

## Just Forensic Podiatry Supporting Investigations

**Introduction** [00:00:01] RTI International's Justice Practice Area presents Just Science. Welcome to Just Science, a podcast for justice professionals and anyone interested in learning more about forensic science, innovative technology, current research and actionable strategies to improve the criminal justice system. In episode three of our case study season, Just Science sat down with Dr. Michael Nirenberg, a clinical and forensic podiatrist and current president of the American Society of Forensic Podiatry, to discuss how analyzing a perpetrator's gait and footprint evidence located at a crime scene can help advance investigations and resolve cases. While locomotive characteristics like the way our hips swing when we walk are not as individualizing as fingerprints or DNA, forensic podiatrists can analyze and compare video footage of a perpetrator's gait to a person of interest gait to develop supplemental forensic evidence. This additional information can be used to support a conviction for the exoneration of a falsely accused individual. Listen along. As Dr. Nirenberg describes the role digital evidence plays and gait analysis, how forensic podiatrists analyze and compare the gait of a perpetrator to a person of interest. And several cases where the analysis of gait or footprint evidence were key to supporting investigations. This episode is funded by the National Institute of Justice's Forensic Technology Center of Excellence. Some content in this podcast may be considered sensitive and may evoke emotional responses or may not be appropriate for younger audiences. Here's your host, Mikalaa Martin.

**Mikalaa Martin** [00:01:35] Hello and welcome to Just Science. I'm your host, Mikalaa Martin, with the Forensic Technology Center of Excellence, a program of the National Institute of Justice. On today's episode, we will discuss several case studies demonstrating the value and utility of footprint evidence located at crime scenes, analysis and the subdiscipline of forensic podiatry. Joining us today to discuss these topics is Dr. Michael Nirenberg. Welcome to Just Science Dr. Nirenberg.

**Dr. Michael Nirenberg** [00:02:05] Thanks for having me.

**Mikalaa Martin** [00:02:06] So, Dr. Nirenberg, to kick us off, can you tell us about what it means to be a forensic podiatrist and your journey to this forensic subdiscipline?

**Dr. Michael Nirenberg** [00:02:15] So I was a podiatry student. I wrote a article on forensic podiatry, and that was published in the Podiatry Journal at the time. And in that article I wrote it just because I was interested in how podiatrists using their knowledge of feet and the lower limb, which is what podiatrists focus on. We treat the foot, the ankle and the lower limb. Using that knowledge to help law enforcement solve crimes and or help a defense attorney show that their client is not the criminal. And so I wrote that paper back in 1989. And in that paper, I said, we need an organization to promote knowledge, ethics and whatnot related to forensic podiatry. And a short time later, the podiatrist doing this called me up and they said, we're we're forming that organization that you called for. We want you to join us. And I did join, but I told them, you know, I'm trying to start a practice and I'm too busy. And eventually I ended up being on the board. And now I'm president of that organization, which is the American Society of Forensic Podiatry. So the American Society of Forensic Podiatry is a relatively new organization. It was started in the 2000s, I believe. And what it does is it promotes knowledge and education for podiatrists and actually non-podiatrists who have an interest in feet, footprints, and gait. Podiatrist focus on biomechanics, disorders of the foot and ankle. Using that and combining it with forensic science to answer a legal question, usually a criminal matter.

**Mikalaa Martin** [00:03:57] Throughout your career in forensic podiatry. You've been called as an expert to provide multiple types of analyzes in criminal cases. What are some examples of the roles you have assumed and the expertise you have provided on these cases?

**Dr. Michael Nirenberg** [00:04:11] Some of the cases have involved footprints where you have a homicide and there's footprints left at the crime scene. For instance, there was a case in Maine where I testified where a woman had been stabbed just shy of 500 times, and there were two people charged with the crime. Law enforcement asked me to take a look at the footprints at the crime scene to help figure out if either of these two individuals or both could have made the footprints found at the crime scene. In that case, we obtained the footprints from the suspects. And that in itself is an entire process. And then I compare the footprints with the crime scene. And I was able to show that one of the persons charged with the crime could not have made those footprints due to a various number of reasons, including the size of the footprints at the crime scene versus his footprints. And I determined that the other suspect, a woman who was also charged her foot, could have made those footprints for someone who has the same footprint as her. And part of educating the jury is explaining how footprints are distinctive and well two people in theory could have the same footprint. The odds of that are typically low. And at this case, there was other evidence provided for both of these people. And ultimately, the jury could not decide with the man if he was guilty or not. And the woman was found to be guilty and she was sentenced.

