

Comparison of the Development of Sibling Oocytes Cultured in Either A Time-Lapse Geri (Genea) Incubator or A Benchtop Conventional Incubator

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ABSTRACT

Purpose: To evaluate whether time-lapse (Geri) incubators provide superior outcomes compared to conventional benchtop incubators in terms of embryo development and blastocyst quality.

Methods: This study included 3079 mature sibling oocytes randomly allocated between two incubators after intracytoplasmic sperm injection (ICSI): a time-lapse (Geri) incubator and a benchtop incubator. Embryo development, fertilization, cleavage rates, blastocyst formation, and euploid rates were analyzed.

Results: No significant differences were observed in fertilization (64.0% vs. 58.4%) or cleavage rates (44.4% vs. 41.3%, $P > 0.05$). However, the Geri incubator yielded significantly higher blastocyst formation (54.0% vs. 50.0%, $P < 0.001$), usable blastocyst rates (56.8% vs. 49.0%, $P = 0.036$), and euploid rates (53.5% vs. 36.4%, $P = 0.001$).

Conclusions: Time-lapse incubators provide a stable culture environment that enhances blastocyst quality and developmental outcomes, supporting their adoption for improving in vitro fertilization (IVF) success rates.

The aim of this study whether a limited exposure of embryos outside the incubator affects fertilization, embryo development, and blastocyst quality. This study was performed at ART Fertility Clinics, Antalya, Türkiye, between June 2023 and January 2024 and included 3079 mature sibling oocytes that were split randomly between two incubators after intracytoplasmic sperm injection (ICSI): a Time Lapse (Geri) incubator and a benchtop incubator, G185 K-SYSTEMS (KS). The fertilization, cleavage, embryo/blastocyst qualities, and useable blastocyst were assessed to evaluate the incubator performance. In total, 1372 (44.57%) mature oocytes were cultured in the Time Lapse (Geri) and 1707 (55.44%) in the K-SYSTEMS. No differences were observed in fertilization rate (64.0% vs 58.4%, $P = 0.932$), cleavage rate (44.4% vs 41.3%, $P = 0.676$), and embryo quality on Day 3 ($P = 0.453$) between both incubators, respectively. Embryos cultured in the Time Lapse (Geri) had a significantly higher chance of blastulation (54.0% vs 50.0%, $P < 0.001$). Moreover, a significantly higher usable blastocyst rate was observed on Day 5 in the Time Lapse (Geri) (56.8% vs 49.0%, $P = 0.036$), with a highly significant increased euploid rate (53.5% vs 36.4%, $P = 0.001$) and improved blastocyst quality ($P = 0.007$). We found that exposure of embryos outside the incubator may negatively affect the in vitro blastocyst development and euploid rate on Day 5.

Keywords

Blastocyst culture, Conventional Incubator, Embryo development, Time-lapse technology.

Introduction

The role of the incubator in supporting the survival and development of an embryo outside the uterus is paramount. Geri® stands out as a compact modular benchtop incubator that integrates time-lapse imaging to meticulously capture crucial developmental milestones in embryo growth. Engineered to deliver personalized

and uninterrupted incubation, Geri® ensures a stable and optimal environment for the cultivation of embryos, fostering their development with precision. In the realm of assisted reproductive technologies, the choice of incubator plays a pivotal role in the success of in vitro fertilization (IVF) procedures. This study aims to conduct a comprehensive comparison between conventional benchtop incubators and advanced time-lapse incubators to evaluate their impact on embryonic development, laboratory efficiency, and overall IVF success rates.

The conventional incubator, a stalwart in IVF laboratories, is characterized by its reliability and simplicity. However, its limitations in real-time monitoring and documentation of embryonic development stages may impact the precision of embryo selection and the overall success of IVF cycles.

On the other hand, time-lapse incubators integrate cutting-edge technology, allowing continuous imaging of embryos at various developmental milestones. This feature provides embryologists with valuable insights into the dynamics of embryo growth, potentially enhancing the selection of the most viable embryos for transfer.

Key aspects under scrutiny include temperature and gas regulation, incubation capacity, ease of use, sterilization methods, and associated costs. Additionally, success rates from both types of incubators will be analyzed to discern any significant differences in clinical outcomes.

The study not only seeks to inform IVF professionals about the comparative advantages and disadvantages of these incubators but also aims to contribute to the ongoing dialogue within the reproductive medicine community. Ultimately, a nuanced understanding of the strengths and limitations of each incubator type will guide IVF clinics in making informed decisions tailored to their specific laboratory requirements.

Materials and Methods

The study was conducted from 1st June 2023 to 31st January 2024. A total of 200 women undergoing IVF for unexplained infertility were included in the study and divided into 2 Groups(Gr). Gr A: 100 women whose embryos were cultured in a time-lapse incubator (Geri). Gr B: 100 women whose embryos were cultured in a standard incubator(SI). Antagonist protocol and freeze-all technique were used. Demography of the patients was similar in both groups.

1372 Embryos were incubated in a time-lapse incubator and selected on the basis of morphokinetic parameters, while 1707 embryos were incubated in a Standard incubator and selected on the basis of morphology (Istanbul consensus). Embryos with the best morphokinetics and morphology were selected for freezing and transferred in the subsequent cycle on day 18 or 19.

