# Neurosurgery - Ref 43MS

*with Marco Sinisi*

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## TRANSCRIPT

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**Steven Bruce:**

We're going to be addressing a very specialist medical topic today because my guest is Mr. Marco Sinisi, who is a neurosurgeon by training. Back in 2002, he became a permanent consultant at the Carlo Besta Neurological Institute in Milan, and was the lead surgeon there for developing treatments for surgical disorders of peripheral nerves. And a couple of years later became a consultant at the Royal National Orthopedic Hospital in Stanmore with the peripheral nerves injury unit there. And he's also a honorary senior lecturer at University College London, which means, I guess, that he's very knowledgeable, very talented, very experienced. And it's a great pleasure of Marco to have you joined us today here, welcome.

**Marco Sinisi:**

Pleasure to be here. Thank you. Thank you for the opportunity.

**Steven Bruce:**

I missed out the fact that on your website, it says you have a particular interest in brachial plexus injuries. Why is that?

**Marco Sinisi:**

Well, the brachial plexus injury was, it did happen. It did happen. I found it within me, it was not that I looked for it. During the medical school the thing that interested me the most when I was studying anatomy was the anatomy of nerves and therefore the plexus goes without saying. And then I started as a neurosurgeon doing brain surgery, spinal surgery, but I met a professor there who was doing neurosurgery, so I tried to work with him and then develop my practice around it, even when I was in Italy. And then I had the opportunity to come work at Stanmore as a consultant, 2004, I was studying, when I was in Milan, I studying on professor Berge's book, who was my predecessor in Stanmore so it was a unique opportunity and ever since I've been there.

**Steven Bruce:**

Well, obviously the sort of things that you do are well outside our sphere of competence as physical therapists, but clearly nerve problems are things that we deal with a lot. You've got obviously a number of very interesting slides in your presentation here. Do you want to start us with the one that's on the screen here behind me?

**Marco Sinisi:**

Yeah. Do you want me to show it on the presentation here?

**Steven Bruce:**

This will do for now. When we get to the images, we'll share those because they're very useful.

**Marco Sinisi:**

So, what I wanted to take the opportunity to do was to tell you how we decide what to do with nerves, because it's not a very clear-thinking process, even in the medical community, even among orthopedic surgeons, plastic surgeons. The issue is always, okay, fine, there is a problem with the nerve, but we don't know what to do. We don't know whether to wait, whether or not to wait. If we've got a chance to do anything. So, this is the way in which I think about a nerve that doesn't work. And there are these three mechanisms. The first is this one, the first way in which a nerve stops working- a nerve in order to carry the electricity, which is what a nerve does, from the periphery to the brain and from the brain to the periphery, to maintain this link between the two parts of the body has to be able to function. So, if the electricity can go through, everything is fine. As soon as there is a problem with the conduction, the nerve will stop working. So, the first way in which a nerve stops working is described by this experiment, which if you know when it was published, it was 1931 but it's essential still today and not enough people know about these experiments. As a matter of fact, we did it with our registrars a few years ago, when health and safety was not such a major issue. But you take a tourniquet to measure the blood pressure, you inflate it above blood pressure and if you leave it for long enough, you will see this happen. There will be a loss of function of the nerve, which has got these characteristics. You don't need to remember all the characteristics, but you need to know that there is a definite pattern, which is described in this slide, first loss of superficial sensibility, then the motor loss, then the pain response is still there, sympathetic function is not affected at all. But the concept to remember, particularly for you, for everybody to that extent, is that there is a temporary pattern, because why is that? Because there are fibers which are myelinated and some fibers which are not myelinated. So, the fibers which are bigger are myelinated and those fibers will be more susceptible to the pressure that comes from the tourniquet. So, think, apply that into clinical practice: if there is a compression from a hematoma, there is a compression from whatever, a fracture, whatever you want, the patient has been lying unconscious for a while. What you see is that because of the constriction upon the nerve, you see that there is a stop in the function, which is due to the fact that there's no blood. So, you reproduce it with this tourniquet that you apply, you leave for long enough, and you have the same effect, which means that there's no oxygen to the pumps, they maintain the gradient, the difference of potential between the inside of the cell and the outside of the cell. So, the action potential cannot happen because there's no difference. So that is called conduction block and the electricity arrives and it stops dead. What you see clinically is that the nerve is not working. So, whatever the nerve does, whether it's just a sensory nerve or a mixed nerve, it won't work. So, there will be a paralysis. Fracture of the humerus with the radial nerve compressed, if the fracture is displaced and the nerve is compressed, as if it was a tourniquet, what you will see is that the hand right at the beginning works and then you leave it long enough, shoulder dislocation, you leave it long enough, you don't reduce it immediately and the function will go. That in itself tells you the diagnosis, gives you the diagnosis. The nerve has been compressed. I need to reduce the compression to restore the blood flow. As soon as the blood flow is restored, the nerve, with a precise pattern, which is reverse to what happened, will start working again. Remember, this is the other thing, this slide is very important to know one thing, I mean, a few things, but the most important at the end is that the nerve is not dead.

