Assisted Reproductive Technology Treatment Outcomes in Women With Liver Disease

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INTRODUCTION: **There is a need for evidence-based counseling for women with chronic liver disease (LD) who may experience impaired fertility. Currently, the literature on assisted reproductive technology (ART) treatment in women with LD has been limited to a single European case series. We evaluated ART treatment outcomes in patients with LD and compared with controls.**

METHODS: **The retrospective study evaluated women with and without LD who had normal ovarian reserve and underwent ART treatment in a high-volume fertility practice from 2002 to 2021.**

RESULTS: **We identified 295 women with LD (mean age 37.8 ± 5.2 years) who underwent 1,033 ART treatment cycles; of these women, 115 underwent 186 *in vitro* fertilization (IVF) cycles. Six women (2.0%) had cirrhosis, 8 (2.7%) were postliver transplantation, and 281 (95.3%) had chronic LD, with viral hepatitis (B and C) being the most prevalent. In the subgroup who underwent IVF and embryo biopsy, the median fibrosis-4 score was 0.81 (0.58–1.03), and there were no statistically significant differences in response to controlled ovarian stimulation, embryo fertilization rate, or ploidy outcome in patients with LD compared with controls. In those who subsequently underwent a single thawed euploid embryo transfer to achieve pregnancy, there were no statistically significant differences in rates of clinical pregnancy, clinical pregnancy loss, or live birth in patients with LD compared with controls.**

DISCUSSION: **To the best of our knowledge, this study is the largest to date to evaluate IVF efficacy in women with LD. Our study demonstrates that patients with LD have similar ART treatment outcomes compared with those without LD.**

KEYWORDS: pregnancy; fertility; reproductive techniques, assisted; fertilization *in vitro*; liver diseases

SUPPLEMENTARY MATERIAL accompanies this paper at http://links.lww.com/AJG/C909

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INTRODUCTION

Women with chronic liver disease may experience impaired fertility (1). For example, limited data suggest that women with chronic liver disease, such as hepatitis C virus, may undergo premature ovarian insufficiency (2). In addition, women with advanced liver disease, cirrhosis, and hepatic decompensation are known to have abnormally low gonadotropins, due to hypothalamic dysfunction (3), and amenorrhea (4). As the prevalence of liver disease continues to rise in women of reproductive age (5,6), there is an immediate need for the clinical assessment of reproductive potential in women with chronic liver disease (7).

Assisted reproductive technology (ART) treatments have become an integral part of management for women with impaired fertility. In 2018, 2.0% of infants born in the United States were conceived through ART treatments, with *in vitro* fertilization (IVF) being the most used by patients (8). An IVF cycle starts with controlled ovarian stimulation followed by egg retrieval, insemination, embryo culture, and embryo transfer (Figure 1). Successful IVF cycles include embryo implantation, occurrence of clinical pregnancy as determined by the presence of a gestational sac on ultrasound, and achievement of a live birth. Contemporary methods have reduced ovulation induction doses and use novel protocols to minimize the risk of developing ovarian hyperstimulation syndrome (9) and include embryo biopsy, to test for chromosomal normalcy, and cryopreservation. Thereafter, modern approach in IVF includes patients undergoing single embryo transfer with a thawed euploid embryo (Figure 1).

To date, the literature about ART treatment outcomes in women with liver disease has been limited to case reports, a few studies on maternal hepatitis B carriers from East Asian countries

