

# How a missing foot in Borneo is upending what we've known about human history

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Liang Tebo burial feature. a, A single adult inhumation (TB1). The skull is to the right of the scale bar, as shown by the exposure of the supraorbital ridge. A flexed burial position with the right knee brought to the chest and a complete right foot, and the left knee flexed below the pelvis, with the tibia and fibula underneath the femur. b, In situ nodule of red ochre (a natural earth pigment) next to the mandible. c, Maxilla and mandible. Scale bar, 5 cm. Credit: *Nature* (2022). <https://doi.org/10.1038/s41586-022-05160-8>

At the center of a cathedral-size cave in remote Borneo, an Indonesian archaeologist brushed away sediment to reveal the top of a human skull. Next came a perfect right foot. Then, a leg.

Teaspoon by teaspoon over 11 days, a team of excavators uncovered the carefully buried skeleton dating to 31,000 years ago. But one piece was mysteriously absent—the left foot.

As the Indonesian and Australian researchers looked closer, they noticed bone growth over a clean cut on the lower leg that pointed to a shocking conclusion: Humans had successfully amputated a limb more than 20,000 years earlier than previously known.

The researchers eventually learned the person was likely a child when their lower leg was amputated, and lived another six to nine years before dying when they were 19 to 20 years old, according to a peer-reviewed paper by 16 researchers published Wednesday in the journal *Nature*.

The discovery challenges prevailing views of prehistoric human life, the authors say.

"The find essentially rewrites the known history of human medicine," said lead author Tim Maloney, a research fellow at Griffith University in Queensland, Australia.

## **Excavating 'Skully' in Liang Tebo cave**

The limestone Liang Tebo cave in East Kalimantan contains some of the world's earliest dated rock art (at least 40,000 years old) and has been studied by researchers for years, said Adhi Agus Oktaviana, a researcher at the Centre for Archaeology, Language and History in Jakarta.

Located on the edges of a river valley, the cave is reachable by about a week's journey of hiking and canoeing.

A group of French archaeologists previously visited the site, but did not find human remains, Oktaviana said. In early 2020, weeks before the COVID-19 pandemic sent the world into lockdown, a group of Indonesian and Australian archaeologists gave it another shot.

"There is no electricity, no telephone signal, and the environment is quite extreme," said archaeologist Andika Priyatno, who first uncovered the skull.

"I immediately thought that it was an animal bone," said Priyatno, with the Borneo Heritage Conservation Center. "But after slowly excavating that skull, it became apparent that it was a ... human burial."

Using soft bamboo, wooden and plastic tools, the archaeologists excavated their beloved "Skully" and associated burial material in 32 stages and recovered three-quarters of the bones, including all teeth.

"We covered Skully up at night and wished them well before we returned the next day and continued working on them," Maloney said.

Fellow excavator India Dilkes-Hall, an archaeobotanist and research fellow at The University of Western Australia in Perth, said it was "intense" working in a small trench for days on end.

"I still am shocked," she said. "I still think—where is that foot? Did we just miss it? And I know we didn't. I know for a fact we did not."

To pinpoint the age of the skeleton, the researchers used a combination of techniques—radiocarbon, uranium-series and electron spin resonance dating—to analyze samples found above and below the skeleton, as well

as microscopic samples from one of the teeth.

The archaeologists initially suspected the lower leg and foot had been deliberately removed. But they couldn't be sure it was an amputation. So that's when they brought in an expert.

## **Reassembling Skully**

When bioarchaeologist Melandri Vlok received photos of the skeleton while in New Zealand, she knew she had to see it in person. So she traveled to Queensland, where the skeleton had been transported.

It took her weeks to put Skully back together. Due to the difficulties of the COVID-19 pandemic and the delays of transporting artifacts internationally, she didn't start working on the skeleton until July 2021, more than a year after the excavation.

