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Original Research

PREGNANCY LOSS AFTER IN VITRO FERTILIZATION AND RELATED FACTORS

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ABSTRACT

Introduction: *After getting pregnant by in vitro fertilization (IVF), pregnancy loss is one factor that prevents the baby from being born. An estimated 80% of pregnancy loss occurs in the first trimester, which is higher than in the natural pregnancy. The reason is said to be that the age of women receiving fertility treatment is often higher, leading to ovarian reserve, and decreased oocyte quantity and quality. However, studies on the pregnancy loss rate in Vietnam are still hard, and global studies still do not provide a complete consensus on the factors affecting this rate. This study aims to evaluate the pregnancy loss rate 12 weeks after in vitro fertilization and find some related factors.*

Methods: *A cross-sectional descriptive study in embryo transfer patients after IVF treatment at Department of Assisted Reproduction in Hue Central Hospital was done from January 2020 to May 2021. Criteria for selection are pregnancy after embryo transfer (βhCG ≥ 25 UI/L after 14 days of embryo transfer) and having ultrasound monitoring up to 12 weeks gestation. Exclusion criteria include donor eggs, multifetal pregnancy reduction and ectopic pregnancy or hydatidiform mole.*

Results: *There are 42 cases of pregnancy loss up to 12 weeks gestation in 133 pregnancies (βhCG ≥ 25 UI/L), equivalent to 31.6%. Among them were 9 cases of biochemical pregnancy, and 33 cases of pregnancy loss when having clinical pregnancy. The rate of at least one developing fetus to 12 weeks gestation is 102/133, equivalent to 76.7%. The pregnancy loss rate was statistically significantly lower in the group with endometriosis ≥ 10 mm before the embryo transferring date.*

Conclusion: *Pregnancy loss after IVF is an issue that needs to be studied with a larger sample size to deeply understand the influencing factors to optimize the outcome of embryo transfer.*

Keywords: *in vitro fertilization, embryo transfer, biochemical pregnancy, pregnancy loss, miscarriage, spontaneous abortion, endometrium.*

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I. INTRODUCTION

The biggest goal of today's assisted reproductive techniques is to born healthy babies. However, since pregnancy is confirmed after IVF, pregnancy needs to go through a long time before the baby can be born; during this time, the pregnancy can end by pregnancy loss.

Pregnancy loss often occurs in the first trimester, with an estimated 80% occurring in the first trimester of pregnancy [1, 2]. Therefore, understanding pregnancy loss in the first trimester is interesting for many couples and clinicians.

After assisted reproduction, the rate of early pregnancy loss is about 16%-29% [3,4]. This rate is higher than a natural pregnancy [5], which is believed that the women receiving assisted reproduction

are often old, leading to ovarian reserve, oocyte quantity and oocyte quality decrease. Risk factors affecting pregnancy loss have been shown included polycystic ovary syndrome [6], endometriosis [7], congenital uterine abnormalities [8], and influence of ovarian stimulation [9]… However, despite many factors mentioned, researches result are still different. There is still no complete consensus on the factors affecting the rate of pregnancy loss in pregnant women after IVF. In Vietnam, the number of studies is still small, so we carried out this study to evaluate pregnancy loss 12 weeks after IVF and to find out the factors related to this rate.

II. MATERIALS AND METHODS

A cross-sectional descriptive study, analyzing embryo transfer cycles with clinical pregnancy after IVF treatment at the Assited Reproductive Department of Hue Central Hospital from January 2020 to May 2021.

The inclusion criteria included: Pregnancy after embryo transfer (βhCG ≥ 25 UI/L at 14 days post-embryo transfer), followed by ultrasound up to 12 weeks gestation.

Exclusion criteria include Oocyte donation, multiple pregnancies with abortion, ectopic pregnancy or molar pregnancy.

Techniques for collecting information and steps

Test for βhCG 14 days after embryo transfer. When the βhCG value is ≥ 25 IU/ml, the patient is pregnant. Recorded cases of bleeding, went to the hospital before 7 weeks of pregnancy with images of gestational sac on ultrasound. Transvaginal ultrasound at 7 weeks of gestational age assesses the number of gestational sacs and pregnancy loss, appointment for an ultrasound if pregnancy loss is suspected after 7-10 days. Ultrasound at 12 weeks of pregnancy assesses fetal growth. If it is inconvenient, we call the patient and record the pregnancy's progress.

