Reversing Paralysis - Health Matters

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Dr. Granet: Hi, everybody. I'm Dr. David Granet, and welcome to Health Matters. When I say the word ‘reanimation’, in regards to the human body, it sounds like it's science fiction, but today, we're going to find out, like we do a lot here on Health Matters, that science fiction is becoming science fact, with a lot of hard work, by a lot of very smart people. One of them is here with us today, Dr. Justin Brown. Welcome.

Dr. Brown: Thank you.

Dr. Granet: Dr. Brown, as director of the Nureosurgery Peripheral Nerve Program here, at the University of California, San Diego, where you have been working on making muscles and things move that couldn't move anymore, that's pretty amazing. When I started medical school, that wasn't possible. I mean, just, people, think about this. They get an injury or something happens, and their hand doesn't move anymore. It's paralyzed. That's the word that we use, and you think it's forever. It used to be, but you're able to make that move again?

Dr. Brown: We can make it move again, and believe it or not, this has been going on for about 100 years now, but it's always been in pockets here or there. Some of the things we thought we discovered about ten years ago, we can look up reports from Russia from 1940 and find somebody there had discovered the exact same thing. So it's not really brand-new technology, but I think we have a better grasp, an understanding of it now, than we did back then.

Dr. Granet: Yeah, everything old is new again.

Dr. Brown: That's right.

Dr. Granet: To talk about this, I think we need to set the stage about how nerves and muscles talk.

Dr. Brown: Sure.

Dr. Granet: And how it works normally and then what goes wrong.

Dr. Brown: Okay.

Dr. Granet: So how does it work normally?

Dr. Brown: So normally, the brain has to communicate to the spinal cord, and the spinal cord has to talk to the muscle to make that muscle move. So just to simplify it, it's the cable, like your light plugged into the socket in the wall. If that cable’s broken the light goes out. If the nerve has been cut in two, that muscle no longer moves.

The idea is to bring that communication back to the muscle so the spinal cord is once again talking to that muscle and causing it to move once again.

Dr. Granet: In the old days, nerves once they were cut, if you got lucky, maybe they reconnected and I remember being taught that they barely grow and this was 30 years ago. How do you get a nerve to talk to each other again, once it's been separated?

Dr. Brown: Sure, well what a lot of people don't understand is once they're separated, there's a part that's connected to the spinal cord and it keeps the wires. There's a part that's disconnected and those wires sort of get eaten up and it ends up an empty conduit. The idea is to put the train tracks back together to get this train from the proximal end to grow all the way down to the muscle on the distal end.

Unlike that, and people get confused, the central nervous system, the brain and spinal cord do not grow well. The peripheral nerves are set up to grow, but there are a lot of parameters that we have to pay attention to – how long it's been since the injury, how old the person is, how complicated a nerve it is. Several of these things we want to pay attention to before we plan how we're going to reconstruct.

Dr. Granet: So to use your analogy, if it's a railroad track and if you've waited too long, it's disintegrated too far. Grass has grown over it. It's been destroyed to a point where you really can't get it to grow back in that pathway.

Dr. Brown: That's right.

Dr. Granet: So if someone has, is it usually an injury that causes this, and what type of injury would you classically see this pass off?

Dr. Brown: So the worst the injuries we see are the motorcycle accidents, and the bundle of nerves that come out of the spine at the neck is called the brachial plexus, and when a patient is thrown from a motorcycle and they land pulling their head away from their shoulder, it will often rip these nerves and so the arm hangs limp at the side. That's one of the most challenging nerve repair cases we have.

Dr. Granet: I mean, I remember when I was in medical school, I was in Connecticut. People didn't wear helmets.

Dr. Brown: Right.

Dr. Granet: They would get brain damage. Now, with helmets, it's a lot better to have an arm damaged than your brain damaged.

Dr. Brown: That's right.

Dr. Granet: Classically, they have this damage to this complex of nerves that come out of the spinal cord down into the arm. If you do nothing what happens?

Dr. Brown: Well, there are variable degrees of injury. So we need to find out what kind of injury it is. Has it been stretched? In which case, it could grow back. Or if it's been stretched too far, sometimes it'll just form a scar tissue there. Or if it's been plucked out of the spinal cord, we know we're done and it's not going grow back on its own.

You have to sort of figure out what kind of injury it is first and then come up with the plan of how to get it back. There are a number of injuries where we see it looks very paralyzed early on, but within about three to four months, things begin to wake up.

