Predictive Factors For The Successful Implantation and Live Birth After Euploid Blastocyst Transfer: A Single Center Study

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Background: Pre-implantation Genetic Testing for Aneuploidy (PGT-A) has enabled IVF specialists to screen embryos for abnormalities in chromosome number and structure. Subsequently, healthy embryos are selected for transfer, decreasing the rate of spontaneous miscarriages and improving pregnancy outcomes. In spite of this, almost only half of the PGT-determined euploid embryos result in a pregnancy.

Objective: This study aimed to determine what other factors among euploid embryo transfers will have an association with successful implantation and live birth.

Methods: This study retrospectively analyzed 159 IVF-PGS cycles performed in CARMI SLMC-GC from January 2017 to December 2019. Of these, a total of 231 euploid embryos (86 single embryo transfers and 73 double embryo transfers) were assessed. The relationship of eight predictive variables (maternal age, maternal BMI, etiology of infertility, history of failed IVF, blastocyst expansion stage, ICM grade, TE grade and endometrial thickness on transfer) with regard to the outcome of successful implantation and live birth among single or double euploid blastocyst transfers were determined via logistic regression analysis.

Results: Overall, the implantation rate was significantly lower when using B-grade ICM or C-grade ICM blastocysts as compared to A-grade ICM blastocysts (OR 0.54, 95% CI 0.356-0.815, p = 0.003). With regard to live birth rate, the success of transfer is statistically lower when using a B-grade or C-grade ICM blastocysts as compared to A-grade ICM blastocysts (OR 0.55, CI 0.354-0.863, p = 0.009). Other predictive factors such as maternal age, maternal BMI, etiology of infertility, number of previous IVF, blastocyst expansion stage, trophectoderm grade and endometrial thickness had no apparent effect on the outcome of implantation and live birth.

Conclusion: Present study results suggest that only the ICM grade of euploid blastocysts correlates with implantation and live birth in IVF-FET cycles. Therefore, the selection of euploid blastocysts based on the presence of a higher grade ICM is the most predictive factor that determines success among those undergoing IVF with PGT-A.

Key words: Euploid embryo transfer, pre-implantation genetic testing for aneuploidy, implantation rate, live birth rate

Introduction

In Vitro Fertilization (IVF) has been widely used to address a variety of infertility problems. Over the years, fertility specialists have been continuously searching for improvements to be able to increase the success of implantation and pregnancy in an IVF cycle.

Majority of implantation failures and early miscarriages in an IVF cycle are secondary to chromosomal aneuploidies.[1] This is a result of errors during gametogenesis and early mitotic divisions.[2]

Pre-implantation Genetic Testing for Aneuploidy (PGT-A) was developed to screen the embryos for abnormalities in chromosomal number and structure. By screening these abnormalities, healthier embryos are selected for transfer to improve outcome in IVF cycles. Worldwide, the pregnancy rate with a euploid embryo transfer is placed at approximately 45%.[3] In the Center for Advanced Reproductive Medicine and Infertility (CARMI) – St. Luke's Medical Center Global City, the pregnancy rate is 48.5% following euploid embryo transfer after PGT-A.

However, the detection of aneuploid embryos explains only a part of all the reasons that causes the failure of implantation. The fact that more than fifty (50) percent of all euploid embryos transferred does not result in pregnancy suggests that there are other factors aside from chromosomal abnormalities that lead to failure. The identification of such factors is crucial for the practice of IVF.

Significance of the Project

This study aimed to determine the factors that will predict the successful outcome after a euploid embryo transfer. The results will guide clinicians in managing the expectations of couples during counseling.

Background Information and Literature Review

Indications of Preimplantation Genetic Testing for Aneuploidy (PGT-A)

Historically, Preimplantation Genetic Testing (PGT), formerly called Preimplantation Genetic Diagnosis, was developed to prevent the birth of children with severe inheritable genetic disorders. Since then, PGD has been renamed Preimplantation Genetic Testing for Monogenic (PGT-M) diseases. Subsequently, the use of PGT was expanded to include the detection of aneuploidies with numerical (PGT-A) and structural (PGT-SR) abnormalities.[4] These conditions can lead to reproductive failures and are at increased risk among women with advanced maternal age, repeated implantation failures, recurrent miscarriages[1,5] and whose partners have severe male factor infertility.[6]

