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Effect of hyaluronic acid-enriched transfer medium on pregnancy outcomes in frozen embryo transfer cycles: A retrospective study

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ABSTRACT

Objective: To compare pregnancy outcomes between a hyaluronic acid (HA)-enriched transfer medium and a conventional HA-free transfer medium in frozen embryo transfer cycles.**Methods:** We conducted a retrospective cohort study at Hung Vuong Hospital including frozen embryo transfer (FET) cycles performed between May 2023 and February 2025. Cycles were classified according to the transfer medium used: HA-enriched EmbryoGlue (EG) *versus* Continuous Single Culture-NX Complete (CSCM-NXC). Outcomes included positive human chorionic gonadotropin (hCG), clinical pregnancy, ongoing pregnancy, live birth, and pregnancy loss.**Results:** A total of 840 FET cycles were analyzed (EG, $n=445$; CSCM-NXC, $n=395$). Pregnancy outcomes were comparable between groups. Use of EG was not associated with higher rates of positive hCG (40.67% *vs.* 41.77%) or live birth (27.87% *vs.* 28.86%). Adjusted analyses similarly showed that transfer medium type was not associated with positive hCG [adjusted odds ratios (aOR) 0.92, 95% CI 0.69-1.22] or live birth (aOR 0.92, 95% CI 0.67-1.25).**Conclusions:** In this retrospective cohort, use of an HA-enriched transfer medium was not associated with improved pregnancy outcomes in FET cycles.**KEYWORDS:** *In vitro* fertilization; Frozen embryo transfer; Hyaluronic acid; Pregnancy outcomes; EmbryoGlue; Embryo transfer medium; Live birth; Clinical pregnancy

assisted reproductive technology and accounts for an increasing proportion of embryo transfers worldwide[1]. Improvements in cryopreservation techniques, particularly vitrification, have enhanced embryo survival rates and pregnancy outcomes[2]. With the growing use of FET, optimizing each procedural step, including embryo transfer, remains important for further improving treatment

Key Points

Question: Does a hyaluronic acid-enriched transfer medium improve pregnancy outcomes in frozen embryo transfer cycles?**Findings:** In this retrospective cohort study of 840 frozen embryo transfer cycles, pregnancy outcomes were similar between cycles using a hyaluronic acid-enriched medium and those using a conventional medium, with no statistically significant differences.**Meaning:** Routine use of hyaluronic acid-enriched transfer medium may not provide additional clinical benefit in unselected patients undergoing frozen embryo transfer.✉To whom correspondence may be addressed. E-mail: tranphuonghuy1994@gmail.com

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1. Introduction

Frozen embryo transfer (FET) has become a major component of

success.

Embryo transfer medium may influence embryo-endometrium interaction at implantation[3]. Hyaluronic acid (HA), a naturally occurring glycosaminoglycan present in the female reproductive tract, has been proposed as an adhesion-promoting component during embryo transfer[4]. Its main receptor, CD44, is expressed on both embryonic and endometrial surfaces[5]. Through HA-CD44 interactions, HA-enriched media are hypothesized to enhance embryo adherence and better resemble the intrauterine environment, thereby potentially improving implantation and subsequent pregnancy outcomes[6]. EmbryoGlue (EG) is a commercially available transfer medium enriched with HA and has been introduced to support these proposed mechanisms.

Evidence regarding the effectiveness of HA-enriched transfer media remains mixed. Some studies and meta-analyses have reported higher pregnancy rates with HA-enriched media, particularly in selected populations such as patients with recurrent implantation failure (RIF), transfers involving poor-quality embryos, or autologous cycles[5,7–9]. In contrast, other studies have found no improvement in pregnancy outcomes among women with previous *in vitro* fertilization (IVF) failures[10] or in transfers involving low-grade embryos[11]. Moreover, several randomized controlled trials have reported that HA-enriched transfer media do not significantly increase live birth rates in FET cycles compared with standard HA-free media[12,13].

Given these inconsistent findings, additional real-world evidence is warranted, particularly in the FET setting where synchronization between endometrial receptivity and embryo competence is considered important for implantation. Therefore, this study aimed to compare pregnancy outcomes in patients undergoing FET using HA-enriched EG *versus* a conventional HA-free transfer medium, Continuous Single Culture-NX Complete (CSCM-NXC). We evaluated pregnancy outcomes to determine whether the use of HA-enriched medium is associated with improved outcomes in routine FET practice.