**Steven Bruce:**

How long have you got, how long can you starve a nerve of oxygen before it is dead?

**Marco Sinisi:**

I mean, it's not that you have a complete, the next slide will explain this a bit better, it's not that you have a nerve that dies immediately. You have different phases. And to that extent, you can even have a precise answer in clinical practice because what dies is the nerve fiber. So, the nerve fiber can grow back as we will see in the next one. But this is the first, the first step you take oxygen away with any sort of compression, you restore the blood flow, the blood flow will restore the activity of the nerve within minutes. Minutes. We are not talking about hours. We're not talking about days. It's minutes. So that is the first degree. Let's say that the pressure is bigger. Let's say that the fracture is not reduced. As you're saying, the fracture is left there, the nerve stops working and you don't do anything. The force is still applied on the nerve. What happens is the second experiment, which again is a very new paper. It was one year old. This describes what happens in that next phase. The next phase is the pressure is bigger or applied for longer. And what you see is that there's not, the nerve is not dead yet. The nerve fiber hasn't died. But what happens is that there is an anatomical change. The anatomical change means that the myelin is being squeezed where the Ranvier node is. So, the Ranvier node disappears. So, the electricity cannot jump. We go back to the electricity, electricity arrives, there is a block which is still a conduction block, but this is a prolonged conduction block. It means that once you relieve the pressure, the force that is squeezing the nerve, the nerve will have to take more time. It's not just a matter of oxygen, it's a matter of anatomy, the myelin sheath has changed. So, it has to take its place again. A few fibers will start getting back to some kind of activity. As a matter of days, sometimes weeks, but up to six months, it might take up to six months to see the full extent of the recovery of this nerve. Does that mean that there is still a force acting upon the nerve? No, there isn't.

**Steven Bruce:**

Marco, can I just reveal my ignorance? I should know this, I was taught it, but could you remind me and possibly a few others of the role of the myelin sheath, as opposed to the nerve fibers themselves?

**Marco Sinisi:**

The myelin sheath makes the insulation of the nerve. Therefore, what you have is a higher velocity of conduction, because rather than having to go across the whole fiber, so having the depolarisation at one point, which progress along the nerve fiber, it jumps because you've got this insulated bit, which stops the electricity from going in and out at that point, but just requires the jump. So, they're much weaker. So, every time there is a myelinated fiber it's definitely quicker.

**Steven Bruce:**

You said the damage to the myelin sheath will block the conduction, but actually does it not just slow it down?

**Marco Sinisi:**

No, it would block it because it will disappear because that fiber works like that. So, you've got the electricity arriving and then at that point, it's not all just one myelin shape, it's a chunk of the nerve, it will arrive there and wouldn't be able to jump along. So, it will stop there. It's called conduction block, you see it even with neurophysiology, you see the electricity, you record the electricity and the interesting thing is that, for example, in theater, if you are operating on someone- you might show, probably the next slide is the picture. That one, yeah.

**Steven Bruce:**

Yeah, I think we ought to see your screen for this one.

**Marco Sinisi:**

Yup. And I can tell you what to look for in this one. Because this, I think, does clarify. Can you see it now?

**Steven Bruce:**

Can you put it up in full screen, in presentation mode? Yeah, that's fine. That's good.

**Marco Sinisi:**

Yeah. So, do you see that arrow? This is a median nerve, this is a supracondylar fracture. So, to the right of the screen is the proximal, part to the left is the distal. So, we are at the level of the elbow. This is a supracondylar fracture in a kid and if you look at where the arrow is, this is exactly- we already decompressed this nerve. There was no activity whatsoever. There was a band of tissue, which cut the nerve down at the moment of the fracture, or better at the moment of the fixing of the fracture, not surgically, but with manipulation of the fracture. So that nerve was anchored by this tight, almost like a guillotine. So, there is a force which is still acting upon the nerve, which means that the whole nerve at that point is squeezed and squeezed badly.

