Ericsson Method of Sperm Separation [1]


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 separation [7] in 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 sperm 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 [8] 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 cells are responsible for determining the sex of an embryo. If the male sperm cell that fertilizes a female egg contains a Y chromosome, the embryo is male. If the male sperm cell that fertilizes the egg contains an X chromosome, the embryo is female. The mechanism of sex determination is, therefore, the ability of sperm cells to move throughout the female reproductive tract to reach and fertilize an egg [9].

During the late twentieth century, emerging research suggested a difference between X chromosome-bearing sperm cells and Y chromosome-bearing sperm 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 cells. Shettles's idea stimulated interest in the field of reproductive biology on sperm cells based on those physical characteristics that had the potential to affect physiological capabilities of sperm cells, such as motility. This research served as a precursor for the development of the Ericsson method.

In the early 1970s, Ericsson, a physician who specialized in reproductive hormones [10], conducted research on sperm separation [11] 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 cells must swim through for fertilization [12] to occur, effectively separated Y chromosome-bearing sperm cells from X chromosome-bearing sperm cells. To test his ideas further, Ericsson filled glass tubes, or separation columns, with the liquid albumin and exposed sperm cells to the column. 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 cells.

In his experiment, Ericsson took a sperm sample and placed it on top of a solution of 25 percent liquid albumin in a glass column. The sperm 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 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 cells that remained at the bottom of the column were faster, and therefore more successful at fertilizing. Ericsson then separated the sperm 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 cells that accounted for about 10 percent of the original sample remained. Ericsson then washed and stained the cells with fluorescent quinacrine, a fluorescent chemical, to determine which sex chromosome the sperm cells carried. Prior research had demonstrated that fluorescent 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 cells in the separated sample carried Y chromosomes.

With that result, Ericsson explicitly demonstrated that albumin was the most appropriate medium to effectively separate sperm cells based on what sex chromosome they carried. Albumin is the ideal consistency for sperm separation because its viscosity inhibits the movements of poorly swimming cells. Furthermore, Ericsson and his colleagues concluded that because the sample sperm cells collected at the bottom of the column had a high concentration of Y chromosome-bearing cells, those sperm cells were more agile and swim faster than X chromosome-bearing sperm 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 became known as the Ericsson method.

In its early development, the Ericsson method’s primary use was not for pre-conception sex selection. In December 1974, Ericsson patented his method and included the objectives of his sperm separation technique, which he listed in order of importance. Ericsson’s primary objective was to provide a process for separating human male sperm samples into samples that have an enriched concentration of sperm cells carrying Y chromosomes. Next, he listed using the enhanced Y chromosome-bearing-sperm fraction for artificial insemination to increase the likelihood of male offspring, and did not list actions on how to do so in the patent. However, artificial insemination, the process in which sperm is injected directly into a female’s uterus for fertilization, was already a common practice at the time Ericsson patented his method. In order for someone to use the Ericsson method for pre-conception sex selection, couples would need to inject the Y chromosome-bearing sperm cells directly into a female’s uterus with an egg, using a syringe after the sperm cells are separated through the albumin medium. In his patent, Ericsson briefly mentioned that the method could be used for family planning. 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 separation for pre-conception 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 sex selection. Prior to that clinical trial, studies had shown that the method was effective for collecting sperm samples with high concentrations of Y chromosome-bearing sperm cells. But there was no evidence that those samples successfully created male offspring because they had not yet been tested using artificial insemination, and it was still unclear if X chromosome-bearing sperm cells were still X chromosome-bearing present in the sample. In 1975 physician Paul Dmowski, who specialized in obstetrics and gynecology and his team of researchers at the University of Missouri School of Medicine in St. Louis, conducted a clinical trial to test whether the separated samples produced by the Ericsson method affected the sex ratio of human conception. During that initial clinical trial, physicians successfully inseminated seven women using artificial insemination with sperm cells 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 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 Ypsilanti, Michigan. The researchers examined sperm samples from twenty-one healthy males. Even after following Ericsson’s methods precisely, the researchers failed to show that Ericsson’s albumin method [14] separation produced an enrichment of sperm cells that carried Y chromosomes. In fact, the results produced a slightly increased concentration of X chromosome-bearing sperm cells in the sample collected at the bottom of the albumin column, which contradicted Ericsson’s original finding. The 1976 study did not use the separated sperm samples for artificial insemination to see if the sex ratio was affected. However, the results did not confirm Ericsson’s results from his initial study.

In 1979, another study conducted 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 Taiwan. The researchers examined sperm samples from twenty-two healthy males. Even after following Ericsson’s methods precisely, the researchers failed to show that Ericsson’s albumin method separation produced an enrichment of sperm cells that carried Y chromosomes. In fact, the results produced a slightly increased concentration of X chromosome-bearing sperm cells in the sample collected at the bottom of the albumin column, which contradicted Ericsson’s original finding. The 1979 study did not use the separated sperm samples for artificial insemination 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 Gametes Limited. As of 2018, Ericsson is the president of Gametics Limited, a company he created that has exclusive access to his patented method of sperm separation using albumin columns. While the company’s headquarters are in Alzada, Montana, it has laboratories, called Sperm Centers, which offer the Ericsson albumin method both in the US and internationally. Instead of the Gametics 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 and data from clinical trials in conjunction with this method. For example, Gametics Limited claimed their Sperm Centers have demonstrated an 86 percent success rate for producing a male offspring. Since then, there have been no additional amendments from the company.

Sources
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