Review / Derleme

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Turk J Obstet Gynecol

The efficacy of single-incision laparoscopic surgery versus conventional laparoscopic surgery in the surgical management of ectopic pregnancy: A systematic review and meta-analysis

Ektopik gebeliğin cerrahi tedavisinde tek kesi laparoskopik cerrahinin etkinliği ile konvansiyonel laparoskopik cerrahinin etkinliğinin karşılaştırması: Sistematik bir inceleme ve meta-analiz

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Abstract

To compare the efficacy and safety of single-incision laparoscopic surgery (SILS) versus conventional laparoscopic surgery (CLS) for the surgical management of ectopic pregnancy through a systematic review and meta-analysis. We searched Medline, PubMed, Scopus, Web of Science, ClinicalTrials.gov, and Cochrane databases from inception to May, 2023 for studies comparing SILS with CLS in ectopic pregnancy treatment. Included studies were controlled and observational, excluding single-arm studies, meta-analyses, and reviews. Quality was assessed using ROBINS-I for observational studies and the Cochrane tool for randomized trials. Data were analyzed with OpenMetaAnalyst and Review Manager 5.4.1, using odds ratios for dichotomous outcomes and mean differences (MD) for continuous outcomes. Twelve studies involving 880 women (372 SILS, 508 CLS) were included. SILS showed significantly less blood loss (MD=-51.01 mL, p=0.004), shorter postoperative hospital stay (MD=-0.24 days, p=0.003), and faster return of bowel function (MD=-1.03 hours, p<0.01), compared to CLS. No significant differences were found in total operative time, hemoglobin change, blood transfusion requirements, or number of patients needing transfusions. Patient satisfaction data were limited but suggested better cosmetic outcomes with SILS. SILS is a feasible and effective alternative to CLS for ectopic pregnancy, offering reduced blood loss, shorter hospital stays, and quicker bowel function recovery. These benefits, alongside potential cosmetic advantages, make SILS a promising option, particularly for young women. Further research is needed to confirm long-term outcomes and optimize patient selection.

Keywords: Ectopic pregnancy, laparoscopy, single-incision laparoscopic surgery, conventional laparoscopic surgery, hemoperitoneum, surgical outcomes

Öz

Ektopik gebeliğin cerrahi tedavisinde tek kesi laparoskopik cerrahinin (SILS) etkinliğini ve güvenliğini sistematik bir inceleme ve meta-analiz yoluyla konvansiyonel laparoskopik cerrahinin (CLS) etkinliği ve güvenliği ile karşılaştırmak amaçlanmıştır. Medline, PubMed, Scopus, Web of Science, ClinicalTrials.gov ve Cochrane veri tabanlarında, ektopik gebelik tedavisinde SILS'yi CLS ile karşılaştıran çalışmalar Mayıs 2023 tarihine kadar taranmıştır. Dahil edilen çalışmalar kontrollü ve gözlemsel olup, tek kollu çalışmalar, meta-analizler ve derlemeler hariç tutulmuştur. Kalite, gözlemsel çalışmalar için ROBINS-I ve randomize çalışmalar için Cochrane aracı kullanılarak değerlendirilmiştir. Veriler, ikili sonuçlar için olasılık oranları ve sürekli sonuçlar için ortalama farklar (OF) kullanılarak OpenMetaAnalyst ve Review Manager 5.4.1 ile analiz edildi. Sekiz yüz seksen kadını (372 SILS, 508 CLS) içeren on iki çalışma dahil edildi. SILS, CLS ile karşılaştırıldığında önemli ölçüde daha az kan kaybı (OF=-51,01 mL, p=0,004), daha kısa postoperatif hastanede kalış süresi (OF=-0,24 gün, p=0,003) ve bağırsak fonksiyonunun daha hızlı geri dönüşü (OF=-1,03 saat, p<0,01) ile ilişkili idi. Toplam ameliyat süresi, hemoglobin düzeyinde değişim, kan transfüzyonu gereksinimi veya transfüzyona ihtiyaç duyan hasta sayısı açısından önemli bir fark bulunamadı. Hasta memnuniyeti

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verileri sınırlıydı ancak SILS ile daha iyi kozmetik sonuçlar olduğunu düşündürmekteydi. SILS, ektopik gebelik tedavisinde CLS'nin uygulanabilir ve etkili bir alternatifidir; daha az kan kaybı, daha kısa hastanede kalış süresi ve daha hızlı bağırsak fonksiyonu iyileşmesi ile ilişkilidir. Bu faydalar, potansiyel kozmetik avantajlarının yanı sıra, SILS'yi özellikle genç kadınlar için umut verici bir seçenek haline getirir. Uzun vadeli sonuçları doğrulamak ve hasta seçimini optimize etmek için daha fazla araştırmaya ihtiyaç vardır.

Anahtar Kelimeler: Ektopik gebelik, laparoskopi, tek kesili laparoskopik cerrahi, konvansiyonel laparoskopik cerrahi, hemoperiton, cerrahi sonuçlar