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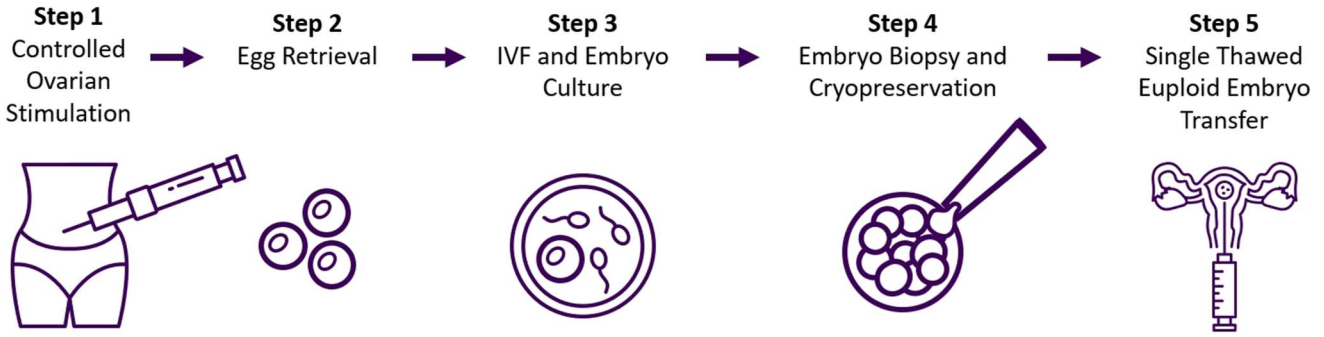

Figure 1. Overview of a contemporary, standard *in vitro* fertilization (IVF) treatment cycle.

(10,11), and a single European case series of 42 women with chronic liver disease, cirrhosis, and postliver transplantation who underwent IVF between 1990 and 2019 (12). That study was the first to suggest comparable IVF efficacy and safety in women with liver disease, although earlier treatment strategies as described in that study do not necessarily reflect contemporary, standard IVF protocols (Figure 1). The authors coined the designation liver-related subfertility to describe women who have impaired fertility and associated chronic liver disease.

This study expands on the previous work by comparing ART treatment outcomes in women with and without liver disease in a large patient cohort evaluated and treated at a single fertility practice. The goals of this study were to (i) evaluate women with liver disease who underwent contemporary, standard IVF treatment, which included obtaining an embryo biopsy and cryopreservation before undergoing single embryo transfer with a thawed euploid embryo (Figure 1) and compare outcomes with those in women without liver disease and (ii) to further determine the association of chronic liver disease and disease subtypes with the outcomes of IVF treatment.

METHODS

This retrospective study evaluated women undergoing ART treatment at a single, high-volume reproductive treatment center from January 2002 to November 2021. This study was approved by the Institutional Review Board of the Icahn School of Medicine at Mount Sinai with a waiver of consent for retrospective analysis of deidentified data.

Identification of patients with liver disease

A keyword search of the study site's electronic medical records was conducted to identify patients who had a history of liver disease (see Supplementary Table 1, Supplementary Digital Content 1, http://links.lww.com/AJG/C909 for a list of keywords). Patients with hepatitis B virus (HBV) and hepatitis C virus (HCV) were confirmed with laboratory evidence, and viral loads were recorded if available. Patients with nonalcoholic fatty liver disease (NAFLD) were confirmed with imaging and/or liver biopsy if available. Patients with autoimmune hepatitis (AIH) and primary biliary cholangitis (PBC) were confirmed with liver biopsy if available. The lowest platelet count and highest aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase, and total bilirubin were recorded for each liver disease patient based on the complete blood count and liver biochemical tests drawn at the initiation of ART treatment or from the most recent external laboratory reports. Fibrosis-4 (FIB-4) scores were calculated for liver disease patients using the lowest platelet count and highest AST and ALT.

Study design

Women with evidence of liver disease who received ART treatment were identified. Baseline characteristics and liver disease etiologies were reported on these patients. The study analysis included women with liver disease who underwent IVF, embryo biopsy for genetic testing, and embryo cryopreservation (Figure 2, panel A). These patients represented a cohort of individuals who underwent contemporary, standard ART treatment (Figure 1) (13). A subanalysis was conducted on those who subsequently underwent a single embryo transfer with a thawed euploid (chromosomally normal) embryo (Figure 2, panel B). Controls included all women without liver disease in the database who received contemporary, standard ART treatment (Figure 1) due to male factor infertility, as this was indicative of these patients having normal ovarian reserve and, therefore, were considered fertile. All patients with anti-Mullerian hormone (AMH) $\leq$1 ng/mL, indicating low ovarian reserve, were excluded from the analysis as they required higher gonadotropin doses during ovulation induction, and this may have influenced clinical outcomes.

