International Journal of Multidisciplinary Research and Growth Evaluation.

Pregnancy Rates After Frozen Embryo Transfer: Insights from an Indian Government Hospital

Sholen Acharya [1*], Sheila Balakrishnan [2], Deepak Rath [3]
[1, 2] Department of Reproductive Medicine and Surgery, Government Medical College, Thiruvananthapuram, Kerala, India
[3] Department of Internal Medicine, John H Stroger, Jr Hospital of Cook County, Chicago, Illinois, USA

* Corresponding Author: **Sholen Acharya**

Article Info

ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 07-02-2025
Accepted: 15-03-2025
Page No: 965-972

Abstract
Objective: This study aims to evaluate the outcomes of frozen embryo transfer (FET) cycles performed at the Department of Reproductive Medicine and Surgery, SAT Hospital, Government Medical College Trivandrum
Methods: A prospective observational study was conducted involving 190 FET cycles in 170 subjects. Demographic and clinical data, including age, body mass index (BMI), duration of infertility, ovarian reserve (assessed by Antral Follicle Count and Anti-Müllerian Hormone), stimulation protocol, and endometrial preparation were analysed. The clinical outcomes, including clinical pregnancy rate, implantation rate, miscarriage rate, and multiple pregnancy rate, were recorded.
Results: The study found a clinical pregnancy rate (CPR) of 35.7% per transfer cycle and 40% per subject. The implantation rate was 22.8% per transferred embryo, while the miscarriage rate was 5.2% per cycle. The ongoing pregnancy rate was 30.5%, with multiple pregnancies occurring in 9.5% of cycles.
Conclusion: The outcomes of FET cycles at SAT Hospital are comparable to European averages, with a favourable CPR and implantation rate. Key areas for improvement include embryo culture till blastocyst formation and the implementation of an elective single embryo transfer (eSET) policy to reduce multiple pregnancy risks. Continuous evaluation and evidence-based advancements shall optimise ART success at SAT Hospital, reinforcing its role in reproductive medicine in South India.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.2.965-972

Keywords: Frozen embryo transfer, In-vitro fertilization, Pregnancy rate, India, Embryo, Endometrium

1. Introduction

Frozen Embryo Transfer (FET) is an integral component of Assisted Reproductive Technology (ART) that involves freezing and storing embryos for transfer at a later date. This approach offers several advantages, particularly for subfertile couples, by maximizing the utilization of embryos obtained from a single ovarian stimulation cycle [1]. By enabling multiple transfer attempts, FET increases the overall chances of conception.

One of the key benefits of FET is its role in reducing the risk of Ovarian Hyperstimulation Syndrome (OHSS), a potentially serious condition that can occur when fresh embryo transfer follows ovarian stimulation [2]. OHSS is caused by vasoactive substances released from hyperstimulated ovaries, leading to increased vascular permeability, fluid accumulation in third spaces, and potential complications in vital organs [2]. Additionally, FET helps lower the incidence of multiple pregnancies, thereby reducing associated obstetric complications [1]. Despite the added costs associated with embryo freezing, storage, and thawing, several studies have indicated that FET may yield higher pregnancy rates compared to fresh embryo transfer [3]. This could be attributed to the more physiologically favourable endometrial environment in FET cycles, as fresh cycles are affected by supraphysiological hormone levels from multiple corpus lutea, potentially impairing endometrial receptivity [1].

Globally, organizations such as the European Society for Human Reproduction and Embryology (ESHRE) maintain ART registries to track outcomes, ensure transparency, and facilitate data-driven decision-making in reproductive medicine [4].

According to the ESHRE Registry report published in May 2022 for the year 2018, approximately 30% of ART cycles were FET cycles, with an average pregnancy rate per cycle of 34.3% [5]. A consistent increase in both the number of FET cycles performed and their success rates has been observed over the years.

In India, the National ART Registry of India (NARI) was initiated by the Indian Society of Assisted Reproduction to document ART services. However, its last report was published in 2013, covering data from 2007 to 2009 [6]. More recently, the Indian government has launched the National ART and Surrogacy Registry, which aims to systematically record ART services, outcomes, and clinic performances nationwide to aid in policy formulation and research initiatives. The primary goal of evaluating FET outcomes, such as clinical pregnancy rates, is to generate data that can be benchmarked against global standards. This allows for the identification of deficiencies and improvements in ART services.