**Marco Sinisi:**

If you look at the proximal part, you will see that the proximal part is way bigger than the distal one. That is also the effect that compression that is still there is having upon the nerve in terms of transport, axonal transport and all the substances. Now, if I show you, this is the same nerve 10 minutes at the end of the procedure. So, once you see the constriction is gone, almost at the end of the surgery, you see that the nerve has taken its shape again, you can easily, I mean, my mother is a housewife, she will understand, that even visually that nerve, it looks more like a nerve now. So, if you leave that constriction there for long enough, like the next one I'm going to show you. If you look at this, this is again, another supracondylar fracture. Here the constriction is still there. You can see this white band there is a sling that I put around the nerve. And the red is another sling that I put around the nerve. And this is the median nerve. You can see the median nerve going, at the beginning I thought going into the fracture, and this is the median nerve at the beginning I thought coming out of the fracture. But the more you carry on with the dissection, what at times you get is nice surprises, because this nerve is the same nerve, which has been extricated from the fracture, well, from the fascia, which was tightened into the fracture, and this nerve can recover completely. But if you leave that constriction at that point, that nerve wilI never come back. Never, ever. There's no chance. So, to your question, visually, you see that if you don't do anything with this nerve for four months, five months, six months you're never going to get a result, never going to get a result because if the constriction is so bad, the swelling of the nerve proximally will get worse. The intraneural fibrosis will kick in, and you're never going to get a nerve coming back from such a constriction.

**Steven Bruce:**

Marco, what was the course of the treatment with these characters? You said the first one was a five-year-old, I think. So, they've come in, they've got a fracture, at what point did somebody say they need you to open them up and hook the nerve out of the fractures?

**Marco Sinisi:**

No, I mean, it varies, unfortunately. Our approach is that if, for example, there is a fracture, think about these mechanisms. What I just told you. There is a child who falls from the monkey bars, usual story, and fractures his humerus root, supracondylar fracture. The hand is moving. Then they relocate. They fix the fracture, whether with pins, without pins or just with a plaster and manipulation. And then they realize two weeks later when they see him back again in clinic, that he's not really moving the hand. The hand, maybe it's just the thumb and the fingers, which are not in the cast. Then they remove the cast, the child complains about pain, but we are going to go back on pain later on, but there was activity in the nerve. Try to follow me. There was activity in the nerve, the nerve was working immediately after the fracture, or they didn't see the nerve because they didn't see the nerve during the operation, or they didn't operate. So, they never saw the nerve, and the cable is not working. Now there is another step to understand what to do, which is the next slide, but already with the information that you have, that I gave you, you can easily say, okay, if the lesion is complete, complete, it cannot be a conduction block of the first degree where it's just the oxygen, because that would have resolved. If it was a stretching at the time of the injury that will have already resolved because the blood flow has been restored. If it was the ben due to the fracture that would have been restored. The blood flow is there, it's normal. So that is eliminated. Then you say, okay, fine. Maybe it was a conduction block, a prolonged conduction block, the pushing of the bone towards the nerve was too bad that this nerve has the need of waiting six months. Yeah, that might be the case. But if that was completely, the whole nerve was in that kind of injury, every single fiber, you would have seen by now, I told you, some fibers would have started recovering. Not all of them, obviously the activity wouldn't be normal, but then maybe there will be a flicker of activity in muscles of the median nerve, will be a flicker of activity in APB in the long flexors. Maybe there will be a bit of feeling, not normal, but that will tell you, this nerve has got a chance. Maybe it's coming back. There is another thing which we need to look at, is that the nerve can be cut like in this situation. So how do we decide whether the nerve needs to be treated urgently or not? There is a next step, if a nerve fiber, this is the other essential bit, if a nerve fiber is cut, it has lost its insulation. So if it is open, but also if it is broken inside the nerve, and there is just the outside layer of the nerve, the epineurium is still there, but the nerve fibers inside have been damaged. The nerve fiber itself will not be covered. The insulation is gone. So, it's like an exposed cable. There is one sign, which is the most important sign that you get when that happens. And that is if you tap on the nerve at the point where the nerve fibers are uncovered, the patient will tell you I'm feeling a tingling that goes wherever that nerve goes. And that is called Tinel. Tinel was a French surgeon who described this sign at the beginning of the past century and it's still the most important thing. It's only for traumatic lesions, entrapment neuropathy is a different physiopathological mechanism. But in nerve surgery, in traumatic events means the nerve fiber is uncovered, is exposed. So, I'm tapping on an exposed cable, even visually, you can see that that cable, if it is exposed, it's going to give some problems. The nerve is cut. The radial nerve is damaged here. You tap here. Two fingers, tap on the course of the nerve, the patient will tell you, Oh, I feel an electrical shock going down towards the thumb because that is the sensory component of the radial nerve. So, if a nerve grows back, because nerve fibers can grow back, what's the damage? If the tube is still there and what is called axionotmesis, which means that just the axon is broken inside the nerve. The nerve can grow back, but grows back at the rate, which is one millimeter a day. So, you see the patient after a month, the nerve should have grown back three centimeters. Which means that if I know that the fracture was here at the humerus and a month later, this Tinel has gone down, but it's not at the site of the fracture any longer, it means that the nerve is growing back. I don't need to do anything because it means that the nerve was damaged badly, but this nerve has got the chance to grow back. And it's doing that. And I will never make it better because the nerve is already doing what it can do. If instead, the Tinel is still at the same point, it's a stationary Tinel, still at the same point where the injury happened, where the fracture happened. Well, I need to intervene because it means two things either. There is still a massive constriction, which is holding the possibility of the nerve to grow back, or it means the nerve has been torn apart, like in this case. This case, you see the nerve had to be repaired. That is a direct suture. You see the little sutures there, and this is a graft This is the radial nerve, that is the plate. This is the distal part of the nerve. That is the proximal part of the nerve. And that is the graft, which is another sensory nerve that we took. That is superficial radial nerve, cut into cables and you repair the nerve. To allow a nerve which has been broken to grow back into the graft here, then grow, grow, grow, and enter into the distal part.

