Video Transcript – Forensic Anthropology – Bone Whispering

Maggy Benson: [00:00:30] Can skeletons speak? A special group of scientists called forensic anthropologists say that yes, they can. But how do we understand the language of bones. Forensic anthropologists know how to investigate human remains to provide evidence for law enforcement. They also examine human skeletons and the objects found with them to learn about people, how they lived in the past, and stories that may otherwise remain untold. We'll learn more about this work [00:01:00] today when we meet with Kari Bruwelheide, a forensic anthropologist from the Smithsonian's National Museum of Natural History.

Maggy Benson: Hi, thanks for joining us. I'm Maggy Benson, host of Live from Q?rius, Smithsonian Science How? We have a really interesting story about forensic anthropology for you today. Before we dive in, I want to ask you a question. You can respond using the poll window that appears to the right of your video screen.

Maggy Benson: [00:01:30] If you found bones in the ground, what would you do? Would you dig them up and study them yourself? Run the other way and keep it a secret? Or call the police and let them know? Take a moment to think about it.

Maggy Benson: It looks like a lot of you are responding that you would call the police. That's really interesting. Let's go to out special guest to find out what she may have done. [00:02:00] Today we have with us forensic anthropologist Kari Bruwelheide from the Smithsonian's National Museum of Natural History. Hi Kari.

Kari Bruwelheide: Hi!

Maggy Benson: Thanks for joining us.

Kari Bruwelheide: Thank you for having me.

Maggy Benson: To kick things off, can you actually just tell us what a forensic anthropologist is?

Kari Bruwelheide: Sure. A forensic anthropologist is somebody who studies human remains, usually bones, and maybe even retrieves them when they're found to determine who that person was, how they lived, and also [00:02:30] possibly how they died. The techniques that we use to study bones are applied to bones of any age. So even though forensic anthropologist applies to people who typically work with law enforcement to solve forensic cases in the present day, we go back and study bones thousands of years old to get the same types of information.

Kari Bruwelheide: Most people don't know that the museum here has over 30,000 sets of human remains.

Maggy Benson: Wow.

Kari Bruwelheide: [00:03:00] Those are used not only to solve crimes in the present, but also to learn more about our past, and to train the next generation of forensic scientists.

Maggy Benson: So can I ask, when you were in middle school or high school, what would you have done if you had found bones while digging or maybe in the woods one day?

Kari Bruwelheide: Right. Well, when I was in middle school, the field of forensic anthropology was not as well known as it is today, so I had no idea what I would do. I probably would have run the other way. But [00:03:30] today, we have so many TV shows, so many news programs about forensics that really, it's a new field, but it's one that's very well known today and very popular.

Maggy Benson: So you've brought a lot of objects here for us to look at today. Can you tell us about something that you've brought?

Kari Bruwelheide: Yes. I've brought some very special objects from our collections. This one, in particular, is special to us because this is a real forensic case that we documented and actually presented [00:04:00] the evidence in court, and convicted an individual on this case. We determined that this person was a white female, 25 to 29 years old. We were able to get a positive identification on her, and determine that the cause of death was from being beaten, and then put into a well while she was still alive.

Kari Bruwelheide: Again, that was a powerful piece of evidence in a court of law that was used. So we're able to get a [00:04:30] lot of information from the skeleton.

Maggy Benson: Wow, that's so interesting that you were able to learn so much and ultimately get a conviction. Can you tell us how you read these bones? How do you know that information?

Kari Bruwelheide: Yeah. There're lots of clues hidden in bones, you just have to know where to look. One of the basic pieces of information we first collect is age. For her, we went first to the teeth. That is absolutely the best way to tell the age of a person from the time that they're born, [00:05:00] even in utero, up to the time they're about early 20s because their teeth are still developing and growing. If you look at her teeth, she has eruption of all of her teeth. She even has a loss of her third molar.

Kari Bruwelheide: But when you look at younger people, their teeth are still developing. This is a mandible, the same bone, of a young person, and it still has teeth that are unerupted. So you can estimate age within about a year. If you have somebody who has [00:05:30] no teeth, as this individual shows, we call that edentulous,

that indicates, typically, an older person. But there are also things in life that can cause loss of teeth at a younger age.

Kari Bruwelheide: Another important area to look at for determining age that we used on this person was looking at growth plates. Now, just like teeth develop and grow throughout somebody's lives, you have areas of bone that, as you grow, they have not yet fused together.

Maggy Benson: [00:06:00] So it grows from this end.

