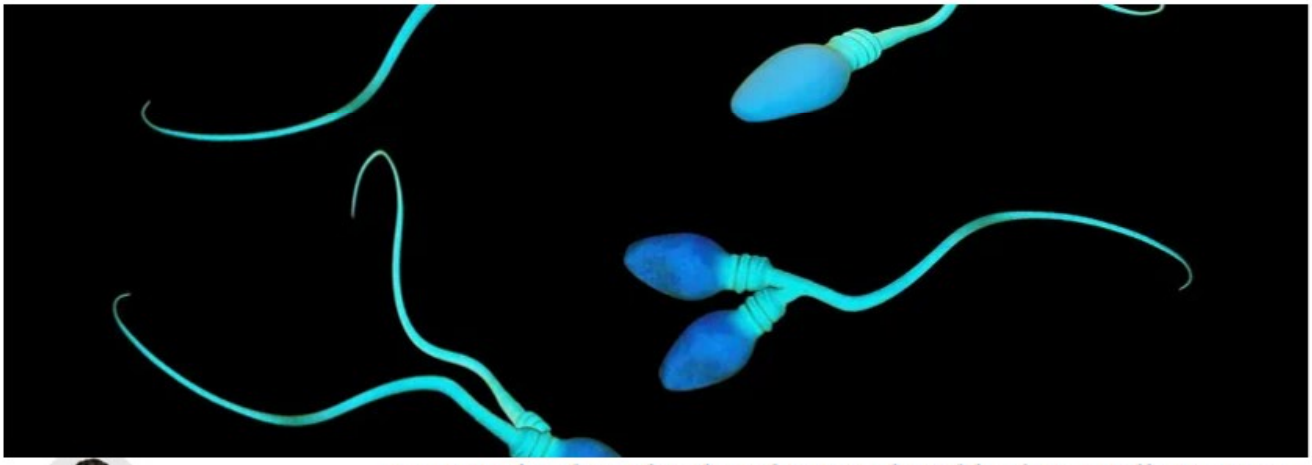
Fertility Breakthrough? New Israeli Technology Could Double IVF Success by Selecting Higher-quality Sperm Cells

Researchers from Tel Aviv University claim to have developed a precise method for selecting the most suitable sperm cells – and clinical research suggests it can dramatically improve the prospects of a healthy birth



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A new technology developed in Israel could substantially improve the success rates of in-vitro fertilization, with research finding that it raised the chances of the birth of a healthy infant from 34 percent to 65 percent.

The technology was developed at Tel Aviv University and is being used at Barzilai Medical Center in Ashkelon. It led to 20 successful pregnancies out of 31 embryo transfers, compared to 14 pregnancies from 41 embryo transfers in the control group. Among the notable cases was a couple that unsuccessfully attempted IVF 15 times and finally became parents.

The breakthrough was developed in Prof. Natan Shaked's laboratory at the Department of Biomedical Engineering at Tel Aviv University. The technology was commercialized by QART Medical, a startup backed by Ramot – the university's technology transfer center – and outside investors. The research was published in several scientific journals, including PNAS, Advanced Science and Fertility and Sterility.

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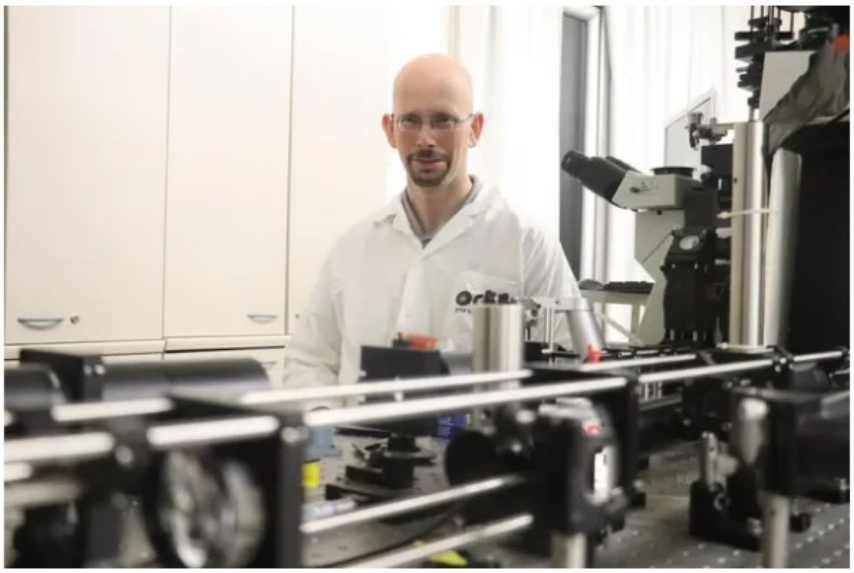