The rationale behind PGT-A is the identification of blastocysts with abnormal chromosome number by genetic analysis. Embryos are cultured until the blastocyst stage (Day 5-6) then a small number (≥5) of trophectoderm cells are biopsied. Genetic analysis of such sampled trophectoderm cells estimates the copy number of each chromosome: 1) euploid embryo with a copy number of two, 2) aneuploid embryo with a copy number of one or three and 3) mosaic embryo with a copy number intermediate between whole numbers.[7]

Documented Predictors of a Successful Euploid Embryo Transfer

With the advent of PGT-A, the role of chromosomal aneuploidies in reproductive failures was taken into consideration. Yet, there is still limited data on which factors will predict a successful outcome after transferring embryos that underwent PGT-A. Boynukalin, et al.[1] found that a higher BMI and an embryo biopsy done on Day 6 negatively correlated with the live birth rate after a single euploid transfer. On the other hand, Zhao, et al.[5] concluded that the overall blastocyst morphological grade best predicts a favorable outcome after a single euploid transfer. Similarly, the study of McCulloh, et al.[8] found that the grades of the Trophoectoderm (TE) and Inner cell mass (ICM) are associated with a successful implantation and live birth.

The objective of this study was to determine the predictive factors for successful implantation and live birth after euploid blastocyst transfer among patients who underwent In-vitro Fertilization with Pre-implantation Genetic Testing for Aneuploidy (IVF-PGT-A) at the Center for Advanced Reproductive Medicine and Infertility (CARMI), St. Luke's Medical Center Global City.

Methods

This retrospective cohort study was approved by the Research and Biotechnology Division of St. Luke's Medical Center, Quezon City. The database comprising of patients who underwent IVF with frozen-thawed transfer of euploid embryos at the Center for Advanced Reproductive Medicine and Infertility (CARMI), St. Luke's Medical Center Global City from July 27, 2017 to December 31, 2019 was reviewed.

Operational Definitions

Etiology of Infertility

Infertility has been defined as the failure to achieve pregnancy within 12 months of unprotected intercourse. Among infertile couples who were advised In-Vitro Fertilization, the main etiologies were as follows: ovulatory dysfunction, tubal pathology, endometriosis, male infertility and unexplained causes.[9]

Assisted Fertilization

Controlled ovarian hyperstimulation is an important step in the In-vitro Fertilization process. In all cases included in this study, the Gonadotropin-Releasing Hormone (GnRH) antagonist protocol for ovarian hyperstimulation was used. Specifically, pituitary suppression was achieved by giving a GnRH antagonist when there is at least 1 leading follicle was at 14 mm size. When at least 1 follicle reached 18mm or 2 follicles reached 17mm, an ovulation trigger was given. Thereafter, oocyte retrieval by ultrasound-guided needle aspiration was performed after 36 hours. Assisted fertilization was performed through Intracytoplasmic Sperm Injection (ICSI) in all mature oocytes. The injected oocytes were then cultured in a pre-equilibrated dish containing G-1TM Plus (bicarbonate buffered media and human serum albumin) with daily observation of development. On the 5th day of culture, the embryos were graded according to morphologic quality based on the Gardner and Schoolcraft classification of the blastocyst stage (degree of blastocyst expansion), trophoectoderm grade (cohesiveness of the trophoectoderm) and inner cell mass grade (consistency of inner cell mass).[10]

Pre-implantation Genetic Testing for Aneuploidy (PGT-A)

The developed blastocyst (stages 3-6) subsequently underwent trophectoderm biopsy at Day 5 or 6. A laser was used to create a hole from the outermost part of the blastocyst then into the trophectoderm wherein approximately 5-10 cells were extracted. The trophectoderm cells were washed in a GMOPS solution, rinsed using a phosphate-buffered saline solution (PBS) and then sealed in a PCR tube containing 2µl of PBS. This was sent via a special freight to Next Generation Genomic Co. Ltd. Bangkok that performed a 24-chromosome aneuploidy screening using the Next Generation Sequencing technique. The results were then emailed back to CARMI with the identified copy number assignment for each chromosome and a predicted karyotype for each embryo.

