

Current status of assisted reproductive technology in Korea, 2011

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Objective: The number of assisted reproductive technology (ART) clinics, ART cycles, clinical pregnancy rate (CPR), and number of newborns conceived using ART have steadily increased in South Korea. This aim of this study was to describe the status of ART in South Korea between January 1 and December 31, 2011.

Methods: A localized online survey was created and sent to all available ART centers *via* email in 2015. Fresh embryo transfer (FET) cases were categorized depending on whether standard *in vitro* fertilization, intracytoplasmic sperm injection (ICSI), or half-ICSI procedures were used. Thawed embryo transfer (TET) and other related procedures were surveyed.

Results: Data from 36,990 ART procedures were provided by 74 clinics. Of the 30,410 cycles in which oocytes were retrieved, a complete transfer was performed in 91.0% (n = 27,683). In addition, 9,197 cycles were confirmed to be clinical pregnancies in the FET cycles, representing a pregnancy rate of 30.2% per oocyte pick-up and 33.2% per ET. The most common number of embryos transferred in the FET procedures was three (38.1%), followed by two (34.7%) and one (14.3%). Of the 8,826 TET cycles, 3,137 clinical pregnancies (31.1%) were confirmed by ultrasonography.

Conclusion: While the overall clinical pregnancy rate for the TET cycles performed was lower than the rate reported in 2010 (31.1% vs. 35.4%), the overall CPR for the FET cycles was higher than in 2010 (33.2% in 2011 and 32.9% in 2010). The most common number of embryos transferred in FET cycles was three, as was the case in 2010.

Keywords: Assisted reproductive techniques; Surveys

Introduction

Subfertility is being overcome through advancements in fertility treatment, including controlled ovarian stimulation, intrauterine insemination, and *in vitro* fertilization (IVF). Since the first IVF baby was born in South Korea (hereafter Korea) in 1985, the use of assisted re-

productive technology (ART) to overcome infertility has dramatically increased, along with the number of the fertility centers and live births of ART-conceived infants. The most recent national statistics indicate that 2.83% of all births in 2011 were associated with financial support from the National Supporting Program for the Subfertile (NSPS) administered by the Korean Ministry of Health and Welfare (KMHW).

The Korean Society of Obstetrics and Gynecology published their first report in 1992 and managed ART data until 2013, when the Korean Society of Assisted Reproduction (KSAR) took over the role of managing the data provided in ART registration forms. Two other independent registry databases exist in Korea: one administered by the KMHW under the rubric of the NSPS and another administered by the Korean Centers for Disease Control and Prevention under the Bioethics and Safety Act beginning in 2005.

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The abundant data on the ART procedures in 2011 that have been collected from fertility centers throughout the nation are a valuable resource and make the publication of this report possible, and additionally represent a rich source of information regarding the factors that successfully lead to a live birth.

The main objectives of this database are to facilitate collaboration between the Committee for ART Statistics and fertility centers in Korea and to gather data on the status and success rate of each ART clinic, based on the voluntary provision of data about the procedures performed in these clinics in Korea between January and December 2011.

Methods

1. Subjects

Of the 137 ART clinics that were invited to input their data into the module created by the Committee of Statistics of the KSAR, 74 reported their outcomes (return rate, 54.0%). The complete list of the ART clinics that participated in this survey is presented by region in Supplement 1.

2. Methods

A revised Korean-language online survey was provided by email to all of the ART clinics registered with the KMHW. Responses were collected online (<http://www.ivfkorea.or.kr>). The survey was originally based on the International Committee Monitoring Assisted Reproductive Technologies Tool Box for Data Collection forms at the national and regional levels (Supplement 2).

The IVF data were also categorized according to outcomes after embryo transfer (ET) in fresh cycles, after thawed ET, and in association with other related procedures, as in the previous survey. Thereafter, the data were subclassified according to the IVF methods, such as conventional IVF, intracytoplasmic sperm injection (ICSI), and half-ICSI.