Research outcome variables

Baseline patient characteristics included age, type of infertility, history of miscarriage, BMI, polycystic ovary syndrome (PCOS), endometriosis, uterine fibroids, diabetes, number of oocytes obtained, type of fresh or frozen embryos, number of embryos transferred, type of cleavage or blastocyst, endometrial thickness, number of fetuses, rate of pregnancy loss, rate of one fetus remaining up to 12 weeks.

Research definitions

Biochemical pregnancy is a pregnancy that does not develop into a clinical pregnancy.

A clinical pregnancy is a pregnancy diagnosed by ultrasound with a gestational sac. An ectopic pregnancy is not considered a clinical pregnancy.

Abortion is defined as a fetus that cannot survive to 20 weeks gestation. When any fetus stops growing, that pregnancy is considered a pregnancy loss.

Data processing

Data entry and processing were performed using SPSS 20.0 medical statistical software (SPSS Inc, Chicagon III). Categorical variables are expressed as the number of cases and percentages, while the normally distributed continuous variables are expressed as the mean ± standard deviation. Categorical variables will be compared between groups by Chi-squared statistical test, Fisher test when Chi-squared test is not satisfied. The algorithms have statistical significance with $p < 0.05$.

III. RESULTS

In our study, there were 9 cases of biochemical pregnancy, 124 cases of clinical pregnancy and among these clinical pregnancies, there were 33 pregnancies that stopped developing before 12 weeks, accounting for 26.6% (33/124).). The rate of one fetus remaining up to 12 weeks gestation is 102/133, equivalent to 76.7%.

Table 1: Relationship between pregnancy loss and general characteristics

Factor	No. Pregnancy loss/ Sum	Rate of pregnancy loss (%)	P
Nhóm tuổi			
< 31 years old	17/61	27,9	0,657
31-35 years old	18/50	36,0	
> 35 years old	7/22	31,6	
Infertile type			
Primary infertility	27/92	29,3	0,407
Secondary infertility	15/41	36,6	
History of miscarriage			
Yes	11/32	34,4%	0,696
No	31/93101	30,7%	
BMI			

Factor	No. Pregnancy loss/ Sum	Rate of pregnancy loss (%)	P
< 18.5	8/20	40%	0,570
18.5 – 22.9	27/94	28,7%	
23 – 24.9	6/17	35,3%	
≥ 25	½	50,0%	
PCOS			
Có	9/18	50,0%	0,071
Không	33/115	28,7%	
Endometriosis			
Yes	2/7	28,6%	1
No	40/126	31,7%	
Uterine fibroids			
Yes	4/9	44,4%	0,463
No	38/124	30,6%	
Diabetes			
Fasting blood glucose disorder	9/19	47,4%	0,119
Normal	33/114	28,9%	

Table 1 describes the characteristics of patients with biochemical pregnancy and the relationship with pregnancy loss. There was no statistically significant difference in the pregnancy loss rate compared with the characteristics of age group, type of infertility, history of miscarriage, BMI, PCOS, endometriosis, uterine fibroids, diabetes.

Table 2: Relationship between pregnancy loss and IVF cycle characteristics

Factor	No. Pregnancy loss/ Sum	Rate of pregnancy loss (%)	P
Number of oocytes obtained			
< 10	17/47	36,2%	0,40
≥ 10	25/56	29,1%	
Type of embryo transfer			
Fresh embryos	8/26	30,8%	0,921
Frozen embryos	34/107	31,8%	
Number of embryos transferred			
≤ 2	27/81	33,3%	0,587
> 2	15/52	28,8%	
Transfer embryo characteristics			
Cleavage embryo	38/117	32,5%	0,546
Blastocyst	4/16	25,0%	
Endometrial thickness			
< 10 mm	24/58	41,4%	0,032
≥ 10 mm	18/75	24,0%	

Table 2 describes the IVF cycle characteristics and the relationship with the pregnancy loss rate. There was no statistically significant difference in the pregnancy loss rate with the number of oocytes obtained, type of embryo transferred, number of embryos transferred, and the characteristics of the transferred embryo. The pregnancy loss rate was significantly lower in the endometrial group ≥ 10 mm.