Dr. Granet: So you talked about not waiting too long,

Dr. Brown: That's right.

Dr. Granet: But it sounds like you don't want to go too soon either.

Dr. Brown: Well, you want –

Dr. Granet: You want to give it a chance for recovery.

Dr. Brown: That's right. You want to get your evidence as quickly as possible. So if the patient comes in with a completely paralyzed arm, and we would then image him and find out has it been plucked from the spinal cord? Or can we see separated nerves?

Dr. Granet: What kind of image?

Dr. Brown: A CT scan myelogram or an MRI.

Dr. Granet: Okay, and so these are either radiation or magnetism.

Dr. Brown: That's right.

Dr. Granet: It’s using to look at it carefully. Can you see down to the level of peripheral nerve on these kinds of scans well enough to determine the type of injury, discussing it from whether it's been plucked out, stretched. Can you tell the difference?

Dr. Brown: A lot of times, we can, particularly the one where it’s pulled out of the spinal cord because when that happens, there's fluid that lives around the spinal cord and when the nerve has been ripped out from the spinal cord, that little fluid creates a pocket on the outside.

Dr. Granet: So that one you know.

Dr. Brown: That one can be easy, sometimes.

Dr. Granet: Okay, and then the others if it's closed, you wait a little bit to see if they recover?

Dr. Brown: That’s right.

Dr. Granet: Is there something that the person who's waiting, if somebody's at home and has had this injury, is there something they can do to help themselves? Is there something that the native body does to help reconnect this or if they’re stretched, to heal it?

Dr. Brown: Well, there’s not a lot that we can do to make it grow better or faster, but the important thing for them to do is maintain the range of motion in the meantime. Some folks will ignore the arm and then by the time that comes for it to recover, they have developed contractures. Their hand no longer opens and their elbow is too far flexed and then

secondary procedures need to be done to loosen it up so that it can move. So maintaining is the big deal.

Dr. Granet: Maintaining it?

Dr. Brown: Yeah, in the anytime.

Dr. Granet: Okay, if we weren't trying to reconnect the nerves, is there anything else? Or is it sit home, pray, and hope? If somebody doesn't go in and do something it's just cross your fingers, pray?

Dr. Brown: If we know it's not going to recover, you're saying?

Dr. Granet: Yeah. I mean, if it's a plucked-out injury?

Dr. Brown: If it's plucked out injuries, that's right. It's just not going to come back. There's no way that if it's been plucked out that anything is going to grow back down that to recover that muscle.

Dr. Granet: So then what techniques, sort of you – I mean you alluded to that people have tried stuff in the past. What's led to what you're able to do now?

Dr. Brown: Sure, so the same way people have been approaching spinal cord injury recently is that desire to recreate a normal spinal cord. That's the original way people approached these big nerve injuries, if they wanted to rebuild the nerves the way they originally were intended to be built. So we would take grafts. So every part that was damaged, you'd find a nerve somewhere else in the body and you'd build a bridge and we do it way up in the neck.

The things that we know that impede good success is the distance from the repair site to the muscle, the amount of time it takes for that muscle to get reinnervated, and the amount of time after the injury. So the strategy is, let's not try to rebuild the normal nerve. Let's try to find a strategy that recovers it quicker.

One of the best ones we've had is when the shoulder and biceps are up and the hand works perfectly, instead of reconnecting it up here, we actually splice one of the nerves that goes to the hands down here and then connect it about a centimeter away from the biceps.

Dr. Granet: Got it and the idea is that if you get it moving or connect early, eventually the body will figure it out?

Dr. Brown: The body will figure it out. So they may go through a training phase where he has to make a fist and the arm begins to come up, and then the brain will figure it out and after a time, he just automatically thinks, flex the elbow, and up it goes.

Dr. Granet: It's kind of amazing.

Dr. Brown. It is. The brain does amazing things. It has so much plasticity or ability to make up for things we wouldn't think would be easy to figure out and to make them normal for a patient down the line. It's wonderful.

Dr. Granet: Well, it's funny because we've talked about it here in Health Matters, previously people who have phantom limbs, where they've lost an arm but they feel like they still have it.

Dr. Brown: Right.

Dr. Granet: It's almost like the brain is still trying to be plastic, it's still trying to make something move, and you're giving it a chance to do that. I mean, that it's not a phantom limb. You're actually saying, "Okay, here go play." I mean, you have to connect it and figure it out.

Dr. Brown: That's right.

Dr. Granet: So that surgery, we're not talking about large surgery. This is all a very small delicate surgery.