**Mikalaa Martin** [00:05:46] And among other forensic analysis types, perhaps under-discussed or even underutilized is gait analysis. Can you explain what gait analysis is to our listeners?

**Dr. Michael Nirenberg** [00:05:56] So gait analysis is something that clinicians, medical people, podiatrists and scientists, researchers they do gait analysis and gait is how an animal or a person moves from place to place. It's a locomotor activity. But in the forensics and in the clinical context, when you're talking about people, gait is typically how we move from one place to another. And that can be walking, that can be running, that could be hopping. It could all be a form of gait. But in the forensic context, when we look at gait analysis. We are looking at walking usually and we're comparing one person's walk or the how that person walks at the crime scene to a suspect or a person of interest, how that person walks. And you're making a comparison and you're looking at that person's manner of walking or their gait literally from head to foot. And there's a process to that that we can talk about. But in a nutshell, in the clinic, people are looking at gait or doing gait analysis to figure out perhaps what's wrong with that person's shoulder or biomechanics or how can we make an orthotic, an arch support a brace to help them walk better? And then forensic gait analysis is doing a comparison of the features that you see from head to foot of a person and comparing that to another person. These are usually cases where their face is not clear or not visible or where a person says That person may look like me, but that's not me. And then law enforcement or a defense attorney might say, I need some additional information and gait is that additional information. Traditionally, gait has been overlooked. There was a case involving gait where a scientist in the 30s determines the criminals gait from shoes, I think boots left at the crime scene, and he described how the criminal walked in detail and in court they had the criminal walk and he walked exactly the way the scientist had described. But forensic gait analysis is involving video and looking at how somebody walks on videotape. And now we get more and more what they call CCTV. So we're getting more gait footage and forensic gait analysis. The first time it was used by a podiatrist was in the video since was in the year 2000, in the United Kingdom, where a

podiatrist helped to show that a jeweler was the same person as a known suspect and he was convicted. So it's sort of growing from the year 2000. In the United States in 1996, a dancer who was very attuned to how people walk and move helped identify somebody at a crime that was on video. So it was used here by someone with some knowledge of movement in 1996. It has evolved now to a more peer reviewed standardized process, which goes back to me working with OSAC to help get that process fully developed. But the methodology now has been peer reviewed, it's been published, it's been tested. We know its reliability.

**Mikalaa Martin** [00:09:16] I appreciate the background and how it's evolved. Can you walk us through with no pun intended there the comparison process and any of the tools that are used in that comparison process?

**Dr. Michael Nirenberg** [00:09:28] The comparison process involves using a checklist, and we call it a tool, and it's called the Sheffield tool, because Professor Birch, out of the United Kingdom, he with some peers, came up with a checklist of features that are commonly seen on video to compare. And that checklist evolved from clinical medical checklists. So people looking at gait can use when they do observational, they look at someone's gait with their eyes. They have different tools that have been published, peer reviewed and check for their reliability. Those tools work. Meaning if two different doctors, Mikalaa, watch you walk on two different days. Those two doctors, to a certain degree of reliability, will be able to use one of those tools and show what's wrong and what's right with your gait looking at certain features. So Dr. Birch and his associates basically took that concept and said, you know, if it's working for medical researchers, let's translate that to the forensic context. And they looked at the features that tend to show up on video and they listed those features and then they went and they did testing. They published it. They did more testing. And they showed that this is a reliable way of determining, you know, looking at someone's features of gait. So how do you do it? Well, you start by getting video of a crime or a crime scene or a criminal. And you can't say, for instance, you don't know their face and you go through from head to foot looking at that videotape, figuring out all their features. For instance, does their left foot tilt in tilt out or is it straight? Does their knee hyper extend at a certain point in what we call the gait cycle? And you do this for that piece of footage looking at their head, their torso, their arms, their elbows, their hands, their hips, their knees. And you look at all these different features literally from head to toe and you get this tool filled out. And what makes forensic gait analysis work and what makes it interesting is you don't just look at one step. You need footage of the person showing multiple steps. Because when we walk, we repeat the same pattern. With each step we take a step. We go where our right foot moves forward, then our left. Then we're back to our right foot. That's one cycle in the gait cycle. In simple terms, we would like to see multiple steps of somebody walking. So when you're comparing if on one step, their arm doesn't completely swing, you're looking at multiple steps, multiple gait cycles when you do this. And that's ideal. If the footage only had one step. I would tell them like, I can't help them.