Introduction

Ectopic pregnancy, where a pregnancy implants outside the uterine cavity, occurs in approximately 1-2% of pregnancies[1]. The presentation of ectopic pregnancy may vary among patients ranging from an asymptomatic condition to lower abdominal pain, to rupture of internal organs resulting in massive hemoperitoneum and severe hemorrhagic shock[2]. Despite its rarity, ectopic pregnancy is the number one cause of maternal mortality in pregnancy[3]. Thus, early diagnosis and management of ectopic pregnancy are essential. It is usually diagnosed by ultrasonography with or without the use of human chorionic gonadotropin titers, and serum progesterone levels can also aid in the diagnosis[4]. Although medical treatment with methotrexate is effective in many cases with a 75% tubal patency rate, surgical management using laparoscopy remains first line treatment for many patients with ectopic pregnancies when medical management is contraindicated or fails[5]. The comparison between single-incision laparoscopic surgery (SILS) and conventional laparoscopic surgery (CLS) is particularly relevant for ectopic pregnancies due to the urgent nature of surgical intervention and the unique patient demographic, often young women of reproductive age. SILS' potential to minimize abdominal wall trauma and improve cosmetic outcomes aligns with patient priorities, such as reduced scarring and faster recovery, which can enhance both physical and psychological outcomes in this population. CLS has become the most commonly used procedure in the management of ectopic pregnancy compared to laparotomy[5]. CLS is associated with less tissue injury, fewer adhesions, less bleeding, shorter total operative time, and shorter hospital stay and a rapid return to daily activities, according to many studies[6-8]. Unlike CLS, SILS uses a multi-channel single port system with articulating instruments through a single skin incision. The single incision is usually at the umbilicus, which may leave no new scar after the operation. This decrease in the number of ports has the potential to reduce the perioperative morbidity and improve the cosmetic results of the procedure[9-11]. However, SILS has some disadvantages including impaired visualization, instrument interference, and loss of laparoscopic triangulation[12]. Our search of previous meta-analyses on this topic reported no considerable differences between CLS and SILS in the treatment of ectopic pregnancy[13,14]. In this study, we aim to compare the surgical outcomes and effectiveness of SILS with CLS in the surgical treatment of women with ectopic pregnancies.

Methods

We searched Medline, Pubmed, Scopus, Web of Science, ClinicalTrials.Gov, and the Cochrane database from each database's inception until June 15th, 2024. We included only English language studies. We included both controlled studies and observational studies. We excluded single-arm studies, meta-analyses, review articles, and studies that did not report any of our selected outcomes. We utilized the PRISMA guidelines in performing our study[15]. We searched in the online databases using this strategy: ("single port laparoscop*" OR "laparoendoscopic single-site surgery" OR "single-incision laparoscopic surgery" OR "single incision laparoscopic" OR "single site laparoscopy") AND ("ectopic pregnancy" OR "tubal pregnancy" OR "tubal ectopic pregnancy") till May 2023 to retrieve the relevant studies.

Studies Selection and Eligibility Criteria

The selection of the included items involved two steps. Step one was the screening of titles and abstracts. Then, the selected relevant articles underwent a full-text screening according to the inclusion criteria of our study. We included studies that investigated the surgical outcomes of SILS compared with CLS in the surgical management of women with different types of ectopic pregnancies. We did not exclude studies based on the types of ectopic pregnancies they included or excluded, as long as the inclusion and exclusion groups were treated equally. Our main outcomes were the duration of postoperative hospitalization, total operative time, the surgeon estimated blood loss, hemoglobin change, the number of women and amount of blood transfusions needed, the patient's satisfaction, and return of bowel function.

Data Extraction

We collected data from the included articles. We extracted the baseline information and the included studies' characteristics. Moreover, we extracted data on our selected outcomes including total operative time, length of hospital stay, the surgeon's estimated blood loss, hemoglobin change, the number of blood transfusions needed, the number of women in need of blood transfusions, and return of bowel function. For outcomes such as surgeon-estimated blood loss and return of bowel function, some studies provided indirect measures, such as ranges or averages, rather than exact values. In these cases, we used standardized methods to estimate mean values and standard deviations, ensuring consistency across studies for inclusion in the meta-analysis.

Quality Assessment

Our study included both observational studies and randomized controlled trials. Thus, the risk of bias in observational articles was measured utilizing the ROBINS-I tool[16]. The Cochrane risk of bias tool was utilized to assess the randomized controlled trials[17].

Statistical Methods

We extracted data for both dichotomous and continuous outcomes. OpenMetaAnalyst and Review Manager 5.4.1 software was used to analyze all the data retrieved. Regarding the dichotomous data, we used an odds ratio (OR) using the Mantel-Haenszel analysis method. For continuous outcomes, we used a mean difference (MD) under the inverse variance analysis method. A fixed effects analysis model was utilized if outcomes were homogeneous, while a random effects model was used if we observed heterogeneity. The heterogeneity was measured by the I2 and the p-value. Heterogeneity is identified if $p<0.1$, or $I^2>50\%$.

Results

Summary of Our Included Studies

Our search results in the online databases are presented in the PRISMA diagram, as seen in Figure 1. We included 12 studies in our analysis[18-29]. In total, these included 880 women experiencing ectopic pregnancies. Of these, 372 women underwent SILS, while 508 women underwent CLS for the surgical management of ectopic pregnancy. The characteristics of the included studies and included participants are illustrated in Table 1 and Table 2.

Risk of Bias Assessment Results

According to the ROBINS-I risk of bias tool, the overall risk of bias in the observational studies was moderate. Table 3 shows all domains. Regarding the randomized studies, the risk of bias assessment was illustrated in Table 4[18].

Analysis of Outcomes

Total Operative Time (in Minutes)

When comparing SILS with CLS utilizing data retrieved from all included studies[18-29], our analysis of the prospective studies showed comparable total operative time in both procedures [MD=1.81 (-10.71, 14.33), (p=0.78), I^2=93%]. The retrospective subgroup analysis also showed similar total operative time in both procedures [MD=0.07 (-1.62, 1.76), p=0.94, I^2=93%]. The overall analysis of both subgroups showed a comparable total operative time in both procedures [MD=0.87 (-6.10, 7.84), p=0.81, I^2=93%], as seen in Figure 2.

Surgeon Estimated Blood Loss (in mL)

We analyzed this outcome using data from four included studies[19,21,22,26]. Regarding the prospective subgroup, there was a significantly lower blood loss in the SILS group [MD=-62.29 (-99.56, -25.02), p=0.001, I^2=98%]. Nasu et al.[26] in the retrospective subgroup showed similar results in both procedures [MD=-51.01 (-86.18, -15.85), (p=0.004), I^2=98%]. However, the overall analysis showed a significantly decreased blood loss among patients in the SILS group [MD=-51.01 (-86.18, -15.85) (p=0.004), I^2=98%], as seen in Figure 3.