Dr. Brown: Right.

Dr. Granet: How do you do that?

Dr. Brown: Well, we do it with a microscope and micro instruments. When we actually put the nerves together, we use a suture that's probably thinner than my hair with a microscope, and we you know, actually, suture the nerve ends together.

Dr. Granet: I'm sorry but it sounds unbelievable – we're suturing nerve ends together. You know, I mean that people, I think, sew hems on dresses or pants, you know. We sew it. Those are big stitches. You're talking about very delicate tissue that you don't want to damage it during the procedure. It's already been damaged,

Dr. Brown: That's right.

Dr. Granet: And you've got to put it back together and you've got to dissect it out and do that. There's a lot of training that goes into that.

Dr. Brown: There is.

Dr. Granet: So let's just take a second and we're going to torture everybody for a second and tell them how many years it took before you finished training, just to get finished training. So in your med school?

Dr. Brown: At the med school, four years, obviously. In the neurosurgical residency, when I finished, it was still six years. It's now become seven, and then I did a fellowship in the peripheral nerve surgery which was a single year.

Dr. Granet: Right. So you're talking about 12 years after college --

Dr. Brown: That's right.

Dr. Granet: -- before you developed the skillset where you're able to go ahead and do these things. Someone doesn't walk out of you know, a technical school and be able to just do this. This is extreme levels of training, pretty much the highest level of training we have in medicine.

Dr. Brown: Right.

Dr. Granet: I'm a pediatric eye surgeon. I didn't spend as many years training as you have. So I mean, this is someone with an incredible skillset to be able to walk in and do that, but you don't work alone when you do all this. You have, sometimes, plastic surgeons and neurologists and there's some teamwork that goes in.

Dr. Brown: That's right.

Dr. Granet: How does that all work?

Dr. Brown: Yeah, we have put together a nice center here so part of the diagnostics in getting these injuries figured out is one, having the proper MRI protocol. When the patient has an injury to the nerves, they can't just go to any MRI shop down the road and get an image that will show us the detail we need. So we head up radiologists who are willing to tweak what they're able to do to get a better picture of nerves. And then we need a neurologist who understands what I do. Many neurologists can do EMGs, the studies where they put the needles in and test the nerves and the muscles, but it takes somebody who is interested and understands what we do to be able to give the answers that we're looking for.

Dr. Granet: What is it that you're looking for that they need to tell you? How do they help you?

Dr. Brown: Okay. One is they can give me a little preview on whether something's recovering or not. Well, before we're able to see the muscle move when he puts that needle in there for the EMG and asks the patient to try as hard as he can to move, and we hear a little pop, pop, pop, that for us, is a nice little preview that probably two to three months from now that arm is going to be flexing without difficulty so let's not bother repairing that. Let's move on to one that does not give a response.

Dr. Granet: Like every good surgeon knowing when not to operate.

Dr. Brown: That’s right.

Dr. Granet: They’re most important decisions that we make.

Dr. Brown: That's exactly right.

Dr. Granet: So that information helps. Is there other information that they give you? I mean, is muscle damage that's irreparable, they can find? Or is there something that would stop you not because of a positive because of a negative?

Dr. Brown: Well sometimes on these nerve transfers, so when I'm taking from what I believe is a healthy nerve and I’m plugging it to one that's gone, sometimes we'll see a muscle that moves very well, but when he tests it, he finds out that although it's moving well, it's running on 1/4 or 1/5 of the wires that it should be running on. So when you transfer that, you're probably not going to get the results you're after.

So he can come up with what's going to recover and then what strategies that I might want to use will be the best strategies?

Dr. Granet: Wow. I mean this is teamwork. This is an ongoing discussion that must be continuous with you guys.

Dr. Brown: That's right.

Dr. Granet: Plastic surgeons?

Dr. Brown: Plastic surgeons, sometimes the answer is not just repairing the nerve. Sometimes it’s using local muscles and moving them into a position that would provide better function.

So after I do nerve repairs, if I'm just getting the fingers to close but the thumb isn't positioned right, we have to fuse the bone or do something else to position the hand better. The other use for plastic surgeons is sometimes the patients come too late. So if they come after a year, when everything, when we’d talked about those railroad tracks, the grass has grown over and it's not going to do well, we can actually steal a muscle from the leg and replace one of these muscles and nerve units that aren't working anymore, and I do that as a team.

Dr. Granet: So everybody working together again.

Dr. Brown: That's right.