**Steven Bruce:**

Where are the sutures on this slide? Are we looking at this part of the nerve here?

**Marco Sinisi:**

This one? These are the sutures. This is the direct repair. This one here. Do you see it? That is a direct repair. These tiny little things are the sutures. Okay. Can you see them? They are a big thing. They are 9-O, it's as thin as a hair. You use the surgical loops to put them in, they are quite small. In the other one, it's just the graft, laying of the graft, there are no sutures yet. When I use the graft, normally, if it lies down very well, like this one, I will only use the glue, fibrin glue, which doesn't interfere too much with the alignment. The sutures for direct repair are essential.

**Steven Bruce:**

Apparently, I'm told that people are loving these slides, Marco.

**Marco Sinisi:**

Oh, I've got many more if you want them. But so, the next one, this one is therefore trying to give how I think in order to decide, to your question, how do you decide whether to operate or not? I have to be like a movie director. And you go back in time. In order to understand what happened to the nerve, you need to go back in time to understand what happened at the time of the injury. It's not, it might be something that is happening now, but you have to think with those three categories that I gave you, three physiopathological categories, you have the anoxic block, you have the constriction, which is so bad that it changes the anatomy, but doesn't cut the nerve fiber inside, and you have the actual death of the nerve fiber inside. So, these three ways of looking at a nerve they give you one big information. The nerve has got a degenerative lesion or a non-degenerative lesion. So, the nerve fiber is dead if there is a Tinel sign, the nerve fiber is not dead if there isn't. The nerve fibre is growing back, trying to grow back. If a nerve is inside the fracture, for example, it will be, obviously there are exceptions, if it is inside the fracture, maybe it's going to be difficult to get the Tinel sign out of it, but you always have to find it. If the nerve is inside the fracture, probably the fracture is not going to heal. That's another, another thing. There are other things, but this is the big one, once you think this way, you understand much more. I think it took me a few years to make it down into something so simple, for me to think about this. So, you have the history, you have to look at the history because the history tells you the energy which was transferred upon the nerve, whether it's the plexus, whether it's the radial nerve, whether it's the CPN, whatever nerve it is. But the history tells you, if you were driving a motorbike at 70 miles an hour and hit a lamp post on your shoulder, obviously that is going to be worse than if you just tripped whilst you were walking and you landed on your shoulder, because the energy transferred is much higher. There is the vector, the direction with which the force has impacted. If it's a head on collision between a motorbike and a car, well, that is going to be different than someone even going, for example: rugby tackles. I've seen evulsions of all the nerve roots of the brachial plexus from rugby tackles. And it is very rare to see evulsions of the plexus in skiing accidents, unless they hit a tree, because you skid. So even if you land with dramatic force on the snow it's a different thing. If you go head on with another big chap running towards you, the vector is completely different. Then there is the Tinel, that I told you. And then there is the pain, which is another aspect, which I might have to clarify.

**Steven Bruce:**

Before you move on, Marco, I've got a question or two from the audience, if I may.

**Marco Sinisi:**

Yep.

**Steven Bruce:**

Robin's asked whether it's just a blood flow that accounts for recovery or is axoplasmic flow relevant? Presumably that will be disrupted as well, he says.

**Marco Sinisi:**

No, no. We are talking about not a chronic condition, we are talking about an acute condition where the pumps cannot maintain the gradient. So, it's just about the oxygen, right, at the beginning. If you maintain the compression there, the second case, when the nerve is swollen, that is the axioplasmic as well. What you see is a result of the stop in the axioplamic flow.

**Steven Bruce:**

And David has asked, I think, referring to this slide, whether it was the proximal or distal part of the note, which was large. So, I think it's proximal is the larger part, isn't it?

**Marco Sinisi:**

Exactly. Exactly. The axioplasmic transport, is stopped. So, the nerve keeps on swelling up.

**Steven Bruce:**

Josephine has asked, do you take the whole nerve when you do a graft you just take a bit from the host nerve?

**Marco Sinisi:**

You take a nerve, which is a sensory nerve, for example, for the radial nerve, we take the whole of the superficial radial nerve. For other injuries, we might have to use the sural nerve. For other injuries, for the plexus, we start from the nerves from the arm, the medial cutaneous nerve of the forearm, medial cutaneous nerve of the arm, the superficial radial, sural nerve. They have to be sensory nerves, obviously.