The Sree Avittam Thirunal (SAT) Hospital, Government Medical College, Thiruvananthapuram, is the first public sector hospital in Kerala to provide ART services since 2012. This study was undertaken to assess the success rates of FET cycles at our center, where a "freeze-all" strategy is predominantly followed. In this approach, embryos are cryopreserved and transferred one to three months later, ensuring a more optimal endometrial environment. The clinical pregnancy rate from FET cycles at our hospital provides a comprehensive measure of ART success at our centre.

As a government-run ART clinic, our facility follows an evidence-based approach rather than a profit-driven model, ensuring unbiased, scientifically robust data. This study aims to provide reliable statistics on pregnancy outcomes following FET in subfertile women using exclusively autologous embryos, with no donor eggs or embryos. The findings will contribute to long-term planning, service enhancement, and the identification of areas requiring improvement in ART services.

2. Methodology

2.1 Study design and setting

This prospective observational study was conducted at the Department of Reproductive Medicine and Surgery of Sri Avittom Thirunal (SAT) Hospital, Government Medical College (GMC), Thiruvananthapuram, Kerala, between July 2020 to December 2021, a period of 18 months.

2.2 Study population and participant characteristics

The study population was sub-fertile women undergoing ART (Assisted Reproductive Technology) treatment at our Department. All women between the ages of 21 and 45 years whose embryos were frozen via vitrification and were planned to undergo frozen embryo transfer with their own embryos (autologous transfer) after endometrial preparation using hormone replacement (programmed cycle) were included in this study. Donor oocyte cycles, endometrial preparation done with natural or modified natural cycles, day 3 of menstrual cycle scan showing thick endometrium ovarian cysts and those who did not provide consent were excluded from the study.

2.3 Sampling and sample size

All candidates undergoing frozen embryo transfer (FET) who met the study criteria were recruited consecutively until the required sample size was reached. The sample size was estimated using the formula for cross-sectional studies [7]. The prevalence of clinical pregnancy rate from a European registry (2014) was used [8] due to the lack of adequate Indian studies. To have a study power of 80%, with a 95% confidence and a 7% error, the required sample size was 156. However, a higher number of subjects were initially recruited to account for cancellations due to inadequate endometrial preparation, thin endometrium, or participant withdrawal.

2.4 Study procedure

Eligible subjects underwent screening, detailed history-taking, and clinical examination. Data collection included age, infertility duration, BMI, cause of infertility, ovarian reserve markers (AFC, AMH), stimulation protocol, days of stimulation, gonadotropin use, trigger method, sperm parameters, donor sperm use, and embryo formation details.

2.4.1. Ovarian Stimulation, IVF, and Embryo Culture

Controlled ovarian hyperstimulation was done using either a flexible GnRH antagonist or long GnRH agonist protocol based on patient characteristics. Stimulation was achieved using Human Menopausal Gonadotropin (HMG), recombinant FSH (r-FSH), or a combination. Some patients received recombinant LH (r-LH) with r-FSH instead of HMG. Ovulation was triggered when three or more follicles reached >17mm diameter, using hCG, GnRH agonist, or a dual trigger. Oocyte retrieval occurred 35 hours post-trigger via transvaginal ultrasound-guided follicle aspiration. Intracytoplasmic sperm injection (ICSI) was performed on all oocytes. Fertilization was confirmed after 16 hours by the presence of two pronuclei. Embryos were cultured in G-TL media with oil overlay inside a MINC mini-incubator. Cryopreservation was done on day 2 or day 3 based on Istanbul consensus grading.

2.4.2 Embryo Freezing (Cryopreservation)

Embryo vitrification followed Kitazato's Cryotop Method. The Cryotop was labeled with the subject's name. Equilibration and vitrification solutions were prepared, and embryos were equilibrated for 7-12 minutes. After equilibration, embryos were transferred sequentially through vitrification solutions before being placed onto Cryotops and plunged into liquid nitrogen at -196°C. Storage conditions were constantly monitored.

2.4.3 Endometrial preparation for FET Cycle

Candidates received oral contraceptive pills (Femilon) for 12-14 days. Transvaginal ultrasound on day 2-3 of withdrawal bleeding assessed endometrial thickness and ovarian cysts. Hormone replacement therapy (HRT) with or without pituitary suppression was used for endometrial preparation. Pituitary suppression involved GnRHa (Leuprolide acetate or Goserelin acetate). Estrogen (estradiol valerate) was given at 4-6 mg/day, and progesterone (natural progesterone 100mg intramuscular) was started once endometrial thickness reached ≥7mm.

2.4.4 Embryo warming and culture

Thawing followed Kitazato's vitrification protocol. Embryos were transferred through solutions (TS, DS, WS1, WS2) before post-warming culture in G-TL medium inside an incubator. Embryos were cultured to day-5 blastocyst or day-3 cleavage stage based on morphology.

