

Original Research

Comparison of Cumulative Live Birth Rates Between Oocyte Retrieval Using Single-Lumen and Double-Lumen Needles: A Retrospective Cohort Study

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Abstract

Background: Diminished ovarian reserve (DOR) is associated with suboptimal oocyte retrieval efficiency during *in vitro* fertilization/intracytoplasmic sperm injection (IVF/ICSI), and conventional single-lumen needle (S-LN) aspiration presents inherent limitations that may further compromise outcomes in this patient population. Double-lumen needle (D-LN) aspiration has been proposed to enhance procedural precision; however, its clinical value in patients with DOR remains unconfirmed. Existing studies on oocyte retrieval techniques for DOR patients still lack high-quality comparative evidence to guide clinical practice optimization. This study aimed to compare the effects of double-lumen versus S-LN aspiration on oocyte yield, embryo quality, and pregnancy outcomes in DOR patients undergoing *in vitro* fertilization and embryo transfer (IVF-ET). **Methods:** A retrospective, self-controlled cohort study was conducted at a tertiary reproductive center over a 6-year period, enrolling 70 DOR patients who underwent a total of 277 oocyte retrieval cycles, of which 153 utilized S-LN and 124 utilized D-LN. Key embryological parameters (fertilization rate and embryo quality) and clinical outcomes (implantation and pregnancy rates) were compared between groups. **Results:** Patients undergoing D-LN retrieval were significantly older, had a longer duration of infertility, and presented with lower anti-Müllerian hormone (AMH) levels compared with the single-lumen group. Although the proportion of successful retrieval cycles was numerically higher in the double-lumen group (91.94% vs. 86.93%, $p = 0.182$), this difference did not reach statistical significance. The S-LN method was linked to a significantly greater oocyte yield than the D-LN method ($B = 0.200$, $p = 0.009$) in the generalized estimating equations (GEE) model adjusted for within-patient clustering, age, AMH, BMI, and protocol, the two methods remained comparable in terms of number of day-3 high-quality embryos, clinical pregnancy rate, implantation rate, live birth rate, and cumulative live birth rate (all $p > 0.05$). **Conclusions:** In the same patient cohort, despite advancing oocyte retrieval age, prolonged duration of infertility, and declining ovarian reserve function, D-LN oocyte retrieval yielded comparable embryo culture outcomes and equivalent clinical outcomes to S-LN retrieval.

Keywords: double-lumen needle oocyte retrieval; diminished ovarian reserve; assisted reproductive technology; oocyte retrieval rate; embryo transfer

1. Introduction

Transvaginal oocyte retrieval is the most common surgical procedure for obtaining oocytes in assisted reproduction technology (ART) [1]. With the rapid advancement of ART, the selection of puncture needles for oocyte retrieval has expanded [2]. Women with poor ovarian reserve or combined advanced reproductive age (≥ 35 years) face multifactorial challenges, including reduced oocyte retrieval rate (ORR), increased rates of embryonic aneuploidy and miscarriage, and decreased live birth rates [3,4,5]. To improve ORR in such patients, double-lumen needles (D-LN) have been introduced in clinical practice for oocyte retrieval [6]. The alternating aspiration-irrigation mechanism of these needles enhances the efficiency of oocyte-cumulus complex dislodgement.

However, the repeated follicular flushing during oocyte retrieval with D-LN may cause mechanical damage to oocytes and adversely affect embryo quality. More-

over, D-LN are more expensive than single-lumen needles (S-LN), and the multiple rinsing required for each follicle may prolong surgical time and increase the risk of surgical complications [2]. These concerns have limited the wide application of D-LN in clinical practice. In this study, we conducted a retrospective, self-controlled cohort analysis of data on ORR, embryo culture outcomes, clinical pregnancy rates, and live birth rates derived from single-lumen versus D-LN retrieval across multiple cycles in the same patients at our institution. Additionally, we aimed to explore the potential clinical applicability of D-LN in oocyte retrieval procedures.