2. Methods

2.1. Study design and population

This single-center retrospective cohort study was conducted at Hung Vuong Hospital, Vietnam. We screened all consecutive FET cycles performed between May 2023 and February 2025. To reduce selection bias, we included consecutive eligible first autologous FET cycles and applied prespecified inclusion and exclusion criteria. Inclusion criteria were: (1) transfer of vitrified-warmed day 3 or day 5 embryos; (2) single or double embryo transfer; and (3) complete follow-up for pregnancy outcomes. Exclusion criteria were: (1) donor gametes or surrogacy cycles; (2) preimplantation genetic

testing cycles; and (3) known uterine abnormalities that could impair implantation.

The sample size was determined by the number of eligible consecutive first autologous FET cycles during the study period; therefore, no formal sample size calculation was performed. The dataset was directly extracted from the medical record database, and a flow diagram with exclusion counts was not constructed. The final analytic cohort comprised all eligible cycles with complete outcome ascertainment.

Cycles were classified according to the transfer medium used in routine practice: an HA-enriched transfer medium (EmbryoGlue; Vitrolife, Sweden) or a conventional HA-free medium (Continuous Single Culture - NX Complete; Irvine Scientific, USA). The choice of transfer medium was primarily driven by supply availability rather than patient prognosis, and both media were used in parallel throughout the study period; no randomization was performed. To address potential confounding, we prespecified multivariable logistic regression adjusting for key prognostic factors, including maternal age, embryo stage at transfer, number of embryos transferred, and number of good-quality embryos transferred.

Baseline characteristics were obtained from medical records, including age, body mass index (BMI), anti-Müllerian hormone (AMH), infertility duration, and infertility diagnosis. Laboratory variables included the number of oocytes retrieved, number of mature oocytes, and embryo quality. Pregnancy outcomes included positive human chorionic gonadotropin (hCG), clinical pregnancy, ongoing pregnancy, live birth, and pregnancy loss.

A preliminary analysis of 348 cycles was previously presented at a conference with implantation outcomes reported[14]. The current study expands on this by analyzing 840 cycles and reporting additional outcomes.

2.2. IVF procedure

All patients were managed using standardized institutional protocols. Briefly, antagonist protocol was used for controlled ovarian stimulation. Oocyte retrieval was performed under transvaginal ultrasound guidance. Following retrieval, oocytes were fertilized using intracytoplasmic sperm injection (ICSI). Embryos were cultured using single-step culture medium. All viable embryos were vitrified. Embryo selection for transfer was performed based on morphological grading[15].

For endometrial preparation in FET cycles, hormone replacement therapy was used. Embryo transfer was performed on day 3 or day 5 of progesterone administration depending on embryo stage. Transfer dishes and media were prepared and equilibrated in advance. On the day of transfer, warmed embryos were incubated in the assigned transfer medium prior to transcervical embryo transfer using a catheter (Frydman, Laboratoire CCD, France) under ultrasound guidance.

2.3. Pregnancy outcomes

Pregnancy outcomes were evaluated per transfer cycle. Positive hCG result was defined as a positive hCG test according to institutional criteria. Clinical pregnancy was defined as ultrasonographic confirmation of an intrauterine gestational sac with a fetal heartbeat at 7-8 weeks of gestation. Ongoing pregnancy was defined as a pregnancy continuing beyond 12 weeks of gestation. Live birth was defined as delivery of at least one live-born infant. Pregnancy loss was defined as any pregnancy loss per cycle. Pregnancy outcomes were routinely captured in the hospital medical record; loss to follow-up was minimal.

2.4. Statistical analysis

Data analysis was conducted using R software. Normality of continuous variables was assessed using the Shapiro-Wilk test and visual inspection. As most continuous variables were non-normally distributed, they were summarized as median with interquartile range (IQR) and compared between groups using the Mann-Whitney *U* test (Wilcoxon rank-sum test). Categorical variables were summarized as counts and percentages and compared using the Pearson's *Chi*-square test or Fisher's exact test when appropriate.

