BENHA MEDICAL JOURNAL bmj

Print ISSN 1110-208X.

Online ISSN 2357-0016

Retrospective Comparison between Ligasure Impact versus Conventional Methods in Elective Cesarean Hysterectomy for Placenta Accreta in Benha University Hospital

Ahmed M. Ahmed [a], Aziza A. Negm [a], Dalia A. Nour [b], Nada K. Mohammed [b], Ashraf N. Elmantwe [a], Fatma F. Darwish [b]

[a] Obstetrics and Gynecology Department, Faculty of Medicine Benha University, Egypt.

[b] Obstetrics and Gynecology Department, Faculty of Medicine Cairo University, Egypt.

Corresponding to:
Dr. Ashraf N. Elmantwe.
Obstetrics and Gynecology Department, Faculty of Medicine Benha University, Egypt.

Email:
ashrafnassifelmantwe@fmed.bu.edu.eg

Received:
Accepted:

Abstract:

Background: Elective Cesarean Hysterectomy (ECH) for Placenta Accreta Spectrum Disorders (PASD) is a high-risk procedure associated with significant blood loss and morbidity. Efficient vascular control is critical to improve surgical outcomes. Aim: To evaluate the effectiveness of LigaSure Impact™ in reducing intraoperative blood loss and morbidity during ECH in patients with PASD. **Patients and Methods:** This retrospective study included 160 women diagnosed with PASD who underwent ECH between 2019 and 2024 across a university hospital and affiliated centers. Patients were divided into two cohorts: the LigaSure-assisted group (LIECH, n=56) and the conventional surgery group (CSECH, n=104). Preoperative characteristics were comparable. Intraoperative and postoperative outcomes were analyzed. **Results:** The LIECH group demonstrated significantly shorter operative time (70±28 vs 90±30 min, p=0.0001) and lower intraoperative blood loss (2150±540 vs 2750±790 ml, p=0.0001). Intraoperative transfusion requirements were significantly reduced in the LIECH group: PRBCs (1.9±1.6 vs 4.4±1.4 units, p=0.0001) and FFP (1.5±0.9 vs 3.4±1.9 units, p=0.0001). Fewer patients required internal iliac artery ligation (44.6% vs 76%, p=0.0001), SICU admission, or surgical revision (9% vs 29%, p=0.004). Postoperative outcomes, including pain scores, analgesic use, drain output, transfusion, and hospital stay (8.3±5.6 vs 13.5±9.8 days, p=0.0003), favored the LIECH group. Vesicovaginal fistula occurred less frequently (1.8% vs 4.8%, p=0.0001). No significant differences were observed in overall postoperative complications, infection rates, or hemoglobin decline. **Conclusion:** LigaSure Impact™ improves operative efficiency and reduces intraoperative blood loss and postoperative morbidity in ECH for PASD. It may be a safe and effective surgical adjunct in high-risk obstetric surgery.

Key Word: Elective Cesarean Hysterectomy, Placenta Accreta Spectrum Disorders, LigaSure Impact™, Placenta Accreta Spectrum

Introduction

Placenta Accreta Spectrum Disorders (PASD) encompasses abnormal placental adherence and invasion into the uterine wall. Placenta accreta (PA) involves superficial attachment to the myometrium; increta (PI) denotes deeper myometrial invasion, and percreta (PP) extends through the serosa, potentially involving adjacent organs such as the bladder or bowel[1]. PAS has emerged as a significant obstetric challenge, with incidence rising globally in parallel with cesarean delivery rates, now estimated between ~0.08% and 2.2% of pregnancies[2]. Historically rare (~0.04% in the 1970s), PAS now affects approximately 0.3% (3/1000) of deliveries[1]. In Egypt, a tertiary center reported a PAS incidence of 0.9%, reflecting global trends[3]. Key risk factors include placenta previa and prior cesarean sections, with additional contributors being advanced maternal age, multiparity, and any uterine intervention that disrupts the decidua [2,3]. These trends have positioned PAS as a leading indication for peripartum hysterectomy (PH) [2,3].