Kari Bruwelheide: Right. The growth occurs from the ends of your bones. This is a femur. This is at your knee. That's why kids often have growing pains in their knee. It's actually this growth plate that's creating more bones. At certain times, these growth plates will lock together, and then you'll be done growing. So we know what stages that occurs, and we can estimate age from that.

Kari Bruwelheide: Another important piece of information is sex. How do we tell [00:06:30] is this is a female or male? Again, you have to know what bones to look for features of males or females. The absolute best area to go to determine sex is the pelvis because women can do something that men can never do, and that is give birth. If you first look at these two pelvises, you can see that they look pretty identical.

Maggy Benson: Yeah.

Kari Bruwelheide: But close observation of certain areas on the bones, the front, [00:07:00] the side, you begin to note differences. For the female, a combination of those features allow that baby to pass through the pelvic inlet, versus in males, that's just not going to be possible. So when we look for sex, we go to the hip bones, and we look for those areas to determine male or female characteristics.

Maggy Benson: So these are the same angles that are different [00:07:30] on the ones that you just showed us.

Kari Bruwelheide: Yeah. But again, you don't always have all the bones of a skeleton. Sometimes you're missing elements. In that case, you can refer to other areas. As I said, this was a female, so in looking at her skull, we can also see traits indicative of being a female. The front here, the brow ridges are very undeveloped, they're very gracile, they look petite, versus [00:08:00] this individual, who is a male, and he has very developed brow ridges. These are where muscles attach.

Kari Bruwelheide: So if you look at the back of the head as well, and you can even feel where your neck muscles join with your skull, you will get an area known as the nuchal crest. In females, if you can take a side shot, this will be, move my hands here, very smooth. Back here, she does [00:08:30] not have a well-developed crest, versus this (other) individual, you can even see a little protuberance, a hook. Those muscles, this piece of bone here behind your ear, in men, it's going to be

very large. Again, it's where a muscle attaches. In women, this is going to be small.

Kari Bruwelheide: So age, sex, and then different marks on bones that tell us possibly how a person died or how they lived are very important. You want me to show you [00:09:00] some?

Maggy Benson: Yeah, I would love that.

Kari Bruwelheide: Okay. When marks occur in bone and you're still alive, you survive the incident, these are called antemortem injuries. This is an incredible fracture that occurred in the femur of an individual, and the bones healed, they remodeled. So we know that this person survived and lived for a longer period of time after the injury.

Maggy Benson: That looks incredibly painful. That's not what a properly healed bone looks like, is it?

Kari Bruwelheide: No. This person wouldn't [00:09:30] have gone to the doctor. Now, if we look at this individual, our forensic case, as I said, she had injuries that occurred at the time of death. Look at her break. There's no healing that occurred to join these bones together. This occurred at the time of death. This is a perimortem injury.

Kari Bruwelheide: You can see that is similar to this individual, who has marks [00:10:00] on-

Maggy Benson: Right here.

Kari Bruwelheide: ... their bones that have not remodeled or healed. These also occurred at the time of death, and you can tell that, too, by color. That's something I didn't mention, is the color of that fractured surface is similar to the outside surface, so we know that that bone injury occurred at the time of death, versus if you look at this bone here, that break is much lighter in color, so that occurred many years after death. That's a postmortem [00:10:30] injury.

Maggy Benson: Wow, so I can't believe how much information that you can get just from the bones themselves. Do you use any other tools or technology?

Kari Bruwelheide: Yes. We use lots of different tools because what we can see with our eyes, we call that gross observation, is very limited. So we use tools to get deeper into the bones. One of those tools is microscopy. You see an image on the screen here of a scanning election microscope, and that's a [00:11:00] picture of a tooth, but you actually can pick out striations on the enamel. It's so detailed.

Kari Bruwelheide: Other tools that we use would be x-rays. In that case, we're not looking at the surface, but we're looking internally into the bone. That gives you information on maybe dental development, what teeth are developing inside the bone. It also gives you information on bone density, which might give clues to a person's

age or health. We also [00:11:30] use CT analysis, CAT scanning. I don't know if you've ever heard that term. But that allows us to look inside even an object like you see here. That individual was in an iron coffin. We didn't even have to open the coffin. We were able to penetrate the burial container and look at that individual, and get his age. We could even see other features of how he was dressed.

Kari Bruwelheide: There are lots of tools.

Maggy Benson: Wow.

Kari Bruwelheide: Also, now, [00:12:00] we're going even deeper and looking at the chemistry of bones to learn how people ate, their diets, and also getting their DNA.