2. Materials and Methods

2.1 Study Design and Ethical Approval

2.1.1 Study Population

The study cohort included 70 patients who underwent at least two consecutive *in vitro* fertiliza-



tion/intracytoplasmic sperm injection (IVF/ICSI) cycles, with ≤ 5 follicles measuring ≥ 14 mm in diameter on the day of human chorionic gonadotropin (hCG) trigger in each cycle. Each oocyte-retrieval cycle employed only one type of aspiration needle. All enrolled patients received both single-lumen-needle (S-LN) and double-lumen-needle (D-LN) oocyte retrieval in separate distinct cycles; the sequence of needle-type use differed across patients. Intra-patient comparisons were stratified by oocyte retrieval needle type: S-LN group and D-LN group.

2.1.2 Inclusion Criteria

Patients were eligible for enrollment if they met all of the following criteria:

Diminished ovarian reserve (DOR) diagnosis [7,8]: At least two of the following validated biomarkers or clinical indicators, confirmed by two consecutive laboratory assessments conducted at least 4 weeks apart to ensure diagnostic reliability:

- Anti-Müllerian hormone (AMH) < 1.1 ng/mL;
- Bilateral antral follicle count (AFC) < 5 –7 follicles;
- Basal follicle-stimulating hormone (FSH) > 10 IU/L,

measured on days 2–3 of the menstrual cycle.

Treatment history: No prior ovarian surgery (e.g., ovarian cystectomy, endometrioma excision) or major systemic diseases known to impair ovarian function.

Informed Consent: Written informed consent obtained prior to study initiation.

2.1.3 Exclusion Criteria

Patients were excluded if any of the following criteria applied:

- Ovarian surgery performed between the two study cycles;
- Exposure to treatments affecting ovarian function between cycles, including chemotherapy, radiotherapy, or systemic hormonal therapy (excluding routine IVF medications such as ovarian stimulation drugs);
- History of autoimmune disease (e.g., systemic lupus erythematosus, Hashimoto's thyroiditis) or infectious oophoritis;
- Diagnosis of polycystic ovary syndrome (PCOS), uterine fibroids ≥ 4 cm in diameter, or other structural uterine abnormalities (e.g., uterine septum, Asherman's syndrome) with potential impact on embryo implantation.

To minimize confounding from temporal fluctuations in ovarian function, the interval between consecutive study cycles was strictly standardized to 4–6 weeks. Ovarian stimulation was managed predominantly with the gonadotropin-releasing hormone (GnRH) antagonist protocol, minimal stimulation protocol, or natural cycle protocol. When the dominant follicle reached > 14 mm in diameter, ovulation was triggered with 5000–10,000 IU of hCG. Transvaginal ultrasound-guided oocyte retrieval via posterior fornix puncture was performed at 36–38 h post-trigger.

2.1.4 Oocyte Retrieval Procedures

For patients in the S-LN group, a 17 G S-LN (Wallach, Cooper Surgical Inc., Trumbull, CT, USA) was loaded into the transvaginal ultrasound-guided puncture device. Follicular fluid was aspirated using a controlled negative pressure of 100–120 mmHg under real-time ultrasound guidance. In the D-LN group, oocyte retrieval was performed with a 17 G D-LN (Wego, Shandong Wego Ruisheng Medical Equipment Co., Ltd., Weihai, Shandong, China) under real-time ultrasound guidance. One lumen was dedicated to follicular fluid aspiration, while the second lumen was used for continuous flushing with pre-warmed (37°C) sterile phosphate-buffered saline (PBS, Dongyun Medical Technology (Shanghai) Co., Ltd., Shanghai, China). Flushing parameters were standardized based on follicle size:

Follicles ≥ 14 mm in diameter: Each follicle was flushed 3–5 times with 5 mL of PBS per cycle.

Follicles < 14 mm in diameter: Each follicle was flushed 3–5 times with 3 mL of PBS per cycle.

