Ericsson Method of Sperm Separation [1]

By: Blight, Alysse Keywords: Ronald Ericsson [2] Sperm separation [3] Sex Chromosome [4] Sperm cells [5] Sex predetermination [6]

In 1973, Ronald Ericsson developed the Ericsson method, which is a technique used to separate human male sperm [7] cells by their genetic material. Ericsson, a physician and reproduction researcher, developed the method while conducting research on sperm [7] isolation in Berlin, Germany, in the early 1970s. He found that the sperm [7] cells that carry male-producing Y chromosomes move through liquid faster than the cells that carry female-producing X chromosomes. As a result of his findings, Ericsson suggested suspending a semen [8] sample in a viscous liquid made from albumin protein, and collecting only sperm [7] that quickly pass through the liquid. Shortly after Ericsson described his method, researchers demonstrated that it was effective for sex selection. However, later studies contested those results. Despite that, the Ericsson method is still utilized by couples in 2018 as a means of sex selection and was the first sperm [7] separation technique used in combination with artificial insemination [9] to enable people to select the sex of their children.

Humans have two sex chromosomes, one passed down from each parent, which affect their biological sex characteristics. People with two X chromosomes are biologically female, while people with one X and one Y chromosome are biologically male. Since females have two X chromosomes, they are able to contribute only an X chromosome to their offspring. Males have both X and Y chromosomes and can therefore contribute either an X or a Y chromosome to their offspring. Therefore, male sperm [7] cells are responsible for determining the sex of an embryo. If the male sperm [7] cell that fertilizes a female egg [10] contains a Y chromosome, the embryo is male. If the sperm [7] cell that fertilizes the egg [10] contains an X chromosome, the embryo is female. The mechanism of sperm [7] motility, or the ability of sperm [7] cells to move throughout the female reproductive tract to reach and fertilize an egg [10], is seen in their capacity for swimming. A sperm's swimming ability can indicate how successfully the sperm [7] can reach and fertilize an egg [10].

During the late twentieth century, emerging research suggested a difference between X chromosome-bearing sperm [7] cells and Y chromosome-bearing sperm [7] cells. In the 1960s, Landrum B. Shettles, a researcher and physician who specialized in human reproduction, claimed that there were physical differences between the two types of male sperm [7] cells. Shettles's idea stimulated interest in the field of reproductive health, as the separation of sperm [7] based on those physical differences had the potential to affect physiological capabilities of sperm [7], such as motility. That research served as a precursor for the development of the Ericsson method.

In the early 1970s, Ericsson, a physician who specialized in reproductive hormones [11], conducted research on sperm [7] separation in Berlin, Germany. There, he worked for Schering AG, a pharmaceutical company, as a senior researcher. During an experiment in 1973, Ericsson found that a liquid medium of albumin, a viscous protein surrounding human female eggs that sperm [7] must swim through for fertilization [12] to occur, effectively separated Y chromosome-bearing sperm [7] cells from X chromosome-bearing sperm [7] cells. To test his ideas further, Ericsson filled glass tubes, or separation columns, with the liquid albumin medium and observed how sperm [7] cells swam through it. Later that same year, he published his findings in an article titled "Isolation of Fractions Rich in Human Y Sperm" that explained how the albumin columns work to separate sperm [7] cells.

In his experiment, Ericsson took a sperm [7] sample and placed it on top of a solution of 25 percent liquid albumin in a glass column. The sperm [7] cells would then swim down the column through the albumin over a two-and-a-half-hour incubation period at 35 degrees Celsius. Afterwards, Ericsson removed the sperm [7] cells at the top of the column because they failed to pass through the albumin medium in that amount of time, and transferred the remaining cells at the bottom of the albumin solution into a new test tube. Under Ericsson's theory, the sperm [7] cells that remained at the bottom of the column were faster, and therefore more successful at swimming. Ericsson then separated the sperm [7] cells from the albumin solution by centrifugation, or the process of separating a liquid mixture through rotational force. After removing the residual albumin solution, a sample of sperm [7] cells that accounted for about 10 percent of the original sample remained. Ericsson then washed and stained the cells with fluorochrome quinacrine, a fluorescent chemical, to determine which sex chromosome the remaining sperm [7] cells carried. Prior research had demonstrated that fluorochrome quinacrine caused the far end of the Y chromosome, called the Y body, to glow under fluorescent microscopes. After microscopic examination, 80 percent of sperm [7] cells in the separated sample carried Y chromosomes.