For pregnancy outcomes, unadjusted associations between transfer medium and each binary outcome were estimated using univariable logistic regression and reported as crude odds ratio (*OR*) with 95% confidence interval (*CI*). Differences in outcome proportions were also assessed using *Chi*-square/Fisher's exact tests. Multivariable logistic regression models were prespecified to estimate adjusted odds ratio (*aOR*) with 95% *CI* for the two primary endpoints (positive hCG and live birth), adjusting for maternal age, embryo stage at transfer, number of embryos transferred, and number of good-quality embryos transferred. There were no missing data for variables included in the analyses. All tests were two-sided, and $P < 0.05$ was considered statistically significant. No subgroup or sensitivity analyses were performed.

2.5. Ethics statement

The study was approved by the Hung Vuong Hospital Ethics Committee (CS/HV/25/38; approval date: October 24, 2025). Given the retrospective nature of the study, the requirement for informed consent was waived.

3. Results

3.1. Baseline characteristics

A total of 840 eligible first autologous FET cycles were included (CSCM-NXC, $n=395$; EG, $n=445$). Baseline characteristics are summarized in Table 1. The two groups were comparable in maternal age (median 31 years *vs.* 32 years), BMI (22.0 kg/m² *vs.* 22.0 kg/m²), AMH (3.09 ng/mL *vs.* 3.23 ng/mL), and infertility duration (3.0 years *vs.* 3.0 years), with no statistically significant differences. The distribution of infertility causes was also similar between two groups ($P > 0.05$).

3.2. Laboratory and transfer characteristics

Laboratory characteristics of the IVF cycle and transfer characteristics are shown in Table 2. Ovarian response and embryology metrics were comparable between two groups, including the number of oocytes retrieved (median 14 in both groups), mature oocytes (median 11), normally fertilized two-pronuclei (2PN) zygotes (median 9 *vs.* 10), day-3 embryos (median 9 *vs.* 10), blastocysts (median 5), and good-quality blastocysts (median 2), with no significant between-group differences. Transfer characteristics were also similar, including embryo stage at transfer (Day 5: 82.8% *vs.* 83.6%), the proportion of single embryo transfer (63.8% *vs.* 62.0%), and the distribution of good-quality embryos transferred ($P=0.09$).

Table 1. Clinical characteristics of the included cycles.

Characteristics	CSCM-NXC ($n=395$)	EG ($n=445$)	<i>P</i> value
Age, years, median (IQR)	31 (29-35)	32 (29-36)	0.51
Body mass index, kg/m ² , median (IQR)	22.0 (20.0-23.7)	22.0 (20.0-24.0)	0.27
Anti-Müllerian hormone, ng/mL, median (IQR)	3.09 (1.96-5.24)	3.23 (1.89-5.20)	0.77
Infertility duration, years, median (IQR)	3.0 (1.2-4.0)	3.0 (1.8-5.0)	0.19
Infertility reasons, <i>n</i> (%):			0.06
Tubal factor	44 (11.14)	60 (13.48)	
Polycystic ovary syndrome	20 (5.06)	28 (6.29)	
Endometriosis	16 (4.05)	11 (2.47)	
Unexplained infertility	27 (6.84)	51 (11.46)	
Male factor	115 (29.11)	133 (29.88)	
Other reasons	173 (43.8)	162 (36.4)	

Data are expressed as median (IQR) or *n* (%); *P* values are calculated using Wilcoxon rank-sum test for continuous variables and *Chi*-square test for categorical variables. CSCM-NXC: Continuous Single Culture-NX Complete; EG: EmbryoGlue.

3.3. Pregnancy outcomes

Table 3 shows that pregnancy outcomes were comparable between CSCM-NXC and EG. Positive hCG occurred in 41.77% *vs.* 40.67% (*OR* 0.96, 95% *CI* 0.73-1.26; *P*=0.75), clinical pregnancy in 33.42% *vs.* 30.56% (*OR* 0.89, 95% *CI* 0.66-1.19; *P*=0.42), ongoing pregnancy in 31.90% *vs.* 28.54% (*OR* 0.85, 95% *CI* 0.63-1.15; *P*=0.29), and live birth in 28.86% *vs.* 27.87% (*OR* 0.95, 95% *CI* 0.71-1.29; *P*=0.75). Pregnancy loss per cycle was also similar (12.91% *vs.* 12.13%; *OR* 0.99, 95% *CI* 0.66-1.49; *P*=0.97).