2.4.5 Embryo assessment and selection

Embryos were graded based on Istanbul consensus [9] for cleavage stage and morula, and Gardner & Schoolcraft's classification for blastocysts [10] and good quality embryos were selected for transfer.

2.4.6 Embryo Transfer

After endometrial preparation and embryo selection, embryo transfer was performed under transabdominal ultrasound guidance using COOK's Sydney IVF Catheter system. Mock transfers were reviewed for cervical characteristics. The outer guiding catheter was placed past the internal os. The inner catheter was loaded with embryos, and 20-30µL transfer media was inserted inside the outer catheter. The tip was positioned 10-15mm from the fundus, and embryos were slowly released. If embryos were retained in the catheter, retransfer was done immediately.

2.4.7 Luteal phase support and follow up

After the embryo transfer, luteal support was given with vaginal micronised progesterone gel (SUSTEN 8% gel, Sun Pharmaceuticals, India). Serum beta-human chorionic gonadotropin (ß-hCG) was done 12 days after the embryo transfer and considered positive if >25 IU/L. Those with positive serum ß-hCG were followed up with a transvaginal scan 6 weeks after embryo transfer for confirmation of clinical pregnancy (defined as the presence of intrauterine sac with or without fetal pole ± cardiac activity). Subjects were followed till first-trimester aneuploidy screening between 11-13 weeks to confirm ongoing pregnancy.

2.5 Outcome measures

2.5.1. Primary outcome:

Clinical pregnancy rate calculated by dividing the number of clinical pregnancies (presence of at least one gestational sac with or without fetal pole ± cardiac activity) by number of FET cycles expressed in percentage.

2.5.2 Secondary outcomes

They are described in Table 1 below.

Table 1: Definition of secondary outcomes

Secondary outcome	Definition (all terms expressed in percentage)
Implantation rate	Total number of gestational sacs divided by total number of embryos transferred for all FET cycles
Miscarriage rate	Absence of cardiac activity at 7mm CRL, at mean gestational sac diameter of 25mm, one week after the appearance of yolk sac in ultrasound, two weeks after gestational sac without a yolk sac per transfer cycle
Ongoing pregnancy rate	Number of pregnancies continuing beyond 12 weeks divided by number of transfer cycles
Multiple pregnancy rate	Number of pregnancies with multiple gestation per transfer
Ectopic pregnancy rate	Number of transfers resulting in gestational sac outside uterine cavity or non-visualisation of sac with serum ß-hCG in discriminatory zone (1,000-1,500 mIU/mL) divided by total number of transfers.

2.6 Data analysis

Data were entered into MS EXCEL file. The clinical pregnancy rate (CPR) was calculated as per the formula

CPR= (Number of clinical pregnancies/ Number of FET cycles) X 100

Further analysis was performed on statistical software Statistical Package for Social Sciences (SPSS) software, IBM manufacturer Chicago, USA, version 20.0. Continuous variables were verified if normally distributed and normal quantitative variables were expressed as Mean with Standard Deviation (SD). Non-normal quantitative data were expressed as Median with Interquartile Range (IQR). Categorical data was represented as proportions and presented in frequency distribution plots.

2.7 Ethical considerations

The study protocol was approved by the Institutional Review Committee (IRC) and the Human Ethics Committee (HEC) of Government Medical College, Thiruvananthapuram (HEC.No.04/92/2020/MCT dated 26/06/2020). Informed written consent was obtained from all participants.

3. Results

A total of 170 subjects underwent 190 frozen embryo transfer (FET) cycles during the study period. Among them, 18 subjects had two FET cycles, and one subject had three cycles. The majority of cycles (95.3%) were "all freeze" cycles, while 4.7% were performed following fresh embryo transfers with surplus embryos.

The continuous attributes of the study participants like age, body mass index (BMI), duration of infertility, ovarian reserve, number of mature eggs, time between freezing and thawing and endometrial thickness on the day of transfer have been demonstrated in Table 2 and categorical variables like type of infertility, cause of infertility, stimulation protocol, endometrial preparation, type of embryo transfer, quality of embryo have been summarised in Table 3. The quantitative parameters have also been added to Table 3 after dividing them into classes for further understanding of patient characteristics.