Statistical methods

Data on patient demographics (age and body mass index [BMI]), ovarian reserve markers (AMH, basal antral follicle count [BAFC] and follicle stimulating hormone [FSH]), and IVF treatment (number of oocytes retrieved and number of embryos biopsied) were collected and reported as means and SDs. Liver biochemical tests were collected and reported as medians and interquartile ranges. Descriptive data were compared using the Student *t* test (Tables 1–3, see Supplementary Tables 3–5, Supplementary Digital Content 1, http://links.lww.com/AJG/C909) and χ^2 test (Table 4). Univariable linear and logistic regressions were performed to evaluate the association of a liver disease diagnosis with each outcome. Multivariable linear and logistic regressions included both variable outcomes significant at $P < 0.05$ on univariable regression and known clinical confounders, including patient age, BMI, AMH, BAFC, estradiol surge, number of oocytes retrieved, embryo fertilization rate, and number of embryos biopsied.

RESULTS

General patient characteristics

We identified 295 women with liver disease who underwent 1,033 ART treatment cycles. Among individuals included in the study, the mean age was 37.8 $\pm$ 5.2. In regards to the liver disease subtype, 6 women (2.0%) had cirrhosis, 8 (2.7%) were postliver

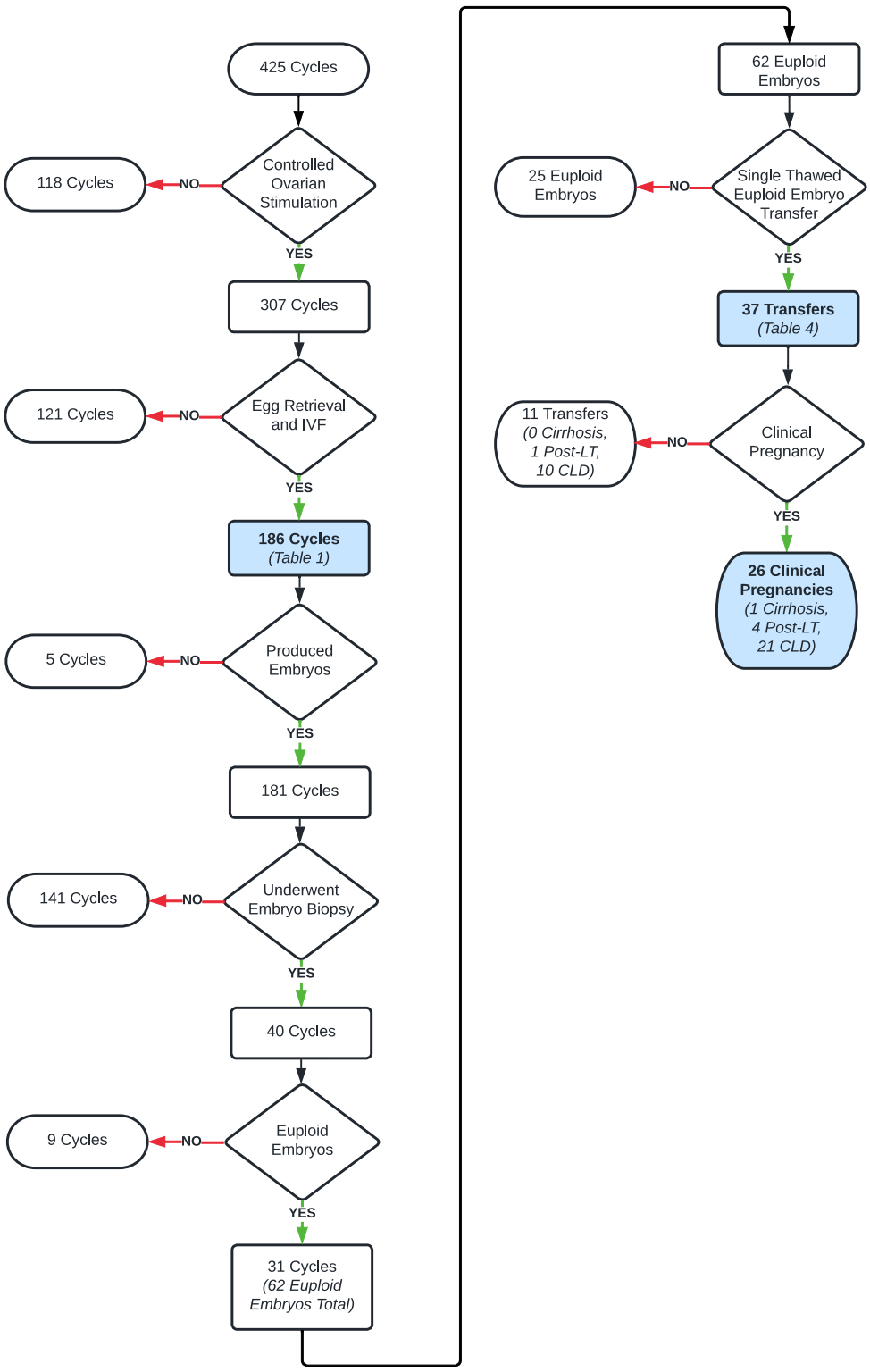

Figure 2. Outcomes among liver disease patients undergoing contemporary, standard IVF treatment. CLD, chronic liver disease; IVF, *in vitro* fertilization; Post-LT, postliver transplantation.

Table 1. Demographic characteristics of liver disease and control patients who underwent controlled ovarian hyperstimulation, IVF, and embryo biopsy

Variable	Liver disease patients (n = 115)	Control patients (n = 624)	*P* value
Demographics			