With that result, Ericsson and his team determined that albumin was the most appropriate medium to effectively separate sperm [7] cells based on what sex chromosome they carried. Albumin is the ideal consistency for sperm [7] separation because its viscosity inhibits the movements of poorly swimming cells. Furthermore, Ericsson and his colleagues concluded that because the sample of sperm [7] cells collected at the bottom of the albumin column had a high concentration of Y chromosome-bearing cells, those sperm [7] cells were more agile and swam faster than X chromosome-bearing sperm [7] cells. The research team published their results in the article "Isolation of Fractions Rich in Human Y Sperm," after which the process of utilizing albumin to separate sperm [7] became known as the Ericsson method.

In its early development, the Ericsson method's primary use was not for pre conception [13] sex selection. In December 1974, Ericsson patented his method and included the objectives of his sperm [7] separation technique, which he listed in order of importance. Ericsson's primary objective was to provide a process for separating human male semen [8] samples into samples that have an enriched concentration of sperm [7] cells carrying Y chromosomes. Next, he listed using the enhanced Y chromosome-bearing sperm [7] fraction for artificial insemination [9] for increasing the likelihood of male offspring, and did not provide instructions on how to do so in the patent. However, artificial insemination [9], the process in which sperm [7] is injected directly into a female's uterus [14] for fertilization [12], was already a common practice at the time Ericsson patented his method. In order for someone to use the Ericsson method for pre-conception [13] sex selection, couples would need to inject the Y chromosome-bearing sperm [7] cells directly into a female uterus [14] with an egg [10] using a syringe after the sperm [7] cells are separated through the albumin medium. In his patent, Ericsson briefly mentioned that the method could be used for family planning [15]. He claimed that a strong desire to have a child of a particular sex often causes couples to have many children until their favored sex is achieved, and that utilizing his method of sperm [7] separation for pre-conception [13] sex selection would therefore reduce the society's chance of possible overpopulation.

Two years after its initial development, a clinical trial tested the Ericsson method for pre conception [13] sex selection. Prior to that clinical trial, studies had shown that the method was effective for collecting semen [8] samples with high concentrations of Y chromosome carrying sperm [7] cells. But there was no evidence that those samples successfully created male offspring because they had not yet been tested using artificial insemination [9], as there were still X chromosomes present in the sample. In 1975 physician Paul Dmowski, who specialized in obstetrics and gynecology and his team of researchers at the University of Chicago [16] Pritzker School of Medicine in Chicago, Illinois, began a clinical trial to test whether the separated samples produced by the Ericsson method affected the sex ratio of human offspring. During that initial clinical trial, physicians successfully impregnated seven women using artificial insemination [9] with sperm [7] samples that were separated by the Ericsson method. Of those seven, five women delivered male infants. The researchers involved in the initial clinical trial determined that when sperm [7] cells are separated using the Ericsson method and artificially inseminated for conception [13], there is an increased chance of producing male offspring.