Dr. Granet: Knowing when to deploy who. You know, I mean, I'm a sports fan. So I'm thinking, sometimes you need a three-point shooter, sometimes you need a center to get a rebound. I mean, you need everybody working together.

Dr. Brown: That's right.

Dr. Granet: The hand is an unbelievable organ. You and I, with fine motor skills. People play instruments, have incredible fine motor skills, even to write our name is an incredible feat, the practice. How much recovery can you get? I assume, it's going to be variable, but to what levels, how good can it get it?

Dr. Brown: It all depends. I tell patients how much has gone, what percentage of the limb is gone and that gives you a good idea to what percentage I can get back. If you were missing a couple of critical muscles, if you can grasp and flex the wrist, but you have no ability extend the finger, or extend the wrist, it's a dramatic recovery because suddenly, they have a hand that doesn't work at all to where it works, but it's just a few different muscle groups that we’re recovering.

If there was absolutely nothing going on from the elbow down and we have to reconstruct that from scratch, it's going to be a very rudimentary hand. It will close, it will open, but it will not play the piano when we're done.

Dr. Granet: But close and open is a big advantage.

Dr. Brown: That's right.

Dr. Granet: So from somebody who can't move their hand to close and open, I mean, that's to me it's a quantum leap. It's the glass is truly half-full, and not half empty.

Dr. Brown: That’s right.

Dr. Granet: So if somebody starts with, I mean, it's a little bit more, could you get somebody to play the piano?

Dr. Brown: That's right. So the first scenario I described where the wrists and fingers don't extend, we could get them to play piano afterwards. We'd be able to get him with independent finger extension or wrist extension. So when there's nothing left there, now we're hoping that he can get that cup to mouth.

Dr. Granet: Well, I mean you know, which is still a good deal.

Dr. Brown: Which is good.

Dr. Granet: Yeah. I mean, to be able to hold your child or to drink or do those things. Do people get back to the point where they can get back to their normal activities and then recover, work? I mean, drive? Use the hand to steer the wheel?

Dr. Brown: That's always the goal is to get them get them back to the occupation they came from, and so a lot of times we can, depending on how severe the injury was. This may simply be a helper arm than an out versus something that he's doing by manual skills with. So it all depends on the severity of their initial injury.

Dr. Granet: So you know, you've talked about, this is incrementally adding on to scientific data that's been collected over many, many years. Is there anything that's been sort of a jump for you that's been able to say, “Wow. We could do so much more than we used to be able to do.” Or is it these incremental steps, putting the team together and just hard work? Has there been a jump that's allowed you to help?

Dr. Brown: Well, I would say the nerve transfer strategy that I talked about has been a big jump because it has taken results on operations that took much longer to do and at times, delays before recovery that were much longer, and final outcomes that were very weak and turned them to very short operations, short recovery times, good strength. But the other, what I feel like a sort of a quantum leap has been applying this to other types of injuries. Some people figured nerve repair is only for nerve injuries. We've said well now that we're using nerves that work and plug them in the nerves that don't, why not apply this to spinal cord injury, or even to stroke? And so we're one of just a couple of centers in the world that's doing this now and seeing good results.

Dr. Granet: Give us an example of what you mean by that.

Dr. Brown: Okay, so a patient who's had a spinal cord injury, if they've injured their spinal cord, ripped in the middle of the neck and they lost their hands and they can't walk anymore and they're in a wheelchair –

Dr. Granet: I think Christopher Reeve is somebody that everybody thinks of when they hear that.

Dr. Brown: Sure. They are left with sometimes shoulders, sometimes biceps and nothing below that. Well, using the same strategy, we can sort of redistribute what's left. We can

take, there are a few muscles that flex at the elbow. We can redistribute that down to getting the hands to close. There's a couple of muscles that turn the palm up. We can use one of those to get the fingers to extend. So we're able to take these patients down and give them the ability to get the glass to mouth and do things they couldn't otherwise.

Dr. Granet: Or hit a button on a keyboard.

Dr. Brown: Sure.

Dr. Granet: Now, they're using a computer and they can communicate in different ways or run a wheelchair with a joystick. That's another step towards independence.

Dr. Brown: It is.

Dr. Granet: That's huge.

Dr. Brown: And if you can just add a little level of function to these patients, it makes a huge difference in their amount of care they need during the day.

Dr. Granet: Yeah, and back in the day, I remember that there were times when people would have Bell's palsy or other problems with the face and they had tumors removed and there would be transplanted muscles and reanimation of the face. Is some of what you're talking about applicable to that? Or it has helped with what you're doing. How does that work?