Age (yr)	37.3 ± 4.2	35.9 ± 4.2	<0.05[a]
Ethnicity[b]			
Hispanic or Latino	4	36	
Not Hispanic or Latino	19	257	
Race[b]			
White	8	193	
Asian	7	45	
Black	3	12	
Two or more[c]	1	6	
Others	—	10	
Body mass index (kg/m^2)	25.7 ± 5.7	23.9 ± 4.1	<0.05[a]
Baseline hormone levels			
Baseline follicle stimulating hormone (IU/mL)	7.1 ± 3.8	6.3 ± 3.0	<0.05[a]
Anti-Mullerian hormone (ng/mL)	2.8 ± 3.4	3.3 ± 2.2	0.10
Basal antral follicle count (n)	9.7 ± 6.6	14.2 ± 6.3	<0.05[a]
Estradiol surge (pg/mL)	2,161.7 ± 1,215.0	2,592.0 ± 1,096.9	<0.05[a]
IVF outcomes			
No. of cycles	186	868	
Age at oocyte retrieval (yr)	37.3 ± 4.2	35.9 ± 4.3	<0.05[a]
Oocytes retrieved (n)	12.3 ± 7.6	16.5 ± 8.2	<0.05[a]
Mature oocytes (n)	9.1 ± 6.2	12.6 ± 6.7	<0.05[a]
2 pronuclear (2pn) embryos (n)	7.0 ± 5.2	9.9 ± 5.9	<0.05[a]
Embryos biopsied (n)	3.4 ± 2.2	5.1 ± 3.5	<0.05[a]
Euploid embryos (n)	1.6 ± 1.4	2.7 ± 2.4	<0.05[a]
Aneuploid embryos (n)	1.6 ± 1.4	2.0 ± 1.8	0.12

IVF, *in vitro* fertilization.
[a]Indicates a statistically significant difference.
[b]All data reported unless unspecified or unknown.
[c]Among liver disease patients, 1 identified as Asian, White, and other. Among control patients, 3 identified as Asian and White; 2 as Black, Indian Alaskan, and White; and 1 as Black and White.

transplantation, and 281 (95.3%) had chronic liver disease. Etiology of chronic liver disease included HBV (46.5%), HCV (34.5%), NAFLD (14.8%), AIH (2.5%), and PBC (1.4%). Of 1,033 ART treatment cycles, 425 were IVF and 519 were other forms of reproductive endocrinology, including mild ovarian stimulation and intrauterine insemination. The final study population (Figure 2) included 115 women with liver disease who underwent 186 IVF cycles, as these patients represented a cohort of individuals who underwent contemporary, standard IVF treatment (Figure 1).