Prof. Natan Shaked. Credit: Tel Aviv University

In addition to Barzilai Medical Center in Ashkelon, the technology has recently been introduced in additional hospitals in Israel for clinical studies. It is also used at two leading international medical centers: the UCSF Medical Center for Reproductive Health in San Francisco and the University of Tokyo Hospital in Tokyo. So far, dozens of couples have been recruited for the clinical trials.

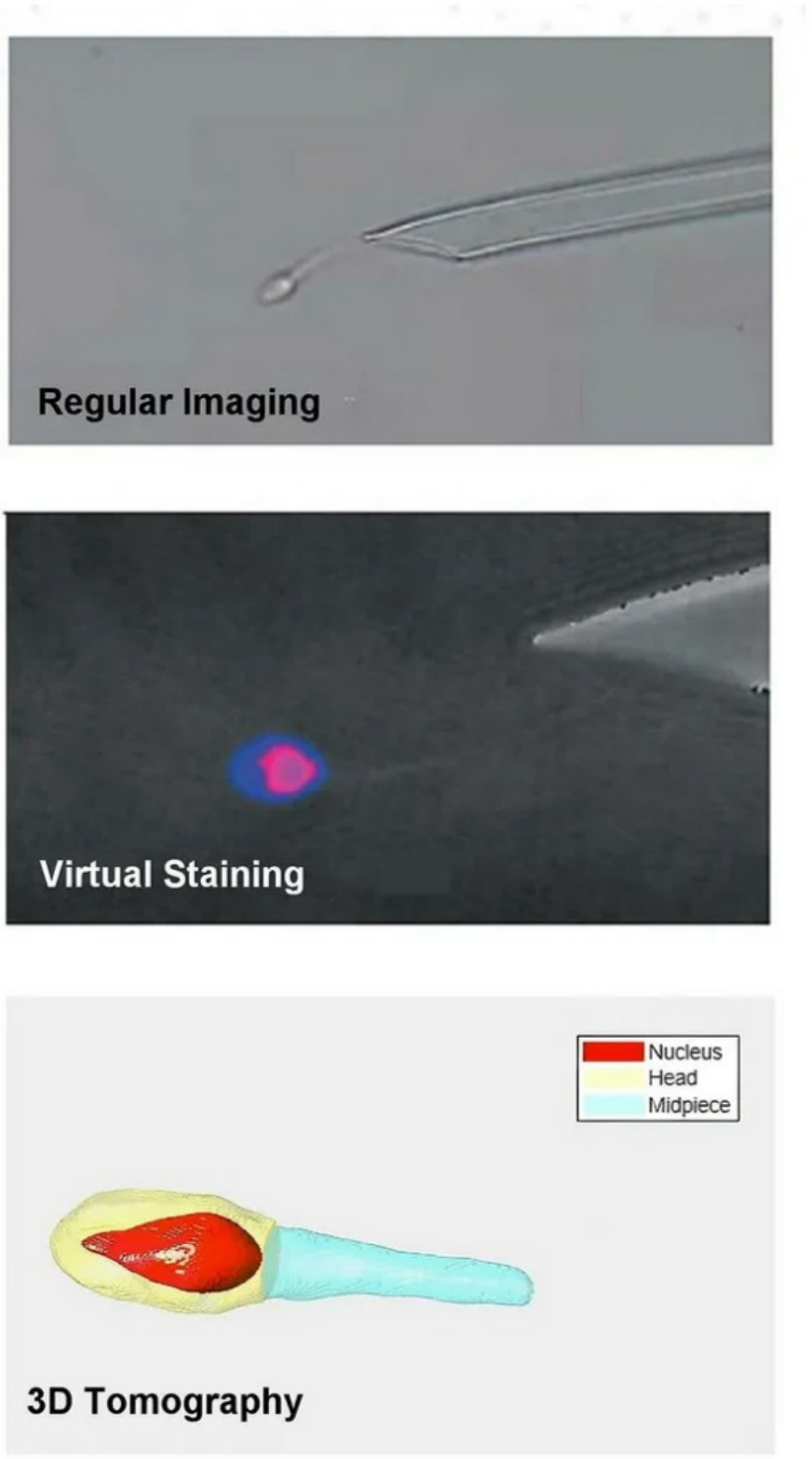
Objective assessment

The innovative method developed by the researchers allows IVF laboratories to select high-quality sperm cells to fertilize eggs, dramatically improving the chances of successful pregnancy and healthy births.

"Biological cells are transparent," says Shaked. "To study their internal structures for research or medical diagnosis, we typically use chemical stains – which allow for the analysis and measurement of the cell's internal structures under conventional microscopes. But such staining isn't possible in the case of IVF, because the staining materials could penetrate the DNA of the embryo and harm it.

"Currently, embryologists choose sperm cells for fertilization based on subjective assessments of their shape and movement," Shaked continues. "Because of this, 90 percent of the sperm cells that seem suitable to embryologists do not actually meet