Flushing fluid was gently injected into the follicular cavity and immediately aspirated to maximize recovery of oocytes and cumulus-oocyte complexes (COCs). All oocyte retrieval procedures in both groups were performed by the same team of two senior reproductive physicians, each with ≥ 10 years of specialized experience in ART. The team strictly adhered to a standardized operating procedure (SOP) to minimize inter-operator variability and ensure procedural consistency across all study participants. The collected oocytes were incubated for at least two hours and then selected for insemination according to IVF/ICSI indications, considering the concentration and viability of the male partner's semen. Routine luteal phase support was initiated immediately following embryo transfer. Serum β -hCG levels are measured on day 14 post-transfer. In patients with a positive β -hCG result, clinical pregnancy was confirmed via transvaginal ultrasonography at 4–5 weeks post-transfer, defined as visualization of a gestational sac with a pulsating fetal heartbeat. Live birth was defined as delivery of a live infant at 28 weeks of gestation.

2.2 Study Outcomes

The main outcomes assessed were as follows: ORR (number of oocyte obtained/number of follicles punctured $\times 100\%$); embryo implantation rate (number of gestational sacs/number of transferred embryos $\times 100\%$); available embryo rate (number of embryo transferred plus number of embryos frozen/number of Two Pronuclei (2PN) cleavage plus number of 0PN cleavage plus number of 1PN cleavage $\times 100\%$); high-quality embryo rate (number of high-quality embryos/number of 2PN cleavage $\times 100\%$); clinical pregnancy rate (number of clinical pregnancy cycles/total number of cycles transferred $\times 100\%$), where clinical pregnancy was defined as visualization of a gestational sac with fetal cardiac activity on transvaginal ultrasound at 4–5 weeks after embryo transfer; cumulative pregnancy rate (number

of patients achieving clinical pregnancy in one retrieval cycle/total number of initiated cycles $\times 100\%$); cumulative live birth rate (CLBR) (number of initiated oocyte-retrieval cycles achieving at least one subsequent live birth / total number of initiated oocyte-retrieval cycles $\times 100\%$; Oocyte-retrieval cycles generating mixed embryos derived from both single-lumen-needle and double-lumen-needle aspirations were excluded from CLBR calculation); miscarriage rate (number of miscarriage cycles/number of clinical pregnancy cycles $\times 100\%$); and live birth rate (number of cycles with live births/total number of cycles transferred $\times 100\%$).

2.3 Statistical Analysis

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to evaluate the normality of continuous variables. Continuous variables with a normal distribution are expressed as mean $\pm$ standard deviation (SD) and compared using the paired samples *t*-test. Categorical variables are presented as proportions or rates (%) and were analyzed using the chi-square test or Fisher's exact test, as appropriate. The association between study variables and the number of retrieved oocytes was assessed using generalized estimating equations (GEE) with a Poisson distribution and log-link function, accounting for the correlated nature of repeated retrieval attempts within the same patient. An exchangeable working correlation matrix was specified. The model included oocyte retrieval method, protocol, maternal age, AMH, and body mass index (BMI) as covariates. A two-sided *p*-value < 0.05 was considered statistically significant.

3. Results

A total of 70 patients were enrolled in this study, contributing 277 oocyte retrieval cycles in total, of which 153 cycles were performed using S-LN and 124 using D-LN. Women in D-LN Group were slightly older and had a longer duration of infertility, with both differences being statistically significant. AFC was lower in the D-LN group, but the difference was not statistically significant. AMH levels, the number of follicles >14 mm on the day of hCG trigger, and the mean number of retrieved oocytes were all significantly lower in the D-LN group than in the S-LN group. The proportion of cycles in which at least one oocyte was retrieved was higher in the D-LN group than in the S-LN group (91.94% vs. 86.93%), but the difference was not statistically significant ($p = 0.182$) (Table 1).