Table 2. Liver-related characteristics of all liver disease patients

Liver disease etiology	
Cirrhosis	1[a]
Postliver transplantation	3[b]
Chronic liver disease	111
Hepatitis B virus	65
Hepatitis C virus	35
Nonalcoholic fatty liver disease	8
Autoimmune hepatitis	3
Primary biliary cholangitis	2
Alcohol use[c]	
No	36
Yes	30
Less than 7 drinks per week	15
7 to 14 drinks per week	2
Greater than 14 drinks per week	1
Unspecified amount	12
Liver biochemical tests, median (IQR)[c]	
Aspartate aminotransferase (IU/L)	24 (18–32)
Alanine aminotransferase (IU/L)	25 (17–43.5)
Alkaline phosphatase (IU/L)	61 (50–77)
Total bilirubin (mg/dL)	0.5 (0.4–0.7)
FIB-4 score	0.81 (0.58–1.03)

FIB-4, fibrosis-4; IQR, interquartile range.
[a]Etiology of cirrhosis is unknown.
[b]Reasons for liver transplantation include biliary atresia, cystic fibrosis with liver involvement, and unknown.
[c]All data reported unless unspecified or unknown.

IVF outcomes of liver disease and control patients

There were 186 IVF cycles in 115 liver disease patients who subsequently underwent embryo biopsy for genetic testing, including 1 cycle in a patient with cirrhosis, 5 cycles in 3 patients postliver transplantation, and 180 cycles in 111 patients with chronic liver disease (Figure 2, panel A). A total of 624 control patients who underwent 868 IVF cycles with embryo biopsy for genetic testing were identified for comparison (Table 1).

Among 115 women with liver disease in our final study population, liver biochemical tests, alcohol use, and medication use as recorded at the time of intake interview was available for a majority but records of liver biopsies and/or fibrosis assessments were limited. Among patients with liver disease, the median AST was 24 (18–32), ALT was 25 (17–43.5), alkaline phosphatase was 61 (50–77), total bilirubin was 0.5 (0.4–0.7), and FIB-4 score was 0.81 (0.58–1.03) with 5 patients identified having a FIB-4 score greater than 1.45 (Table 2). Among those that reported alcohol use, median consumption was 3 (1.125–5) drinks per week, and there was 1 patient who consumed greater than 14 drinks per week (Table 2). Among 89 patients with medication records, 2 postliver transplantation patients were on immunosuppression (tacrolimus and prednisone), all 3 AIH patients were on immunosuppression (azathioprine and prednisone), both PBC patients were on ursodiol, 5 HBV patients (10.2%) were on tenofovir, and 10 HCV patients (38.5%) had received treatment with only 1

Table 3. Treatment outcomes of liver disease and control patients who underwent controlled ovarian hyperstimulation, IVF, and embryo biopsy

Variable outcome	Liver disease patients		Control patients		*P* value
Mature oocyte rate[a]	1,684/2,287	73.6%	10,927/14,349	76.2%	0.05
Fertilization per mature oocyte rate[b]	1,260/1,684	74.8%	8,482/10,927	77.6%	0.07
Euploid embryos rate[c]	62/135	45.9%	1,582/2,998	52.8%	0.96
Aneuploid embryos rate[d]	64/135	47.4%	1,202/2,998	40.1%	0.78

IVF, *in vitro* fertilization.
[a]Mature oocyte rate = number of mature oocytes/number of oocytes retrieved.
[b]Fertilization per mature oocyte rate = number of fertilized embryos/number of mature oocytes.
[c]Euploid embryos rate = number of euploid embryos/number of embryos biopsied.
[d]Aneuploid embryos rate = number of aneuploid embryos/number of embryos biopsied.

patient without sustained virologic response by the time of intake interview (see Supplementary Table 2, Supplementary Digital Content 1, http://links.lww.com/AJG/C909). Among 100 viral hepatitis patients, 42 had viral loads recorded (ranges in Supplementary Table 2, Supplementary Digital Content 1, http://links.lww.com/AJG/C909) and 4 had genotypes recorded (genotypes A and D in 2 HBV patients and genotype 1 in 2 HCV patients). Among 8 patients with liver biopsies recorded (see Supplementary Table 2, Supplementary Digital Content 1, http://links.lww.com/AJG/C909), 1 was performed for NAFLD, 1 for AIH, 1 for PBC, 1 for HBV (conducted in 2003), and 4 for HCV (all performed before 2003). In addition to the patients with liver biopsies, 2 patients had fibrosis assessments recorded with no evidence of advanced fibrosis.