Frozen Euploid Embryo Transfer

Frozen euploid embryo transfer (FET) was performed at least 6 weeks from the initial oocyte retrieval. Endometrial preparation involved a protocol of hormonal replacement in all cases. A baseline transvaginal ultrasound (TVS) was performed on the 2nd day of menstruation and estradiol valerate 4-8 mg/day was given. Daily progesterone supplementation was started once the endometrial thickness reached 8-12 mm. After 5 days, the transfer of the euploid embryo was performed under ultrasound guidance.[11]

Description of Study Procedure

Method of Subject Selection

The subjects that were included this study were retrieved from the CARMI's database of patients who underwent In-Vitro Fertilization with PGT-A from July 27, 2017 to December 31, 2019. The records of subjects who fell within the inclusion criteria were collected and charted into the data collection form.

Inclusion and Exclusion Criteria for Subject Population

All women who underwent IVF using the GnRH antagonist protocol with pre-implantation genetic testing for aneuploidy and subsequent frozen-thawed transfer of a single or double euploid embryos were included in this study. On the other hand, two conditions were excluded: 1) mosaic embryo transfers, whose chromosome numbers are intermediate between whole numbers and 2) double embryo transfers who resulted in only one implantation or live birth with uncertainty to which embryo resulted in such outcome.

Data Gathered from the Subjects or Medical Records

The following predictive variables were collected in this study and correlated with the clinical outcomes: 1) characteristics of each female subject: maternal age, maternal BMI, etiology of infertility and number of previous failed IVF treatments[1,12]; 2) morphological parameters of each blastocyst transferred: blastocyst stage (3 to 6), inner cell mass grade (A to C) and trophoectoderm grade (A to C)[5] and; 3) data on the endometrial thickness on the day of embryo transfer.[13]

Description of Outcome Measures

The two primary outcomes that were analyzed in this study were: 1) Implantation Rate (IR) which was calculated based on the number of gestational sacs seen at 7 weeks AOG by means of ultrasound divided the total number of euploid embryos transferred and 2) Live Birth Rate (LBR) was calculated based on the number of live born fetuses divided by the total number of euploid embryos transferred.

Sample Size Estimation

The sample size was calculated based on the comparison of the implantation rate among patients who had a transfer of excellent quality of oocyte versus patients with poor quality oocyte. Assuming that among those with excellent quality of oocyte, implantation rate is 65%, and those with poor quality oocyte, 33.3%; with an α error of 5%, power of 80% and a 1-tailed alternative hypothesis, the sample size calculated is 30 per group or 60 for 2 groups. Controlling for 7 other predictive factors in the analysis, with an additional 20% for each predictor factor, the final sample size calculated is 144.

Statistical Analysis

This study aimed to determine the association of the eight (8) predictor variables with regard to two different primary outcomes (implantation and live birth). This relationship was explored by means of Generalized Estimating Equations (GEE), which accounts for a result even though one or two embryos were transferred for the same subject. For the statistical analysis, a univariate GEE regression model was initially done, selecting those variables with p values <0.1 for further analysis. Interaction of several variables was also assessed. The interaction between variables age and etiology was observed and this was also included in the model building. Those variables who met the criteria were analyzed via a multivariate GEE regression for model building. For the final prediction model, all pair-wise correlations were examined. The standard $p< 0.05$ was considered to be statistically significant. The final model was presented with the Odds Ratio (OR), 95% Confidence Interval (CI) and p value for each predictor. The performance of the model was evaluated by means of QIC and QIC_u to check the fitness of the model with the variables. All analyses were performed with the Statistical software STATA/IC version 12.0 for Windows.

Ethical Considerations

This study abided by the Principles of the Declaration of Helsinki (2013) and was conducted along the Guidelines of the International Conference on Harmonization-Good Clinical Practice (ICH-GCP), E6 (R2) and other ICH-HCP 6 (as amended); National Ethical Guidelines For Health and Health-Related Research (NEG HHRR), 2017. The Clinical Protocol and all relevant documents were reviewed and approved by the SLMC Ethics Review Committee. Patient confidentiality was respected wherein patient data remained anonymous. Each patient document is CODED and did not contain any identifying information in order to ensure confidentiality. All study data were recorded and investigators were responsible for the integrity of the data i.e accuracy, completeness, legibility, originality, timeliness and consistency. The manner of disseminating and communicating the study results guarantee the protection of the confidentiality of patient's data. All study-related documents such as the all versions of the protocol, ethical clearance, data collection forms, hard copies of source documents, signed informed consent forms were kept and stored by the Principal Investigator in strict confidentiality for at least 5 years' after which they will be shredded.