Maggy Benson: Wow, that's really interesting. So a lot of different tools and a lot of gross observations.

Kari Bruwelheide: Yes.

Maggy Benson: We have a question, actually, from Dyson from New York.

Kari Bruwelheide: Okay.

Maggy Benson: Ready to take it?

Kari Bruwelheide: Yes.

Maggy Benson: All right. Dyson would like to know, how can you figure out what the person looked like?

Kari Bruwelheide: Ah, well that deals with forensic facial reconstruction. I [00:12:30] actually brought a model at the end of the table there that shows a half reconstructed face, and an unreconstructed model underneath. Basically, we know how deep our tissues are on our faces, and we vary that by the age of the person, their ancestry, and also their sex. Are they a man or a woman? We can use the tissue depths to put tissue markers and rebuild the person's likeness. And [00:13:00] things that you wouldn't think would be able to tell from the bone, things like the size of the nose, or the wideness of the mouth, they're all based on structures of the skull underneath.

Maggy Benson: Oh, that's so interesting. So with all of these observations and tools and technology that you're using, you're really being able to go from something that you're finding in the ground to really being able to put a face to those bones.

Kari Bruwelheide: Yes. Facial reconstruction is really powerful.

Maggy Benson: Wow. I [00:13:30] really feel like I have a grasp on what a forensic anthropologist is now. Let's go to some of your research here at the Smithsonian. I know that you've worked in Jamestown a little bit.

Kari Bruwelheide: Yeah, for the past, wow, two decades now, we've been doing-

Maggy Benson: Longer than a little bit!

Kari Bruwelheide: ... yeah, a lot of work on early colonial sites in the Chesapeake. They're important because for that first 100 years of settlement, from 1607 at Jamestown, up until the 1700s, very little was written [00:14:00] down. So what we have is the archeology, what we can find, and then what we can interpret. One of the pieces of evidence regarding that is the human skeleton. We have looked at the burials of numerous colonists, but also Africans who were brought to this region, and were able to piece together their stories that were never written down.

Kari Bruwelheide: At Jamestown, it's particularly exciting because that was a colony that almost [00:14:30] dissolved.

Maggy Benson: How?

Kari Bruwelheide: Well, during one period in time, there was a lot of starvation, particularly during one winter, and there was also a lot of violence and turmoil. So 80% of the people who arrived one winter did not survive. And figuring out why that occurred, what these colonists were dealing with is really something that only can be answered in the bones.

Maggy Benson: So I understand that you've actually [00:15:00] brought a real case from Jamestown here today for us to analyze together, and with our viewers online.

Kari Bruwelheide: Yes. We're going to talk about a particular find or discovery at Jamestown that just was brought to light about a year ago. These were bones that were found in a trash pit. It wasn't an actual grave or burial, and not a whole skeleton was found. All that was found of this individual [00:15:30] was partial crania, and you can see that on your screen. The bones were in all separate pieces. Then in the corner of the screen are the bones from the top of a leg that were also recovered.

Maggy Benson: Were they all in the same trash pile?

Kari Bruwelheide: They were in a trash pile with debris that's dated to this starving time winter at Jamestown, 1609, 1610.

Maggy Benson: Interesting. So what can we solve here with you [00:16:00] today having just that limited amount of artifact?

Kari Bruwelheide: Well, again, based on what I talked about earlier, the basic types of information we can collect, one of the first questions that we could answer is how old is this person, and are they a male or a female?

Maggy Benson: Great. So I understand we're going to ask a series of questions of our audience right now, and you can lead us through the discovery. I guess we'll start with age?

Kari Bruwelheide: Yes, why don't we start with age. [00:16:30] Because we have the skull, one of the things that we're going to look at is the teeth, the dentition of this person to see if there are any clues that can tell us how old they were. Here you have the upper jaw and the lower jaw, and you can see that the teeth are mostly all there, with the exception of the third molar. I don't see that, but if you look closely at the bottom jaw, that's on the right hand side, you can see the little surface of the tooth. [00:17:00] So this person had an unerupted third molar.

Maggy Benson: Interesting. So we have a poll up there for you now. Let us know if you think this was of a young child, a teenager, or maybe an adult. It looks like a lot of you, 83% of you are responding that it is a teenager. What do you think about that response?

Kari Bruwelheide: Well, I think that's a great response because they're right. This is a teenager, and actually, we can look at the stage of formation of that [00:17:30] third molar inside the bone by looking at her x-ray, or its x-ray, and we can tell that it is about, well just the root of the tooth is starting to form. Based on growth standards, that's a 13 to 14 year old person.

