other. After they've achieved about a 10% deficit, then we'll stop doing the neuro assessment and then we'll only continue to really use that device if they feel it's continuing to give them added benefit. But then on the flip side, in an overhead athlete, it could be at any point in time. If we start to notice that their shoulder is sort of hiking one side to the other-- they could be 12 months out and just sort of in their throwing program now-- but their shoulder still seems sort of off. So maybe we'll use it in a one-day use at a random part in their program as well. More to sort of hone them back in on some of those building blocks that we achieved earlier on in their in their rehab phase.

Do patients ask to use the mTrigger at home?

Yeah, no, definitely. I think some individuals early on especially enjoy that game aspect, especially younger kids. It's hard to convince people to do their home exercise program. I'm not the biggest fan of giving them more challenging exercises at home. I like to challenge my patients in the clinic while I'm with them to keep them engaged, keep things fun. But at home I don't want them doing anything too crazy. And I sort of trust them to do these building block exercises that give them a baseline of where we need to be so that when they come back into the clinic, we can do all the fun, fancy things that we sort of see. But again, that- with using these devices and then having a game to it, it creates a little bit more of a buy-in at home when we're doing sort of like these more boring type exercises. So yes, patients definitely have asked to take it home and the overwhelming response every time it's nope, that's mine. We need it here.

Do you have concerns with patients using the mTrigger at home?

No, I don't really think so because I don't think there's any negative effect. The only downside would be if they put the pad in the wrong placement. It's not like an electrical stimulation where they would sort of shock themselves or injure themselves. The only thing that would happen is if they put the pad in the wrong placement, they may not receive the expected output that they were receiving in clinic. So if they sort of put it a little off to the left or to the right, the device may not pick up on as much motor output as they were once seeing, which can lead to frustration and annoyance, but no true damage. I think it would take a little bit of training to teach these individuals sort of where the pads need to be, how to set up the games, how to set up the goals, et cetera, et cetera. But in terms of a harmful effect, no, definitely not.

Do different populations respond differently to the mTrigger?

I definitely think that there's a big difference. You've got to understand the individual. Are they competitive by nature? If so, these devices may be beneficial for them because there's some goal attached to it versus a less motivated individual, I may not take the time to set this up and have them sort of engage. Maybe their goal is just they want to walk up and down the stairs if it's an elder individual or they just want to be able to do the laundry or walk their dog. They don't necessarily need to know is my quad 100% the same as the other side? But if you're working with an athlete looking to continue back on their collegiate dreams or athletic dreams, they kind of have the desire to know these statistics.

How do you define the success of a device?

So in my world, success is what the other individual on the opposite side of me feels success is. My goal is to help my patients achieve their goal. So I'm constantly asking them, do you feel this helps you? And if not, we don't use it anymore. And if so, we keep on using it. So to me, success is defined by patient engagement and their responsiveness to the use of these devices. So I ask every single person, do you feel like you can use this muscle more than you did before using this? If so, cool, we'll use it as a training module. If not, we'll throw another tidbit or a little trick at you to try to get you to feel the way that we want you to feel. So again, it's really just managing expectations from the other individual and then sort of taking their consideration into account.

What is the importance of user feedback?

In terms of these devices, I think it's a matter of, you know, don't force the device on the patient. Allow the patient to sort of—or individual; I don't want to say patient-- but allow the individual to give you the feedback that you're looking for. Again, this is just an adjunct to the treatment that you're providing and just another tool. I hate this term, but it's another tool in your toolbox. If you have a good understanding of the clinical application of the device, then it can be indicated for specific individuals where you see it best fit. But don't force it on the individual. They'll most likely tell you if they like it or not. And if they do like it, then it's definitely got some significant benefit.