Patients with liver disease had a significantly higher mean age (37.3 ± 4.2 vs 35.9 ± 4.2 years, $P < 0.05$), higher BMI (25.7 ± 5.7 vs 23.9 ± 4.1 kg/m^2, $P < 0.05$), and differences in selected baseline hormone levels, including FSH (7.1 ± 3.8 vs 6.3 ± 3.0 IU/mL, $P < 0.05$), BAFC (9.7 ± 6.6 vs 14.2 ± 6.3, $P < 0.05$), and estradiol surge (2,161.7 ± 1,215.0 vs 2,592.0 ± 1,096.9 pg/mL, $P < 0.05$) compared with controls (Table 1). Patients with liver disease had a significantly lower number of oocytes retrieved (12.3 ± 7.6 vs 16.5 ± 8.2, $P < 0.05$), number of mature oocytes (9.1 ± 6.2 vs 12.6 ± 6.7, $P < 0.05$), number of fertilized embryos (7.0 ± 5.2 vs 9.9 ± 5.9, $P < 0.05$), number of embryos biopsied (3.4 ± 2.2 vs 5.1 ± 3.5, $P < 0.05$), and number of euploid embryos (1.6 ± 1.4 vs 2.7 ± 2.4, $P < 0.05$) compared with controls (Table 1).

There were no statistically significant differences in mature oocyte rate (an indicator of response to controlled ovarian stimulation), fertilization per mature oocyte rate (an indicator of oocyte quality and ability to be fertilized), or embryo ploidy rate (an indicator of genetically normal embryos), as determined by embryo biopsy, among the groups (Table 3). When adjusted for known clinical confounders, liver disease was not found to be significantly associated with any of these outcomes on univariable and multivariable linear regression analyses (Table 5).

Single embryo transfer clinical outcomes of liver disease and control patients

There were 37 euploid embryos in the liver disease cohort and 609 euploid embryos in the control cohort that underwent single embryo transfer (Figure 2, panel B). When comparing clinical outcomes between liver disease and control patients (Table 4), there were no significant differences in rates of clinical pregnancy (70.3% vs 65.5%, $P = 0.55$), clinical pregnancy loss (7.1% vs 8.8%, $P = 0.76$), or live birth (64.9% vs 58.6%, $P = 0.45$). When adjusted for known clinical confounders, liver disease was not found to be significantly associated with any of these outcomes on univariable and multivariable logistic regression analyses (Table 6).

IVF laboratory outcomes between liver disease etiologies

IVF laboratory outcomes between postliver transplantation and chronic liver disease patients were compared to evaluate the effect of liver disease etiology. The subanalysis was not limited to patients who underwent contemporary, standard IVF protocols (Figure 1) to ensure a sufficient number of patients in the postliver transplantation group. Of 1,033 ART treatment cycles originally identified in liver disease patients, 425 were IVF cycles, and 199 of those cycles attempted embryo transfer per patient preference. Eleven cycles in 3 postliver transplantation patients were compared with 188 cycles in 102 chronic liver disease patients (see Supplementary Table 3, Supplementary Digital Content 1, http://links.lww.com/AJG/C909).

The only variables that had statistically significant differences (see Supplementary Table 3, Supplementary Digital Content 1, http://links.lww.com/AJG/C909) among postliver transplantation and chronic liver disease patients were the number of oocytes retrieved (21.0 ± 6.1 vs 12.6 ± 6.9, $P < 0.05$), number of mature oocytes (17.7 ± 4.9 vs 9.1 ± 5.8, $P < 0.05$), and number of fertilized embryos (14.7 ± 3.5 vs 6.8 ± 4.7, $P < 0.05$). There were no statistically significant differences in the mature oocyte rate (an indicator of response to controlled ovarian stimulation) and fertilization per mature oocyte rate (an indicator of oocyte quality and ability to be fertilized) among