Maggy Benson: Wow, interesting. So we know that it's a young teenager.

Kari Bruwelheide: Mm-hmm (affirmative).

Maggy Benson: What else can we learn?

Kari Bruwelheide: Well, we want to find out if this is a boy or a girl. So one of the things that we look at, of course, we don't have the hip [00:18:00] bones, which would have been the best way to determine sex, so we're going to look at features on the cranium and on the mandible. But if you look at this cranium, and also remembering what you saw on the screen, look for those areas on the skull that I pointed out that ha the muscles attached, you can see the mastoid here is very small, it's undeveloped. Part of that is age because this is a young teenager. But also, the forehead [00:18:30] has very little development of the brow ridges, and the back of the skull is very smooth, there is no defined crest where the muscles attached in the back.

Maggy Benson: So let us know what you think. Is this a boy or a girl? Again, I think we have some pretty good answers out there. 88 percent think it is a girl.

Kari Bruwelheide: It is. I might have given that away because I refer to it as a her! But is a young [00:19:00] woman, about 13 to 14 years of age. Again, that corresponds beautifully with the piece of leg bone that was found because that also has an open growth plate. We talked about those growth plates. So this person was still growing when they died.

Maggy Benson: Interesting. So what's next?

Kari Bruwelheide: Well, let's figure out why these bones were not in a typical burial, what got them to being thrown away in a trash pit. We look for marks on the bone that might help us solve that [00:19:30] mystery. One of the first areas on the cranium that we saw these marks were the forehead. So maybe your students can look at these marks here, those roughly parallel four marks on the forehead, and that is a good clue, or a starting point to determine what happened to this person.

Maggy Benson: You're thinking right now at home what caused those marks on those bones. Is it from animal scavenging? [00:20:00] Was it caused by some kind of tool or weapon? Or maybe damage from excavation when he was dug up?

Maggy Benson: It looks like we have 75% have said B, impacts from tools or weapons. What do you think about that?

Kari Bruwelheide: Well, that's a great answer because that's what we thought too. If you look very closely, you can see the internal areas of those marks are dark in color. If they were lighter, they would [00:20:30] have been made by a trowel of the excavator, but they're not, they were made at the time or near the time of death. You can also actually get the imprint of the tool that made them if you look close enough. So we do think these are made by tools.

Maggy Benson: Why would there be tool marks on her head? That's a little disturbing.

Kari Bruwelheide: It is disturbing, and you have to think of the context of the time. Again, I said that she was found in remains from the starving time [00:21:00] period. It was called the starving time because people had very little to eat, they were resorting to drastic measures. Now, you might think, "Well, did these marks kill her? Are they evidence of death?"

Maggy Benson: Yeah.

Kari Bruwelheide: Well, these marks on the forehead here actually would not have killed her. They do not penetrate the bone. But if you look at other areas of the skull, you start to see a pattern. If you look at the back of her head, you see these forceful chops made. We know [00:21:30] that these frontal marks were made first because there would have been no reason to chop the back of the head before you attempted to do it at the front.

Maggy Benson: The front was successful.

Kari Bruwelheide: We also can look at how these are arranged. So let me ask you a question. Do you think she was alive when these marks were made?

Maggy Benson: I'm not sure. It looks like ... I wouldn't let somebody hit me in the head that many times.

Kari Bruwelheide: No, you would be moving around, you would be struggling. So there's no way that somebody could have chop, chop, [00:22:00] chop at the head without that person already being dead. So these marks were made first, they turned her over, they forcefully chopped at the back of the head, and then you start to see more clues. You start to look at the mandible, and you see there are little striations, little cuts on the jaw. You start to see that there are punctures underneath the jaw. These were made on areas that muscles attach to.

Kari Bruwelheide: So basically, [00:22:30] they were trying to get the muscle, the tissue off her face, and they were trying to get into the skull to get the brain. And you might ask, "Oh, this is really getting gross. What could have caused this?" But again, this is at a starving time period, and people were resorting to survivor cannibalism. And this is real proof of that occurring.

Kari Bruwelheide: We know that colonists talked about it, but historians today were starting to dismiss those [00:23:00] tales as rumors. But actually, now we can say, "This happened in history, and you can no longer deny it."

Maggy Benson: Interesting. So really, the discovery of this skeleton, or the pieces of this skeleton have really helped you better understand the historical context of what was happening in that really harsh winter.

