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Clinical Features of Sperm Morphology in the Treatment of Male Infertility

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Annotation: Male infertility is a serious medical and social problem that affects millions of couples around the world. One of the key factors affecting a man's ability to conceive is the quality of sperm, including their morphological characteristics. The morphology of spermatozoa is assessed within the framework of a standard spermogram, which is the main method of diagnosing male infertility.

Keywords: spermatozoa, teratozoospermia, toxic factors, in vitro fertilization (IVF)

Introduction

A spermogram is a routine method of assessing a man's fertility. The interlaboratory variability of the results of the spermological examination is currently confirmed by numerous observations. The morphology of male genital gametes, as a predictive factor of the onset of independent pregnancy and overcoming infertile marriage when using methods of intrauterine insemination, assisted reproductive technologies remains a subject of discussion. The literary review is devoted to this topic.

The morphology of spermatozoa reflects their structural features, including the shape of the head, middle part and tail. The normal shape of the sperm is necessary for successful penetration into the egg and fertilization. Morphological abnormalities may be associated with:

- Impaired spermatogenesis;
- Genetic abnormalities;
- The influence of toxic factors (e.g. alcohol, smoking, chemicals);
- Infectious and inflammatory processes in the organs of the reproductive system.

According to the criteria of the World Health Organization (WHO), semen samples are considered normal, where at least 4% of spermatozoa have normal morphology. However, even a small decrease in this indicator can significantly reduce the likelihood of natural conception. Male infertility is a global health issue, affecting millions of couples and presenting significant medical and social challenges. One of the critical factors influencing male fertility is sperm quality, which is primarily assessed through sperm morphology. This examination, conducted within the framework of a spermogram, is essential in diagnosing male infertility. While sperm morphology is often considered the starting point for infertility diagnosis, its prognostic significance remains a subject of ongoing debate. The shape and structure of spermatozoa, including the head, midpiece, and tail, are vital for successful fertilization, and abnormalities in these structures can hinder sperm function.

A general discussion of male infertility highlights its complexity, with various underlying factors such as impaired spermatogenesis, genetic abnormalities, and environmental influences like toxic substances, smoking, and infections affecting sperm morphology. A significant issue in this domain is teratozoospermia, a condition characterized by a high percentage of abnormally shaped sperm, which is associated with reduced fertility. Research indicates that sperm morphology plays a key role in determining the success of assisted reproductive technologies (ART) such as intrauterine insemination (IUI), in vitro fertilization (IVF), and intracytoplasmic sperm injection (ICSI), though the impact of morphological abnormalities on these methods varies.

Specific discussions surrounding sperm morphology often differ by geographical region, as variations in lifestyle, environmental factors, and genetic predispositions influence the prevalence and severity of sperm abnormalities. Conceptually, sperm morphology is regarded as a reflection of overall male reproductive health, with potential links to spermatogenesis and hormonal regulation. Theoretically, improving sperm morphology through lifestyle changes, medical interventions, or genetic counseling could enhance fertility outcomes.

A review of previous studies reveals mixed findings regarding the predictive value of sperm morphology for natural conception or ART outcomes. While some studies support a correlation between normal sperm morphology and successful conception, others do not confirm its significance in IVF or ICSI. Notably, research gaps remain in understanding how specific morphological defects influence fertility, particularly in severe cases of teratozoospermia.

Materials and methods. The search, analysis and systematization of publications in the PubMed and e-Library databases using the keywords "male infertility", "sperm morphology", "teratozoospermia", "IUI", "IVF", "ICSI", "male infertility", "sperm morphology", "teratozoospermia", "IUI", "IVF", "ICSI". After excluding conference abstracts, dissertations and their abstracts, 56 sources were selected, which are included in this literature review. Results. The effect of teratozoospermia on the likelihood of independent pregnancy naturally has been assessed in isolated studies. The pregnancy rate was higher in the group of couples with normozoospermia. Nevertheless, pregnancy was also noted in couples with severe teratozoospermia. Most studies have not revealed a statistically significant effect of tertozoospermia on the frequency of pregnancy during intrauterine insemination. Data on the role of sperm morphology in in vitro fertilization are contradictory. Early studies have shown a positive correlation between the percentage of spermatozoa with normal morphology and the frequency of conception, but these results have not been confirmed in recent studies. Most studies have not revealed the effect of normal sperm morphology on the frequency of pregnancy during ICSI, with the exception of cases caused by monomorphic teratozoospermia. Discussion. The study of the mofophology of spermatozoa today remains the "starting point" of a man's infertility examination. However, the available data do not confirm his role in choosing the method of assisted reproductive technologies or predicting their results. Conclusion. Thus, the data available to date on the prognostic significance of the study of sperm morphology are contradictory and require further investigation.