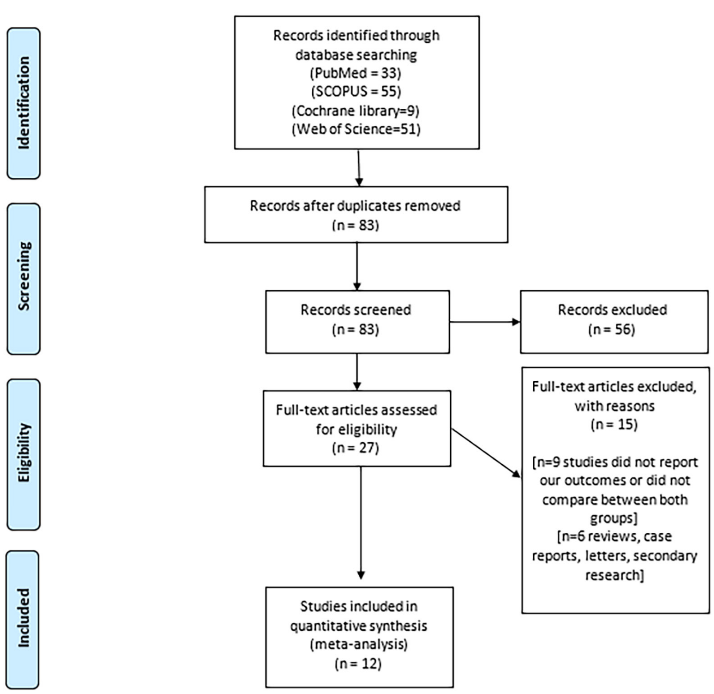

Figure 1. PRISMA workflow diagram illustrating our literature search

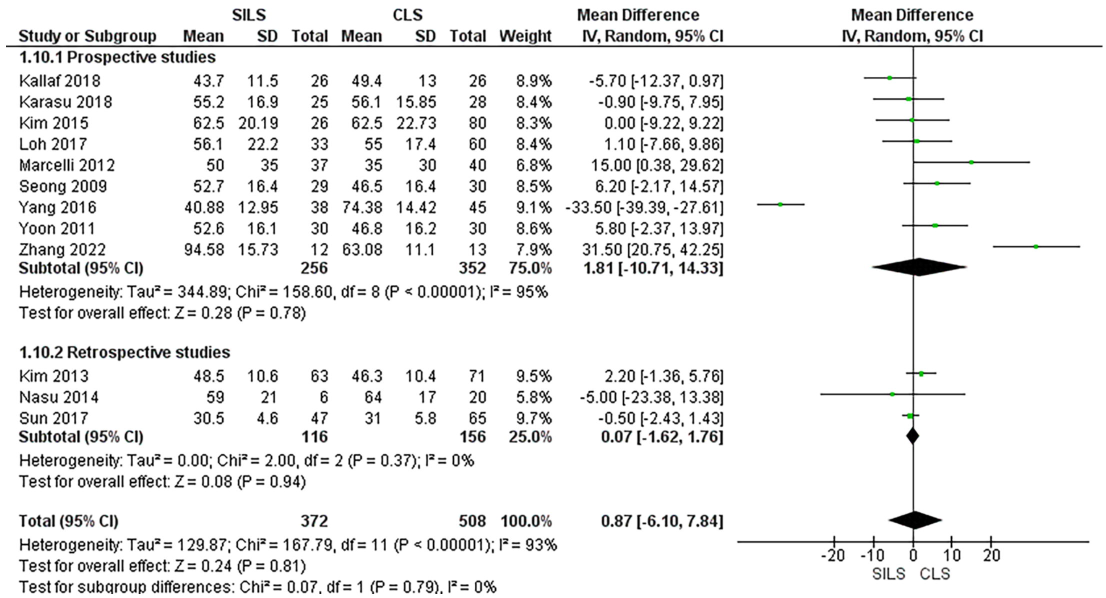

Figure 2. Meta-analysis of total operative time (in minutes)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

Table 1. The characteristics of the included studies and demographic data of participants

Study	Study design	Sample size		Age, years		BMI (kg/m^2)		Parity	
		SILS	CLS	SILS	CLS	SILS	CLS	SILS	CLS
Kallaf[18] 2018	Prospective randomized study	26	26	24.3±3.6	24.7±3.5	28.6±3	28.2±3.5	NR	NR
Karasu and Akselim[19] 2018	Prospective case control study	25	28	31.8±5.9	33.4±5.9	26.6±4.1	24.4±3.0	1.75±0.76	2.75±1.98
Kim et al.[23] 2013	Retrospective study	63	71	31.2±5.2	30.4 ±5.0	21.0±2.1	21.3 ± 2.3		
Kim et al.[22] 2015	Prospective observational case–control study	26	80	30.7±4.8	30.25±5.16	20.61±1.86	22.5±2.9	0.75±0.75	1±0.82
Loh et al.[24] 2017	Prospective observational study	33	60	30.0±5.95	31.0±5.65	23.8±2.84	25.2±2.08	1.06±1.46	0.77±0.87
Marcelli et al.[25] 2012	Prospective observational case-control	37	40	29.3±3	28.7±2.8	23±4	24±4.5	1±1.1	1.2±1.5
Nasu et al.[26] 2014	Retrospective observational study	6	20	29.3±6.2	31.2±5.4	NR	NR	NR	NR
Seong et al.[27] 2009	Prospective observational study	29	30	31.1±5.3	32.6±4.9	NR	NR	NR	NR
Sun et al.[28] 2017	Retrospective cohort study	47	65	35.3±5.9	36.9±6.0	NR	NR	NR	NR
Yang et al.[29] 2016	Prospective observational case-control study	38	45	30±2.01	29.14±1.49	22.69±0.87	22.55±0.69	0.62±0.24	0.52±0.20
Yoon et al.[20] 2011	Prospective observational case-control study	30	30	30.9±5.4	32.1±5.0	20.6±2.6	20.1±2.2	0.3±0.5	0.2±0.6
Zhang and Zhu[21] 2022	Retrospective observational study	12	13	34.5±6.5	36.7±7.2	22.6±3.6	21.7±4.1	NR	NR