All data reflected treatment cycles that took place in 2011. However, the precise characteristics of the starting and ending day of the data submitted (oocyte pick-up day or controlled ovarian stimulation day) was left to its clinic's discretion, thereby resulting in a mixed dataset. Clinical pregnancy was defined as the presentation of an intrauterine gestational sac on ultrasound examination. Cases of biochemical pregnancy were excluded if elevated serum beta-human chorionic gonadotropin was the only sign of pregnancy. Live birth delivery was defined as the birth of one or more live infants, with the delivery of multiple infants counting as one live birth delivery.

3. Analysis

The contribution of ART to each outcome was calculated by dividing the total number of outcomes by the number of oocyte pick-ups

and number of ETs. All data analyses were performed using PASW ver. 18.0 (SPSS Inc., Chicago, IL, USA).

Results

1. Overview

1) Data provided by the fertility clinics

Seventy-four centers reported on treatment cycles that were initiated in 2011. In total, 36,990 cycles of ART treatment were reported.

2) Type of ART procedures

Fresh ET was used in approximately 75% ($n=27,683$) of the 36,990 ART cycles that were reported. ART cycles that used frozen embryos were the next most common type of procedure, accounting for approximately 23.9% of total ART cycles ($n=8,826$). The less common procedures were oocyte donation ($n=233$), preimplantation genetic diagnosis ($n=227$), and preimplantation genetic screening ($n=21$) (Table 1).

3) Trends by age

Women 30 to 34 years of age comprised the majority (38.0%) of all fresh ET cycles performed in 2011. The age distribution among the other patients who received fresh ET cycles was as follows: 36.6% among those 35 to 39 years of age, 18.3% among those over 40 years of age, 6.7% among those 25 to 29 years of age, and 0.4% among those younger than 25 years. Similarly, women 30 to 34 years of age comprised the largest group of women who underwent thawed ET cycles, accounting for 44.5% of those cycles. Women 35 to 39 years of age comprised the next most common age group. A total of 287 fresh ET cycles and 290 thawing ET cycles were missing age data.

A plurality of women who underwent a fresh ET cycle were 30 to 34 years of age in 2011, whereas the largest group was comprised of women 35 to 39 years of age in 2010. The plurality of women who underwent thawed ET cycles were 30 to 34 years of age in 2011 ($n=3,802$, 44.5%) (Table 2).

4) Clinical outcomes by age

Among the patients from whom oocytes were retrieved ($n=30,410$),

Table 1. Types of ART cycles

Type of ART procedure	No. of cycles in 2011	No. of cycles in 2010
Fresh ET	27,683 (74.8)	23,202 (75.4)
Thawed ET	8,826 (23.9)	6,945 (22.6)
Others	481 (1.3)	638 (2.1)
Total	36,990 (100.0)	30,785 (100.0)

Values are presented as number (%).

ART, assisted reproductive technology; ET, embryo transfer.

Table 2. The number of cycles in fresh ET and thawed ET by age group

Age group (yr)	Fresh ET		Thawed ET	
	2011	2010	2011	2010
< 25	106 (0.4)	70 (0.3)	50 (0.6)	28 (0.4)
25–29	1,843 (6.7)	1,738 (6.7)	667 (7.8)	701 (11.2)
30–34	10,416 (38.0)	9,192 (35.4)	3,802 (44.5)	3,427 (54.5)
35–39	10,029 (36.6)	9,883 (38.0)	3,039 (35.6)	2,226 (35.4)
≥ 40	5,002 (18.3)	5,114 (19.7)	978 (11.5)	540 (8.6)
Total	27,396 ^{a)} (100.0)	25,997 (100.0)	8,536 (100.0)	6,285 (100.0)

Values are presented as number (%).

ET, embryo transfer.

^{a)}Patient age was missing for 287 fresh ET patients and 290 thawed ET patients.