**Steven Bruce:**

Yeah. And last question, Hazel's asked, how long after an injury can a nerve be repaired? And I presume she's referring to a complete transection.

**Marco Sinisi:**

Well, it depends. You can try, but after six months, the chances for a nerve to have a decent result, they go dramatically lower. They become dramatically lower after three months. The ideal is within a week.

**Steven Bruce:**

Doesn't that pose you a problem though? We were talking to a spinal consultant last night who was saying that quite often now someone will go to a fracture clinic and they will be given their initial treatment, which may or may not include a cast and then told to come back in 12 weeks' time, which obviously if that's the first opportunity for someone recognise a nerve injury, that makes your job much more difficult, doesn't it?

**Marco Sinisi:**

Yes, it does. Yes.

**Steven Bruce:**

You like a challenge, I'm sure.

**Marco Sinisi:**

Well, the problem is that it's going to be a challenge for the nerve itself to get better, more for the patients than for us, because even the plexus injuries, we used to be able to treat them more urgently even a few years ago than now.

**Steven Bruce:**

Maraz has asked if you'd just clarify the business about the Tinel's sign. He's asked whether it moves when it's healing or whether it disappears completely.

**Marco Sinisi:**

No, it moves, because in the process, very good question, in the process of regrowth, what happens is that the axion sprouts. So, in the sprouting of the axion, there is a bit of the axion which is not covered yet. So, the sprouting happens and then you have the insulation being provided. So, it's a two-step phenomenon, the regrowth, the axion and the nerve fiber grows out and then insulation is provided. So, if you tap on the tip of the nerve that is growing back, there are still exposed fibers. So that is the reason of the progression of the Tinel, which can tell you the nerve is growing back. So, if the radial nerve injury was at the elbow and you see the Tinel distal to the mid forearm, first of all, you have already some recovery in the wrist fracture, at least the radial bit, but then you know that the nerve at least is trying to grow back. If instead, the Tinel remains there, or you can find both. You can find some nerve fibers are coming back. Some others are stuck there. So, at times, even if there is some recovery happening, you want to go back because I'll tell you how much is important. I mean, this question is so relevant because if you have a hundred fibers inside a nerve, obviously it has to have a sensory component otherwise you don't have Tinel, but the sensory component, hundred fibers and your patient, when you tap tells you that he's got this tingling happening here, there, everywhere, at the site of where the lesion happened and distally. You can quite precisely ask the patient to divide in a percentage and if the patient tells you 20% of this intensity is higher up where the fracture was and 80% is further down, you can say, listen, 80% of the nerve fibers are coming back. You're going to be fine. If instead is the other way around, I would tend to say, okay, fine, you know what? The nerve is very likely still there, very likely still there, because we have this Tinel further down, which implies that some fibers managed to grow back, but 80% of the others are still stuck there. I might have to do an operation to give you the best chance for the nerve to grow back.

**Steven Bruce:**

Thank you. And while you were saying that Josephine sent in a follow up asking whether there is a replacement for a myelin sheath, can you graft something in?

**Marco Sinisi:**

No. no, no. The reason is, what you need to do there, if it's completely, we are on a microscopic level. We are on a microscopic level. So, if the whole nerve is disrupted, you need to replace the nerve. I mean, you need to put the graft. If instead the mechanism is the different one, you need to remove the constriction and that will provide the myelin sheath to reorganize itself. So, it's not that you can do anything about that.

**Steven Bruce:**

A number of people have asked what it is that one is testing when nerve conduction tests are carried out, what are they measuring?