Data are presented as mean ± standard deviation.
SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery, BMI: Body mass index, NR: Not reported

Table 2. The characteristics of the included studies and demographic data of participants (continued)

Study	Prior abdominal surgery		Presence of hemoperitoneum		Duration of amenorrhea (days)		Gestational age (w)		hCG level (mIU/mL)		Size of ectopic mass (cm)	
	SILS	CLS	SILS	CLS	SILS	CLS	SILS	CLS	SILS	CLS	SILS	CLS
Kallaf[18] 2018	NR	NR	12 (46.2)	15 (57.7)	NR	NR	7.1±1.1	6.8±1	NR	NR	NR	NR
Karasu and Akselim[19] 2018	7 (28)	5 (17.85)	25 (100)	28 (100)	NR	NR	8.5±1.5	7±1	5685.6±5929.6	4894.9±3074.6	4.7±2.3	4.6±1.4
Kim et al.[23] 2013	8 (12.7)	11 (15.5)	NR	NR	53.3±11.5	50.4 ± 10.3	NR	NR	NR	NR	4.0±0.9	3.8±0.8
Kim et al.[22] 2015	NR	NR	18 (69.2)	53 (74.6)	40.25±10.34	52.75±15.9	NR	NR	NR	NR	NR	NR
Loh et al.[24] 2017	11 (33.3)	21 (35)	NR	NR	NR	NR	NR	NR	9657.3±11734	11053.1±22350	3.48±1.53	3.86±1.16
Marcelli et al.[25] 2012	NR	NR	28 (75.7)	30 (75)	NR	NR	7.4±3	7.3±3	3500±1100	3650±1200	NR	NR
Nasu et al.[26] 2014	NR	NR	2 (33)	1 (5)	NR	NR	6.3±1.2	7.2 ± 1.3	NR	NR	NR	NR
Seong et al.[27] 2009	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sun et al.[28] 2017	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Yang et al.[29] 2016	6 (15)	7 (14.5)	38 (100)	45 (100)	NR	NR	7±0.46	7.75±0.68	NR	NR	NR	NR
Yoon et al.[20] 2011	3 (10.0)	7 (23.3)	9 (30)	11 (36.7)	52.0±14.0	48.4±9.9	NR	NR	5442±7802	6921±10366	3.4±1.6	3.2±1.3
Zhang and Zhu[21] 2022	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Data are presented as mean ± standard deviation or number (%).
SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery, BMI: Body mass index, NR: Not reported

Table 3. The risk of bias assessment of the included studies by ROBINS-I tool

Study	Bias due to confounding	Selection bias	Bias in classification of interventions	Bias due to deviations from intended intervention	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported result
Kallaf[18] 2018	Moderate	Moderate	Low	Low	Low	Moderate	Moderate
Karasu and Akselim[19] 2018	Low	Moderate	Low	Low	Low	Moderate	Low
Kim et al.[22] 2015	Moderate	Moderate	Low	Low	Moderate	Moderate	Low
Loh et al.[24] 2017	Low	Moderate	Low	Low	Low	Moderate	Low
Marcelli et al.[25] 2012	Moderate	Low	Low	Moderate	Low	Moderate	Low
Nasu et al.[26] 2014	Moderate	Low	Low	Low	Low	Moderate	Low
Seong et al.[27] 2009	Low	Low	Low	Low	Low	Moderate	Low
Sun et al.[28] 2017	Low	Low	Low	Moderate	Low	Moderate	Moderate
Yang et al.[29] 2016	Moderate	Low	Low	Low	Low	Moderate	Low
Yoon et al.[20] 2011	Moderate	Low	Low	Low	Low	Moderate	Low
Zhang and Zhu[21] 2022	Low	Low	Low	Low	Low	Moderate	Low

Table 4. The risk of bias assessment of the randomized controlled study by the Cochrane tool

Study	Randomization	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Attrition bias	Selective reporting
Kallaf[18] 2018	Low	Low	High	High	Low	Low