Dr. Brown: It is. It's absolutely applicable to that. So we have a facial nerve team and it's Dr. Nguyen, in Otolaryngology, and Dr. Gosman in plastic surgery, and the same things apply. So there's reconstructing the facial nerve way back in the bone, if you know, was injured back there, but there's also the same transfers. So the chewing nerve, the masseter muscle here which helps you chew, there's a nice big nerve in there that we can connect to the facial nerve or the temporalis muscle that lives up here in the head can be connected to the upper face. Or we can go to the contralateral side and wire that over so when the right side of the mouth goes up, then the left goes up together. So when they are happy, it automatically smiles.

Dr. Granet: If you do functional MRI scanning of the brain, can you actually see the brain plasticity in action? Can you see the brain change how its approaching its use of some of these muscles or the face or whatever part it is? Because at first, it's off and then it has to learn it.

Dr. Brown: Right.

Dr. Granet: Can you watch those changes take place?

Dr. Brown: You can. There have been some centers that have done these serial studies on these things and watched how the function migrates to different parts of the brain and it's fascinating.

Dr. Granet: You can teach an old dog new tricks?

Dr. Brown: That's right.

Dr. Granet: That's amazing. So this is incredible. Whenever I hear some of these, I think about athletes for example, the old Tommy John Surgery where you could take a piece of, you know, tendon and put it in the elbow and make someone throw again, and they could get back. When they had an injury, that didn't work. I mean, are there athletes who have had injuries or damage on a football field or in athletics that have numbness or tingling that you do this for? Or is that too mild to go, to put them through an operation like this?

Dr. Brown: Yeah, those are usually sort of nerve compression entities. So it's a nerve that's still there, but it's not functioning its best. It's usually because something is compressing it. So it could be over developed muscle. It could be the posture they've assumed from their activity, and just getting pressure off those nerves usually allows them to wake up and they get back to sports.

Dr. Granet: So they don't need this kind of whole thing that you're talking about.

Dr. Brown: That's right.

Dr. Granet: Okay. There are people who have pain in their nerves and from compression or other spinal cord problems along the way. You're not talking about replacing those nerves? That’s still traditional, take the pressure off of them.

Dr. Brown: That's right.

Dr. Granet: Okay.

Dr. Brown: So the difference here is these are complete, complete injuries. So a lot of times after we have a discussion, like these patients will call and say “I'm a little weak in my grasp.” We want a muscle that does not work at all, before we go to these types of procedures.

Dr. Granet: Okay. You mentioned something that I want to disconnect you for a second. You said these are short operations.

Dr. Brown: It depends.

Dr. Granet: Compared to what it used to be.

Dr. Brown: Compared to what it used to be.

Dr. Granet: What does that mean? You know, is to you five hours a short operation? Is it in an hour? I mean, how long does it take now for you, a typical case? How long would it take you?

Dr. Brown: So if we're doing separate nerve transfers in the arm, each nerve transfer can be about you know, three hours.

Dr. Granet: Okay.

Dr. Brown: So previously, when we are reconstructing the entire brachial plexus it could be a 12-hour, 15-hour operation.

Dr. Granet: Yeah. I wanted people to hear that because in ophthalmology, 3 hours is a long case.

Dr. Brown: Right. Okay.

Dr. Granet: But for neurosurgery three hours is a relatively short case, compared to a 12-hour previous case.

Dr. Brown: Right, right.

Dr. Granet: So it's still an enormous amount of work. We don't want people to think this is you know, five minutes and you're out to do that.

Dr. Brown: Sure.

Dr. Granet: There's something that I don't think that we need to have too much to talk about, but it's in every show now and everywhere we go, people are asking both me and you about these things all the time, and that's stem cells.

Dr. Brown: Sure.

Dr. Granet: This is not stem-cell based. This is a whole different approach. This is connecting things. Is there, just because people are going to ask, is there a role that stem cells will eventually play, you think, in this, in helping connections or in the future?

Dr. Brown: I think that there probably will be a role in peripheral nerve reconnections for stem cells to sort of enhance how well those wires cross, how well the axons grow from the repair side from one side to the other. I think there's probably an area there that will enhance things. And then when we get back to the spinal cord to gain a level or two of function in the spinal cord, stem cells may be able to do that as well, But we've got a little more work to do before we're there.

Dr. Granet: Yeah and medicine is often hard work.