GEE analysis revealed that the S-LN oocyte retrieval method and higher anti-Müllerian hormone (AMH) level were each significantly associated with a greater number of retrieved oocytes (all $p < 0.05$). In contrast, the natural-cycle protocol was associated with a significantly lower number of retrieved oocytes, using the "other protocols" group as the pre-specified reference category in the model

($p < 0.001$). No statistically significant associations with the number of retrieved oocytes were observed for GnRH antagonist protocol, minimal stimulation protocol, female age, and BMI in this GEE model (all $p > 0.05$) (Table 2).

Regarding the live birth rates following embryo transfer in the two groups, a total of 90 transfer cycles were performed in the S-LN group, comprising 32 fresh embryo transfer cycles and 58 frozen embryo transfer cycles. In the D-LN group, a total of 50 transfer cycles were performed, of which 19 were fresh embryo transfer cycles and 31 were frozen embryo transfer cycles (Table 3).

A total of 70 patients were included in this study. For the analysis of cumulative pregnancy outcomes from frozen embryo transfer cycles, the FET (Frozen Embryo Transfer) cycles with mixed thawing of single-lumen embryos (8 couples) were excluded. Cumulative pregnancy outcomes for the remaining 62 patients using exclusively S-LN- or D-LN-derived embryos, are shown in Table 4.

4. Discussion

Oocyte retrieval is a key step in assisted reproduction [9]. Obtaining a satisfactory number of oocytes is a prerequisite for successful embryo culture, morphological assessment and subsequent embryo transfer; sufficient oocyte yield provides the foundation for evaluating embryo developmental potential and euploid risk, and maximizing ORR in patients with limited follicles therefore represents a significant clinical challenge [10]. With advances in ART, D-LN have been increasingly adopted for oocyte retrieval in clinical practice. These needles enable simultaneous aspiration of follicular fluid and injection of culture fluid to rinse the inner follicular wall, thereby minimizing oocyte retention, especially for oocytes that are deeply located or tightly adherent to the follicular wall.

Since 2021, our center has gradually adopted the use of D-LN in patients with limited follicles, defined as those with 1–5 follicles measuring ≥ 14 mm in diameter, or more follicles on the trigger day. In this population, the low number of oocytes acquired per cycle and the difficulty in the formation of viable embryos frequently preclude live birth from a single retrieval cycle, often necessitating multiple ovulation induction cycles to accumulate sufficient embryos for transfer, consistent with the prognostic observations among DOR patients [11]. In this study, a before-and-after controlled analysis of such patients was performed, including all oocyte retrieval cycles and analyzing embryo culture outcomes and clinical results according to the oocyte retrieval needle type used on the day of the procedure. The present study included 277 oocyte retrieval cycles performed between January 2019 and December 2024 in 70 patients, comprising 153 S-LN cycles and 124 D-LN cycles, with some undergoing multiple cycles of each type. Outcomes including the number of oocytes retrieved, fertilization rate, number of high-quality embryos, and number of available embryos were expressed as appro-

Table 1. Baseline characteristics and oocyte retrieval outcomes in the two groups.

Variable	S-LN group	D-LN group	p-value
Number of cases	70	70	
Total number of cycles	153	124	
Percentage of oocyte-obtained cycles (%)	133/153 (86.93)	114/124 (91.94)	0.182
ORR (%)	343/489 (70.14)	219/311 (70.42)	0.934
AMH (ng/mL)	0.70 ± 0.58	0.51 ± 0.44	0.001*
Female patient age (years)	39.35 ± 5.25	40.79 ± 5.01	<0.001*
Duration of infertility (years)	4.37 ± 3.86	4.97 ± 3.87	0.031*
AFC	3.87 ± 1.84	3.44 ± 1.31	0.062
Number of follicles >14 mm on hCG day	2.18 ± 1.09	1.75 ± 0.75	0.002*
Mean number of oocytes obtained	2.31 ± 1.49	1.85 ± 1.03	0.003*
Protocols	GnRH antagonist protocol	64/153 (41.83)	59/124 (47.58)
	Minimal stimulation protocol	58/153 (37.91)	31/124 (25.00)
	Natural cycle protocol	14/153 (9.15)	21/124 (16.94)
	Other protocols	17/153 (11.11)	13/124 (10.48)