**Mikalaa Martin** [00:12:22] So from that overview, it sounds like while gait analysis can provide helpful information on a case, it sounds like there's some things that it cannot be used to inform. Can you speak a little bit about that?

**Dr. Michael Nirenberg** [00:12:33] So the important thing to keep in mind with forensic gait analysis and this is something that I'm often telling law enforcement detectives and sometimes a detective will call me up and say, I know it's him, and you can tell by how he or she walks and gait in the context that we do it in the forensic gait analysis context. So

looking at a piece of video, it is not unique. What I mean by that is people have distinctive mannerisms when they walk. And each mannerism, whether their their hip swings in a circle or straight ahead, that motion is what's considered a class characteristic, meaning there are a lot of people in the population whose left hip may swing in a circular manner when they walk, and that is not at the level of DNA. But what we do do is we're going from head to foot. So each feature is a class characteristic and you stack those on top of one another and you get a higher level of discrimination. But at the end of the day, gait in this context is not unique. Gait in the laboratory where you put little sensors on every joint in someone's body and they're digitized on to a computer screen, that may reach the level of being unique. But at this point, what we're doing is class level characteristics and we're stacking them on top of one another. And as you do that, it becomes more discriminatory. The important thing is that you're also looking for a feature that would rule out them being the same person. So, you know, and this is just a very simple example, and I wouldn't want this example to come back to a specific case I work on. But just as an educational example, if that criminal needs hyper extend when his foot hits the ground, meaning the knee, our knee should not move backwards when our foot strikes the ground. But some people have knee problems and their knee will hyper extend with every step. It sort of bounces backwards a little and that may be for both knees. And you have somebody who's a suspect whose knees never hyperextended. In fact, they don't even extend all the way straight. Their knee is always bent a little for each foot when it hits the ground. So that would be a significant difference. And that would start to lead us down the path of the gait of these two people is different. Now, what I get at this point a lot of times is couldn't somebody just change their gait? And if you've seen a fashion show, of course people can change their gait runway models. I don't think they walk like that when they're doing the laundry. So they they change their gait. But the thing is, is that one forensic gait analysis is not widely known. A criminal may wear gloves to hide their fingerprints because that's pretty widely known. But and they may and they may wear a mask to hide their face because they know they can be identified by their face, but they don't think to change their gait when they walk. So so it is unlikely that they're going to change their gait. It may happen at some point, but when somebody is changing their gait, you know, a experienced forensic gait analyst or even somebody who does gait gait analysis, a lot may be able to look at that and go, something is not actually something is off here that the person is doing. And and if they do do that, you may not be able to use forensic gait analysis. If somebody is just jacked up on five hour energy. I had a armed robbery that I worked on where the lead detective, it was his only case in his entire career he told me he could not solve and he finally figured out that one of the criminals walked the same as a known perpetrator in his in his area where he worked. And so he had me come in to compare the gait of three people. It is violent armed robbery and one person was just jumping around. His gait was erratic to the point that you couldn't compare that gait with anybody else. So I don't know if he was on five hour Energy. I don't know if he was on drugs. I don't know if he was just excited to be doing an armed robbery. But he was just jumping around and it was so erratic that guy couldn't be compared. Now, another guy, the guy, the other person, the other two people at the armed robbery, their gait could be compared and they weren't erratic. But you could get that. If somebody's on drugs, you just may not be able to compare their gait, you know, depending what you have there.

**Mikalaa Martin** [00:17:12] And you have already given us a couple of case examples where gait analysis has been used to support cases leading to prosecutions. However, it's also been used to support exonerations. Can you discuss a case where gait analysis supported an exoneration?

