

Radiant zinc fireworks reveal human egg quality

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A stunning explosion of zinc fireworks occurs when a human egg is activated by a sperm enzyme, and the size of these "sparks" is a direct measure of the quality of the egg and its ability to develop into an embryo, according to new research from Northwestern Medicine.

The discovery has potential to help doctors choose the best eggs to transfer during [in vitro fertilization](#) (IVF), the scientists said.

This is the first time the zinc sparks have been documented in a human egg.

"This means if you can look at the zinc spark at the time of fertilization, you will know immediately which eggs are the good ones to transfer in in vitro fertilization (IVF)," said Teresa Woodruff, one of the study's two senior authors and an expert in ovarian biology at Northwestern. "It's a way of sorting [egg quality](#) in a way we've never been able to assess before."

Woodruff is the Thomas J. Watkins Memorial Professor in Obstetrics and Gynecology at Northwestern University Feinberg School of Medicine and director of Northwestern's Center for Reproductive Science.

Scientists activated the egg by injecting a sperm enzyme into the egg that triggers calcium to increase within the egg and zinc to be released from the egg. (The eggs in the study were not fertilized with actual sperm

because that is not permitted in human research under federal law.)

"It was remarkable," Woodruff said. "We discovered the zinc spark just five years ago in the mouse, and to see the zinc radiate out in a burst from each human egg was breathtaking.

"All of biology starts at the time of fertilization, yet we know next to nothing about the events that occur in the human. This discovery required a unique partnership between biologists and chemists and non-federal dollars to support the research," she said.

The study will be published April 26 in *Scientific Reports*.

As the zinc is released from the egg, it binds to small molecule probes, which emit light in fluorescence microscopy experiments. Thus the rapid zinc release can be followed as a flash of light that appears as a spark.

"These fluorescence microscopy studies establish that the zinc spark occurs in [human egg](#) biology, and that can be observed outside of the cell," said Tom O'Halloran, a co-senior author. O'Halloran is the Charles E. and Emma H. Morrison Professor in Chemistry in the Weinberg College of Arts and Sciences and director of Northwestern's Chemistry of Life Processes Institute.

Eggs compartmentalize and distribute zinc to control the development of a healthy embryo. Over the last six years this team has shown that zinc controls the decision to grow and change into a completely new genetic organism.

"This is an important discovery because it may give us a non-invasive and easily visible way to assess the health of an egg and eventually an embryo before implantation," said co-author Dr. Eve Feinberg, who took care of the patients who provided [eggs](#) for the basic science study and

collaborated with the research team.

Feinberg will become an assistant professor of obstetrics and gynecology at Feinberg and will be ambulatory medical director of Northwestern Medicine's Fertility and Reproductive Medicine division beginning July 1. Feinberg currently is a physician at Fertility Centers of Illinois (FCI).

"There are no tools currently available that tell us if it's a good quality egg," Feinberg said. "Often we don't know whether the egg or embryo is truly viable until we see if a pregnancy ensues. That's the reason this is so transformative. If we have the ability up front to see what is a good egg and what's not, it will help us know which embryo to transfer, avoid a lot of heartache and achieve pregnancy much more quickly."

First author Francesca Duncan made the human zinc spark discovery. "We now know that the release of zinc at the time of fertilization is a conserved phenomenon, which will help us address one of the largest unanswered questions in reproductive medicine—what makes a good egg?" Duncan said.

Duncan was an assistant research professor in obstetrics and gynecology at Feinberg when she made the discovery and will become the executive director of Northwestern's Center for Reproductive Science on August 1. She is currently an assistant professor at the University of Kansas Medical Center. Emily Que and Nan Zhang are co-first authors.

In a companion paper published in *Scientific Reports* on March 18, a zinc spark is shown at the precise time a sperm enters a mouse egg. This discovery was made by Zhang, a postdoctoral fellow at Northwestern. Zhang said little is known about the events that occur at the time of fertilization, because it is difficult to capture the precise time of sperm entry.

Provided by Northwestern University

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