Table 4 presents multivariable logistic regression models for positive hCG and live birth. After adjustment for age, embryo stage at transfer, number of embryos transferred and number of good-quality embryos transferred, transfer medium was not associated with either positive beta hCG (*aOR* 0.92, 95% *CI* 0.69-1.22) or live birth (*aOR* 0.92, 95% *CI* 0.67-1.25). Increasing age was associated with lower odds of both outcomes (beta hCG: *aOR* 0.96 per year, 95% *CI* 0.93-0.99; live birth: *aOR* 0.96, 95% *CI* 0.93-1.00). Day 5 transfer was associated with higher odds of live birth (*aOR* 2.23, 95% *CI* 1.27-4.13) and showed a borderline association with positive hCG (*aOR* 1.57, 95% *CI* 1.00-2.49). Compared with transferring no good-quality embryos, transferring one or two good-quality embryos was strongly associated with higher odds of both positive beta hCG (*aOR* 2.48 and 4.09, respectively) and live birth (*aOR* 2.52 and 4.31,

respectively), whereas transferring two embryos (*vs.* one) was not significantly associated with either outcome.

4. Discussion

In this retrospective cohort, the use of an HA-enriched transfer medium was not associated with improved pregnancy outcomes in an unselected population undergoing FET. Rates of positive hCG, clinical pregnancy, ongoing pregnancy, live birth, and pregnancy loss were comparable between EG and the conventional HA-free medium (CSCM-NXC). These findings add to the ongoing debate regarding the clinical value of HA supplementation during embryo transfer, particularly in FET practice.

Our results are broadly consistent with studies questioning the routine clinical benefit of HA-enriched transfer media in FET cycles. A Cochrane review by Bontekoe *et al* concluded that while the use of HA as an adherence compound may improve clinical pregnancy and live birth rates, the evidence was of moderate quality[16]. More recent observational data, including an 8-year experience reported by Kim *et al*, did not demonstrate improved outcomes with sustained EG use, aligning with our findings[17]. Additionally, several randomized trials have reported that any potential enhancement of

Table 2. Laboratory and transfer characteristics of the included cycles.

Characteristics	CSCM-NXC (n=395)	EG (n=445)	P value
No. of oocytes retrieved, median (IQR)	14 (10-21)	14 (10-22)	0.92
No. of mature oocytes, median (IQR)	11 (7-18)	11 (8-18)	0.91
No. of fertilized oocytes, median (IQR)	9 (7-16)	10 (7-15)	0.93
No. of day-3 embryos, median (IQR)	9 (6-16)	10 (7-16)	0.78
No. of good quality day-3 embryos, median (IQR)	2 (1-3)	2 (1-3)	0.79
No. of blastocysts, median (IQR)	5.0 (2.5-8.0)	5.0 (3.0-8.0)	0.75
No. of good quality blastocysts, median (IQR)	2 (1-5)	2 (1-4)	0.65
Embryo stage at transfer, n (%)			0.82
Day 3	68 (17.2)	73 (16.4)	
Day 5	327 (82.8)	372 (83.6)	
No. of transferred embryos, n (%)			0.65
1	252 (63.8)	276 (62.0)	
2	143 (36.2)	169 (38.0)	
No. of good quality embryos transferred, n (%)			0.09
0	166 (42.0)	163 (36.6)	
1	201 (50.9)	259 (58.2)	
2	28 (7.1)	23 (5.2)	

Data are expressed as median (IQR) or n (%); *P* values were calculated using Wilcoxon rank-sum test for continuous variables and *Chi*-square test for categorical variables. CSCM-NXC: Continuous Single Culture-NX Complete; EG: EmbryoGlue. No.: number.

Table 3. Pregnancy outcomes.

Outcomes	CSCM-NXC (n=395)	EG (n=445)	OR (95% CI)	P value
Positive beta hCG	165 (41.77)	181 (40.67)	0.96 (0.73-1.26)	0.75
Clinical pregnancy rate	132 (33.42)	136 (30.56)	0.89 (0.66-1.19)	0.42
Ongoing pregnancy rate	126 (31.90)	127 (28.54)	0.85 (0.63-1.15)	0.29
Live birth rate	114 (28.86)	124 (27.87)	0.95 (0.71-1.29)	0.75
Pregnancy loss rate	51 (12.91)	54 (12.13)	0.99 (0.66-1.49)	0.97

Data are expressed as n (%). Univariable logistic regression is used. CSCM-NXC: Continuous Single Culture-NX Complete; EG: EmbryoGlue. *OR*: odds ratio; *CI*: confidence interval.