**Dr. Michael Nirenberg** [00:17:28] I was involved in a case in New York State. What happened in that case was I was brought on because a man who apparently didn't have the funds at the time for a high level legal counsel, he was convicted of a kidnaping in 2013. And it was there was a place of business involved. And they sent me it came about through one of these government programs to look into exonerating people who may have been wrongly convicted. And what I did was I looked at the gait of this person who visited the business at that period of time, and I compared it to the gait of the kidnaper, who also visited the same business that the same period of time. So these were two African-American men. And on the surface, they their body types and shapes look similar. But once you compare their gait, you saw their gait was very different. And this video of this known person walking in and out of this place of business, as well as the kidnaper, this was all done way before he was charged with the crime. So they said it was the same person and the jury found him guilty. And so I wrote a report and there was another report involving showing his cell phone was not at the business at the time of the crime. And there may have been some additional information. But the the judge in New York exonerated him, I believe, in December of 2022, and he was let out of jail immediately. So in the documents that I was sent later, it showed that they referenced the I believe, the judge, as best as I can recall, referenced that gait analysis was part of her decision. So she looked at my report. So that felt pretty good because to me, it's more important in my for me to to free an innocent man then convict or help help free an innocent man than to help free help convict a guilty person. It just feels more meaningful to me.

**Mikalaa Martin** [00:19:38] And from that example, in a couple earlier case examples that you have provided, it sounds like with gait analysis, having other information or evidence in the case can support it. Can you speak a little bit to the importance of having additional evidence and case information?

**Dr. Michael Nirenberg** [00:19:55] Mikalaa that's a great question because I think I mentioned earlier that gait is not unique. And so when I get a detective saying I know it's him by his gait or how he walks, I always immediately tell the detective that you need more evidence than just gait analysis to convict somebody because more than one person can walk the same, even though there is all these different features that we pick up with people. And so I always tell the police right up front, if this is your only evidence, I'm not going to be part I'm not going to knowingly be part of having someone convicted based on gait. Gait can exonerate by itself and show these two people do not walk the same. And that creates a large amount of doubt. So I'm up for that. But to to participate in having someone convicted based on on gait by itself, wouldn't it be it wouldn't be fair for the for the person charged with the crime.

**Mikalaa Martin** [00:20:56] And as you've mentioned, the gait analysis hinges on digital evidence, such as surveillance footage or CCTV being available in that case. How does technology such as surveillance footage enable you to perform gait analysis?

**Dr. Michael Nirenberg** [00:21:09] So cameras are becoming less expensive and more prevalent. And we're using cameras more and more now in society law enforcement, people's phones, they've ring doorbells and the quality of the footage is improving with time. Sometimes you still get footage where the quality is low, the resolution or the frame rate. So. With good quality footage, you'll have a higher frame rate. You'll have more frames in a given instant of time. So you can see more detail. I actually had a case where they had drone footage looking at someone from above. You know, when you look at someone from above, some people will twist from side to side when they walk. There's different features of gait that you can pick up from above. In an ideal scenario, you'll have

a crime scene with multiple cameras. You know, there's three planes. When you look at the human body, there's the frontal plane and then the side plane and then sort of coming straight down on the person. And if you have multiple cameras, that helps because you're seeing more aspects of the person's gait and you can put all three views or cameras together. What the problem with technology and cameras is that the people who sell the cameras are not the people who actually, at the end of the day, need to use the cameras. So I get sent a lot of footage where the camera was placed in a really bad position because the salesman, they never really have to analyze the footage of anybody. And I imagine a better camera company, at a minimum, would get a police officer or law enforcement involved in the camera's placement. So I see an improvement in the placement of these cameras coming in the future as these companies realize we need to give more thought to what these cameras are being used for at the end of the day. Sometimes there's just a lot of cameras that don't show you much usable footage. Even even if you see people who get robbed in gas stations and whatnot. A lot of times the camera doesn't really show you much of the criminal just because of the place of the camera. So I see that improving in time. I see the quality improving. I see more cameras coming about and I see hopefully law enforcement beginning to recognize that gait can be used to assist in a criminal investigation.

**Mikalaa Martin** [00:23:38] We have previously discussed the use of footwear impression evidence on the podcast. However, you have supported many cases where footprint impression evidence played a crucial role. Can you talk to us about the distinctiveness of footprints and how footprint impression analysis is completed?