Results

This study included 159 IVF-PGS cycles performed in CARMI SLMC-GC from January 2017 to December 2019. Of these, there was a total of 231 euploid embryos that were analyzed (86 single embryo transfers and 73 double embryo transfers). In summary, 49.06% of the total embryos had a successful implantation (113 out of 231) and 40.25% had a successful live birth (93 out of 231) (Table 1).

Table 1. Implantation and live birth outcomes.

Outcome	Total IVF cases N= 231 n (%)
Implantation	
Failed	118 (50.94)
Successful	113 (49.06)
Live birth	
Failed	138 (59.75)
Successful	93 (40.25)

A summary of the patients' characteristics, blastocyst morphology and endometrial thickness are presented in Table 2. Majority of the women in this study were 36-40 years old (41.5%) and had normal BMI (43.4%). Female factor is the most common reason for infertility among the couples (49.06%). Most of the cases had a first-time IVF procedure and had no previous history of failed IVF (69.81%). The mean endometrial thickness during embryo transfer was 11.4 mm ± 1.6 mm (Table 3). Data on the quality of the transferred embryos (n = 231 embryos) are summarized in Table 4. Majority had a Stage-4 blastocyst expansion stage (46.32%), Grade-B Inner Cell Mass (ICM) (58.44%) and Grade-B Trophoectoderm (TE).

The univariate GEE model (Table 5) summarizing the association of the predictor variables and successful implantation yielded five (5) variables with significant values ($p<0.1$): age, etiology of infertility, endometrial thickness, ICM grade and TE grade. These were then analyzed in a Multivariate GEE regression model, for which only three (3) variables ($p<0.05$) were included in the final model of analysis (Table 6).

Table 2. Summary of distribution for each predictor variable.

Predictor Variables	Total IVF Cases N= 159 n (%)
Age (years)	
Less than 30	29 (18.24)
31-35	56 (35.22)
36-40	66 (41.51)
41 and above	8 (5.03)
BMI (kg/m^2)	
< 17.5	2 (1.26)
17.5-22.9	69 (43.4)
23-27.9	55 (34.59)
> 28	33 (20.75)
Etiology of infertility	
Male factor	27 (16.98)
Female factor/s	78 (49.06)
Mixed	46 (28.93)
Unexplained	8 (5.03)
Number of previous failed IVF cycles	
0	111 (69.81)
1	29 (18.24)
2	16 (10.06)
3	3 (1.89)

Table 3. Mean endometrial thickness.

Predictor Variable	Total	Mean	Standard Deviation
Endometrial thickness (mm)	159	11.4	1.6

Table 4. Summary of distribution for the blastocyst morphology.

Predictor Variables	Total Embryos Transferred N= 231 n (%)
Blastocyst stage	
3	81 (35.06)
4	107 (46.32)
5	37 (16.02)
6	6 (2.60)
Inner cell mass grade	
A	33 (14.29)
B	135 (58.44)
C	63 (27.27)
Trophoectoderm grade	
A	29 (12.55)
B	115 (49.78)
C	87 (37.66)

Table 5. Univariate GEE regression model for the association of the 8-predictor variables with the outcome of successful implantation.

Predictor Variables	Odds Ratio	95% CI	p value
Age Category			
< 30 years	control		
31-35 years	1.32	0.695-2.503	0.397
36-40 years	1.81	0.967-3.378	0.064
> 41 years	0.47	0.136-1.642	0.238
BMI	0.99	0.952-1.046	0.946
Etiology of infertility	1.51	1.131-2.021	0.005
Number of previous failed IVF	0.90	0.670-1.209	0.484
Endometrial thickness	0.86	0.738-0.994	0.042
Blastocyst stage	1.13	0.809-1.582	0.470
ICM grade	0.55	0.360-0.845	0.006
TE grade	0.74	0.498-1.095	0.131

Table 6. Final multivariate GEE regression model for the association of the predictor variables and successful implantation.