Table 4. Multivariable logistic regression of pregnancy outcomes.

Covariates	aOR	95% CI	P value
Panel A – Positive beta–hCG outcome			
Medium			
CSCM-NXC	Reference		
EG	0.92	0.69-1.22	0.56
*Age	0.96	0.93-0.99	0.004
Day of the transferred embryo			
Day 3	Reference		
Day 5	1.57	1.00-2.49	0.05
No. of transferred embryos			
1	Reference		
2	1.2	0.84-1.72	0.32
No. of good quality transferred embryos			
0	Reference		
1	2.48	1.78-3.46	<0.001
2	4.09	2.13-8.06	<0.001
Panel B – Live birth outcome			
Medium			
CSCM-NXC	Reference		
EG	0.92	0.67-1.25	0.58
*Age	0.96	0.93-1.00	0.03
Day of the transferred embryo			
Day 3	Reference		
Day 5	2.23	1.27-4.13	0.008
No. of transferred embryos			
1	Reference		
2	0.82	0.54-1.23	0.34
No. of good quality transferred embryos			
0	Reference		
1	2.52	1.74-3.72	<0.001
2	4.31	2.18-8.56	<0.001

aOR: adjusted odds ratio; CI: confidence interval. hCG: human chorionic gonadotropin; CSCM-NXC: Continuous Single Culture-NX Complete; EG: EmbryoGlue; No.: number. *Age was modeled as a continuous variable in the multivariable logistic regression model, and the adjusted odds ratio represents the change in odds for each 1-year increase in maternal age.

embryo adhesion observed *in vitro* does not consistently translate into improved clinical outcomes, particularly live birth, *in vivo*[12,18].

Collectively, our findings support the view that routine use of HA-enriched transfer medium may not provide additional benefit in unselected FET populations. Nevertheless, some studies have suggested potential advantages in selected subgroups such as patients with RIF or transfers involving poorer-quality embryos[5,7,9,19]. Because subgroup analyses were not prespecified or performed in the present study, further prospective studies that stratify by prognosis and embryo quality are warranted.

Although transfer medium was not associated with improved outcomes, the multivariable models identified predictors consistent with established clinical knowledge. Increasing maternal age was independently associated with lower odds of both positive beta hCG and live birth. Day-5 transfer was associated with higher odds of live birth, and showed a borderline association with positive beta hCG. Transferring good-quality embryos demonstrated a strong association with both outcomes. These results reinforce that embryo quality and developmental stage at transfer remain primary drivers of success in FET.

Several factors may explain the lack of observable benefit of HA-enriched transfer media in our cohort. First, although HA has long been proposed to improve implantation through its interaction with CD44 receptors and increased attachment to the endometrium[8,13], recent emerging evidence reports that HA-containing media do not enhance human blastocyst attachment to endometrial epithelial cells[20]. This raises questions about the biological effect of EG on embryo-endometrial adhesion, suggesting that it may not function as an effective "glue" in clinical settings. Second, the physiological benefit of HA may be redundant in modern FET cycles that use optimized endometrial preparation protocols. The transfer of high-quality embryos into a well-prepared endometrium may already create an ideal environment for implantation, reducing the potential additional impact of HA supplementation. Some studies have suggested more favorable effects in patients with RIF or poor embryo morphology[7,9]. However, in our study, which included a broader and unselected IVF population, the effect may have been diluted, leading to non-significant outcomes. Third, the explanation may lie in the distinction between early and sustained reproductive outcomes. HA may support the initial stages of implantation by

several mechanisms[8,13]. However, downstream factors such as embryo chromosomal competence, endometrial receptivity, and immune tolerance ultimately determine whether implantation continues to live birth[21]. For example, one study reported improvements in clinical pregnancy rates, but without corresponding increases in live birth rates[5]. This suggests that while HA may facilitate early embryo-endometrial interactions, it may not affect the key factors that determine whether the embryo develops successfully. Finally, the inconsistency in reported outcomes may also be due to procedural variability, as there are no international guidelines or consensus on embryo transfer protocols. Critical steps, such as the type of catheter used, embryo loading techniques, the duration of the transfer procedure, and the time of HA exposure, are difficult to standardize across IVF centers[22]. These technical differences may influence implantation success and confound attempts to evaluate the specific contribution of HA-enriched transfer media. Therefore, while HA may still play a supportive role, its effectiveness should be interpreted with caution, particularly in the absence of standardized embryo transfer protocols and global consensus.