Since that initial clinical trial, further studies have supported the effectiveness of the Ericsson method. In 1976, Ericsson began a clinical trial in collaboration with Ferdinand Beernink, an obstetrician and gynecologist, in Berkeley and Sausalito, California. Over the course of the first six years of using the Ericsson method of sperm [7] separation and artificial insemination [9], ninety-one births occurred and sixty-eight of them were males. Those results produced a 75 percent male birth ratio. Beernink and Ericsson continued their clinical trial until 1993. They concluded the clinical trial with a total of 1,034 births after artificial insemination [9] with sperm [7] separated using the Ericsson method, 749 of which were male. Those results produced a 72 percent male birth ratio, only slightly lower than their results eleven years prior. Beernink and Ericsson published their results in the journal *Fertility and Sterility* the same year the study concluded. In their article, the authors claimed that to date, the Ericsson method was the only clinical method of pre-conception [13] sex selection favoring males that had been continuously supported by scientific data.

However, other researchers have contested the method's effectiveness at skewing the sex ratio in favor of males. In 1994, Ericsson published an article in the journal *Human Reproduction*, in which he specifically addressed the studies conducted in the twenty years after the development of his method that did not support his results. He claimed that those studies did not duplicate his original methods correctly, and therefore were unable to definitively evaluate his work. Ericsson provided examples of how his methods were reproduced incorrectly, including over-staining of the separated sperm [7] cells, failure to remove immotile cells that remained at the top of the albumin column effectively, and increasing the temperature at which the experiment was performed from thirty-five to thirty-seven degrees Celsius. In the article, Ericsson stated that researchers who did not replicate his method accurately essentially conducted experiments that were completely unrelated to his. Therefore, he concluded that those studies did not correctly confirm or contrast the results from his original publication and should thus be dismissed entirely.

In 1997, another study published in *Human Reproduction* attempted to make definitive conclusions on the effectiveness of the Ericsson method. That study replicated the original methods exactly, and also addressed the alterations made in previous studies that did not confirm Ericsson's initial results. The experiment was conducted at Taichung Veterans General Hospital's Department of Obstetrics and Gynecology in Taichung, Taiwan. The researchers examined semen [8] samples from twenty-one healthy males. Even after following Ericsson's methods precisely, the researchers failed to show that Ericsson's albumin method of sperm [7] separation produced an enrichment of sperm [7] cells that carried Y chromosomes. In fact, the results produced a slightly increased concentration of X chromosome-bearing sperm [7] cells in the sample collected at the bottom of the albumin column, which contradicted Ericsson's original finding. The 1997 study did not use the separated sperm [7] samples for artificial insemination [9] to see if the sex ratio was affected. However, the results did not confirm Ericsson's results from his initial study.

Despite the inconclusive data that both supports and invalidates the Ericsson method, the method is still utilized for sex selection at Gametrics Limited. As of 2018, Ericsson is the president of Gametrics Limited, a company he created that has exclusive access to his patented method of sperm [7] separation using albumin columns. While the company's headquarters are in Alzada, Montana, it has licensed laboratories, called Sperm Centers, which offer the Ericsson albumin method both in the US and internationally. According to the Gametrics Limited website, thousands of children have been born using the Ericsson method, but the success rates for couples that have achieved their desired sex are not advertised directly. Instead, the website provides twelve citations of scientific papers that discuss the development of the Ericsson method and data from clinical trials that only support the method's effectiveness. In a memorandum from the company published in October 1987, Gametrics Limited claimed their Sperm Centers have demonstrated an 86 percent success rate for producing a male offspring. Since then, there have been no additional memorandums from the company.

Sources

1. Beernink, Ferdinand, and Ronald Ericsson. "Male Sex Preselection Through Sperm Isolation." *Fertility and Sterility* 38 (1982): 493–5. http://www.fertstert.org/article/S0015-0282(16)46587-8/pdf [17] (Accessed March 28, 2018).
2. Beernink, Ferdinand, and Ronald Ericsson. "Sex Preselection Through Albumin Separation of Sperm." *Fertility and Sterility* 59 (1993): 382–6. http://www.fertstert.org/article/S0015-0282(16)55681-7/pdf [18] (Accessed March 28, 2018).
3. Carson, Sandra Ann. "Sex Selection: The Ultimate in Family Planning." *Fertility and Sterility* 50 (1988): 16–19. http://www.fertstert.org/article/S0015-0282(16)60000-6/pdf [19] (Accessed March 28, 2018).