* $p < 0.05$ was considered to indicate a statistically significant difference. Values are presented as mean ± standard deviation (SD). Reported mean numbers of retrieved oocytes are patient-specific averages. For each patient, mean oocyte yields were computed separately for all their S-LN cycles and all their D-LN cycles. These patient-level mean values were then compared by paired-samples t-test, instead of simple cycle-level arithmetic means. ORR, oocyte retrieval rate; AMH, anti-Müllerian hormone; AFC, antral follicle count; hCG, human chorionic gonadotropin; GnRH, Gonadotropin-releasing hormone.

Table 2. Associations of study factors with the number of retrieved oocytes, analyzed by GEE.

Parameter	B	SE	95% Wald CI	Wald χ^2	df	p-value
Intercept	-0.029	0.5112	(-1.031, 0.973)	0.003	1	0.955
S-LN oocyte retrieval method	0.2	0.0768	(0.049, 0.350)	6.761	1	0.009*
D-LN oocyte retrieval method	0 ^a	-	-	-	-	-
GnRH antagonist protocol	0.055	0.0975	(-0.136, 0.246)	0.32	1	0.572
Minimal stimulation protocol	-0.171	0.1301	(-0.426, 0.084)	1.718	1	0.19
Natural cycle protocol	-0.865	0.136	(-1.132, -0.598)	40.415	1	<0.001*
Other protocols	0 ^a	-	-	-	-	-
Female age (years)	0.01	0.0104	(-0.010, 0.030)	0.907	1	0.341
AMH (ng/mL)	0.242	0.0849	(0.076, 0.409)	8.155	1	0.004
BMI (kg/m ²)	0.008	0.0175	(-0.027, 0.042)	0.195	1	0.659

* $p < 0.05$ was considered to indicate a statistically significant difference. ^a This parameter is redundant and set to zero as the reference category.

GEE, generalized estimating equations; CI, confidence interval; S-LN, single-lumen needle; D-LN, double-lumen needle; BMI, body mass index.

Table 3. Pregnancy outcomes following fresh and frozen embryo transfer in the S-LN and D-LN groups.

Variable	S-LN group fresh ET	D-LN group fresh ET	p-value	S-LN group FET	D-LN group FET	p-value
Total number of cycles	32	19		58	31	
Implantation rate (%)	4/54 (7.41)	4/22 (18.18)	0.219	14/118 (11.86)	7/58 (12.07)	0.969
Clinical pregnancy rate (%)	4/32 (12.50)	4/19 (21.05)	0.450	11/58 (18.97)	7/31 (22.58)	0.686
Miscarriage rate (%)	1/4 (25.00)	0/4 (0.00%)		6/11 (54.55)	2/7 (28.57)	0.367
Live birth rate (%)	3/32 (9.38)	4/19 (21.05)	0.402	5/58 (8.62)	5/31 (16.13)	0.285

ET, embryo transfer; FET, frozen embryo transfer.

priate counts or percentages. The primary objective was to determine whether D-LN oocyte retrieval yields clinical outcomes similar to those of S-LN as patients age and

ovarian reserve function decreases. Although the number of follicles >14 mm on the day of hCG trigger, AMH levels, and the mean number of oocytes retrieved were all sig-

Table 4. Cumulative pregnancy and live birth outcomes in the S-LN and D-LN groups.