Table 3. Clinical outcomes by age group

Outcome	Fresh cycle (yr)						Thawed cycle (yr)					
	≤ 24	25–29	30–34	35–39	> 40	All	≤ 24	25–29	30–34	35–39	> 40	All
ET cycles (n)	106	1,843	10,416	10,029	5,002	27,396	50	667	3,802	3,039	978	8,536
Clinical pregnancy (n)	48	815	4,250	3,304	707	9,124	20	260	1,455	1,049	245	3,029
Delivery reported (n)	24	395	2,076	1,527	229	4,251	12	112	720	348	257	1,449
CPR per ET (%)	45.3	44.2	40.8	32.9	14.1	33.3	40	39	38.3	34.5	25.1	35.5

ET, embryo transfer; CPR, clinical pregnancy rate.

Table 4. Live births by fertilization methods

	Singleton	Twin	Triplet	Quadruplet or more	Total
IVF	1,179	385	10	0	1,565
ICSI	1,352	446	7	0	1,832
Half-ICSI	616	242	2	0	865
Thawed ET	840	313	2	0	1,146
Total	3,987	1,386	21	0	5,408

Values are presented as number.

IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; ET, embryo transfer.

90.1% (n = 27,396) successfully transferred their embryos in 2011. Of these, 9,124 patients were confirmed to have achieved clinical pregnancy, representing 30.0% of oocytes retrieved per cycle and 33.3% of ETs per cycle. Among the patients who underwent thawed ET (n = 8,536), 3,029 patients were confirmed to have achieved clinical pregnancy, which represents a 35.5% clinical pregnancy rate per ET cycle. The clinical pregnancy rate per ET of fresh cycles was higher among patients 34 years of age or younger than the clinical pregnancy rate per ET of thawed ET cycles (Table 3).

5) Live deliveries by treatment type

Although many of the clinics that participated in this study may not have been able to follow up with pregnant patients until the actual delivery, a total of 5,408 patients were confirmed to have undergone live births. However, several clinics did not report the number of live births or whether they were accomplished by IVF, (half) ICSI, or

thawed ET in 2011 (Table 4).

2. Fresh cycles

1) Clinical pregnancies by fertilization method

Of the 27,683 fresh ET cycles, 33.3% used embryos obtained by IVF, 49.4% by ICSI, and 17.4% by half-ICSI. Among the embryos that were successfully transferred, the clinical pregnancy rate was 36.6%, 28.5%, and 40.2% among those who received IVF, ICSI, and half-ICSI procedures, respectively (Table 5).

2) Clinical pregnancies by the number of transferred embryos

Of the 26,454 fresh embryo cycles, nearly three quarters (72.8%) were 2-ET or 3-ET cycles (2-ET, 34.7%; 3-ET, 38.1%), and 14.3% were single ETs. Overall, the clinical pregnancy rate was 41.9% for 2-ET cycles and 34.7% for 3-ET cycles.

The multiple pregnancy rate per ET was the highest among women

Table 5. Clinical pregnancies by the fertilization method in fresh cycles

Outcome	IVF	ICSI	Half-ICSI	All
ET cycles, n (%)	9,207 (33.3)	13,670 (49.4)	4,806 (17.4)	27,683
Clinical pregnancies (n)	3,373	3,893	1,931	9,197
CPR per ET (%)	36.6	28.5	40.2	33.2

IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; ET, embryo transfer; CPR, clinical pregnancy rate.

Table 6. Clinical pregnancies by the number of transferred embryos in fresh cycles

Outcome	No. of embryos transferred						Total
	One	Two	Three	Four	Five	Six or more	
ET cycles, n (%)	3,795 (14.3)	9,180 (34.7)	100,071 (38.1)	2,916 (11.0)	453 (1.7)	39 (0.1)	26,454 (100.0)
Clinical pregnancies (n)	748	3,844	3,494	957	105	10	8,947
CPR per ET (%)	19.7	41.9	34.7	32.8	23.2	25.6	33.8
Two or more gestational sacs (n)	10	1,000	963	293	26	4	2,201
MPR per ET (%)	0.3	10.9	9.6	10	5.7	10.3	8.3

ET, embryo transfer; CPR, clinical pregnancy rate; MPR, multiple pregnancy rate.