Managing PASD is highly complex due to the risk of massive hemorrhage at delivery [2,4]. Incomplete placental separation leads to severe bleeding, especially during lower uterine segment incision. Median estimated blood loss can exceed 3500 mL during PAS hysterectomy[4], often requiring major transfusions and intensive care [2,4,5]. Maternal morbidity is substantial, including bladder or ureteric injury, respiratory failure, sepsis, and prolonged ICU stays [2,6]. A recent series noted that 96% of PAS cases experienced postpartum hemorrhage, with many exceeding 3500 mL[4]. Current guidelines advise delivery in high-level centers with multidisciplinary teams including gynecologic oncologists, urologists, anesthesiologists, interventional radiologists, and full transfusion support [2,5]. Even with optimal care, maternal mortality may reach 7% [1,2]. Urgent intraoperative decisions, particularly timely hysterectomy before coagulopathy develop, remain a key clinical challenge [2,5].

Current guidelines from ASGO, ACOG, and SMFM recommend planned Elective Cesarean Hysterectomy (ECH) with the placenta left in situ as the standard for severe PAS[5]. After fetal delivery via an incision away from the placental bed, the uterus is closed, and hysterectomy proceeds without placental removal[5]. This approach, reaffirmed in 2025, prevents forcible separation and massive hemorrhage [5,6]. However, cesarean hysterectomy (CH) has major limitations. It results in permanent loss of fertility and often involves significant blood loss despite meticulous technique [1,2,5,6]. Neovascularization and distorted anatomy increase the risk of intraoperative injuries to bladder, ureters, bowel, or major vessels [1,2,5,6]. Coagulopathy, extended operative time, and multiple transfusions are common. Even when performed electively by experienced teams, maternal morbidity remains high [1,2,5,6]. Key complications include massive hemorrhage, multi-organ injury, and infertility [1,2,5,6]. These challenges have driven interest in adjunct tools and techniques to improve safety and reduce complications during PASD surgeries.

LigaSure Impact™ (Medtronic) is a high-powered bipolar vessel-sealing device for open surgery, combining pressure and bipolar energy to seal vessels up to 7 mm. Its large, curved, non-stick jaws allow simultaneous sealing and tissue transection with minimal eschar buildup. Compared to conventional techniques, LigaSure enables faster hemostasis, reduced surgical smoke, and less instrument exchange[7–12]. In gynecology and general surgery, LigaSure has shown reduced bleeding and operative time[7–12]. Its application in obstetrics, particularly PAS surgery, is promising. A retrospective Turkish study comparing 28 CH cases in placenta percreta (PP) found that LigaSure significantly reduced operative time, intraoperative blood loss, and transfusion needs versus conventional techniques. Fewer patients in the LigaSure group required internal iliac artery ligation (p=0.013) or prolonged hospital stays[13].

Importantly, complication rates were not increased[13]. LigaSure's ability to rapidly seal multiple small vessels during dissection of the broad and cardinal ligaments may reduce the need for time-consuming ligatures. Its curved jaws aid pelvic dissection near the lower uterine segment—an anatomically complex area in PAS cases. Overall, LigaSure Impact may improve surgical efficiency, reduce blood loss and transfusion requirements, and shorten anesthesia duration in cesarean hysterectomy for PAS. Medtronic also reports reduced eschar buildup and instrument cleaning due to the jaw coating, though this is based on vendor data.

Despite its potential, limited studies have reported on LigaSure use in PAS hysterectomy[13–19]. Only a few directly compared the large-jaw LigaSure Impact™ to conventional techniques[13–15]. Others focused on different surgical innovations while still using LigaSure Impact™, such as retrograde peripartum hysterectomy via the posterior fornix[18] or extraperitoneal retrograde hysterectomy[19]. Additional studies evaluated the smaller-jaw LigaSure Exact™ for bladder dissection in the neovascularized uterovesical space in PASD [16,17]. Notably, no large randomized or retrospective comparative trials have specifically examined the role of LigaSure Impact™ versus traditional clamp-cut-ligate methods for elective cesarean hysterectomy (ECH) in PASD patients. While LigaSure has demonstrated benefits for operative efficiency in general surgery [7,8] and gynecology[9–12], the complex vascular anatomy of PAS necessitates targeted investigation.