Variable	S-LN group	D-LN group	p-value
Total number of fresh transplant cycles	32	19	
Clinical pregnancy rate (%)	4/29 (13.79)	4/18 (22.22)	0.692
Implantation rate (%)	4/49 (8.16)	4/22 (18.18)	0.243
Miscarriage rate (%)	1/4 (25.00)	0/4 (0.00%)	
Total number of cycles of frozen embryo transfer	58	31	
Clinical pregnancy rate (%)	10/53 (18.87)	6/29 (20.69)	0.842
Implantation rate (%)	12/103 (11.65)	6/52 (11.54)	0.984
Miscarriage rate (%)	5/10 (50.00)	1/6 (16.67)	0.307
Cumulative pregnancy rate (%)	14/130 (10.77%)	10/106 (9.43%)	0.736
CLBR (%)	8/130 (6.15%)	9/106 (8.49%)	0.490

CLBR, cumulative live birth rate. 32/19 (fresh transfer cycles) and 58/31 (FET cycles) are the total transfer cycles for the SLN/D-LN groups. For cumulative live-birth analyses, patients with mixed-origin embryo transfers (embryos obtained from both single-lumen and double-lumen oocyte retrieval) were excluded, yielding the analytical sample of 29/18 fresh cycles and 53/29 FET cycles. Cumulative pregnancy rate and cumulative live-birth rate were calculated per initiated oocyte-retrieval cycle. Oocyte-retrieval cycles generating mixed embryos derived from both single-lumen-needle and double-lumen-needle aspirations were excluded from these calculations. Multivariable GEE analysis was conducted to identify independent predictors of CLBR, while accounting for within-patient clustering across multiple ovarian stimulations and subsequent frozen embryo transfer cycles. After adjustment for oocyte retrieval method, maternal age, AMH, BMI, number of retrieved oocytes, number of transferred embryos, embryo transfer type, and number of high-quality embryos, none of the included factors demonstrated a statistically significant independent association with CLBR (Table 5).

Table 5. Multivariable GEE analysis of factors associated with CLBR.

Variable	B	SE	OR	95% Wald CI		p-value
				Lower	Upper	
Oocyte retrieval method (S-LN vs. D-LN, ref = D-LN)	1.46	1.08	4.31	0.52	35.62	0.175
Female age	0.08	0.08	1.08	0.93	1.26	0.287
AMH	-0.39	0.72	0.68	0.17	2.76	0.586
BMI	-0.19	0.18	0.83	0.58	1.18	0.300
Number of retrieved oocytes	0.34	0.40	1.41	0.64	3.09	0.396
Number of embryos transferred	-1.15	1.82	0.32	0.009	11.31	0.529
Embryo transfer type (Fresh vs. Frozen, ref = Frozen)	-0.14	1.95	0.87	0.02	39.77	0.944
Number of high-quality embryos	-0.80	0.58	0.45	0.14	1.39	0.164

OR, odds ratio.

Multivariate GEE analysis was performed to explore factors associated with embryo outcomes. For the number of available embryos, the single-lumen oocyte retrieval method was significantly associated with a higher number of available embryos compared with the double-lumen method ($B = 0.267$, 95% CI: 0.051–0.483, $p = 0.016$). The natural cycle protocol was associated with fewer available embryos. Higher AMH was a positive predictor for available embryo count, whereas female age and BMI exhibited no significant associations (**Supplementary Table 1**). For the number of day-3 high-quality embryos, multivariate GEE analysis showed that only AMH served as a significant positive predictor ($B = 0.314$, 95% CI: 0.052–0.577, $p = 0.019$). No significant differences were observed between single-lumen and double-lumen oocyte retrieval methods. Similarly, treatment protocol, female age, and BMI were not significantly related to the number of day-3 high-quality embryos (**Supplementary Table 2**).

nificantly lower in the D-LN group than in the S-LN group, analysis of CLBR demonstrated that, despite advancing age and declining ovarian function in the D-LN group, cumulative pregnancy rate and CLBR were comparable to those using S-LN. Although oocyte retrieval method was associ-

ated with the number of available embryos in multivariate analysis (**Supplementary Table 1**), this difference did not translate into a significant independent effect on cumulative live-birth rate (Table 5).