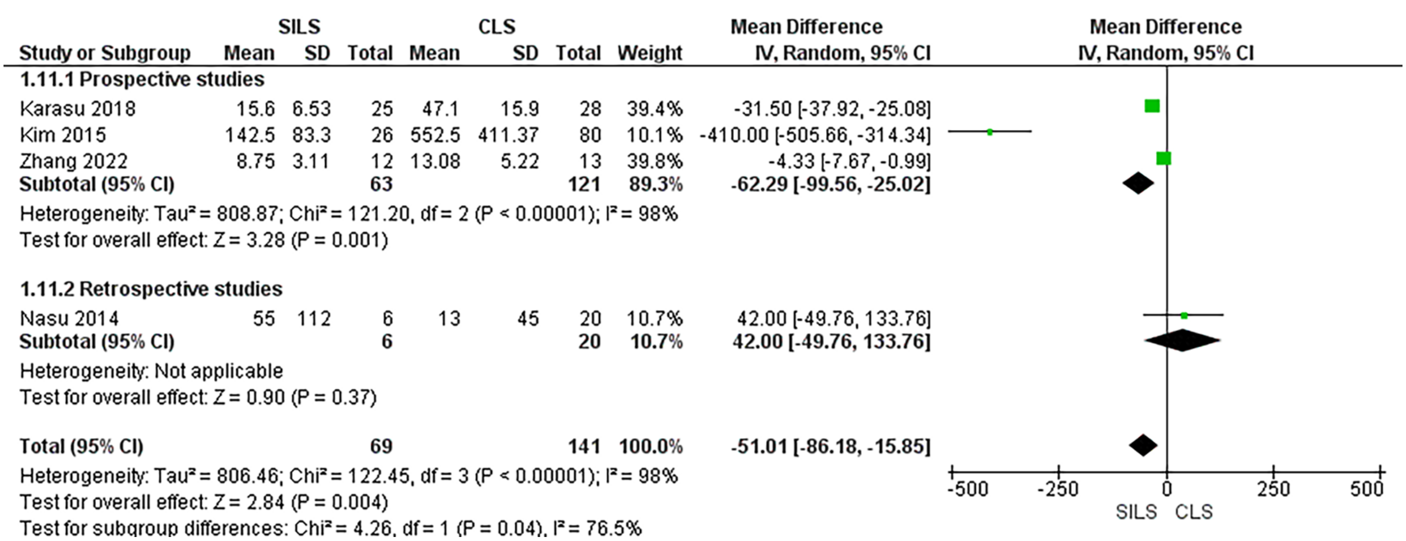

Figure 3. Meta-analysis of the surgeon declared estimated blood loss (in mL)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

Length of Postoperative Hospital Stay (in Days)

Most studies assessed this outcome[18-29]. The prospective subgroup analysis yielded a significantly decreased duration of hospital stay in the SILS group [MD=-0.30 (-0.51, -0.09) (p=0.005), I^2=76%]. The retrospective subgroup analysis demonstrated no difference between the two procedures [MD=-0.11 (-0.40, 0.17) p=0.43, I^2=76%]. The pooled analysis showed a significantly decreased duration of postoperative hospitalization among patients who underwent SILS compared to those who underwent CLS [MD=-0.24 (-0.39, -0.08) (p=0.003), I^2=76%], as shown in Figure 4.

Hemoglobin Change (in g/L)

When comparing SILS with CLS, the prospective studies analysis demonstrated no significant difference in the hemoglobin change between the two techniques [MD=-0.08 (-0.22, 0.05)

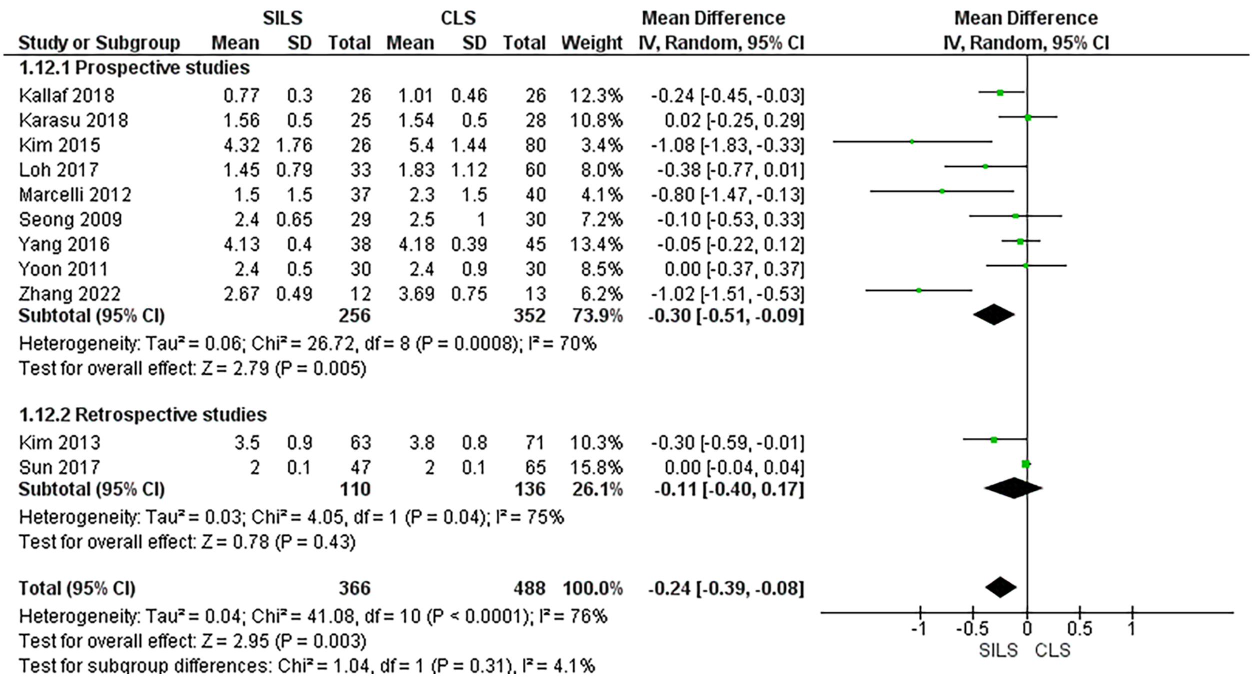

Figure 4. Meta-analysis of the length of the postoperative hospital stay (in days)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