Table 2: Summary of continuous attributes of participants

Participant characteristics	Mean± SD	Median (IQR)	Range
Age (years)	31.84 ± 4.364	32 (28-35)	23 – 43
BMI (kg/m^2)	24.58 ±3.67	24 (22-27)	15-37
Duration of infertility (years)	7.71 ± 4.21	7 (4 – 10)	1-18

Antral Follicle Count (AFC)	20.22 ± 11.63	17 (12-25)	4 – 52
Anti-Müllerian Hormone (AMH) (ng/ml)	3.82 ± 2.58	3.2 (1.9 – 5.2)	0.14 – 16
Number of mature eggs (M2 oocytes)	11.41 ± 5.64	11 (7-15)	2-36
Time between freezing and thawing (months)	9.08 ±5.88	8 (4 - 12)	2 – 32
Endometrial thickness (mm)	7.9	7.5 (7-8.5)	6.3-14

Table 3: Summary of categorical attributes of participants

	Class	Frequency	Percent
Age (years)	< 25 years	8	4.2
	25 - 29 years	49	25.8
	30 - 34 years	80	42.1
	35 - 39 years	47	24.7
	≥ 40 years	6	3.2
BMI (kg/m^2)	<18.5	8	4.2
	18.5-22.9	45	23.7
	23-24.9	48	25.3
	25-29.9	71	37.4
	≥30	18	9.5
Type of infertility	Primary	131	68.9
	Secondary	59	31.1
Duration of infertility	0-5 years	51	26.8
	5-10 years	80	42.1
	>10 years	59	31.1
Cause of infertility	Female	118	62.1
	Male	60	31.6
	Combined	12	6.3
Female infertility distribution (n=118)	Hypogonadotropic Hypogonadism	1	0.8
	Uterine	9	7.6
	Tubal	20	16.9
	Polycystic ovarian syndrome	22	18.6
	Endometriosis	23	19.5
	Unexplained	43	36.4
Male infertility distribution (n=60)	Severe OAT	43	71.7
	Azoospermia	17	28.3
Antral Follicle Count (AFC)	<5	4	2.1
	5 - 10	24	12.6
	10 - 15	45	23.7
	> 15	117	61.6
Anti-Müllerian Hormone (AMH) (ng/ml)	0-1.2	16	8.4
	1.2 - 2.0	33	17.4
	2.0 - 4.0	61	32.1
	≥4.0	80	42.1
Stimulation protocol	Agonist	19	10.0
	Antagonist	171	90.0
Number of mature eggs (M2 oocytes)	<4	11	5.8
	4-9	67	35.3
	10-14	61	32.1
	≥15	51	26.8
Time between freezing and thawing (months)	0 - 3 months	33	17.4
	4 - 6 months	46	24.2
	7 - 12 months	66	34.7
	13- 24 months	41	21.6
	25 - 60 months	4	2.1
Endometrial preparation	HRT without GnRH-a	11	5.8
	HRT with GnRH-a	179	94.2
Endometrial thickness (mm)	<7mm	4	2.1
	7-8mm	100	52.6
	8 -10mm	74	38.9
	>10mm	12	6.3
Number of embryos transferred	Single embryo	38	20.0
	Double embryo	109	57.4
	Three embryos	43	22.6
Day of embryo transferred	Day 3	71	37.4
	Day 4	4	2.1
	Day 5	115	60.5
Type of embryo transferred	Blastocyst	85	44.7
	Not blastocyst	105	55.3

Type of Day 5 embryo transferred (n= 115)	Blastocyst	85	73.9
	Not blastocyst	30	26.1
Quality of embryo transferred	Good	113	59.5
	Poor	77	40.5
Day 3 embryo quality (n=71)	Day-3 good	68	95.7
	Day-3 poor	3	4.3
Day 5 embryo quality (n=115)	Day-5 good	43	37.4
	Day-5 poor	72	62.6
Quality of blastocyst transfer (n=85)	Good quality blastocyst	42	49.4
	Poor quality blastocyst	43	50.6

3.1 Demographic Characteristics

The mean age of participants was 32 years (range: 23–43 years), with the highest proportion (42.1%) in the 30-34 years age group. The median BMI was 24 kg/m² (IQR: 22-27), with 37.4% of subjects classified as overweight (BMI 25-29.9) and 9.5% as obese (BMI ≥30). Primary infertility was more prevalent (68.9%) compared to secondary infertility (31.1%). The median duration of infertility was 7 years (IQR: 4-10), with 42.1% experiencing infertility for 5-10 years and 31.1% for over 10 years. The leading cause of infertility was female factor (62.1%), followed by male factor (31.6%) and combined factors (6.3%). Among female infertility cases, unexplained infertility (36.4%) and endometriosis (19.5%) were most common. Among male infertility cases, severe oligoasthenoteratozoospermia (71.7%) was the predominant cause.