Predictor Variables	Odds Ratio	95% CI	p value
Age Category			
< 30 years	control		
31-35 years	1.35	0.497-3.648	0.559
36-40 years	2.31	0.862-6.196	0.096
> 41 years	0.60	0.094-3.877	0.596
Endometrial thickness	0.83	0.678-1.015	0.070
ICM grade	0.54	0.356-0.815	0.003

The final Multivariate GEE model for the association of the predictor variables and successful implantation yielded the following results (Table 6). The likelihood of successful implantation was higher when maternal age was between 31-35 years (OR 1.35, 95% CI 0.497-3.648, p = 0.559) and 36-40 years (OR 2.31, 95% CI 0,862-6.196, p=0.096) as compared to women who are less than 30 years of age. On the other hand, there is a 40% decrease in the odds of successful implantation for women 41 years and above (OR 0.60, 95% CI 0.094-3.877, p=0.596). With regard to endometrial thickness, the authors found that there is a 17% decrease in the odds of successful implantation for each unit (mm) increase in thickness (OR 0.83, 95% CI 0.67-1.015, p= 0.070). However, these findings on the variables of maternal age and endometrial thickness during transfer were not statistically significant.

Looking at the ICM grade, the authors found that there is a statistically significant decrease by 46% in the odds of a successful implantation for each unit of increase in the ICM grade (from Grade A to B to C). In other words, the implantation rate was significantly lower when using a B-grade ICM as compared to an A-grade ICM or C-grade ICM blastocysts as compared to A-grade ICM blastocysts (OR 0.54, 95% CI 0.356-0.815, p = 0.003).

The second primary outcome of this study is the association of the predictive variables and successful live birth. In Table 7, the Univariate GEE model yielded five (5) variables with significant results (p<0.1): age, etiology of infertility, history

of previous IVF, ICM grade and TE grade, which were included in the Multivariate GEE regression model. Thereafter, only the two (2) variables with $p<0.05$ were included in the final model of analysis (Table 8).

This final multivariate model analysis with regard to successful live birth outcome yielded the following results (Table 8). The odds of successful live birth was higher when maternal age was between 31-35 years (OR 1.15, 95% CI 0.433-3.072, p = 0.775) and 36-40 years (OR 1.21, 95% CI 0.475-3.084, p=0.688) as compared to women who are less than 30 years of age. There is an 86% decrease in the odds of a successful live birth for women 41 years and above (OR 0.14, 95% CI 0.017-1.203, p=0.073). However, the strength of the abovementioned association is not statistically significant.

With regard to the ICM grade, we found that there is a statistically significant decrease by 45% in the odds of a successful live birth for each unit of increase in the ICM grade (from Grade A to B to C). In other words, the live birth rate was significantly lower when using a B-grade ICM blastocyst as compared to A-grade ICM blastocyst or a C-grade ICM blastocysts as compared to A-grade ICM blastocysts (OR 0.55, CI 0.354-0.863, p = 0.009).

Discussion

This study analyzed the relationship of eight predictive variables (maternal age, maternal BMI, etiology of infertility, history of failed IVF, blastocyst expansion stage, ICM grade, TE grade and

Table 7. Univariate GEE regression model for the association of the 8-predictor variables with the outcome of successful live birth.

Predictor Variables	Odds Ratio	95% CI	P value
Age Category			
< 30 years	control		
31-35 years	1.14	0.595-2.185	0.692
36-40 years	1.28	0.682-2.413	0.440
> 41 years	0.23	0.048-1.128	0.070
BMI	1.00	0.955-1.051	0.941
Etiology of infertility	1.35	1.007-1.799	0.045
Number of previous failed IVF	0.699	0.506-0.967	0.030
Endometrial thickness	0.973	0.844-1.121	0.702
Blastocyst grade	1.146	0.814-1.612	0.435
ICM grade	0.553	0.358-0.854	0.008
TE grade	0.699	0.468-1.046	0.082

Table 8. Final multivariate GEE regression model for the association of the predictor variables and successful live birth.

Predictor Variables	Odds Ratio	95% CI	P value
Age Category			
< 30 years	control		
31-35 years	1.15	0.433-3.072	0.775
36-40 years	1.21	0.475-3.084	0.688
> 41 years	0.14	0.017-1.203	0.073
ICM grade	0.55	0.354-0.863	0.009

endometrial thickness on transfer) with regard to the outcome of successful implantation and live birth between single and double euploid blastocyst transfers. Present study results show that only the Inner Cell Mass (ICM) grade was found to be a significant predictor of implantation and live birth after euploid embryo transfer. These findings further suggest that higher ICM grade blastocysts (Grade A) are more likely to result to a successful implantation and live birth than lower ICM grade blastocysts (Grade B and Grade C).