Table 3: Relationship between pregnancy loss and number of fetuses

Factor	No. Pregnancy loss/ Sum	Rate of pregnancy loss (%)	P
Number of fetuses			
1	20/81	24,7%	0,506
≥ 2	13/43	30,2%	

Table 3 shows the rate of pregnancy loss in the multiple pregnancy group was higher than in the single pregnancy group, but the difference was not statistically significant.

IV. DISCUSS

Currently, the number of children born from IVF is increasing, the risk of pregnancy loss is a matter of concern for scientists and couples wishing to have children. We performed the study to evaluate early pregnancy loss with gestational age <12 weeks. Our biggest limitation is the small sample size, making it difficult to understand factors related to pregnancy loss.

The rate of pregnancy loss in our study was 42/133 (31.6%). According to Neubourg (2004) studied over 370 cases of 1 embryo transfer of good quality in women under 38 years old (166 ICSI cycles and 204 classic IVF cycles), pregnancy is defined as HCG >5 UI/l, and the definition of early pregnancy loss includes biochemical pregnancy, clinical pregnancy, and ectopic pregnancy before 13 weeks of gestation. There were 192 pregnancies, 30 biochemical pregnancies, 4 ectopic pregnancies, and 23 clinical pregnancy losses. The rate of early

pregnancy loss was 29.7%. When ectopic pregnancy was excluded, the rate of early termination of pregnancy was 28.2% [4]. Compared with our study, this ratio is not statistically significantly different (p>0.05).

In our study, there were 124 cases of clinical pregnancy; the pregnancy loss rate since the clinical pregnancy was confirmed was 33/124 (26.6%). Hipp's study (2016) studied the rate of early pregnancy loss from clinical pregnancy to before 14 weeks of gestation, in which pregnancy loss was calculated when total intrauterine fetal loss, the rate of early pregnancy loss is 15% [10]. Our study had a much higher rate of pregnancy loss which could be explained by counting any pregnancy with at least 1 fetus death as pregnancy loss. According to Hu's study (2018), with a sample exclusion of preimplantation genetic diagnosis and natural cycle in endometrial preparation, uterine abnormalities such as uterine fibroids, asherman syndrome. In which, early pregnancy loss is calculated from the time of clinical pregnancy to 12 weeks before pregnancy, accounting for 8.4% [9]. In this study, pregnancy using GnRH anta and controlled ovarian stimulation regimens was associated with a higher risk of pregnancy loss compared with GnRH a. Compared with our study, all patients used GnRH anta regimen. Due to differences in description and sampling, fetal growth arrest rates may vary across studies.

Maternal age is the most important determinant of pregnancy rates in the context of natural pregnancy as well as after assisted reproductive techniques [11]. Due to the decrease in ovarian reserve, the quality of the follicles decreases and eventually leads to a decrease in ovarian fertility [12], and an increase in the incidence of aneuploidy [13] in older women. Hipp's research (2016), the rate of early pregnancy loss increased by age groups: < 30 (9.8%), 30-34 (11.2%), 35-37 (14.7%), 38 -40 (22%), > 40 (36.8%) [10]. In the study of Hu (2018), the rate of pregnancy loss in women > 40 years old was 37.7%. There was a significant increase when compared to women < 30 years old [9].

Regarding the classification of infertility, the study by Hipp (2016) had an increase (p < 0.0001) in the rate of pregnancy loss according to the number of previous pregnancies: 0 (13.2%), 1 (15),4%), ≥ 2 (17.6%) [10]. However, the study of Hu (2018) did not have a difference in the rate of early pregnancy loss between the secondary and primary infertility groups [9].

Regarding the history of miscarriage, in the Magnus study (2019), the risk of pregnancy loss increased with the number of previous miscarriages: 1 (OR 1.54), 2 (OR 2.21), 3 (OR 3,97) [14]. Hipp's study (2016) also showed that the rate of early pregnancy loss increased with the number of previous miscarriages, this rate according to the number of miscarriages: 0 (13.2%), 1 (15), 4%), ≥ 2 (17.6%) (p < 0.0001) [10].