This study has several strengths. The cohort included 840 first autologous FET cycles, improving the precision of effect estimates. Both day 3 and day 5 transfers were represented, reflecting real-world practice. Moreover, baseline characteristics and key laboratory and transfer variables were broadly comparable between groups, and adjusted models accounted for prespecified prognostic factors.

Several limitations should be acknowledged. First, the retrospective, non-randomized design and absence of blinding may introduce potential bias. Second, live birth was self-reported in some cases, and pregnancy loss classification was based on available follow-up, which may have led to minor data inconsistencies. Third, the study focused primarily on short-term pregnancy outcomes and did not evaluate long-term effects, such as neonatal development or maternal health. Finally, the lack of standardization in protocols across different IVF centers may have introduced variability and limit the generalizability of the findings.

Future research should focus on well-designed randomized controlled trials in FET cycles, including predefined subgroup analyses based on patient-specific factors and standardized embryo transfer procedures. Studies incorporating longer-term maternal and neonatal outcomes would further clarify the clinical value of HA-enriched embryo transfer media.

In conclusion, in this retrospective cohort of first autologous FET cycles, the use of an HA-enriched transfer medium (EmbryoGlue) was not associated with improved pregnancy outcomes compared with a conventional HA-free medium. These findings suggest that routine HA supplementation during embryo transfer may not be warranted for unselected patients undergoing FET, although selected subgroups may merit further investigation.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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Authors' contributions

Huy Phuong Tran and Ngoc Thanh Truong conceptualized the study. Vy Nguyen-Thao Do and Quan Van Pham collected data and performed statistical analysis. Tuyet Thi-Diem Hoang and Trang Nguyen-Khanh Huynh investigated the results. Huy Phuong Tran and Ha Le-Bao Tran interpreted the data and drafted the manuscript. All authors approved the final version of the study.

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References

- [1] Roque M, Haahr T, Geber S, Esteves SC, Humaidan P. Fresh *versus* elective frozen embryo transfer in IVF/ICSI cycles: A systematic review and meta-analysis of reproductive outcomes. *Hum Reprod Update* 2019; **25**(1): 2-14.
- [2] Saket Z, Källén K, Lundin K, Magnusson Å, Bergh C. Cumulative live birth rate after IVF: Trend over time and the impact of blastocyst culture and vitrification. *Hum Reprod Open* 2021; **2021**(3): hoab021.
- [3] Ojosegros S, Seriola A, Godeau AL, Veiga A. Embryo implantation in the laboratory: An update on current techniques. *Hum Reprod Update* 2021; **27**(3): 501-530.
- [4] Juncan AM, Moisă DG, Santini A, Morgovan C, Rus LL, Vonica-Țincu AL, et al. Advantages of hyaluronic acid and its combination with other bioactive ingredients in cosmeceuticals. *Molecules* 2021; **26**(15): 4429.
- [5] Yan Q, Zhao M, Hao F, Zhao R, Teng X, He B, et al. Effect of hyaluronic acid-enriched transfer medium on frozen-thawed embryo transfer outcomes in RIF patients: A single-centre retrospective study. *Front Endocrinol* 2023; **14**: 1170727.
- [6] Rashki Ghaleno L, Pennisi CP, Shahverdi A, Dardmeh F, Alipour H, Rezazadeh Valojerdi M. Exploring the role of hyaluronic acid in reproductive biology and beyond: Applications in assisted reproduction and tissue engineering. *Adv Biol* 2024; **8**(6): 2300621.