3.2 Ovarian Reserve

More than 60% of subjects had an antral follicle count (AFC) >15, with a median AFC of 17 (IQR: 12-25). Three-quarters of them had anti-Müllerian hormone (AMH) levels >2 ng/ml, with a median AMH of 3.2 ng/ml (IQR: 1.9-5.2).

3.3 Stimulation and oocyte characteristics

The antagonist protocol was the most commonly used stimulation regimen (90%). The median number of M2 oocytes retrieved was 11 (IQR: 7-15), with 94.2% of subjects having ≥4 M2 oocytes.

3.4 Endometrial and embryo characteristics

The majority of cycles (94.2%) used hormone replacement therapy (HRT) with pituitary suppression for endometrial preparation. The median endometrial thickness at transfer was 7.5 mm (IQR: 7-8.5 mm), with 91.5% having a thickness between 7-10 mm. Most transfers (76.3%) occurred within one year of embryo freezing, with a median thawing time of 8 months (IQR: 4-12 months). Double embryo transfers were most common (57.4%), followed by single embryo transfers (20%) and three embryo transfers (22.6%). Day-5 transfers accounted for 60.5% of cycles, of which 73.9% involved blastocysts. Good-quality embryos were used in 59.5% of all transfers. However, among Day-5 transfers, only 37.4% had good-quality embryos. Blastocyst transfers occurred in 44.7% of cycles, with 49.4% involving good-quality blastocysts.

3.5 Outcomes (Table 4)

Table 4: Summary of outcomes

Total number of FET cycles	190
Total number of subjects	170
Total number of clinical pregnancies	68
Clinical pregnancy rate per transfer cycle	35.7%
Clinical pregnancy rate per subject	40%
Total number of embryos transferred	385
Total number of gestational sacs seen	88
Implantation rate per transferred embryo	22.8%
Number of miscarriages	10
Miscarriage rate per transfer cycle	5.2%
Miscarriage rate per subject	5.9%
Number of ongoing pregnancies	58
Ongoing pregnancy rate	30.5%
Number of multiple pregnancies	18
Multiple pregnancy rate per transfer cycle	9.5%
Number of ectopic pregnancies	2
Ectopic pregnancy rate	1.05%

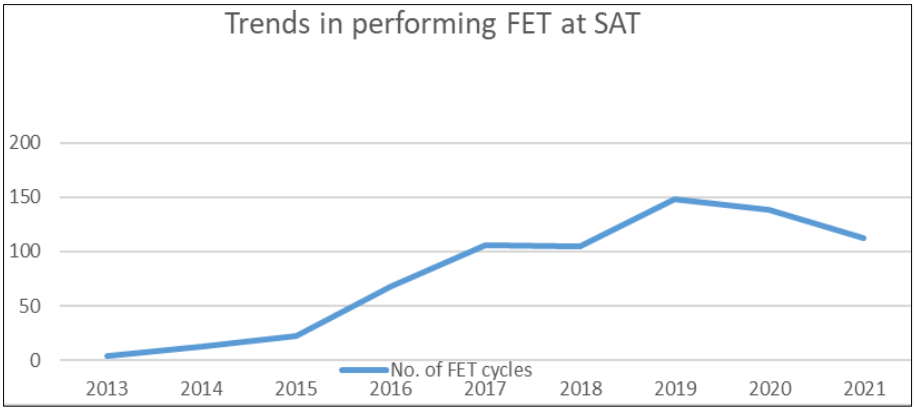
The clinical pregnancy rate was 35.7% per transfer cycle and 40% per subject. The implantation rate was 22.8% per transferred embryo. The miscarriage rate was 5.2% per cycle, and the ongoing pregnancy rate was 30.5%. Multiple pregnancies occurred in 9.5% of cycles, and the ectopic pregnancy rate was 1.05%.

4. Discussion

The findings of this study provide valuable insights into the clinical pregnancy rate (CPR) after Frozen Embryo Transfer (FET) cycles at Sree Avittam Thirunal (SAT) Hospital, Government Medical College, Thiruvananthapuram. With a CPR of 35.7% per cycle, our results are comparable to the European Society for Human Reproduction and Embryology (ESHRE) 2022 registry report, which documented an average CPR of 34.3% for European countries [5]. This suggests that the ART services provided at our centre adhere to global standards despite being in a resource-limited public healthcare setting.