Regarding the BMI group, obesity was considered a risk factor for pregnancy loss. This risk is explained by the fact that the action of the hormone leptin produced in adipose tissue affects not only the functioning of the ovaries and endometrium, but also interacts with the release and activity of gonadotropins and hormones that control their synthesis also affects the developing embryo [15]. In a mouse study by Han (2018), the embryonic defects of obese pregnant female mice were caused by a deficiency of the Stella protein (also known as DPPA3 or PGC7) in oocytes [16]. In Hu's study (2018), women with BMI ≥ 28 seem to have a higher risk of pregnancy loss than women with BMI 18.5-25 (HR=1.52, 95% CI=1.11-2.10, P = 0.010) [9]. Low BMI is also a risk factor. In Winter's study (2002), the risk of pregnancy loss was higher in women with BMI < 18.5 (35%) than in women with BMI 18.5-25 (12). %) with p < 0.01 [2].

Regarding PCOS, the study of Winter (2002) showed that women with PCOS had a statistically significant higher rate of early pregnancy loss than women without PCOS (26% vs. 15%) [2]. In a study by Wang (2001) in subjects receiving assisted reproduction, women with PCOS had an increased rate of pregnancy loss when compared with women without PCOS (25% vs 18%, P < 0,01), however when using multivariable logistic regression analysis, this increase was not statistically significant. These results suggest that the increased risk of pregnancy loss in women with PCOS may be due to the high prevalence of obesity and the type of treatment they received during IVF treatment [6].

According to Geber (1995), the severity of endometriosis does not affect the outcome of IVF or the rate of pregnancy loss [17]. Yang's study (2019) in IVF fresh embryo transfer also showed no significant difference in the risk of pregnancy loss in women with endometriosis [18]. However, there are still studies with differences. In the study of Santulli (2016), a retrospective cohort study on 2 groups of women with endometriosis diagnosed histologically after surgical examination and the group of women without endometriosis, the result was that there was

a difference between women with endometriosis (29%) compared with the group of patients without endometriosis (19%) with p < 0.001 [7].

Regarding uterine fibroid, according to Sundermann (2017), the presence of 1 or more uterine fibroids identified by ultrasound does not significantly affect the risk of pregnancy loss [19]. A meta-analysis of the Metwally (2020) based on 2012 Cochrane library data showed no evidence of a significant effect of ablation of any type of uterine fibroid on pregnancy loss [20].

Regarding the number of oocytes obtained, according to Hipp (2016), there was a decrease in pregnancy loss as the number of oocytes collected increased, the highest pregnancy loss in the group of <5 oocytes (21.6%) and the lowest in the group number of oocytes obtained ≥ 30 (13.6%) [10]. Sunkara's study (2014) also gave similar results when age-affected factors were excluded [24]. One possible explanation is that the poor ovarian response may be related to ovarian aging, which is associated with a decrease in the number of primordial follicles [25]. A small study by Setti (2011) showed no difference in the rate of aneuploidy and pregnancy loss between poor ovarian responders (≤ 4 oocytes) and normal (≥ 5 oocytes) [26]. The question is whether AMH, a valuable indicator in the assessment of ovarian reserve, that is associated with the risk of pregnancy loss. According to P Peuranpää (2020), low AMH value is not a risk factor for early pregnancy loss after IVF/ICSI treatment [27].

Regarding the type of embryo transfer, according to Hipp (2016), the rate of early pregnancy loss in the frozen embryo transfer cycle was higher (18.1%) than in the fresh embryo transfer group (14.3%) p<0.0001. When comparing subgroups, this difference was only found in women younger than 30 with similar embryo quality [10]. The study of Hu (2018), and Yang (2021) also showed the high risk of early pregnancy loss in the frozen embryo transfer group [9,28]. However, the Aflatoonian study (2016) showed no difference in pregnancy loss rate between fresh and frozen embryo transfer cycles [29].