Kari Bruwelheide: Right. I mean, this gives you a very different sense of the desperation that the people who were surviving had experienced. It also gives us a real connection [00:23:30] with the people who were there who were victims, even unwilling victims, of that struggle. You know, this young girl is part of the Jamestown story. Usually you think of Jamestown and you think of John Smith and Pocahontas, but they were real desperate times, and most of the people who came and settled here were teenagers, like her, and many of them did not survive. And we have to tell their stories, too.

Maggy Benson: So how do you know, it sounds like she was a colonist, but how do [00:24:00] you know that she's a colonist and not maybe native to that area?

Kari Bruwelheide: Right. Well that's one of the questions we needed to answer, and there are a number of different clues again. One of them is the shape of the skull, but another important clue is the bone chemistry. European diet was very different from diet in the Americas during the 1600s. Europeans ate wheat, Americans were mostly corn based. So by looking at her bone chemistry, we're actually

able to tell what she ate. You are [00:24:30] what you eat is not just a term that we use today lightly, it actually is true. Her isotope signal, we look at stable isotopes, told us that she was a strong European diet signal, so she is definitely a colonist who came.

Maggy Benson: Interesting. So that's another example of how you're using these tools, technologies, multiple lines of evidence to be able to really pull this story together.

Kari Bruwelheide: Yeah, it's truly a team effort. We couldn't do this alone. We go to lots of different labs that help us get this information. [00:25:00] So it really is piecing all of this together, including historical documents that we do know exist, to help us fill in these gaps.

Maggy Benson: Wow, that's wonderful. I feel like we've learned a lot about what you do as a forensic anthropologist, that's a mouthful-

Kari Bruwelheide: Yeah.

Maggy Benson: ... and all of the tools that you use to be able to put these stories together. We do have some student questions out there for you, if you're willing to take them.

Kari Bruwelheide: Okay, great. Okay. Sure.

Maggy Benson: All right, [00:25:30] wonderful. This one is, how can you tell how long a person has been dead? This comes from Sam.

Kari Bruwelheide: Ah, well, there are different clues. Now, if we're dealing with a forensic case and how long (ago) that person might have died, we would look at certain clues on the preservation of the bone. A lot of the cases we find are bodies that are out in the woods. And when you're exposed to different elements for different periods of time, you have different [00:26:00] levels of bone decay.

Kari Bruwelheide: This is a great example. We didn't really talk about this, but these are actually tooth marks from an animal that scavenged the bone for the calcium. And if you're out in the woods, and you get exposed to different things like sunlight, algae, animals, that'll affect the bones, and we can interpret these marks. We even know that some rodents who scavenge bones will wait until [00:26:30] all of the tissue is off. So that might tell us, well, this body has been there for at least six months, or for at least a year. There is lots of different ways you can tell how old.

Kari Bruwelheide: Now, if you're talking about ancient remains, thousands of years old, we would use radio carbon dating.

Maggy Benson: Interesting. We have another question for you. How do you become a forensic anthropologist?

Kari Bruwelheide: Oh, well, that's a more difficult question to answer. Well, you would have to go and get your [00:27:00] undergraduate degree, and then you'd have to go on to graduate school. And a lot of the classes you might take, of course, are science based classes. But one of the things that a lot of students don't know is that you have to be a good communicator. Because even though you could be a good scientist and collect all of this information, you have to tell the public what you're finding.

Kari Bruwelheide: So for forensic cases, of course, you'd have to write very detailed reports and present it in court. For the historic remains, you have to be a good [00:27:30] storyteller. You have to know how to write, and how to communicate. So you have to take classes like English classes. You have to know how to use computers. You have to know some math to do statistical analysis. So there's lots of different pathways to get to where I am, but basically, just start with getting a good undergraduate degree.

Maggy Benson: So we're actually already out of time.

Kari Bruwelheide: Wow, that went fast.

Maggy Benson: Really fast. Thank you, students, so much for all of [00:28:00] your really wonderful questions. And thank you, Kari, for being here today with us.

Kari Bruwelheide: Well, thank you for having me.

Maggy Benson: If you would want to learn more about some of Kari's work, you can visit Written in Bone on the Smithsonian's website. You can also visit the Jamestown Rediscovery Archeology Project at HistoricJamestown.org.

Maggy Benson: If you missed part of this webcast, or you just want to watch it again, then it will be archived later today at qrius.si.edu. [00:28:30] Thanks again for joining us, and please come again on March 13th when we are here with Dan Babbitt who will talk about insect adaptations.

Maggy Benson: Thanks for joining us, and see you next time on Smithsonian Science How.