the internal structural measurements recommended by the World Health Organization. As a result, the percentage of live birth rates from IVF cycles is only 15-25 percent, with many couples needing more than five cycles of treatment to achieve a successful pregnancy. Furthermore, since the process of sperm selection is

not recorded, it becomes impossible to reverse-engineer success and understand which sperm cells will work and which sperm cells won't."



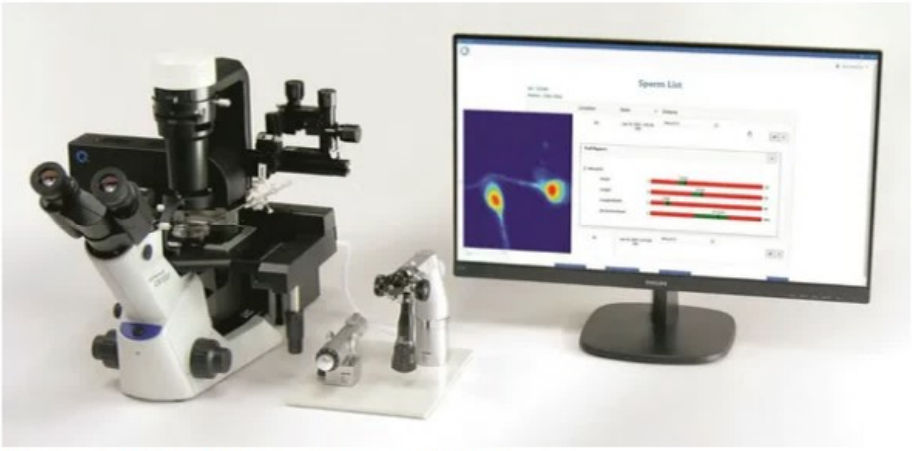
Top: A sperm cell seen through a regular microscope. Middle: A sperm cell colored virtually using the new technology. Bottom: A 3D rendering of a sperm cell using the new method. Credit: QART Medical

The method developed by Shaked and his team is based on the refractive index – a fundamental physical property of the materials in biological cells that, until now, couldn't be measured in medical clinics. "The refractive index of the cell gives an

indication of the local mass within the cell, effectively replacing chemical staining and making it possible for us to visualize the internal structure of the transparent cell without staining it," says Shaked. "Our technology creates a refractive index map of the cell by measuring the delay of light when it passes through it. We measure this by using a phenomenon called quantitative light beam interference.