4.1 Trends in FET cycles and the impact of covid-19 (figure 1)

Our study observed a continuous rise in the number of FET cycles performed since the first transfer in 2013, reaching a peak of approximately 150 cycles in 2019. The temporary decline in FET cycles during the COVID-19 pandemic is consistent with global trends. The Human Fertilization and Embryology Authority (HFEA) of the UK reported a decrease in NHS-funded IVF treatments from 35% in 2019 to 28% in 2020, alongside a 28% reduction in fresh cycles and an 11% reduction in frozen cycles [11]. Despite these setbacks, efforts were made to resume services promptly, minimizing delays in embryo transfer.



Source: Author

Fig 1: Time trends of Frozen embryo transfers at the Department of Reproductive medicine and Surgery at SAT Hospital

4.2 Demographic and clinical characteristics

The median age of study participants was 32 years, aligning with HFEA data, which reports an average IVF patient age of 34 years. A majority of our patients had a BMI between 23-30 kg/m² (median 24 kg/m²), slightly higher than the European IVF population average of 22.5 kg/m² [12]. Given that BMI influences endometrial receptivity and implantation [13], this difference might have had a marginal impact on our success rates.

Primary infertility was the predominant diagnosis, affecting 70% of the study population, with a median infertility duration of seven years—longer than the average five to six years reported in other studies [12]. This reflects the tertiary nature of our center, where patients are referred following unsuccessful treatments elsewhere. Female factor infertility accounted for 62% of cases, while male factors constituted 30%, with severe oligo-astheno-teratozoospermia being the most common male infertility diagnosis. In contrast, global studies often report a more equal distribution between male and female infertility factors [14].

4.3 Ovarian reserve and stimulation characteristics

Our findings on ovarian reserve metrics were consistent with international studies [15]. Around 85% of patients had an antral follicle count (AFC) >10, with a median AFC of 17 and a mean of 20.22 ± 11.63. Similarly, 75% of cycles had an Anti-Müllerian Hormone (AMH) >2 ng/ml, with a median of 3.2 ng/ml. Higher AMH levels correlate with increased embryo yield [16], facilitating the "freeze-all" strategy, which was followed in 181 of the 190 cycles analyzed.

The predominant ovarian stimulation protocol used was the flexible antagonist protocol, which offers cost-effectiveness and a lower risk of ovarian hyperstimulation syndrome (OHSS). This approach aligns with global best practices and is widely used in randomized controlled trials comparing fresh and frozen embryo transfers [16].

4.4 Endometrial preparation and transfer timing

A critical determinant of FET success is endometrial preparation. At our center, most patients underwent hormone replacement therapy (HRT) with GnRHa pituitary suppression, ensuring optimal endometrial receptivity. While this method prevents ovulation efficiently, some studies advocate for HRT without suppression due to its patient-friendly nature, albeit with a higher cycle cancellation rate [17]. The thickness of the endometrium on day of transfer was 7-10 mm in 90% of cycles, which is reported as optimal for achieving maximum success [18].

The median duration between embryo freezing and thawing was eight months, with most transfers occurring within one year. Recent studies indicate a possible decline in pregnancy rates with prolonged embryo storage [19], highlighting the importance of minimizing delays in FET cycles.

4.5 Embryo characteristics and transfer protocols

Blastocyst transfer was performed in 45% of cycles, significantly lower than the 75% reported in the ESHRE 2018 registry [5]. Our study showed that all cleavage-stage embryos did not grow up to blastocyst after warming and post-warm culture. However, no embryo transfer was deferred due to an absence of blastocyst on day 5. This may have resulted in a reduction in pregnancy rates. Regarding the quality of embryos, more than 90% of day 3 embryos were good quality whereas only 37% of day 5 embryos were good quality. Longer post-warm culture results in poor-quality embryos [20], potentially impacting success rates. Therefore culturing embryos up to day 5 followed by freezing them and warming them with minimum post-warm culture time, may enhance results significantly.

Our centre does not have a strict policy for elective single embryo transfer (eSET) [21]. In this study, 20% of cycles involved single embryo transfer, whereas the majority had double embryo transfers, and around 20% had triple embryo transfers. In contrast, the HFEA 2019 report states that 75% of IVF cycles in the UK involve eSET, contributing to lower multiple pregnancy rates [22]. Given the global trend towards eSET to reduce twin and triplet gestations, implementing a structured policy at our centre is advisable.

4.6 Clinical outcomes and pregnancy rates

The clinical pregnancy rate of 35.7% at our centre was similar to published reports from UK of 36.3% [5]. Our implantation rate of 22.8% and miscarriage rate of 5.2%, align to other global figures [23]. Multiple pregnancies occurred in 9.5% of cycles, which is in line with ESHRE data but higher than the 6% reported by HFEA for the UK in 2019 [22]. There is no established single embryo transfer protocol at our centre which may have contributed to this. The ectopic pregnancy rate was 1.05%, comparable to other studies.