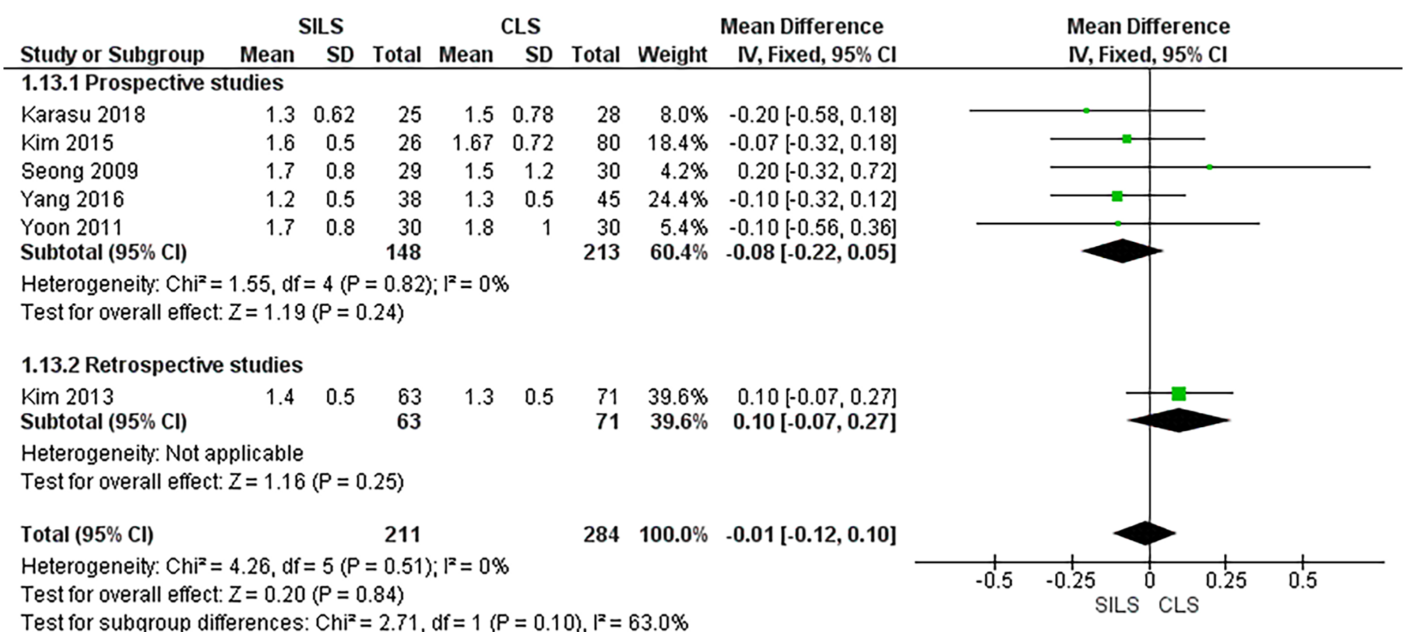

Figure 5. Meta-analysis of the change in hemoglobin levels (in g/L)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

(p=0.24), I^2=0%]. The overall analysis from the six included studies also showed no differences between the two procedures [MD=-0.01 (-0.12, 0.10), p=0.84, I^2=0%], as seen in Figure 5.

Amount of Blood Transfused (in Units)

We compared SILS and CLS, analyzing data from three studies that reported this outcome(18,23,29). Both prospective and retrospective subgroups showed similar amounts of blood transfused in both groups [MD=-0.02 (-0.12, 0.07) (p=0.60), I^2=53%]. Pooled analysis showed no difference between the two procedures regarding the amount of blood needed [MD=-0.02 (-0.12, 0.07); p=0.60, I^2=53%], as seen in Figure 6.

Number of Patients Requiring a Blood Transfusion

Eight studies reported this outcome(18-20,22-25,29). The prospective studies subgroup showed a comparable number of patients who needed blood transfusions in both groups [OR=0.885 (0.524, 1.496) (p=0.649), I^2=0%]. Our overall analysis of prospective and retrospective subgroups showed a similar incidence of blood transfusion in both groups as well [OR=0.986 (0.635, 1.531), p=0.951, I^2=0%], as seen in Figure 7.

Return of Bowel Function (in Hours)

The time needed for the bowel to return to normal function was reported in three studies(18,22,28). The prospective subgroup analysis demonstrated similar results in both cohorts [MD=-1.29 (-2.62, 0.05) p=0.06, I^2=0%). However, the overall analysis

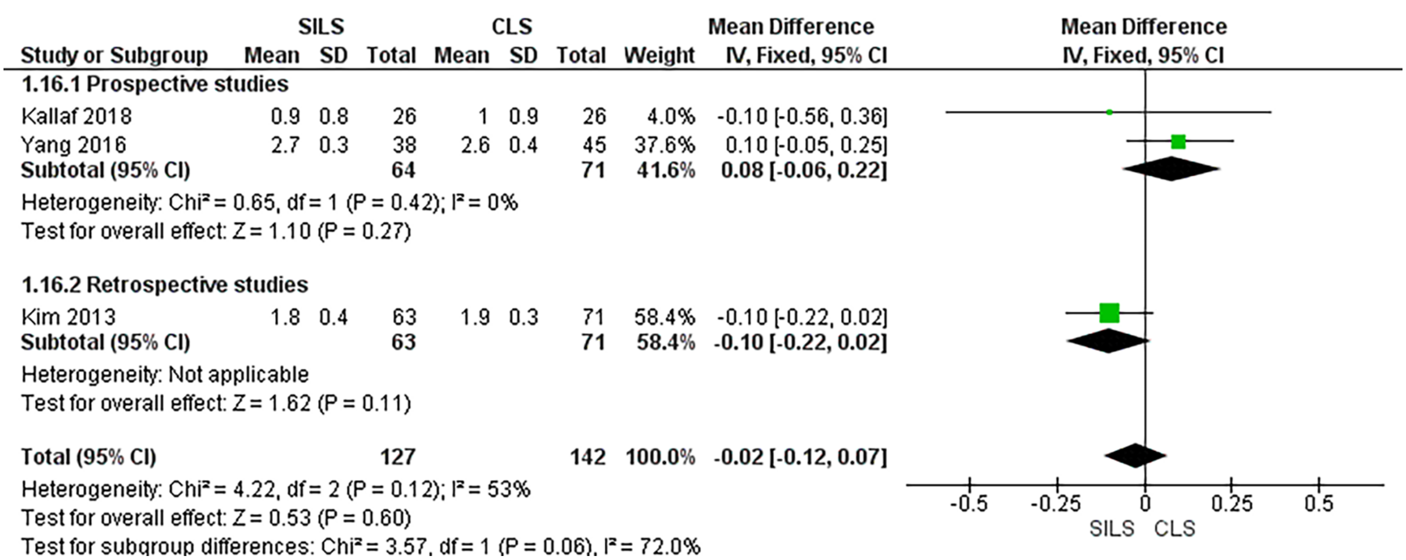

Figure 6. Meta-analysis of the number of units of blood transfused (in units)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