**Marco Sinisi:**

Yep. Okay. So, I told you about the myelin. I told you how the electricity goes. So, the only thing that you need to know, actually I mean, obviously neurophysiologists will know more details, but think about the nerve conduction studies as an element of the neurophysiology. Neurophysiology is nerve conduction studies and electromyography, two parts of the same investigation. The nerve conduction studies, they study the velocity. So, if you have a cable with a hundred fibers, and you know that normally that cable conducts at a particular velocity and contralateral, you see that it still conducts at that velocity, and you see that there is a massive reduction in velocity, and then further down, it starts working again, like we see, for example, in theater, when we stimulate directly that nerve, for example, that I showed you with a massive constriction. You stimulate proximal with electricity and you wouldn't get any response in the hand, you stimulate distal and you will see movement in the hand, which means that it is a conduction block. The nerve distally is still alive. So, you record distally and you see a normal nerve. If you record across from proximal to distal, you wouldn't get the signal. So, you look at the velocity first and then at the amplitude. So, the velocity tells you about the myelination, whether there is a constriction, loss of myelination, therefore a reduction in that capacity to let the electricity jump across. The amplitude will tell you how big the potential is. So, if there are still a hundred fibers or not. If there are 50, it will be halved. So, you look with the nerve conduction studies at the number of axions, and you look at the state of the myelin sheath. With the electromyography, you look at the confusion that is generated inside the muscle. Think about the nerve, like a, I always explain to the patients like this, but I think it's quite suggestive, think about a classroom. The muscle is like a classroom, and there is the teacher and the teacher is explaining to the children. It tells the children to one thing rather than the other. And then the teacher is the nerve. So, the nerve has got a role to say, do this, do that. And you see an accomplishment of a function. If you take the teacher way, which is you take the nerve away, what you will hear, even before seeing, is the noise in the classroom. When the neurophysiologist sticks a needle inside the muscle, they listen first, they listen to the noise, which is fibrillations. It's a noise, which is due to the fact that every single cell, every single child in the classroom is making noise. They are doing whatever they want. The result though is that this electrical fibrillation, which is an incredible noise, doesn't reflect in any movement. So, if you ask them to do anything, they can't do anything. So, there's great noise, but no action. So, you cannot see anything in terms of potentials, but you just see this fibrillation potential, which is this great disorganized confusion. So that is the other thing that you look at. The two things combined, together with their history, they tell you quite a lot actually,

**Steven Bruce:**

I've had a couple of questions, Marco, about recovery of peripheral nerves. As you can expect from practitioners like us. How many times, asks Karen, have you seen a sciatic patient where motor control returns, but they lose sensation to some degree in the leg or the foot?

**Marco Sinisi:**

From hip replacement?

**Steven Bruce:**

She's just saying sciatic patients. So, I'm guessing she's saying, we see patients with raging sciatic pain, which hopefully we can fix, and someone else has said, Jan has said, well, what if they go for lumbar decompression? Is it likely that they will regain full function?

**Marco Sinisi:**

Okay. So, the sciatic nerve can be damaged. I mean, due to hip surgery, unfortunately, I see one a week roughly. And they normally have the most horrendous pain, sympathetic changes, you need to operate on them. And I've seen quite a number during the years where nothing was done, even if it should have been done right at the beginning. But if the question is more on pain, which is due to a compression that is coming from the back, you need to think that the back is pressing on spinal nerves. So, we're already peripheral nerve situation. So, we are already in the peripheral nervous system. We are already in the same mechanisms that I told you. The problem here is that that kind of compression is normally a chronic compression, or it can be an acute compression but it's less frequent. Discs which come out and push on the nerves. If you think about the length, once you remove the cause, so if there is a cause still pushing on a nerve, the nerve will have pain. Unless it's in the scenario of a traumatic disaster, like the one I show you where the nerve is paralyzed from the beginning, it cannot feel pain and it cannot really come back. But if it's a compression, like a disc, the nerve will have pain, and it must be excruciating pain. And if that pain becomes associated by a lack of function, that means that the pressure was so dramatically bad, that that nerve either died, if the pressure is still there, or if the pressure is removed, the pain will go away, we go back to those scenarios that I told you. So again, you will have a force that has been removed. So, the nerve will have fibers, which are dead inside, and that have to grow back or fibers which have to wake up, like from the conduction block. If the time was short enough not to have damaged and make the nerve die, that nerve will come back and you will see a restoration of function in the foot from the decompression. But if the nerve did die, we have another problem, which is the distance. If a muscle remains denervated, completely denervated, if the classroom is with no teacher for more than a year, I mean, good luck, when a teacher goes back, to get them to work. It is exactly the same thing. If you want to stay in the example, the motor end plate, the capacity of the muscle to accept the nerve, reduces dramatically. Which is one of the reasons why, even if you repair a nerve, if I repair a median nerve at the wrist, there's less distance, I can still get a result after six months. If I repair a sciatic nerve completely cut after six months, forget about it. You will never see anything in the foot.

**Steven Bruce:**

We've only got to net slide number 10, and we're out of time.

**Marco Sinisi:**

Just if we want to have a look at this.

**Steven Bruce:**

Yeah. Could you just run us through perhaps a few more of your pictures?