**Dr. Michael Nirenberg** [00:23:56] What I do is footprints analysis, and I don't look at the ridge detail that a fingerprint examiner would look at. I look at the overall shape, the morphology. I consider the biomechanics of the foot that made the footprint, and I consider some other factors as well. So if there is ridges, if there is region detail or dramatic glyphs, I would tell law enforcement, you know, you need a fingerprint expert perhaps to take a look at that. But I will look at the footprint, the shape, the size, the position of the toes and the biomechanics. And there was a there was multiple studies done by the Royal Canadian Mounted Police, by researchers there who ultimately determined that the chance of a match of a footprint is something to the effect of 1 in 1.2 billion. Now, that is under laboratory conditions, not necessarily in the real world, but it does give some measure of the distinctiveness of footprints in the real world. It may not be that high, but our footprints differ again because of our heredity, our biomechanics. Spend the day with me in my podiatry office. I see 30 people. I see 60 feet. Assuming no one's had an amputation. And you know, every foot is different. Even our our left and right feet have been proven scientifically to not be mirror images of one another. So even a lot of people will say my feet are different sizes to that difference. But I've looked at I did a study on looking at identical female twins, and even their foot impressions in footwear were different. So over time, due to injury, due to some people wearing poor footwear, they've shown that women who wear high heels in their early part of their adult life, in their 20s, for instance, and then they stop wearing them later in life. They'll have more foot problems as a result of that than a woman who did not wear high heels when they were younger. And I'm not telling women not to wear high heels, but I'm just giving an example. I think as a podiatrist, high heels are like if you're on a diet, having Haagen-Dazs ice cream once in a while, you know, it's like a decadent treat, put on whatever. But just to show you that it takes a toll on your foot, it can change your foot later as you age and different things develop as you grow older and injury and putting on weight, losing, having being very slim, being underweight, neurologic diseases, medical problems, diabetes. There's a lot of things that affect our feet and make our feet distinctive. Again, not unique distinctive.

**Mikalaa Martin** [00:26:35] On the topic of case studies. You presented a lecture at the 2024 International Association for Identification or IAI Educational Conference entitled Footwear to Feet: how a killer's feet were connected to shoes found at a homicide. Can you speak to how an association from a perpetrator's foot can be made to their footwear?

**Dr. Michael Nirenberg** [00:26:57] So the way we connect or disconnect, the way we show a connection between someone's foot and footwear found at a crime scene is not necessarily by looking at their footprints. We do consider their footprints, but the main thing we do is we compare the shoes the suspect has on his feet at the time he's arrested or questioned by police. So, for instance, in Canada, there was a 14 or 15 year old girl who was raped and murdered in shoes near the crime scene were found. And the shoes near the crime scene had a blood, but the blood was mixed. It was the victim's blood. And there was other DNA found on the shoes. And therefore, the suspect said that these aren't his shoes or someone else wore his shoes or they borrowed issues because it was mixed DNA. And a lot of times with footwear, because we walk around, you don't get just one person's DNA. You get multiple people's DNA on the shoes. So that's when they bring in a forensic podiatrist. And I compared the shoes that he was wearing when he was arrested with the shoes, with the victim's blood found near the crime. And you look at different things inside and outside the shoes. You do an actual what I call a shoe autopsy. It's nowhere near as involved as a real autopsy on a person. But a shoe autopsy, where I look at the wear, I look at the wear patterns, the wear on the bottom of the shoe inside the shoe. And I compare the insole, the foot impression in that shoe to the crime scene shoes. And what's interesting in that case is the person who did the murder wore skateboard type shoes. And the suspect when he was arrested had skateboard type shoes. In Virginia, a guy came home and found a burglar in his home and they scuffled and the burglar stood up and shot him a couple of times and killed him and left his shoe. That shoe left at that crime scene was a basketball Nike shoe. And when that suspect was arrested, he had the new version of the basketball Nike shoe. So it's been interesting that people, at least criminals in a very small subset of criminals that I've had in my life, they seem to purchase or put on a similar shoe and then they wear that. And so the comparison of the wear in one shoe to the wear in the other shoe is stronger. It's a stronger comparison because it's not like he went from wearing a basketball type sneaker, Nike, to wearing, you know, some fancy dress shoe. So you get similar wear patterns in the shoes and you compare those. Then you look at the person's footprints and compare those. Then you look at the person's foot. And that's the thing that forensic podiatrists do that a lot of other people who look at footprints or compare footwear don't necessarily do and some may do. But podiatrists beyond doing the comparison, actually look at the foot and see how that can relate or not relate to the findings they're obtaining. So in that case, in Canada, I was due to testify and just before I did, they were going to challenge my testimony and I wrote a report showing that this methodology had been done in Canada. It had been appealed to their Supreme Court previously because someone in the RCMP had done something similar. The RCMP stands for the Royal Canadian Mounted Police, and after they got that report, he decided to to plead guilty. In Virginia I testified and that with other evidence, he was found guilty.