The findings of the present study is consistent with that of Irani, et al.[13] who concluded that it is the inner cell mass (ICM) grade which is the most useful predictor of the ongoing pregnancy rate in a euploid embryo transfer. They suggested that in selecting among poor-quality or average-quality embryos, priority should be given to those with A-grade ICM morphology than those with B-grade or C-grade.

In contrast, several studies have shown conflicting results and considered other morphological factors for a successful IVF outcome. The study of Zhao, et al.[5] found that both the TE grade and ICM grade are significantly correlated with a successful euploid embryo transfer. Lou, et al.[14] found that the overall blastocyst morphology is the best predictor of successful implantation in women less than 35 years. On the other hand, Hill, et al.[15] concluded that it is only the TE morphology, which is significantly correlated with live birth rate in non-biopsied blastocysts.

According to literature, a blastocyst's overall morphology correlates with its early implantation and developmental potential. Blastocyst grading mainly involves three morphologic parameters: stage of blastocyst development, amount of tightly packed cells within the inner cell mass (ICM) and the quantity of the cells forming the dense epithelium trophectoderm (TE). The role of the blastocyst developmental stage has been inconsistent in literature. In the present study, the authors found that the blastocyst expansion was not a significant predictor of IVF outcome since it is possible that high quality embryos may continue to expand after trophectoderm biopsy regardless of the stage of blastocyst expansion before the biopsy.[13]

The role of the trophectoderm cells (TE) is to function in the immediate implantation period through hCG-mediated signaling, hatching from the zona pellucida, adhesion and invasion of the endometrium and maternal immune response communication.[16] Accordingly, it was found that having a poor TE grade in non-biopsied embryos is associated with higher aneuploidy rate, hence a higher rate of spontaneous abortion.[13] Thus, this relationship may explain current finding that in PGT-A determined euploid embryos, the TE grade is not an important factor in predicting the implantation or live birth outcomes anymore.

The importance of the Inner Cell Mass (ICM) originates from its role in initiating the formation of the three germ cell layers after the implantation period. Specifically, the ICM is responsible in forming a paracrine signal, namely Fgf4, which gives rise to the early signals for ectoderm and endoderm development.[17] Subsequently, literature says that having a poor grade ICM grade carries an increased risk of early pregnancy loss among euploid blastocyst.[13,18] The role of ICM is thus crucial in the maintenance of the pregnancy and this is seen in the present study with the significant correlation of an excellent ICM grade with a successful implantation and live birth outcome.

Maternal age has already been documented as one of the strongest predictors of a successful IVF outcome.[1,12,19] This finding is due to the fact that the aneuploidy rate is higher among the older population. In the present study, the authors found that once a euploid embryo is identified, the role of maternal age on implantation and live birth is not significant anymore. With regard to BMI, it was the study of Boynukalin, et al.[1] that found a significant association of elevated maternal BMI and poorer IVF outcomes. They concluded that obesity creates a problem with endometrial receptivity. However, authors of the present sutdy found that the role of maternal BMI in a PGT-A determined euploid embryo is not significant.

The study of Vaegter, et al.[12] found that the following factors are associated with a successful IVF outcome in a single, non PGT-A blastocyst transfer: history of first-time IVF, endometrial thickness of greater than 1mm during transfer and tubal factor infertility. This finding is contrary to this current research wherein the authors found that the implantation and live birth rate were not affected by factors such as a history of previous IVF

treatment, etiology of infertility and endometrial thickness during embryo transfer. It is good to note that the embryos analyzed by Vaegter, et al.[12] were those not biopsied to evaluate their ploidy status. This means that these factors are not critical in the prediction of IVF outcome once an embryo has already undergone PGT-A and was identified as euploid. Present data confirm that the blastocyst morphology, specifically the ICM grade, is the only factor statistically significantly correlated with the developmental potential of a euploid embryo.

This study has two limitations. First, some bias is inevitable due to its retrospective nature. Secondly, a larger sample size may also show that the trophectoderm grade and/or blastocyst expansion grade are also statistically significant to implantation and live birth rate.

Conclusion

The results of this study suggest that the ICM grade has a statistically significant correlation with the successful implantation and live birth after a euploid blastocyst transfer. Therefore, an embryo with a high-grade ICM should be prioritized during the selection process since this is the most predictive factor that can determine the success among couples undergoing IVF with PGT-A.

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