**Marco Sinisi:**

Okay. So, you want to see the gory stuff? I see. Let me see. I'll try to reshare it. There you go. And now it should be coming in. Okay. So, this is a picture that says not every single nerve requires the same thing. So, this nerve is a rupture. This nerve, obviously, if there is a discontinuity, I need to graft it. But if there is a compression, like the one I did before, I need to remove the force. So, if I leave the force still there, the nerve will never come back. The other picture down here, if you look at this, this is an ulnar nerve. This ulnar nerve was a complete lesion, but it's not, you can see the ulnar nerve there, which is still, this is a supracondylar fracture treated with K-wiring. So, they caught part of the nerve, just the epineurium of the nerve. So, what happens is that you have two things acting together. You have a nerve, which has been partly damaged. So, 10% of the nerve is cut, but because that nerve has been cut and got stuck where the scar generated because of the rapture, the rest of the nerve is distorted. So, the rest of the nerve has got a force which is acting upon it, distorting the nerve, but that 90% could come back. I'm not talking about the 10%. 10% in this situation, you just released the nerve. It's not that you have to graft that nerve. So, the two things, they can go together, you can have situations where even, I'll show you a few others, but even a nerve that is a partly cut becomes a nerve completely damaged, because it's distorted in its course, so it cannot really function because there is still a force applied. This is a radial nerve. I'll show you some pictures just for you to be horrified. Okay. So, this is a radial nerve, a radial nerve palsy after a fracture of the humerus and fixation. Where is the nerve? The nerve is- let me see if I can go down. Doesn't work. Why is that not working? There we go. Okay. So that is the K-wire, which you were seeing with the x-ray. That is the nerve. And that is the wire going across, obviously that is not just a conduction block. That is a nerve, which has been squeezed against the bone. That is a nerve that is completely cut. That is a nerve that requires a grafting or-

**Steven Bruce:**

People in medicine say unkind things about orthopedic surgeons. Is that the sort of thing that happens?

**Marco Sinisi:**

Well, I'll show you the next one and you tell me. This is a nerve, which is still a radial nerve, which has not only been plated, as you can see. This is the radio nerve. It's just under the plate but it's been screwed as well, as you can see. There is a screw, which is going through the nerve. So, this is another. I mean, at times there are difficult, difficult situations, difficult fractures, but I've seen all sorts of things, which are really quite- this is for example, nothing to do with the orthopedic surgeons. So, this is the radial nerve. This is the radial nerve and a fracture, which was a displaced fracture. They treated it with a cast, they didn't do anything more. They decided because the nerve wasn't working, wasn't recovering and this is the proximal part in the blue, with this blue sling. This is the distal part. The nerve is going into the fracture there, that is the callous behind there. It goes into the fracture and comes out of the fracture there. This is again, a nerve which required grafting, which is this one. Now this is to go back to the sciatic nerve.

**Steven Bruce:**

I'm looking for the pictures that you've got there. I think that's the ones.

**Marco Sinisi:**

Yup. That is the sciatic nerve. So, this patient was left there with a hip replacement, wakes up with horrifying pain. Okay. Horrifying pain, which has got the burning characteristics, the tingling characteristics of the nerve. I always try to explain to patients that pain, which is generated by a nerve, which is caused by the fact that one of the major nerves is unwell, is everything that you can possibly think with a bit of imagination a cable would say, if he had the gift of eloquence. It will use terms like burning, will use terms like tingling, like electrical shock, everything that has got those characteristics. If a pain is coming from a bone, it will be using words that describe more the grind in between two stones. If the pain is coming from a tendon, the patient will refer it as a pain that has got pulling characteristics. Because in the characteristic of the pain, there is already 90% of the diagnosis. So this patient that wakes up with a complete paralysis of the sciatic nerve after a hip replacement, and he's left on morphine for a year, 10 months, with burning pain, tingling, electrical shocks, going up and down the foot, particularly on the top of the foot, every day, on morphine for 10 months, it's a disgrace. This is a disgrace. There are complications that can happen. And they are not disgraceful. There are complications. This one is disgraceful. When something happens that you don't look at what could have happened and you don't want to look at what happened. That is actually negligent. This is a sciatic nerve with a suture, which is there, which is the suture which was used to close the capsule. So, from the front they got the nerve and it was going all the way down. You can see it was going all the way down. That first part here was the first knot that I went up all the way to dissect, up all the way. And what I found is that here is where I already cut that bit and it goes all the way up. So that is a nerve that is transfixed. Obviously, it's gonna be painful. And even the other part of the nerve, which is the tibial nerve component will be extremely painful because of that, because of this constriction. This is a sciatic nerve again, which is not only, this is the sciatic nerve that you can see here. This is a hip replacement. Again, this poor lady woke up with, she was 80 something years old, and this is many years ago, and she woke up with the same characteristics of pain. She was sent to us. And then you start a dissection. And then you see the sciatic nerve, here is what is supposed to be the foramen. And you see that it's flat and I can't even go around it with a loop because it's so flat and it's not a tube any longer. And then you understand why, because that is the sciatic foramen and this is cement. So, the sciatic foramen had been obliterated by the extrusion of cement and the cement reaches temperatures, which are very, very high, so that cement had burned the nerve and flattened the nerve, you can't do anything in that situation. I mean, possible, right on the edge of the pelvis and outside. You can repair it if it was a younger patient, we could have tried something more but there was no chance to do anything. But anyway, these are only few examples of disasters that you can see. But the most important thing is the mechanism, the thinking. You have just to think about what is a nerve, the characteristics of a nerve, how a nerve can be damaged, the temporal pattern, the kind of injury. You need to almost try to look inside and see what has happened, because these mechanisms are the mechanisms that make a nerve stop working, not others. So, you need to see and try to understand what is what.