"Almost every single fragment was there. It was amazing," said Vlok, who studies evidence of disease and trauma in prehistoric human skeletons. "We were able to re-fit together pieces that were 3 millimeters thick, which made my job harder in the sense that I was sitting across multiple tables to piece the individual together."

Vlok said that once she had laid out the skeleton and stepped back, she concluded almost immediately that the leg had been amputated.

"When a rockfall happens or when there's an animal attack, the bone tends to get crushed. It doesn't get cut cleanly. So it's very different from what you would expect in an accident," Vlok said. "It should be relatively obvious, even to the public, that this is a case of someone having their leg chopped off."

There was also no evidence of an infection, which would have been

common in the case of an animal attack, the researchers found.

"There's a whole story that we're able to create with this individual," Vlok said. "This was a person who suffered something incredibly severe and managed to survive as a child. And so it's a story about them. And it's the story about the community and people who loved and cared for this individual enough to help them survive."

## **What Skully means**

The discovery of evidence of such an early complex medical act challenges the "prevailing view" of the evolution of medicine and human life at the time, the researchers said.

The prevailing narrative suggests that the human transition from hunter-gatherers to settled agricultural societies at the end of the Ice Age around 10,000 years ago—what's called the "Neolithic Revolution"—gave rise to new health problems and prompted the first major innovations in prehistoric medicine.

Previously, researchers dated the oldest known "operation" to around 7,000 years ago. In 2007, researchers in France discovered a Neolithic farmer near Paris had survived the amputation of his left forearm.

But the new discovery in Borneo suggests that at least some modern human foraging groups in tropical Asia had developed sophisticated [medical knowledge](#) and skills long before the Neolithic farming transition, the researchers said.

"There's this concept of the desperate-hunter gatherer trapping a small sickly deer. That's an absolute myth and probably always has been," Maloney said. "These people weren't [hunter-gatherers](#) eking out an existence of survival in a rainforest. They were thriving with figurative

rock art and advanced medical and botanical practices."

Researchers say the "surgeon" who performed the amputation must have understood the importance of removing the limb for survival and have had detailed knowledge of anatomy and muscular and vascular systems to prevent fatal blood loss and infection.

The person's survival suggests their society had some form of anesthetic for pain relief and some form of antiseptic or antimicrobial for post-operative care, likely found in the tropical rainforest environment, Dilkes-Hall said.

"While we don't have the direct evidence, I truly don't think the person would have survived this surgery without an antiseptic or an anesthetic. It would be really nuts," she said.

It's not clear what was used to perform the amputation, the archaeologists said. But Maloney suspects a sharp stone could have been the tool. Blades made of obsidian, a rock that forms when lava cools, are even used in some surgeries today, for example. Marine shell tools and bamboo were also in circulation at the time, he said.

The patient's recovery also suggests there was nursing and care after the operation, such as regular feeding and bathing and moving them to prevent bed sores, the researchers said. Maloney said the person must have received a high degree of community care because they were able to survive without a lower limb in a rugged, mountainous terrain inhabited by dangerous animals.

"There's little doubt that they were a valued member of their community," he said. "They were buried in a deliberate and ritualized mortuary practice."



Oktaviana, the Jakarta-based researcher, said he takes pride in knowing the person was cared for in their community. He said the discovery is an important moment for Indonesian archaeology and gives locals a powerful argument for preservation, as some areas of rainforest in Borneo are threatened by the development of palm oil plantations.

The find, Vlok said, is also in step with the wider field of archaeology, which is slowly beginning to move away from the view of hunter-gatherer groups as "simple societies."

"As a species, as anatomical modern humans, we've always been bright, insightful and questioning our world," she said. "This is a case of concrete evidence of 30,000 years ago to demonstrate just what the whole field is starting to edge toward, which is that we've always been complex."

Tom Higham, an archaeologist at the University of Vienna who helped peer-review the study, noted archaeologists have a long record of "underestimating the abilities of past populations."

"Every so often a sobering example of this speaks to us from the deep past," he said. "This is another of those cases which makes us pause and think."

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