Regarding the number of embryos transferred, according to Hu (2018), there was a significant difference in the rate of early pregnancy loss between the group of 2 embryos (11.9%) and 3 embryos (13.2%) when compared with the group with 1 embryo transfer (17.3%) [9]. In contrast, in Zhang Q's study (2021), the rate of early pregnancy loss was not significantly correlated with the number of embryos and the quality of embryos transferred [30].

Regarding cleavage or blastocyst transfer, according to Papanikolaou (2006), the rate of early pregnancy loss in single-embryo transfer on day 3 was higher than in single-embryo transfer on day 5 (26.8% versus 17.2%, p = 0.017) [31]. The reason seems to be that the embryo enters the uterus on days 4-5; the endometrium may not provide the appropriate physiological environment for the cleavage stage embryo, especially in ovarian stimulation and increasing estrogen. Thus blastocyst transfer improves Embryo-uterine synchronization and improves embryo transfer outcomes. However, according to Hu (2018), blastocyst transfer had a higher rate of early pregnancy loss than the cleavage embryo transfer group after considering maternal age [9]. According to a meta-study in the Cochrane library by Glujovsky (2016) based on 27 randomized controlled trials, there was no evidence of a higher rate of pregnancy loss between blastocyst and cleavage embryo transfer groups [32].

Regarding endometrial thickness, in our study, the percentage of early pregnancy loss after embryo transfer with endometrial thickness 10 mm (24%) was statistically significantly lower than that of embryo transfer group with endometrial thickness before embryo transfer < 10 mm (41.4%) with p = 0.032. According to Gallos (2018) of 25767 IVF cycles, pregnancy loss is defined to include both in biochemical pregnancy as well as clinical pregnancy, the maximum endometrial thickness during ovarian stimulation is closely related to the rate of pregnancy loss during IVF cycles and it is recommended that an endometrial thickness of 10 mm or more minimizes the rate of pregnancy loss and maximize the live birth rate [33]. Research by Detti (2008) also shows an increase in pregnancy loss if the endometrium is < 9.8 mm [34]. The study by Kimberly Liu (2019) showed an increase in the rate of pregnancy loss and a decrease in the rate of live birth for each millimeter of endometrial thickness less than 8 mm [35]. Although other studies have not been completely homologous, they have shown a relationship between endometrial thickness and pregnancy loss rate. Based on our results, women undergoing endometrial preparation for embryo transfer should optimize outcomes with an increase in endometrial thickness ≥ 10 mm.

Regarding the number of fetuses, according to Tummers (2003) the rate of early pregnancy loss in twins was significantly higher than that of

singleton pregnancies after IVF. However, the rate of total fetal death in the twin group (5.1) %) was significantly lower than in the singleton group (21.1%) [36]. The József Gábor study (2012) in IVF and natural pregnancies showed a higher rate of pregnancy loss in the multiple pregnancy group than in the singleton pregnancy group [37]. Despite the increased incidence of pregnancy loss, at least 1 live birth rate in the twin pregnancy group appeared to be higher than in singleton pregnancies.

V. CONCLUSION

The rate of pregnancy loss 12 weeks after IVF was 31.6%. The rate of at least one fetus remaining to 12 weeks gestation was 76,7%. The pregnancy loss rate decreased when the endometrial thickness was ≥ 10 mm before the endometrial transition.

Pregnancy loss in vitro fertilization is an issue that needs to be studied with larger sample sizes to understand the influencing factors to optimize embryo transfer outcomes.