**Steven Bruce:**

Marco, that's all fantastic stuff. And we do see people quite often post-surgery and so hearing your description of these things that can go wrong and what we should be looking for was very useful. Can I ask you a couple of quick questions before we close? Michael's asked whether that regrowth of nerve fibers occurs from both ends proximal and distal?

**Marco Sinisi:**

It's proximal. I'll tell you why, I'll tell you why. Sorry.

**Steven Bruce:**

Justin, can you unshare the screen please?

**Marco Sinisi:**

Did I manage to do that or not?

**Steven Bruce:**

Yeah. We're back

**Marco Sinisi:**

You're back? It's fine? The reason why, the reason why the nerve grows from the top is because the nerve is the projection of a cell, which is either in the spinal cord or in the ganglion. So, the body of the cell is still there. And that's the reason why, if you've got a lesion of the plexus, which is very proximal, that you get loss even of cells, which die because the injury is very close to the body of the cell and therefore, they can die. But then they grow from the top.

**Steven Bruce:**

Joe has almost whether the myelin sheath rearranges itself with the correct nodes of Ranvier.

**Marco Sinisi:**

The myelin sheath does. The problem is that if you have a pure axonal lesion, which means that the nerve is still there, what happens is that the distal part of the nerve dies away but it leaves the basal lamina, which is like a track on which the nerve fiber grows back. If there is a destruction of that, which means if there is a complete tearing apart of the whole nerve, which is one bit here, one bit there that is never going to happen, it's never going to happen. So as soon as you have a lesion, which is a neurotmesis, which is the nerve is cut, the results will be always less than a proper axonotmesis, where the nerve can grow back to the right place, because there is a track. So, the motor fiber will go to the right motor end plate, the sensory fiber will go to the right receptor. Instead, if you put a graft, the myelin sheath will organize, but it's not about the myelin sheath itself, it's about where this nerve fiber is going to go, and they can get confused. And there's no chance to do anything about that.

**Steven Bruce:**

Clive has asked if you recommend any studies for investigating or monitoring a plexopathy or peripheral nerve injury. I suspect there's quite a few you've written yourself.

**Marco Sinisi:**

Yeah. But I mean, the other thing to think in terms of nerves is the anatomy. So, if you've got a plexus lesion, for example, as distribution, a C5 lesion is different from an upper trunk lesion. Upper trunk lesion is C5/C6. So, the anatomical distribution of that nerve will tell you if it's spinal or not. If it is a C8/T1 it will be different from a radial nerve. C8/T1, Lower plexus due to whatever reasons is going to have an involvement also of the medial aspect of the forearm, medial aspect of the arm, last two fingers. The ulnar nerve doesn't go here. So, there's no lack of feeling here for the ulnar nerve. The ulnar nerve, the only sensory component it has is in the hand, the dorsal aspect of the hand with the dorsal branch and the rest main ulnar nerve. So, there's no lack of feeling in the forearm. So, the anatomy already tells you where this site is. So, in nerve surgery, first you need to establish where. So, the anatomy tells you, the history tells you, the fractures tell you, you know that where the nerve lesion happened. Is that an infraclavicular lesion, is that a supraclavicular lesion, is that a distal lesion? And the sensory distribution and motor distribution will tell you that. And the Tinel will tell you that. And the story will tell you that.

**Steven Bruce:**

Do you have any studies or texts on neurophysiology, which would be a good way of revising that detailed anatomy?

**Marco Sinisi:**

I would say that, not neurophysiology, I would say that it would be useful for everybody to have at least an idea of the distribution. What is a radicular distribution? What is a plexus distribution? At the level of the trunk. It's very difficult to remember, because either you do it every day or it's very difficult. But at least to have an idea that a root problem, visually. Netter anatomy, the simple drawings with the colours. That a root distribution is one thing, a plexus distribution is another, a peripheral distribution is completely another thing. I have operated on far, far too many patients, not operated, seen far too many patients where plastic surgeons, just let me blunt about it, have operated on ulnar nerves which were lower trunks or spondylosis. I mean, it really is a different thing that you need to, if you're not sure you might ask your neurophysiologist colleagues to see inside the muscles, but it's not that you defer to them the diagnosis there is already, I mean, a lot that you should be looking at to have an idea what's happened.

**Steven Bruce:**

Marco, thank you. I also want to thank Josephine Wholesale, who is the lady who recommended you to us because we have had, I'm told so many people asking if you will come back and show us more gory pictures and tell us more about this fantastic subject of yours. It has been truly fantastic. Thank you. And I apologize for taking up a quarter of an hour more of your time than we said we would. It would have been difficult to not ask some of those questions. Apologies to those people whose questions I didn't ask.