- [7] Nakagawa K, Horikawa T, Orita Y, Yamashiro E, Watanabe H, Shirai A, et al. Hyaluronan-enriched transfer medium (HETM) can improve the implantation rate in morphologically poor euploid blastocyst transfer. *Arch Gynecol Obstet* 2023; **308**(2): 611-619.
- [8] Heymann D, Vidal L, Shoham Z, Kostova E, Showell M, Or Y. The effect of hyaluronic acid in embryo transfer media in donor oocyte cycles and autologous oocyte cycles: A systematic review and meta-analysis. *Hum Reprod* 2022; **37**(7): 1451-1469.
- [9] Nayar KD, Sanan S, Sachdeva M, Arora S, Kant G, Arora A, et al. P-452 Clinical impact of hyaluronic acid-based transfer medium on frozen-thawed embryo transfer outcome in recurrent implantation failure patients: A randomized controlled trial. *Hum Reprod* 2025; **40**(Suppl 1): dea097.758.
- [10] Check JH, Summers-Chase D, Yuan W, Swenson K, Horwath D, Press M. “Embryo glue” does not seem to improve chances of subsequent pregnancy in refractory *in vitro* fertilization cases. *Clin Exp Obstet Gynecol* 2012; **39**(1): 11-12.
- [11] Horiuchi Y, Yanaihara A, Hatakeyama S, Taga Y, Kondou T, Kuramoto G, et al. Efficacy of hyaluronan-enriched transfer medium for low-grade frozen embryo transfer. *Cureus* 2023; **15**(5): e39210.
- [12] Child TJ, Bevan A, Frettsome-Hook R, Craig J, Shahbazian S, Mounce G. A randomised controlled blinded trial assessing the effectiveness of EmbryoGlue as an embryo transfer medium in IVF cycles. *Fertil Steril* 2021; **116**(3): e4.
- [13] Yung SSF, Lai SF, Lam MT, Lui EMW, Ko JKY, Li HWR, et al. Hyaluronic acid-enriched transfer medium for frozen embryo transfer: A randomized, double-blind, controlled trial. *Fertil Steril* 2021; **116**(4): 1001-1009.
- [14] Tran HP, Hoang TTD, Tran HLB, Huynh TNK, Do VNT, Mai CK. *The effect of hyaluronan-enriched medium on human embryo implantation in patients undergoing in-vitro fertilization*. In: 10th International Conference on the Development of Biomedical Engineering in Vietnam. IFMBE Proc. Singapore: Springer; 2025: 764-769.
- [15] Coticchio G, Ahlström A, Arroyo G, Balaban B, Campbell A, De Los Santos MJ, et al. The Istanbul consensus update: A revised ESHRE/ALPHA consensus on oocyte and embryo static and dynamic morphological assessment. *Hum Reprod* 2025; **40**(6): 989-1035.
- [16] Bontekoe S, Heineman MJ, Johnson N, Blake D. Adherence compounds in embryo transfer media for assisted reproductive technologies: Summary of a Cochrane review. *Fertil Steril* 2015; **103**(6): 1416-1417.
- [17] Kim HY, Kim S, Son HJ, Kim MJ, Kim G, Heo GD, et al. Impact of EmbryoGlue use on *in vitro* fertilization/frozen embryo transfer outcomes: An 8-year retrospective analysis. *Fertil Steril* 2024; **122**(4): e192.
- [18] Fancsovi P, Lehner A, Murber A, Kaszas Z, Rigo J, Urbancsek J. Effect of hyaluronan-enriched embryo transfer medium on IVF outcome: A prospective randomized clinical trial. *Arch Gynecol Obstet* 2015; **291**(5): 1173-1179.
- [19] Fu W, Yu M, Zhang XJ. Effect of hyaluronic acid-enriched transfer medium on frozen-thawed embryo transfer outcomes. *J Obstet Gynaecol Res* 2018; **44**(4): 747-755.
- [20] Ruane PT, Buck CJ, Babbington PA, Aboussahoud W, Berneau SC, Westwood M, et al. The effects of hyaluronate-containing medium on human embryo attachment to endometrial epithelial cells *in vitro*. *Hum Reprod Open* 2020; **2020**(2): hoz033.
- [21] Neykova K, Tosto E, Giardina A, Tsibizova A, Vakrilov A. Endometrial receptivity and pregnancy outcome. *J Matern Fetal Neonatal Med* 2022; **35**(13): 2591-2605.
- [22] D’Angelo A, Panayotidis C, Amso N, Marci R, Matorras R. Evidence and consensus on technical aspects of embryo transfer. *Hum Reprod Open* 2022; **2022**(4): hoac038.