REFERENCES

1. Wilcox AJ, Weinberg CR, O'Connor JF, Baird DD, Schlatterer JP, Canfield RE, et al. Incidence of early loss of pregnancy. N Engl J Med. 1988. 319: 189-94.
2. Winter E, Wang J, Davies MJ, Norman R. Early pregnancy loss following assisted reproductive technology treatment. Hum Reprod. 2002. 17: 3220-3.
3. Bu Z, Hu L, Su Y, Guo Y, Zhai J, Sun YP. Factors related to early spontaneous miscarriage during IVF/ICSI treatment: an analysis of 21,485 clinical pregnancies. Reprod Biomed Online. 2020. 40: 201-206.
4. De Neubourg D, Gerris J, Mangelschots K, Van Royen E, Vercruyssen M, Elseviers M. Single top quality embryo transfer as a model for prediction of early pregnancy outcome. Human Reproduction. 2004. 19: 1476-1479.
5. Rossen LM, Ahrens KA, Branum AM. Trends in Risk of Pregnancy Loss Among US Women, 1990-2011. Paediatr Perinat Epidemiol. 2018. 32: 19-29.
6. Wang JX, Davies MJ, Norman RJ. Polycystic ovarian syndrome and the risk of spontaneous abortion following assisted reproductive technology treatment. Hum Reprod. 2001. 16: 2606-9.
7. Santulli P, Marcellin L, Menard S, Thubert T, Khoshnood B, Gayet V, et al. Increased rate of spontaneous miscarriages in endometriosis-affected women. Hum Reprod. 2016. 31: 1014-23.
8. Homer HA, Li TC, Cooke ID. The septate uterus: a review of management and reproductive outcome. Fertil Steril. 2000. 73: 1-14.
9. Hu L, Du J, Lv H, Zhao J, Chen M, Wang Y, et al. Influencing factors of pregnancy loss and survival probability of clinical pregnancies conceived through assisted reproductive technology. Reprod Biol Endocrinol. 2018. 16: 74.
10. Hipp H, Crawford S, Kawwass JF, Chang J, Kissin DM, Jamieson DJ. First trimester pregnancy loss after fresh and frozen in vitro fertilization cycles. Fertility and Sterility. 2016. 105: 722-728.
11. Nybo Andersen AM, Wohlfahrt J, Christens P, Olsen J, Melbye M. Maternal age and fetal loss: population based register linkage study. Bmj. 2000. 320: 1708-12.
12. Baird DT, Collins J, Egozcue J, Evers LH, Gianaroli L, Leridon H, et al. Fertility and ageing. Hum Reprod Update. 2005. 11: 261-76.
13. Franasiak JM, Forman EJ, Hong KH, Werner MD, Upham KM, Treff NR, et al. The nature of aneuploidy with increasing age of the female partner: a review of 15,169 consecutive trophectoderm biopsies evaluated with comprehensive chromosomal screening. Fertil Steril. 2014. 101: 656-663.e1.
14. Magnus MC, Wilcox AJ, Morken NH, Weinberg CR, Haberg SE. Role of maternal age and pregnancy history in risk of miscarriage: prospective register based study. Bmj. 2019. 364: l869.
15. Mitchell M, Armstrong DT, Robker RL, Norman RJ. Adipokines: implications for female fertility and obesity. Reproduction. 2005. 130: 583-97.
16. Han L, Ren C, Li L, Li X, Ge J, Wang H, et al. Embryonic defects induced by maternal obesity in mice derive from Stella insufficiency in oocytes. Nat Genet. 2018. 50: 432-442.
17. Geber S, Paraschos T, Atkinson G, Margara R, Winston RM. Results of IVF in patients with endometriosis: the severity of the disease does not affect outcome, or the incidence of miscarriage. Hum Reprod. 1995. 10: 1507-11.
18. Yang P, Wang Y, Wu Z, Pan N, Yan L, Ma C. Risk of miscarriage in women with endometriosis undergoing IVF fresh cycles: a retrospective cohort study. Reprod Biol Endocrinol. 2019. 17: 21.
19. Sundermann AC, Velez Edwards DR, Bray MJ, Jones SH, Latham SM, Hartmann KE. Leiomyomas in Pregnancy and Spontaneous Abortion: A Systematic Review and Meta-analysis. Obstet Gynecol. 2017. 130: 1065-1072.
20. Metwally M, Ong KJ, Ledger WL, Li TC. Does high body mass index increase the risk of miscarriage after spontaneous and assisted conception? A meta-analysis of the evidence. Fertil Steril. 2008. 90: 714-26.
21. Al-Agha R, Firth RG, Byrne M, Murray S, Daly S, Foley M, et al. Outcome of pregnancy in type 1 diabetes mellitus (T1DMP): results from combined diabetes-obstetrical clinics in Dublin in three university teaching hospitals (1995-2006). Ir J Med Sci. 2012. 181: 105-9.