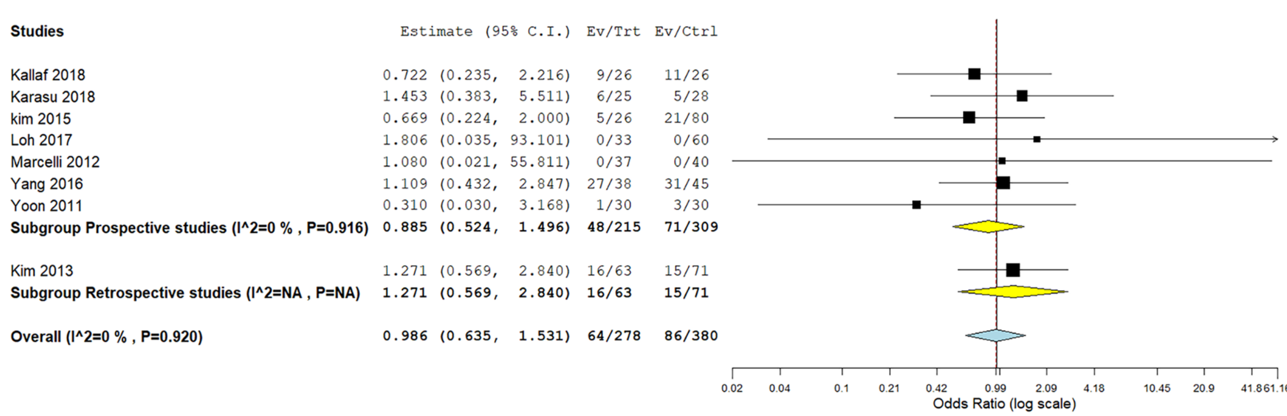

Figure 7. Meta-analysis of the number of patients requiring any blood transfusion

of both prospective and retrospective subgroups showed that patients who underwent the SILS operation required less time to return to normal bowel function [MD=-1.03 (-1.45, -0.61), p<0.01 I^2=0%]. Pooled analysis was homogeneous (p=0.78), I^2=0%, as seen in Figure 8.

Patient Satisfaction Scores

As only two studies reported this outcome, a quantitative synthesis was not possible[18,24]. Kallaf[18] reported higher satisfaction rates in the SILS group versus the CLS group. A total of 46.2% of patients in the SILS group were very satisfied with the wound cosmesis, compared to 19.3% of patients in the CLS group. Loh et al.[24] assessed the satisfaction score after both procedures as well. The satisfaction score was slightly higher in the SILS group (8.5) compared to the CLS group (7.9), with no statistically significant difference.

Discussion

In the last decade, great efforts have been made to enhance surgical techniques and improve patient care through advancing minimally invasive gynecologic surgery (MIGS). One important aspect of MIGS is minimizing the abdominal wall injury, caused by using multiple and larger trocars in conventional laparoscopy[30,31]. SILS is a type of surgical procedure in which surgeons use a single port through a small skin incision, usually at the umbilicus[32,33]. Since it was first described by Peters et al.[34] in the management of cholecystectomy, SILS has been utilized for various other indications including appendectomy[35], adrenalectomy[36], and ectopic pregnancy[37]. SILS has been recognized as a reliable alternative to CLS with the possible advantages of reduced abdominal wall trauma, less postoperative pain, less bleeding, quicker recovery, and improved cosmetic results, especially in young women in the reproductive age[38,39]. Unfortunately, there are limitations to this method as having only a single port for the instruments and camera may reduce the field of vision and impair depth perception[40]. In our meta-analysis, we compared the surgical results of SILS with CLS in the management of women with ectopic pregnancies. Our study demonstrated overall comparable surgical outcomes in both procedures. We found no significant differences between the two procedures regarding the total operative time, hemoglobin change, the number of blood transfusions needed or the percent of women who needed blood transfusions. However, SILS was associated with significantly lower surgeon-estimated blood loss, a shorter duration of postoperative hospitalization, and quicker return to normal bowel function. A notable gap in the literature is the lack of cost-effectiveness data comparing SILS and CLS for ectopic pregnancy management. While our analysis found that SILS is associated with a shorter postoperative hospital stay, which could potentially reduce healthcare costs, the initial investment in specialized single-port equipment may pose a financial barrier. Future studies should include formal cost-effectiveness analyses to better inform clinical decision-making and healthcare policy regarding the adoption of SILS. Optimizing patient selection for SILS is critical, particularly in stratifying outcomes by ectopic location and the presence of hemoperitoneum. Such stratification could identify subgroups of patients, such as those with tubal ectopic pregnancies or minimal hemoperitoneum, who may derive greater benefits from SILS, thereby guiding clinicians in tailoring surgical approaches to individual patient needs.

Comparison with Existing Literature

In 2018, Gasparri et al.[13] conducted a meta-analysis of 460 women with ectopic pregnancy. This study reported no advantages of SILS over CLS in terms of surgeon-estimated

Study or Subgroup	SILS Mean	SILS SD	SILS Total	CLS Mean	CLS SD	CLS Total	Weight	Mean Difference IV, Fixed, 95% CI
1.8.1 Prospective Studies								
Kallaf 2018	5.2	2.7	26	6.6	2.4	26	9.2%	-1.40 [-2.79, -0.01]
Kim 2015	31.4	10.5	26	31.3	12.23	80	0.8%	0.10 [-4.74, 4.94]
Subtotal (95% CI)			**52**			**106**	**10.0%**	**-1.29 [-2.62, 0.05]**
Heterogeneity: Chi² = 0.34, df = 1 (P = 0.56); I² = 0%								
Test for overall effect: Z = 1.89 (P = 0.06)								
1.8.2 Retrospective studies								
Sun 2017	6.2	1	47	7.2	1.4	65	90.0%	-1.00 [-1.44, -0.56]
Subtotal (95% CI)			**47**			**65**	**90.0%**	**-1.00 [-1.44, -0.56]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 4.41 (P < 0.0001)								
Total (95% CI)			**99**			**171**	**100.0%**	**-1.03 [-1.45, -0.61]**
Heterogeneity: Chi² = 0.50, df = 2 (P = 0.78); I² = 0%								
Test for overall effect: Z = 4.78 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.16, df = 1 (P = 0.69), I² = 0%								