4.7 Implications and Future directions

The clinical pregnancy rate of 35.7% at our centre is comparable to international benchmarks, demonstrating the efficacy of our protocols despite infrastructural limitations. However, key areas for improvement include:

- Implementation of an elective single embryo transfer (eSET) policy to reduce multiple pregnancy rates.
- Increased emphasis on blastocyst culture to enhance implantation rates.
- Optimization of endometrial preparation protocols to reduce cycle cancellations.
- Streamlining the freezing-to-thawing interval to mitigate potential embryo viability decline.

With the establishment of the National ART and Surrogacy Registry in India, there is an opportunity to strengthen data collection, improve ART services, and ensure standardized outcomes across centres. Our findings contribute to this effort by providing evidence-based insights into FET success rates in a public healthcare setting.

5. Conclusion

This study provides valuable insights into the outcomes of frozen embryo transfer (FET) cycles at the Department of Reproductive Medicine and Surgery at SAT Hospital, Government Medical College Trivandrum. Since the introduction of ART services in 2012, the centre has successfully performed a steadily increasing number of FET cycles, with a clinical pregnancy rate (CPR) of 35.7%, which aligns with the average CPR reported in Europe. Despite the challenges posed by the COVID-19 pandemic, which temporarily interrupted fertility services, efforts were made to minimise delays, and embryos were transferred within a median of 8 months from freezing. These efforts resulted in a pregnancy rate that reflects both the resilience of the fertility services and the robust processes in place at SAT Hospital.

However, several areas for improvement were identified. Prolonged post-warm culture affects embryo quality. Therefore, efforts must be made to culture embryos up to blastocyst before freezing, and warming should be just before their use with minimum post-warm culture time. The lack of a formal elective single embryo transfer (eSET) policy at SAT Hospital is one of the key areas for future development to reduce the risks associated with multiple pregnancies. Further best practices in ovarian stimulation, embryo culture and endometrial preparation will contribute to the success of ART services at the centre. This study highlights the importance of continuous evaluation and improvement, and the outcomes observed at SAT Hospital are a testament to the skill and dedication of the medical team. With ongoing advancements in clinical protocols, the centre is well-positioned to provide the best care and contribute to the growing field of reproductive medicine in South India.

6. Acknowledgement

I thank consultants in the department Dr Anitha M, Dr Reji Mohan and Dr Ramesh P, for their constructive criticism and my colleague Dr Sujani Chigurupati for being supportive throughout this work. I also express gratitude towards my parents Kalyani Acharya and Subas Acharya, for continuous encouragement.

7. References

1. Bardhi E, Drakopoulos P. Frozen embryo transfer. In: Management of Infertility. Elsevier; 2023:317–324. doi:10.1016/B978-0-323-89907-9.00029-6
2. Mathur R, Drakeley A, Raine-Fenning N, Evbuomwan I, Hamoda H. The management of ovarian hyperstimulation syndrome. (Green-top Guideline No. 5). Royal College of Obstetricians and Gynaecologists (RCOG). Published February 2016. Available from: https://www.rcog.org.uk/media/or1jqxbf/gtg_5_ohss.pdf
3. Chang CT, Weng SF, Chuang HY, Hsu IL, Hsu CY, Tsai EM. Embryo transfer impact: a comprehensive national cohort analysis comparing maternal and neonatal outcomes across varied embryo stages in fresh and frozen transfers. Frontiers in Endocrinology. 2024;15:1400255. doi:10.3389/fendo.2024.1400255
4. De Geyter C, Wyns C, Calhaz-Jorge C, *et al*. 20 years of the European IVF-monitoring Consortium registry: what have we learned? A comparison with registries from two other regions. Human Reproduction. 2020;35(12):2832–2849. doi:10.1093/humrep/deaa250
5. European IVF Monitoring Consortium (EIM), for the European Society of Human Reproduction and Embryology (ESHRE), Gliozheni O, Hambartsoumian E, *et al*. ART in Europe, 2018: results generated from European registries by ESHRE. Human Reproduction Open. 2022;2022(3):hoac022. doi:10.1093/hropen/hoac022
6. Malhotra N, Shah D, Pai R, Pai H, Bankar M. Assisted reproductive technology in India: a 3 year retrospective data analysis. Journal of Human Reproductive Sciences. 2013;6(4):235. doi:10.4103/0974-1208.126286
7. Czaja R, Scheaffer RL, Mendenhall W, Ott L. Elementary Survey Sampling. Journal of the American Statistical Association. 1987;82(400):1185. doi:10.2307/2289408
8. De Geyter C, Calhaz-Jorge C, Kupka MS, *et al*. ART in Europe, 2014: results generated from European registries by ESHRE. Human Reproduction. 2018;33(9):1586–1601. doi:10.1093/humrep/dey242
9. Alpha Scientists in Reproductive Medicine and ESHRE Special Interest Group of Embryology, Balaban B, Brison D, *et al*. The Istanbul consensus workshop on embryo assessment: proceedings of an expert meeting. Human Reproduction. 2011;26(6):1270–1283. doi:10.1093/humrep/der037
10. Gardner DK, Schoolcraft WB. Culture and transfer of human blastocysts. Current Opinion in Obstetrics and Gynaecology. 1999;11(3):307–311. doi:10.1097/00001703-199906000-00013
11. Human Fertilisation and Embryology Authority (HFEA). UK statistics for IVF and DI treatment, storage