22. Hewapathirana NM , Murphy HR. Perinatal outcomes in type 2 diabetes. Curr Diab Rep. 2014. 14: 461.
23. Kitzmiller JL, Wallerstein R, Correa A, Kwan S. Preconception care for women with diabetes and prevention of major congenital malformations. Birth Defects Res A Clin Mol Teratol. 2010. 88: 791-803.
24. Sunkara SK, Khalaf Y, Maheshwari A, Seed P, Coomarasamy A. Association between response to ovarian stimulation and miscarriage following IVF: an analysis of 124 351 IVF pregnancies. Hum Reprod. 2014. 29: 1218-24.
25. Broekmans FJ, Kwee J, Hendriks DJ, Mol BW, Lambalk CB. A systematic review of tests predicting ovarian reserve and IVF outcome. Hum Reprod Update. 2006. 12: 685-718.
26. Setti AS, de Almeida Ferreira Braga DP, de Cássia Savio Figueira R, de Castro Azevedo M, Iaconelli A, Jr., Borges E, Jr. Are poor responders patients at higher risk for producing aneuploid embryos in vitro? J Assist Reprod Genet. 2011. 28: 399-404.
27. Peuranpää P, Hautamäki H, Halttunen-Nieminen M, Hydén-Granskog C, Tiitinen A. Low anti-Müllerian hormone level is not a risk factor for early pregnancy loss in IVF/ICSI treatment. Human Reproduction. 2020. 35: 504-515.
28. Yang A-M, Xu X, Han Y, Wei J-J, Hao G-M, Cui N, et al. Risk Factors for Different Types of Pregnancy Losses: Analysis of 15,210 Pregnancies After Embryo Transfer. Frontiers in endocrinology. 2021. 12: 683236-683236.
29. Aflatoonian A, Karimzadeh Maybodi MA, Aflatoonian N, Tabibnejad N, Amir-Arjmand MH, Soleimani M, et al. Perinatal outcome in fresh versus frozen embryo transfer in ART cycles. International journal of reproductive biomedicine. 2016. 14: 167-172.
30. Zhang Q, Zhang J, Zhou X, Li Y, Chen Y, Chen X, et al. Association of number and quality of embryos transferred with early pregnancy loss in infertile women at an advanced age undergoing frozen-thawed embryo transfer. Nan Fang Yi Ke Da Xue Xue Bao. 2021. 41: 1050-1055.
31. Papanikolaou EG, Camus M, Fatemi HM, Tournaye H, Verheyen G, Van Steirteghem A, et al. Early pregnancy loss is significantly higher after day 3 single embryo transfer than after day 5 single blastocyst transfer in GnRH antagonist stimulated IVF cycles. Reprod Biomed Online. 2006. 12: 60-5.
32. Glujovsky D, Farquhar C, Quinteiro Retamar AM, Alvarez Sedo CR, Blake D. Cleavage stage versus blastocyst stage embryo transfer in assisted reproductive technology. Cochrane Database of Systematic Reviews. 2016.
33. Gallos ID, Khairy M, Chu J, Rajkhowa M, Tobias A, Campbell A, et al. Optimal endometrial thickness to maximize live births and minimize pregnancy losses: Analysis of 25,767 fresh embryo transfers. Reproductive BioMedicine Online. 2018. 37: 542-548.
34. Detti L, Yelian FD, Kruger ML, Diamond MP, Rode A, Mitwally MF, et al. Endometrial thickness is related to miscarriage rate, but not to the estradiol concentration, in cycles down-regulated with gonadotropin-releasing hormone antagonist. Fertil Steril. 2008. 89: 998-1001.
35. Liu KE, Hartman M, Hartman A. Management of thin endometrium in assisted reproduction: a clinical practice guideline from the Canadian Fertility and Andrology Society. Reproductive BioMedicine Online. 2019. 39: 49-62.
36. Tummers P, Sutter PD, Dhont M. Risk of spontaneous abortion in singleton and twin pregnancies after IVF/ICSI. Human Reproduction. 2003. 18: 1720-1723.
37. Joó JG, Csaba Á, Szigeti Z, Rigó J. Spontaneous abortion in multiple pregnancy: Focus on fetal pathology. Pathology - Research and Practice. 2012. 208: 458-461.