A randomized controlled trial has demonstrated that for monofollicular IVF using a single-lumen needle, the oocyte retrieval rate was 25% after initial aspiration and rose to 83% following five sequential follicular flushes; repeated flushing exerted no adverse effects on oocyte maturation rate or embryo quality [12]. Nevertheless, observational real-world evidence comparing clinical reproductive outcomes between single-lumen and double-lumen needles remain limited, as illustrated by a self-controlled retrospective cohort study investigating their cumulative live-birth performance [13]. Another study concluded that D-LN could increase ORR and maturation rate in patients with single follicular development [14]. Two prospective controlled studies concluded that using D-LN in poorly responding patients resulted in a lower ORR and prolonged procedure time [15,16]. A Cochrane review concluded that for both poorly responding and normally responding patients, oocyte retrieval using D-LN presents no benefit [17]. Many studies evaluated the efficacy after using S-LN and D-LN oocyte retrieval, but the study population showed no difference in baseline data. A notable strength of this study is its self-controlled design, in which the same patients underwent both S-LN and D-LN oocyte retrieval, each experiencing at least one cycle with each needle type. This approach effectively eliminates inter-individual variability as a source of bias and reduces confounding. In patients with reduced ovarian function, it is often difficult to achieve live birth with a single oocyte retrieval [18]. This study analyzed the live births of fresh embryo transfer and frozen embryo transfer in both S-LN and D-LN groups and compared the CLBRs of the two methods. After adjusting for baseline confounding factors such as age and AMH level, there was no statistically significant difference in CLBR between the two groups ($p > 0.05$). Furthermore, the high-quality embryo rate, implantation rate, cumulative pregnancy rate, and CLBR were similar. This finding indicates that despite poorer ovarian reserve in the D-LN group, the use of D-LN aspiration enabled these patients to achieve clinical outcomes comparable to those in the S-LN group. This suggests that the use of D-LN is more beneficial to patients with increasing age and declining ovarian function.

ORR is one of the most important factors affecting the live birth rate in ART, especially in women with fewer follicles, in which one more precious oocyte may result in one more chance of embryo transfer [19,20]. In this group of patients who usually undergo more than one ovarian stimulation cycle, if the ORR can be improved through the use of the D-LN technique in each oocyte retrieval procedure, the financial and psychological pressure on the patient will be greatly reduced.

Limitations

This study has several limitations, including a relatively small sample size and the lack of molecular biological analysis of oocyte quality. Nevertheless, the self-controlled

design and rigorous statistical analysis mitigate these limitations to a considerable extent. Future research should include large-scale, multicenter studies incorporating indicators such as oocyte mitochondrial function and chromosomal euploidy to further elucidate the mechanisms by which D-LN retrieval may improve clinical outcomes in patients with declining ovarian reserve.

5. Conclusions

Notably, this study represents one of the first retrospective self-controlled cohort study investigations to directly compare S-LN and D-LN aspiration in a well-characterized cohort of patients with DOR. By employing this rigorous study design, we addressed a critical gap in the literature, as prior research on this topic remains notably scarce, especially studies utilizing self-controlled comparisons to minimize confounding variables.

In summary, this study demonstrates that within the same patient cohort, despite older age at oocyte retrieval, longer duration of infertility, and DOR, D-LN oocyte retrieval yields comparable embryo culture outcomes and equivalent clinical pregnancy and live birth rates relative to S-LN retrieval. These findings support the potential clinical value of D-LN aspiration in patients with DOR and suggest its broader adoption in this population. Future studies with larger sample sizes are warranted to further evaluate whether D-LN oocyte retrieval increases implantation rates and live birth rates in patients with poor ovarian response.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

XZ: Writing-original draft, Data curation; LS: Data curation; EZ: Conceptualization, Data curation; JO: Methodology; SG: Conceptualization, Formal analysis, Supervision, Writing-review & editing, and all authors contributed to critical revisions for intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in full compliance with the Declaration of Helsinki. The research protocol was approved by the Ethics Committee of the Third Affiliated Hospital of Sun Yat-sen University (approval number: H2025-155-01), and written informed consent was obtained from all study participants prior to data collection.

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Conflicts of Interest

The authors declare no conflicts of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.31083/CEOG51308>.

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