Dr. Brown: Right.

Dr. Granet: It sounds sexy when you see it in the newspaper, but there's a lot of hard work that goes in with people's noses to the grindstone, and an academic center like you and I are at, there's a lot of research labs. There's a lot of teamwork that goes on between the clinician, helping to translate that bench research to the clinics, the value of being at a place like UC San Diego.

Dr. Brown: That's right.

Dr. Granet: So in the time we have left, sort of the world according to you, what would you like to see happen, so that for example, if somebody had an injury, is there a quicker detection of getting them to you quicker that you want to see? Or from a research standpoint, the kinds of things that you'd like to see going forward?

Dr. Brown: Sure. So both of those. Number one is, it still seems that across the nation, really across the world, there is a general misunderstanding of paralytic injuries. That patients are told to wait, go get therapy. Let's give it a year or two and see how you do. And

that's when they've missed the golden opportunity. So if there's one thing I'd want to get out there is, if you have an injury that results in paralysis, come see a specialist soon. Come see him within three months. That's what we consider soon, within three months of the injury. We can help determine if this is one that will go on to recovery with therapy or if this is one that needs surgery.

Dr. Granet: So the answer is still maybe wait.

Dr. Brown: It's still maybe wait.

Dr. Granet: But if it's not wait, you've not lost the time.

Dr. Brown: That's right.

Dr. Granet: Okay, so get to you a little bit sooner. I assume that partly means that you are talking to our colleagues out there, educating them as well so that that message continues to get passed down.

Dr. Brown: That’s exactly right.

Dr. Granet: That's part of the teaching efforts that you do. From a research standpoint, what would you like to see happen? Or what are you working on now?

Dr. Brown: I would like to see more focus on enhancing regeneration, and we've been happy that the peripheral nerves regenerate compared to the central nervous system. They're set up to do so, but I think that can be improved upon. I think that we could maybe stretch the window so that patients don't have to be here within a year. Maybe it could be acceptable up to two years after their injury. Some of the research is going into maintaining the distal nerve, maintaining the muscle, enhancing how many axons cross when we repair. I think that would really bring this field into the next level

Dr. Granet: A little more money for a little more research would be okay?

Dr. Brown: That’s right.

Dr. Granet: That never hurts, right, does it? One of the things that you're here is that there are training programs that you have here. It must be exciting to be able to pass this knowledge down --

Dr. Brown: It is.

Dr. Granet: -- to the neurosurgical residents, etc. Do they get -- because I listen to what you're saying and it sounds near miraculous to me. To them is it just par for the course? Like when they pull out their iPhone, they don't think it's that big a deal? I still think it's amazing. Do they think this is par for the course?

Dr. Brown: You know, it depends on the resident. It is certain everybody comes in with certain things that sort of light their fire, and the ones that they'd like it more, they get really excited about it. There are others that they've been focused on brain tumors since their medical school and they come in and say “That's interesting, but I'm a brain tumor guy.”

Dr. Granet: Yeah, I want to do something else.

Dr. Brown: But I've had you know, we have residents coming over from other programs now. They've come from Phoenix and from Irvine to learn this stuff, and they're fascinated by it. And so they want to spend extra time after their residency to learn how this all works.

Dr. Granet: I started the show by saying this is science fiction but just think of somebody walking in with an arm that doesn't move or just sitting there and no matter what they're trying to do in their brain, they can't get it to move and that they can walk out and now their hand is moving, even if they can just grasp a cup. That is a gift and a miracle that is hard to even describe, what the level of that is. So I can't imagine the gratitude that you hear from the patients and the impact that it has in their lives.

Dr. Brown: Well, it's a lot of fun to have that clinic when the patient walks in a year later and says, “Look what I could do now.” Yeah, I enjoy those clinic visits a lot.

Dr. Granet: A lot of high fives.

Dr. Brown: That's right.

Dr. Granet: Yeah. Well, thank you so much for joining us and more importantly, thank you for the work that you're doing.

Dr. Brown: Well, thanks for having me.

Dr. Granet: My pleasure. You've been listening to Dr. Justin Brown discuss something that is really near miraculous. The idea that you can make muscles and nerves work that were gone is something that is incredible. So I hope everybody was listening carefully. If you know anyone in this scenario and they haven't had an opportunity to be evaluated, or they've been waiting, it might be a good idea to get them to get checked. This is Health Matters and on Health Matters, we believe knowledge is power. I'm Dr. David Granet, and I'll see you again next time.