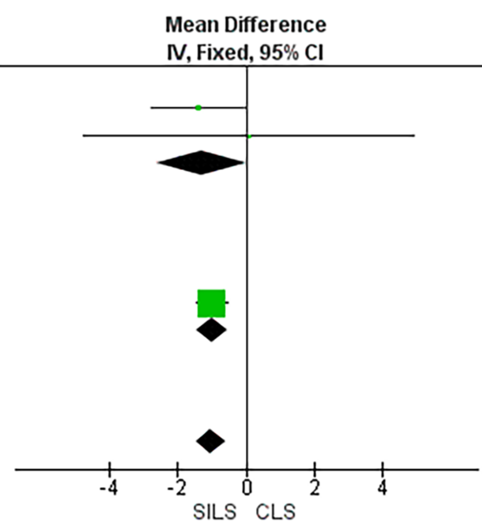

Figure 8. Meta-analysis of the amount of time until the return of bowel activity (in hours)

CI: Confidence interval, SD: Standard deviation, SILS: Single incision laparoscopic surgery, CLS: Conventional laparoscopic surgery

blood loss in both procedures. Another meta-analysis of 2,085 women evaluating the surgical outcomes of SILS compared to CLS in various gynecologic surgeries showed no considerable difference between the two procedures in the total operative time or the duration of postoperative hospitalization, which is in line with our findings[14]. Kallaf[18] conducted a randomized comparative study evaluating the intraoperative and immediate postoperative results of SILS compared to CLS for the management of ectopic pregnancy. They concluded that there is a significant advantage of the SILS procedure over CLS in short-term outcomes. Additionally, they found significantly better satisfaction with cosmetic in the SILS group. These results go hand in hand with Yang et al.[29], Karasu and Akselim[19], and Kim et al.[22], all of which superiority of SILS over CLS in managing women with tubal ectopic pregnancy even if complicated with massive hemoperitoneum. Contrary to these results, Loh et al.[24] reported no differences between the conventional laparoscopy and the SILS regarding the total operative time, length of hospital stay, and the satisfaction score. However, this study included only tubal ectopic pregnancies and excluded other types of ectopic pregnancies. In 2022, Zhang and Zhu[21] reported better satisfactory cosmetic results, reduced pain, decreased bleeding, and quicker recovery in patients who underwent SILS for ectopic pregnancy or leiomyoma. However, they also reported that SILS required a longer total operative time compared to CLS. They attributed this prolonged total operative time to the difficulty in the fixation of the multi-channel laparoscopic devices[21]. A previous meta-analysis of six randomized controlled trials comparing SILS with CLS in adnexal surgery showed no significant difference between both techniques in all surgical outcomes except the total operative time, which was longer in women who underwent SILS. This may be explained by the limited triangulation and frequent instrument collisions[41]. In another study, Sun et al.[28] retrospectively evaluated 112 patients with tubal pregnancies operated on by a single surgeon. They reported almost identical surgical results in both procedures. However, they found that patients who underwent SILS experienced quicker resumption of normal bowel function, which is consistent with our findings.

Strengths

Our study is the largest meta-analysis to date to compare SILS and CLS head-to-head in the laparoscopic treatment of ectopic pregnancy. In addition, the quality of the included studies was found to be relatively high according to the grading scales.

Limitations

Our main limitations include the relatively small sample size, the paucity of included randomized controlled trials, and the inclusion of studies with different study designs. As a result, we faced heterogeneity in some forest plots, which could not be solved by subgroup analysis. Another limitation is the lack of data on surgeon experience, which may influence outcomes such as operative time and complication rates due to the technical challenges of SILS, including instrument triangulation and visualization. Future studies should evaluate the impact of surgeon expertise and training on SILS outcomes to better understand its learning curve and broader applicability. The reliance on surgeon-estimated blood loss introduces potential bias due to its subjective nature. Future studies should adopt more objective and standardized methods, such as gravimetric or volumetric techniques, to measure blood loss, thereby improving the reliability and comparability of results. Additionally, we did not consider the experience of the surgeons in our analysis since this information was not reported in the studies. Another possible source of bias is the subjective definition of blood loss. Although we specifically defined our blood loss as “surgeon estimated”, we cannot be certain in some studies that this did not include at least some preexisting hemoperitoneum, which could skew our results. Lastly, because of the limited number of ectopic pregnancies not in the ampullary portion of the fallopian tubes or with a hemoperitoneum, we were unable to perform a subgroup analysis for these events. As a result, these special circumstances could have influenced our findings.

Conclusion

SILS is a reliable and effective alternative to CLS for the surgical management of ectopic pregnancy. Our meta-analysis demonstrates that SILS offers significant clinical benefits, including reduced blood loss and a shorter postoperative hospital stay, being approximately 0.24 days, which can enhance patient recovery and reduce healthcare costs. These advantages, combined with potential cosmetic benefits from a single umbilical incision, are particularly valuable for young women of reproductive age seeking minimal scarring. Additionally, the quicker return of bowel function with SILS may improve postoperative comfort. We recommend that clinicians consider SILS as a preferred approach when surgical expertise and resources are available, especially for uncomplicated ectopic pregnancies. Future research should focus on long-term outcomes, such as tubal patency and fertility, and stratify results by ectopic location and hemoperitoneum to optimize surgical techniques and patient selection.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: G.J.M., A.A., Concept: G.J.M., Data Collection or Processing: D.H.G., B.H., M.R., E.K., S.M., N.P., G.J., Literature Search: A.A., Writing: G.J.M.

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