4. Chen, Ming-Jer. “Efficiency of Sex Pre-Selection of Spermatozoa by Albumin Separation Method Evaluated by Double-Labeled Fluorescence In-situ Hybridization.”*Human Reproduction* 12 (1997): 1920–6. https://pdfs.semanticscholar.org/054b/6483053c8908039ada874f3a2de9dbb7ccee.pdf [20] (Accessed March 28, 2018).
5. Dmowski, Paul. “Use of Albumin Gradients for X and Y Sperm Separation and Clinical Experience with Male Sex Preselection.”*Fertility and Sterility* 31 (1979): 52–7. http://www.fertstert.org/article/S0015-0282(16)43760-X/pdf [21] (Accessed March 28, 2018).
6. Ericsson, Ronald. “Fractionation of Sperm”. US Patent 4009260A filed 11 December 1974, and issued 22 February 1977.
7. Ericsson, Ronald. “Isolation of Fractions Rich in Human Y Sperm.”*Nature* 246 (1973): 421–4.
8. Ericsson, Ronald. “Sex Selection via Albumin Columns: 20 Years of Results.”*Human Reproduction* 9 (1994): 1787–91.
9. Glass, Robert, and Ronald Ericsson. *Getting Pregnant in the 1980s*. Berkeley and Los Angeles: University of California Press, 1982.https://books.google.com/books?id=0mJI3FUJj-UC&pg=PP8&lpg=PP8&dq=Getting+Pregnant+in+the+1980s+glass+robert&source=bl&ots=MOujhyKkzz&sig=SycXxGQiJRVLKBFyWa4QlcFZSXI&hl=en&sa=X&ved=0ahUKEwjik-zCj5DaAhUSZawKHdngBnoQ6AEISDAK#v=onepage&q&f=false [22] (Accessed March 28, 2018).
10. Rorvik, David Michael and Landrum, B. Shettles. *How to Choose the Sex of Your Baby: The Method Best Supported by Scientific Evidence* New York City: Broadway Books, 2006. https://archive.org/details/howtochoosesexof00shet [23] (Accessed March 27, 2018).

In 1973, Ronald Ericsson developed the Ericsson method, which is a technique used to separate human male sperm cells by their genetic material. Ericsson, a physician and reproduction researcher, developed the method while conducting research on sperm isolation in Berlin, Germany, in the early 1970s. He found that the sperm cells that carry male-producing Y chromosomes move through liquid faster than the cells that carry female-producing X chromosomes. As a result of his findings, Ericsson suggested suspending a semen sample in a viscous liquid made from albumin protein, and collecting only sperm that quickly pass through the liquid. Shortly after Ericsson described his method, researchers demonstrated that it was effective for sex selection. However, later studies contested those results. Despite that, the Ericsson method is still utilized by couples in 2018 as a means of sex selection and was the first sperm separation technique used in combination with artificial insemination to enable people to select the sex of their children.

Subject
Sex chromosomes [24] Gonosomes [25] Sperm [26] Male gametes [27] Spermatozoa [28] Sex Preselection [29] X-Chromosome-Bearing Sperm [30] Y-Chromosome-Bearing Sperm [31]

Topic
Technologies [32]

Publisher
Arizona State University. School of Life Sciences. Center for Biology and Society. Embryo Project Encyclopedia.

Rights

Format
Articles [33]

Last Modified
Friday, September 20, 2019 - 21:14

DC Date
2019-09-20

DC Date Accessioned
Friday, September 20, 2019 - 21:07

DC Date Available
Friday, September 20, 2019 - 21:07

DC Date Created
2019-09-20

- The Embryo Project at Arizona State University, 1711 South Rural Road, Tempe Arizona 85287, United States

---