Table 7. Clinical pregnancies by fertilization method in frozen-thawed ET cycles

Outcome	Thawing ET				Total
	IVF	ICSI	Half-ICSI		
ET cycles, n (%)	3,447 (40.5)	2,794 (32.8)	2,278 (26.7)		8,519 ^{a)}
Clinical pregnancies (n)	1,207	946	868		3,021
CPR per ET ^{a)} (%)	35	33.9	38.1		35.5

ET, embryo transfer; IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; CPR, clinical pregnancy rate.

^{a)}The total number of thawed ET cycles was 8,826. Data on the fertilization method was missing in 307 patients.

Table 8. Clinical pregnancies by the number of transferred embryos in frozen-thawed ET cycles

Outcome	No. of frozen-thawed embryos transferred						Total
	One	Two	Three	Four	Five	Six or more	
ET cycles, n (%)	1,442 (16.3)	4,057 (46.0)	2,307 (26.1)	897 (10.2)	109 (1.2)	14 (0.2)	8,826 (100.0)
Clinical pregnancies (n)	366	1,515	882	344	25	5	3,137
CPR per ET (%)	25.4	37.3	38.2	38.4	22.9	35.7	31.1
Two or more gestational-sacs (n)	11	387	270	123	7	1	750
MPR per ET (%)	0.8	9.5	11.7	13.7	6.4	7.1	8.5

ET, embryo transfer; CPR, clinical pregnancy rate; MPR, multiple pregnancy rate.

who received 2-ET cycles (10.9%), followed by women who underwent 6-ET cycles (10.3%) (Table 6).

3. Thawed cycles

1) Clinical pregnancies by fertilization method

Of the 8,519 thawed ET cycles, 40.5% used IVF, 32.8% used ICSI, and 26.7% used half-ICSI procedures. The clinical pregnancy rate was 35.0% for the IVF group, 33.9% for the ICSI group, and 38.1% for the half-ICSI group (Table 7).

2) Clinical pregnancies by the number of embryos transferred

Of the 8,826 thawed ET cycles, approximately 72.1% were 2-ET or

3-ET cycles (2-ET, 46.0%; 3-ET, 26.1%), and 16.3% were single ETs. Overall, the clinical pregnancy rate per ET was 37.3% for 2-ET cycles and 38.2% for 3-ET cycles.

The multiple pregnancy rate per ET was the highest among women who received 4-ET cycles (13.7%), followed by women who underwent 3-ET cycles (11.7%) (Table 8).

4. Other related procedures

1) Surgical retrieval of sperm

A total of 824 cases of surgical sperm retrieval were reported to have successfully progressed to the ET stage. The overall clinical pregnancy rate per ET was 31.8% (Table 9).

Table 9. Outcomes of the surgical retrieval of sperm

Techniques	OPU cycle	Transfer cycle	Clinical pregnancies	Live birth	CPR per ET (%)
PESA	69	66	24	1	34.8
TESE	827	758	261	151	31.6
Total	896	824	285	152	31.8

Values are presented as number.

OPU, oocyte pick-up; CPR, clinical pregnancy rate; ET, embryo transfer; PESA, percutaneous sperm aspiration; TESE, testicular sperm extraction.

2) Preimplantation genetic diagnosis and preimplantation genetic screening

Of the 227 cycles of preimplantation genetic diagnosis that were planned, a total of 39 cases successfully progressed to clinical pregnancy after ET (179 cycles). In 2011, a total of 2,259 embryos were examined at the preimplantation stage, and 511 of these embryos were diagnosed as normal.