**Mikalaa Martin** [00:30:43] And from the perspective of a forensic podiatrist, and given the multiple hats that you wear within the forensic community, where do you see the field going next.

**Dr. Michael Nirenberg** [00:30:53] In the future I see gait analysis, forensic gait analysis growing just because of the wide use of cameras. I believe that is going to really weigh large in the future. I know there is a significant need for this. It can be used to assist with

defense or law enforcement. It doesn't stand by itself by any means, but it's assistive to assist in investigation. And I see that growing people do not typically use their feet when they do crimes, and they typically don't leave their footwear. That happens now and then. It's not that common, but the forensic gait analysis. That is going to just continue to grow. It's going to become larger. More and more people are reaching out to me to look at footage. The problem and the limiting factor has been is that the footage up until this point a lot of times is just not adequate for meaningful analysis. And I think that will improve just with more cameras getting out there. They'll send me the footage that is not meaningful, but they'll also send me three, four, five more cameras, and somewhere in there I'll have what I need to do this right for them.

**Mikalaa Martin** [00:32:06] And for a final takeaway today, are there any identified needs or recommendations you have for overcoming any current challenges or gaps within the forensic podiatry field?

**Dr. Michael Nirenberg** [00:32:17] I really think we in terms of forensic podiatry, our biggest challenge is finding podiatrists who have the time and energy to learn what they need to learn to do this. Any podiatrist can be a forensic podiatrist, but to do it right, you really need to be a bit of a foot nerd. And I'm a foot nerd. And the people who do this, I would say, in the kindest complementary way, are foot nerds. And I like problem solving with feet. I like puzzling out things. And as a result of my interest in forensic podiatry, I've stumbled into, you know, doing other kinds of foot related issues pedicurists who may have injured somebody, you know, slip and falls at various places car accidents, patent cases, patent infringement cases and other cases, fraud and whatnot. So like, for instance, there was a case where somebody said he was hurt at work and he couldn't even walk. He had trouble walking and he had an ankle injury. And in between to doctor visits, they did surveillance footage where basically he wasn't just walking normally, he was like carrying big bags of groceries and whatnot. He was doing better, better than most people do. So I've fallen into some other things. But the biggest challenge for forensic podiatry is finding a podiatrist who a lot of podiatrists are interested in this and they sort of dabble in it and they find it fascinating and they love learning about it and they love attending lectures and seminars and hearing about it. But to make the leap to start to do it requires that you just learn a lot of forensic science and have that knowledge base. And, you know, people are so busy nowadays that there's not a lot of people who who have the time to put into it.

**Mikalaa Martin** [00:34:06] Thank you for your time discussing the fascinating realm of forensic podiatry. Dr. Nirenberg, it has been a pleasure talking with you today.

**Dr. Michael Nirenberg** [00:34:14] Thanks for having me. I've enjoyed talking to you, Mikalaa. I really appreciate it.

**Mikalaa Martin** [00:34:19] If you enjoyed today's episode, be sure to like and follow Just Science on your platform of choice. For more information on today's topic and resources in the forensic science field, visit [forensicCOE.org](http://forensicCOE.org). I'm Mikalaa Martin and this has been another episode of Just Science.

**Speaker 2** [00:34:42] Next week, Just Science sits down with Denton County Sheriff's Office senior forensic investigator Ashleigh Berg to discuss the capital murder case that was resolved through bloodstain pattern analysis and the use of surveillance footage and real time tracking data uncovered throughout the investigation. Opinions or points of views expressed in this podcast represent a consensus of the authors and do not necessarily represent the official position or policies of its funding.