Table 4. Clinical outcomes of liver disease and control patients who underwent controlled ovarian hyperstimulation, IVF, embryo biopsy, and single embryo transfer with a thawed euploid embryo

Variable outcome	Liver disease patients		Control patients		*P* value
Clinical pregnancy[a]	26/37	70.3%	399/609	65.5%	0.55
Clinical pregnancy loss[b]	2/28	7.1%	42/476	8.8%	0.76
Ongoing pregnancy/live birth[c]	24/37	64.9%	357/609	58.6%	0.45

IVF, *in vitro* fertilization.
[a]Clinical pregnancy rate = number of intrauterine pregnancies with positive fetal heartbeat/total single embryo transfer cycles.
[b]Clinical pregnancy loss rate = number of spontaneous abortions before 13 weeks/number of pregnancies confirmed by positive serum human chorionic gonadotropin.
[c]Ongoing pregnancy/live birth rate = number of ongoing pregnancies or deliveries of viable infants/total single embryo transfer cycles.

Table 5. Univariable and multivariable linear regression analyses of outcomes by history of liver disease

Variable outcome	Univariable analysis β	Univariable analysis *P* value	Multivariable analysis B	Multivariable analysis *P* value
Mature oocyte rate[a]	−2.75	0.05	−1.20	0.62
Fertilization per mature oocyte rate[a]	−3.30	0.07	−1.36	0.65
Euploid embryos rate[b]	0.28	0.96	3.09	0.61
Aneuploid embryos rate[b]	−1.45	0.78	−3.05	0.60

AMH, anti-Mullerian hormone; BAFC, basal antral follicle count; BMI, body mass index.
[a]Adjusted for age, BMI, AMH, BAFC, estradiol surge, and oocytes retrieved.
[b]Adjusted for age, BMI, AMH, BAFC, estradiol surge, oocytes retrieved, fertilization per mature oocyte rate, and embryos biopsied.

the groups (see Supplementary Table 4, Supplementary Digital Content 1, http://links.lww.com/AJG/C909).

Non-IVF ART laboratory outcomes between liver disease etiology

Non-IVF ART laboratory outcomes between postliver transplantation and chronic liver disease patients were compared to evaluate the effect of liver disease etiology. Of 1,033 ART treatment cycles originally identified in patients with liver disease, 519 cycles were other forms of reproductive endocrinology, including mild ovarian stimulation and intrauterine insemination, and 325 of those cycles attempted pregnancy. Eleven cycles in 3 postliver transplantation patients were compared with 314 cycles in 86 chronic liver disease patients (see Supplementary Table 5, Supplementary Digital Content 1, http://links.lww.com/AJG/C909). The only variables that had statistically significant differences (see Supplementary Table 5, Supplementary Digital Content 1, http://links.lww.com/AJG/C909) among postliver transplantation and chronic liver disease patients were mean age and mean age at oocyte retrieval (31.6 ± 3.1 vs 37.9 ± 5.2 years, $P < 0.05$).

DISCUSSION

Liver disease among women seeking ART treatment is not uncommon. We identified 295 women with liver disease who underwent 1,033 ART cycles in a single-center database. To the best of our knowledge, this is the largest cohort to date of women with liver disease undergoing ART treatment.

Although we identified some differences in baseline characteristics, hormone levels and IVF laboratory outcomes in women with liver disease, IVF treatment and pregnancy outcomes were not significantly different compared with controls. However, patients with liver disease had fewer oocytes during egg retrieval and subsequently fewer mature oocytes, fertilized embryos, and euploid embryos compared with controls as IVF treatment progressed. Furthermore, patients with liver disease were older than controls, but given our findings, a liver disease diagnosis should not cause delays in receiving ART counseling and treatment due to concerns about IVF efficacy. Therefore, women with liver disease and impaired fertility should receive counseling about fertility preservation options earlier to establish access to reproductive care. Interestingly, patients who were postliver transplantation had a significantly higher number of oocytes retrieved, mature oocytes, and fertilized embryos compared with patients with chronic liver disease, suggesting that fertility and response to ART treatments may be restored postliver transplantation as supported by other studies (14,15), but this needs to be validated with larger cohorts. Overall, women with chronic liver disease can be counseled that IVF treatment will not significantly differ in response to controlled ovarian stimulation, embryo fertilization rate, or ploidy outcome compared with women without liver disease.