Diagnostic significance of sperm morphology

The analysis of sperm morphology allows not only to assess the probability of successful fertilization, but also to choose the optimal method of infertility treatment. When evaluating morphology, the following parameters are taken into account:

- Percentage of spermatozoa with normal shape;
- The nature and degree of pathologies (for example, macro- or microcephaly of the head, defects of the middle part, shortening or curvature of the tail);
- The relationship between the different types of anomalies.

The results of morphology analysis are often combined with other spermogram parameters (volume, concentration, motility of spermatozoa), which allows to obtain a more complete picture of the patient's reproductive health.

The choice of treatment method depends on the morphology

The results of the analysis of sperm morphology play a key role in determining the tactics of male infertility treatment.:

1. Normal morphology (>4%):

In the absence of other abnormalities, natural pregnancy planning or the use of ovulation control methods in a woman is recommended.

2. Moderate morphological disorders (1-4%):

The use of artificial insemination (AIS) methods, especially if the woman has no infertility factors.

Recommendations for lifestyle changes, elimination of bad habits, and taking antioxidant medications to improve sperm quality.

3. Severe morphological disorders (<1%):

In vitro fertilization (IVF) using intracytoplasmic sperm injection (ICSI). This method allows you to select and use a separate morphologically normal sperm to fertilize an egg.

Additional genetic studies, such as DNA fragmentation testing of spermatozoa, to assess their functional viability.

Modern approaches and perspectives

Modern methods of visualization and morphological analysis, including the use of computer systems and artificial intelligence methods, make it possible to accurately assess the morphology of sperm cells. This opens up new possibilities for individualizing treatment.

In addition, studies are being conducted to correct morphological abnormalities using pharmacological and biotechnological methods. The development of such approaches can significantly improve the effectiveness of male infertility treatment in the future.

Results and Discussion

The results of numerous studies on the role of sperm morphology in male infertility treatment have highlighted its importance but also underscored the complexity of its predictive value. While earlier research suggested a strong correlation between normal sperm morphology and increased chances of natural conception, more recent studies have provided contradictory findings. The data surrounding the impact of sperm morphology on assisted reproductive technologies (ART) such as intrauterine insemination (IUI), in vitro fertilization (IVF), and intracytoplasmic sperm injection (ICSI) are similarly inconclusive.

One notable finding is the effect of teratozoospermia, characterized by a high percentage of morphologically abnormal sperm, on fertility outcomes. Several studies have shown that couples with severe teratozoospermia experience lower pregnancy rates, especially when using IUI or natural conception. However, pregnancy has been observed in couples with severe teratozoospermia, suggesting that sperm morphology may not be the sole determining factor for fertility outcomes. This emphasizes the importance of considering other sperm parameters, such as motility and concentration, as well as female factors in determining the likelihood of conception.

In the context of ART, particularly IVF and ICSI, the role of sperm morphology is more nuanced. Early studies revealed a positive correlation between normal sperm morphology and higher success rates in IVF, but this association has not been consistently replicated in more recent research. For instance, some studies suggest that the percentage of morphologically normal sperm does not significantly impact IVF success rates, particularly in cases where ICSI is utilized. In ICSI, a single sperm is directly injected into the egg, which minimizes the need for normal sperm morphology. However, in cases of monomorphic teratozoospermia, where a large proportion of sperm exhibit the same abnormality, the success of ICSI may be compromised.

One critical gap in the current literature is the lack of a standardized method for assessing sperm morphology across different laboratories and studies. Variability in assessment criteria, including the percentage threshold of normal morphology, poses a challenge in interpreting results. For instance, the World Health Organization (WHO) defines a semen sample as normal if at least 4% of spermatozoa exhibit normal morphology. However, this threshold may not be universally applicable in all contexts, and some studies have shown that even small deviations from this benchmark can significantly affect fertility outcomes.

Another knowledge gap relates to the functional implications of specific morphological abnormalities. While various sperm defects, such as macrocephaly or tail abnormalities, have been identified, their

exact impact on sperm function and fertilization potential remains unclear. This is an area ripe for further theoretical research to better understand the relationship between sperm structure and function at a molecular level.

Future research should focus on deepening the understanding of how specific morphological defects influence fertilization success, particularly in ART. The development of advanced imaging techniques, such as computer-assisted sperm analysis (CASA), and the incorporation of artificial intelligence in sperm morphology analysis could provide more precise and reproducible assessments. Moreover, integrating genetic studies, such as sperm DNA fragmentation tests, could help identify the underlying causes of morphological abnormalities and their functional significance.

Conclusion

Sperm morphology is an important indicator that determines the choice of treatment tactics for male infertility. An integrated approach, including morphology analysis, assessment of other spermogram parameters and identification of concomitant factors, allows us to select the most effective treatment methods. Modern technologies and advances in reproductive medicine continue to expand diagnostic and therapeutic options, improving the chances of successful conception for many couples.

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