and donation. Impact of COVID-19 on fertility treatment 2020. Published May 2022. Available from: https://www.hfea.gov.uk/about-us/publications/research-and-data/impact-of-covid-19-on-fertility-treatment-2020/
12. Arvis P, Lehert P, Guivarc'h-Leveque A. Simple adaptations to the Templeton model for IVF outcome prediction make it current and clinically useful. Human Reproduction. 2012;27(10):2971–2978. doi:10.1093/humrep/des283
13. Zheng D, Wang Y, Chen L, Zeng L, Li R. Association between body mass index and in vitro fertilization/intra-cytoplasmic sperm injection outcomes: an analysis of 15,124 normal ovarian responders in China. Chinese Medical Journal. 2024;137(7):837–845. doi:10.1097/CM9.0000000000002992
14. Yeung WSB, Li RHW, Cheung TM, Ng EHY, Lau EYL, Ho PC. Frozen-thawed embryo transfer cycles. Hong Kong Medical Journal. 2009;15(6):420–426.
15. Shi Y, Sun Y, Hao C, *et al*. Transfer of fresh versus frozen embryos in ovulatory women. New England Journal of Medicine. 2018;378(2):126–136. doi:10.1056/NEJMoa1705334
16. Simón C, Gómez C, Cabanillas S, *et al*. A 5-year multicentre randomized controlled trial comparing personalized, frozen and fresh blastocyst transfer in IVF. Reproductive BioMedicine Online. 2020;41(3):402–415. doi:10.1016/j.rbmo.2020.06.002
17. Prato LD, Borini A, Cattoli M, Bonu MA, Sciajno R, Flamigni C. Endometrial preparation for frozen-thawed embryo transfer with or without pretreatment with gonadotropin-releasing hormone agonist. Fertility and Sterility. 2002;77(5):956–960. doi:10.1016/S0015-0282(02)02960-6
18. Zhang T, Li Z, Ren X, *et al*. Endometrial thickness as a predictor of the reproductive outcomes in fresh and frozen embryo transfer cycles: a retrospective cohort study of 1512 IVF cycles with morphologically good-quality blastocyst. Medicine. 2018;97(4):e9689. doi:10.1097/MD.0000000000009689
19. Hu KL, Hunt S, Zhang D, Li R, Mol BW. The association between embryo storage time and treatment success in women undergoing freeze-all embryo transfer. Fertility and Sterility. 2022;118(3):513–521. doi:10.1016/j.fertnstert.2022.06.003
20. Rato ML, Gouveia-Oliveira A, Plancha CE. Influence of post-thaw culture on the developmental potential of human frozen embryos. Journal of Assisted Reproduction and Genetics. 2012;29(8):789–795. doi:10.1007/s10815-012-9793-z
21. Elective single-embryo transfer. Fertility and Sterility. 2012;97(4):835–842. doi:10.1016/j.fertnstert.2011.11.050
22. Human Fertilisation and Embryology Authority (HFEA). UK statistics for IVF and DI treatment, storage, and donation. Fertility treatment 2019: trends and figures. Published May 2021. Available from: https://www.hfea.gov.uk/about-us/publications/research-and-data/fertility-treatment-2019-trends-and-figures/
23. Pirtea P, De Ziegler D, Tao X, *et al*. Rate of true recurrent implantation failure is low: results of three successive frozen euploid single embryo transfers. Fertility and Sterility. 2021;115(1):45–53. doi:10.1016/j.fertnstert.2020.07.002