Of the 21 cycles of preimplantation genetic screening that were planned, a total of five cases successfully progressed to clinical pregnancy after ET (16 cycles). In 2011, a total of 158 embryos were examined at the preimplantation stage, and 44 of these embryos were diagnosed as normal.

3) Oocyte cryopreservation

In 2011, oocyte cryopreservation was performed in 78 cycles. Twenty-seven cycles were reported to have been planned for medical reasons and 15 cycles for personal reasons.

4) *In vitro* maturation

A total of 538 cycles using *in vitro* maturation were reported in 2011. From these cycles, 168 clinical pregnancies and 108 live births were reported.

5) Oocyte donation

In 2011, oocyte donation was performed in 233 cycles. Of these, 197 cycles were successfully transferred, resulting in clinical pregnancies in 97 cycles and live births in 45 cycles.

6) Selective fetal reductions

In 2011, 297 selective fetal reductions were reported. The majority of selective fetal reductions were performed in triplet pregnancies, resulting in twin pregnancies (55.2%).

5. Intrauterine insemination

Of the 27,299 cycles of intrauterine insemination, 3,256 cases successfully progressed to clinical pregnancy (11.9% per cycle).

Discussion

Since the first report on this topic was issued in 1995, the number of ART procedures and the number of fertility clinics has increased in Korea. Although the clinical pregnancy rate per ET in fresh IVF cycles slightly increased from 2010 (32.9%) to 2011 (33.3%), these figures do not automatically apply to a particular couple without a consideration of their individual factors.

The 36,990 ART cycles performed at the clinics who reported their data from 2011 resulted in 4,251 live births in fresh cycles and 1,449 live births in thawed cycles (including data on embryos that might have been frozen in 2010, but were thawed and transferred in 2011).

This survey suggests that factors pertaining to the infertile couples (e.g., the woman's age) and procedural factors (e.g., the number of embryos transferred) play an important role in the success of ART treatments. However, the findings of this report are subject to some serious limitations. First, the data submitted were reported by each ART clinic voluntarily and were not validated by any third parties. Furthermore, the definition of infertility and subfertility diagnoses may vary from clinic to clinic [1]. Second, data regarding patient demographics, medical histories, and infertility diagnoses were absent. Third, these data were not linked to the individual patients in whom the procedures were performed. The data do not indicate whether cycles were performed in women undergoing ART for the first time or in women who had previously undergone an unsuccessful ART cycle.

Despite the aforementioned limitations, the KSAR is now launching an online system to collect information related to other infertility-related procedures, including intrauterine insemination, the miscarriage rate, preimplantation genetic screening, and oocyte donation (<http://www.ivfkorea.or.kr>).

The above website will aid in expanding the relationship between infertile couples and healthcare providers. Showing the general success rate of ART through metrics such as the clinical pregnancy rate per cycle in fresh and thawed ART cycles, as well as cycles involving intrauterine insemination, may reassure infertile couples who are seeking options for a future pregnancy.

In this survey of voluntarily submitted data from 2011, we reported data providing an overview of the overall national picture of fertility

treatment in Korea. We hope that this information will reduce the informational gap between infertile couples and ART clinics and serve as a reference for quality control and the self-promotion of ART centers in Korea.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

We are deeply grateful to those who contributed to this report and helped collect the 2011 ART data. We believe that their contribution to this report will be greatly appreciated by future patients who consider undergoing an ART procedure (Supplement 1).

Supplementary materials

Supplement 1. Seventy-four *in vitro* fertilization centers participated in 2011 survey. Supplemental data can be found at: <http://ecerm.org/src/sm/cerm-43-45-s001.pdf>

Supplement 2. A revised Korean-language online survey form used in 2011. Supplemental data can be found at: <http://ecerm.org/src/sm/cerm-43-45-s002.pdf>

Reference

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