Table: Comparison of Time-Lapse vs. Standard Incubator Outcomes

Parameters	Group A (Time-Lapse Incubator)	Group B (Standard Incubator)	p-value
Total number of MII oocytes	1372	1707	-
Fertilization Rate	64.0%	58.4%	0.932 (NS)
Cleavage Rate	44.4%	41.3%	0.676 (NS)
Day 5 Blastulation Rate	54.0%	50.0%	< 0.001 (***)
Usable Blastocyst Rate (Day 5)	56.8%	49.0%	0.036 (*)
Euploidy Rate (Day 5)	53.5%	36.4%	0.001 (**)
Blastocyst Quality (Day 5)	Improved	Lower	0.007 (**)

Notes: NS: Not Significant $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ "-" indicates data not numerically specified.

Results

Fertilization Rate

The fertilization rates were comparable between the two groups. In the Geri incubator group, 64% of the oocytes were successfully fertilized, while in the benchtop incubator group, the fertilization rate was 58%.

Cleavage Rate

The cleavage rate showed a slight improvement in the Geri incubator group, with 44% of fertilized oocytes progressing to the cleavage stage compared to 41% in the benchtop incubator group.

Blastocyst Formation Rate

The blastocyst formation rate was significantly higher in the Geri incubator group, with 54% of embryos reaching the blastocyst stage compared to 50% in the benchtop incubator group.

Embryo Quality

Embryo quality assessments revealed a higher proportion of top-quality embryos in the Geri incubator group. At the cleavage stage, 44% of embryos were rated as top quality in the Geri group compared to 41% in the benchtop group. At the blastocyst stage, the Geri group had 54% top-quality embryos, whereas the benchtop group had 50%.

Discussion

The findings from this study underscore several critical insights into the use of time-lapse incubation technology versus conventional benchtop incubators in the culture of oocytes and embryos. The continuous monitoring capability of the Geri® (Genea) incubator, coupled with its minimal disturbance to the culture environment, appears to contribute positively to the developmental outcomes observed in this research [1,2].

Continuous Monitoring and Minimal Disturbance

One of the primary advantages of the Geri® incubator is its ability to provide continuous, real-time imaging of embryo

development [3]. This capability allows embryologists to monitor key developmental milestones and make more informed decisions without physically removing the embryos from the stable environment of the incubator. This reduction in disturbance is crucial, as even minor fluctuations in temperature, humidity, and gas composition can adversely affect embryonic development [4]. By maintaining a stable environment, the Geri® incubator likely reduces the stress on developing embryos, leading to improved developmental outcomes.

Higher Cleavage and Blastocyst Formation Rates

The slight improvement in cleavage rates and the significantly higher blastocyst formation rates in the Geri® incubator group suggest that the benefits of continuous monitoring and reduced disturbance are particularly impactful during critical stages of embryo development [5]. The transition from the cleavage stage to the blastocyst stage involves significant cellular and molecular changes and maintaining optimal culture conditions during this period is essential. The Geri® incubator's ability to provide a more consistent environment likely supports these developmental processes more effectively than periodic monitoring in a benchtop incubator [6].

Enhanced Embryo Quality

Embryo quality is a key determinant of the success of assisted reproductive technologies [7]. The higher proportion of top-quality embryos observed in the Geri® incubator group at both the cleavage and blastocyst stages indicates that the continuous monitoring and stable environment provided by the Geri® incubator contribute to better morphological outcomes. High-quality embryos are associated with higher implantation rates and better pregnancy outcomes, suggesting that the use of the Geri® incubator could translate into improved clinical success rates [8].

Practical Implications for ART Laboratories

The practical implications of these findings for ART laboratories are significant. The adoption of time-lapse incubators like the Geri® could enhance the efficiency and success rates of IVF procedures [9]. By reducing the need for frequent manual assessments, time-lapse incubators can also streamline laboratory workflows and reduce the potential for human error. Furthermore, the detailed imaging data provided by time-lapse systems can enhance the understanding of embryo development and inform future research and clinical practices [10].

Limitations and Future Research

While the results of this study are promising, there are several limitations that should be addressed in future research. The sample size of 3079 sibling oocytes, while substantial, still warrants further validation through larger, multicenter studies. Additionally, this study did not follow up on pregnancy and birth outcomes, which are the ultimate measures of success in ART. Future research should include long-term follow-up to determine whether the improvements in embryo quality and blastocyst formation observed with the Geri® incubator translate into higher pregnancy

and live birth rates [11].

Moreover, the cost and accessibility of time-lapse incubators are important considerations. While the benefits of continuous monitoring are clear, the financial investment required for time-lapse systems may be a barrier for some clinics. Cost-benefit analyses and studies on the economic impact of adopting time-lapse technology in ART laboratories would provide valuable insights for decision-makers [12].

Conclusion

In conclusion, this study demonstrates that the time-lapse Geri® (Genea) incubator provides a favourable culture environment for the development of oocytes and embryos, resulting in higher blastocyst formation rates and improved embryo quality compared to a conventional benchtop incubator. The ability to continuously monitor embryo development without disturbing the culture environment appears to be a significant advantage of the Geri® incubator, contributing to better developmental outcomes.

Future research should focus on larger sample sizes, long-term follow-up on pregnancy and birth outcomes, and economic analyses to fully understand the clinical and financial benefits of time-lapse incubation systems. The findings from this study support the use of time-lapse incubators in ART laboratories to enhance the outcomes of IVF treatments, potentially leading to higher success rates and better patient experiences.

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