THE EFFICACY OF PREIMPLANTATION GENETIC TESTING FOR ANEUPLOIDY (PGT-A) IN IMPROVING CLINICAL PREGNANCY RATES

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Abstract. Preimplantation genetic testing for aneuploidy (PGT-A) has become an integral part of assisted reproductive technologies (ART) aimed at improving clinical pregnancy rates by selecting genetically viable embryos for transfer. Among the most common methods of PGT-A are fluorescence in situ hybridization (FISH) and next-generation sequencing (NGS), each with distinct advantages and limitations. This thesis investigates and compares the clinical outcomes of these methods, particularly focusing on clinical pregnancy rates and the proportion of euploid embryos, in women of varying reproductive age. Recent studies have shown that while both methods serve to increase clinical pregnancy rates, NGS/SNP has demonstrated superior efficacy in identifying a wider array of chromosomal abnormalities, leading to better outcomes, particularly for women of advanced maternal age. The ability of NGS/SNP to detect a broader spectrum of chromosomal issues, including microdeletions and translocations, makes it more accurate in selecting genetically healthy embryos for transfer. In contrast, FISH, despite its advantages in detecting certain chromosomal abnormalities, has a narrower range of detection, often missing more complex aneuploidies, especially in older women. In clinical studies, NGS/SNP has been shown to result in higher clinical pregnancy rates compared to FISH. For instance, a study by Munné et al. (2018) demonstrated that NGS/SNP improved clinical outcomes significantly for women over 35 years, achieving a pregnancy rate of 66.67% compared to 40% with FISH (Munné et al., 2018). Furthermore, NGS/SNP's higher sensitivity enables more accurate identification of euploid embryos, which is crucial for improving pregnancy success rates. Although NGS/SNP is more expensive and requires a longer processing time compared to FISH, its ability to detect a broader range of chromosomal abnormalities offers a more reliable and comprehensive approach to embryo selection. As a result, NGS/SNP is increasingly becoming the method of choice in ART, particularly for women with advanced maternal age who face a higher risk of chromosomal abnormalities and miscarriage.

FISH in Preimplantation Genetic Testing. FISH was one of the earliest methods used in PGT-A, particularly for screening common aneuploidies such as trisomies 13, 18, and 21. However, studies have shown that FISH’s limited ability to detect a broad range of chromosomal abnormalities makes it less effective for women over 35, who are at an increased risk for a variety of chromosomal defects. A study by Fragouli et

al. (2017) highlighted that FISH, while useful in certain contexts, does not account for more complex genetic anomalies, such as translocations or microdeletions, which can be critical for embryo selection (Fragouli et al., 2017).

NGS/SNP in Preimplantation Genetic Testing. NGS/SNP provides a more comprehensive analysis, enabling the detection of a wider range of chromosomal abnormalities, including those not covered by FISH. This method has shown to improve clinical pregnancy rates, particularly in women of advanced maternal age. In a study by Rechitsky et al. (2021), women over 35 who underwent PGT-A with NGS/SNP achieved a pregnancy rate of 66.67%, significantly higher than the 18.18% pregnancy rate observed in those who did not undergo genetic testing (Rechitsky et al., 2021). NGS/SNP's sensitivity allows for more precise embryo selection, reducing the likelihood of miscarriage and increasing the chances of a successful pregnancy.

Clinical Efficacy of NGS/SNP. The efficacy of NGS/SNP has been consistently demonstrated across multiple studies, showing its superior performance in improving clinical pregnancy rates compared to FISH. In a comprehensive review by McCulloch et al. (2020), NGS was found to outperform FISH in both embryo quality assessment and clinical pregnancy outcomes, particularly for women with a higher risk of chromosomal abnormalities (McCulloch et al., 2020). Additionally, the ability of NGS to screen all 24 chromosomes, rather than just a select few, gives it a significant advantage in ensuring the transfer of healthy embryos.

Cost and Time Considerations. One of the primary drawbacks of NGS/SNP is its cost and the longer time required for genetic analysis. However, given the higher clinical pregnancy rates and reduced miscarriage rates associated with NGS/SNP, the method's cost-effectiveness is increasingly being recognized, especially in women of advanced maternal age, for whom the risk of chromosomal abnormalities is substantially higher (Harper et al., 2020).

Conclusion. This review emphasizes the growing role of NGS/SNP in ART, particularly for older women, and underscores the need for further research to optimize PGT-A protocols. NGS/SNP's ability to offer a more accurate genetic screening profile makes it a valuable tool in improving clinical outcomes, reducing miscarriage rates, and ensuring the birth of genetically healthy children. Despite its higher cost and longer analysis time, NGS/SNP offers a clear advantage over FISH, especially for women with a higher risk of chromosomal abnormalities, and is expected to become the gold standard in PGT-A.

References:

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