This study's results are comparable with those published in the case series by Rahim et al (12), which reported a clinical pregnancy rate of 61% and a live birth rate of 40% in women with chronic liver disease, cirrhosis, and postliver transplantation who underwent IVF compared with rates of 70% and 65% in our cohort, which may reflect our adherence to more contemporary, standard IVF protocols rather than the impact of liver disease. To build on Rahim et al findings, our study compared IVF efficacy in women with liver disease with those without liver disease to better understand the independent risk of liver disease on IVF outcomes.

Our study has several strengths. This study is the largest to date to evaluate IVF efficacy in women with liver disease. Furthermore, the final study population represented a cohort of individuals who underwent contemporary, standard IVF treatment (Figure 1), reflecting changes to IVF protocols over time. Since women with liver disease were identified from a fertility practice, our study contained detailed information on the type of IVF regimen, number of IVF cycles, dose of gonadotropins, number of oocytes retrieved, number of embryos transferred, and type of embryo transfer. We were also able to compare outcomes with a large control population without liver disease and able to conduct a subanalysis to compare IVF outcomes between liver disease etiologies. These data are important for determining the optimal IVF regimen in women with liver disease.

Our study has a few but notable weaknesses. In our practice, a 0.42% (295/69,890) prevalence of liver disease, with viral hepatitis being the most common etiology, was observed. As the prevalence of women with liver disease in the United States was 1.4% in 2018 (16), our number is potentially underestimated given underreporting of liver disease (particularly NAFLD) and the lack of routine liver function testing before ART treatment. In addition, our study was unable to track maternal-fetal outcomes and liver disease outcomes as patients transferred care to outside obstetrical practices once clinical pregnancy was established. Future work should analyze recent, large populations in IVF registries linked to liver data or enroll large prospective cohorts.

There is an increasing need for evidence-based prepregnancy counseling of women with the potential for liver-related subfertility as liver disease prevalence continues to rise among women. Our

Table 6. Univariable and multivariable logistic regression analyses of outcomes by history of liver disease

Variable outcome	Univariable analysis OR (95% CI)	Multivariable analysis OR (95% CI)
Clinical pregnancy[a]	1.24 (0.60–2.57)	1.56 (0.64–3.83)
Clinical pregnancy loss[a]	0.79 (0.18–3.46)	0.61 (0.08–4.78)
Ongoing pregnancy/live birth[a]	1.30 (0.65–2.61)	1.68 (0.71–3.96)

AMH, anti-Mullerian hormone; BAFC, basal antral follicle count; BMI, body mass index; CI, confidence interval; OR, odds ratio.
[a]Adjusted for age, BMI, AMH, and BAFC.

study showed that patients with liver disease have similar IVF treatment outcomes compared with patients without liver disease. Based on our findings, women with liver disease and impaired fertility should be counseled about contemporary, standard IVF treatment, and the presence of liver disease should not prevent them from seeking IVF as an option due to concerns about efficacy.

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CONFLICTS OF INTEREST

Guarantor of the article: Tatyana Kushner, MD, MSCE.

Specific author contributions: T.K.: study concept and design. T.K.: study supervision. J.D.L. and D.G.: acquisition of data. J.D.L., J.A.L., and T.K.: analysis and interpretation of data. J.D.L.: drafting of the manuscript. T.K., J.A.L., and T.M.: critical review of the manuscript. D.G. and J.D.L.: statistical analysis.

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Study Highlights

WHAT IS KNOWN

- ✓ Women with chronic liver disease may experience impaired fertility.
- ✓ The literature on assisted reproductive technology treatment outcomes in women with liver disease is limited.

WHAT IS NEW HERE

- ✓ Largest study to date to evaluate *in vitro* fertilization efficacy in women with liver disease.
- ✓ Women who underwent contemporary, standard *in vitro* fertilization treatment had similar outcomes to women without liver disease.

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