"In the past, this technology couldn't be implemented in a clinical setting because of the system's extremely high sensitivity to mechanical vibrations, its large size and the complexity of its setup," he adds. "You needed a physics lab located in a basement and a vibration-isolated table. No one could afford to get such expensive, sophisticated microscope technology in a clinical setting."

Shaked and his team had to find solutions for the challenges involved in taking the technology from the lab to the clinic. "We invented a compact and user-friendly module – a device that attaches to an ordinary lab microscope and doesn't require high mechanical stability," he says. "Embryologists can now analyze sperm cells as though they have been chemically stained. The technology also provides the embryologists with many parameters that had been unavailable, like 3D imaging, cell mass, the volume of each cell organelle and more."



The system developed by the researchers. Credit: QART Medical

The technology gives embryologists a new, powerful set of tools for assessing and selecting sperm cells for fertilization. According to Shaked, "Selecting which sperm cell will be injected into an egg is a critical step in the fertilization process. In recently published papers, we demonstrated that being able to measure the cell both

structurally and materially allows us to assess the level of DNA fragmentation of the cell and to perform an internal, external and three-dimensional morphological examination of the cell, as well as to perform internal, external, and three-dimensional morphological examinations. This dramatically improves this critical selection process."

A critical issue in some countries

The IVF process is lengthy, exhausting and often painful. In addition to the emotional challenges, it requires hormonal treatments, which come with physical side effects. In most cases, several cycles of egg retrieval, fertilization and embryo transfers are necessary.

Currently, IVF success rates are not high, and they decline as the patient's age increases. For women up to age 35, the success rate is up to 28 percent. Women between the ages of 35 and 39 have a 19 percent success rate, while women aged 40-42 have a success rate of 9.6 percent for every 10 treatment cycles. For patients aged 43 and up, only 3.5 percent of egg retrieval cycles end in the birth of an infant (1 out of 28 cycles).

While these statistics focus on women and their age, choosing the most suitable sperm for fertilization is an important and decisive factor in the IVF process and its chances of success. In Israel, where over 60,000 treatment cycles are performed every year, this issue is relevant to many families.

Dr. Bujana Sa'ar-Ris, the director of the IVF unit and the sperm bank at Barzilai Medical Center.

"The subject of fertility in general and IVF in particular is especially critical right now: One in every six couples encounters fertility problems, and in at least half of these cases, the problem lies with the man," says Dr. Bujana Sa'ar-Ris, the director of the IVF unit and the sperm bank at Barzilai Medical Center. "In some countries, such as Japan, South Korea, and Spain, a dramatic decline in birth rates has resulted in shrinking populations.

"The causes for this are varied and include social phenomena such as career focus and late marriages, as well as health problems that may be caused by environmental pollution," she adds. "In fact, over the past few decades, there has been a decline of about 50 percent in the sperm count of young, healthy men. One of the major challenges in IVF is choosing sperm cells with high-quality morphology and motility," she says.

A study conducted at Barzilai included women aged 23-41 (with an average age of 34) and men aged 26-48 (with an average age of 36). Among the participants was a couple in their 30s who joined the study after 15 IVF cycles that failed because of the man's fertility issues. The new technology enabled the optimal selection of sperm for fertilization, and the woman was able to conceive and give birth to a healthy baby.

"Choosing the right sperm for fertilization is critical," says Dr. Yulia Michaylov, a clinical embryologist and the director of the IVF lab at Barzilai, who led the clinical study. "A man can produce tens of millions of sperm cells, depending on his fertility condition. Even when fertility is normal, though, only 4 percent of sperm cells are suitable for fertilization according to the parameters of the World Health Organization. In other words, even when success rates are reported in relation to women and their age, they also reflect the male component and the issue of male fertility."