To address this gap, we conducted a retrospective comparative study evaluating ECH for PASD using LigaSure Impact™ versus conventional techniques. The primary aim was to assess whether LigaSure Impact™ improves intraoperative efficiency by reducing operative time, blood loss, transfusion requirements, and complications. Findings from this study may help guide the best practices for high-risk obstetric surgery.

Patients and Methods

This retrospective cohort study was conducted to compare surgical outcomes between large-jaw LigaSure Impact™ (LIECH) and conventional clamp-cut-ligate techniques (CSECH) during elective cesarean hysterectomy (ECH) performed for placenta accreta spectrum disorders (PASD). Data were collected from October 2019 to October 2024 at Benha University Hospital and affiliated private centers. A total of 160 patients were included and divided into two groups based on the surgical approach used: the LigaSure Impact™ group (n = 56) and the conventional surgical instruments group (n = 104). Ethical approval was obtained from the Benha University Institutional Review Board (Approval Code: RC:14-8-2023). Due to the retrospective nature of the study, informed consent was waived. All patient data were anonymized in compliance with institutional and ethical guidelines.

Patients were eligible if diagnosed with PASD, had completed childbearing, and consented to Elective Cesarean Hysterectomy (ECH). Diagnosis was confirmed via transabdominal and/or transvaginal ultrasound (TAS/TVS) using at least two established grayscale or color Doppler criteria: (1) irregularity or loss of the hyperechoic zone between placenta and myometrium; (2) thinning or disruption of the uterine serosa–bladder interface with myometrial thickness <1 cm; (3) multiple placental lacunae with turbulent flow >15 cm/s; (4) pronounced uterovesical hypervascularity; and (5) chaotic, confluent intraplacental vascularity spanning the placental width [5,6,20]. Exclusion criteria included interval hysterectomy (placenta left in situ), gravid hysterectomy, urgent cesarean hysterectomy (UCH), including cases where LigaSure Impact™ was used after attempted placental separation and hemorrhage, as well as segmental uterine resection with repair, incomplete operative or pathology records, and unscheduled surgeries. Only preplanned ECHs conducted by the PAS surgical team on designated dates were analyzed.

Most ECH procedures for PASD were performed via a sub-umbilical midline laparotomy. Initially, fetal extraction was achieved through a vertical fundal hysterotomy using a cold knife, scissors, or monopolar diathermy, away from the placenta. In later cases, uterovesical dissection was performed prior to uterine entry to reduce the risk of bladder injury, particularly in settings of anticipated hemorrhage or uterine atony. Uterine entry involved a longitudinal fundal incision, occasionally made using LigaSure Impact™, followed by breech delivery and immediate umbilical cord clamping, also sometimes performed with LigaSure Impact™ instead of sutures. Rapid uterine closure was performed to minimize bleeding.

In cases of significant intraoperative hemorrhage, a temporary tourniquet was applied around the lower uterine segment to reduce perfusion before proceeding with hysterectomy. The uterus and placenta were removed en bloc for histopathological examination. In the LigaSure Impact™ group, all surgical steps—including pedicle ligation and colpotomy—were completed using the large-jaw device. Major vascular pedicles were sealed in 3–4 consecutive applications before activating the cutting mechanism to minimize forward and back bleeding. Lateral pedicle portions (1.5–2.5 jaw widths) required multiple seals due to systemic pressure, while medial parts (0.5–1.5 jaw widths) were sealed to control retrograde bleeding before contralateral ligation. In the conventional group, back bleeding was managed by double clamping, lateral suturing, and delayed medial clamp removal, with suture ties as needed. The vaginal cuff was opened from the posterior fornix using either LigaSure or conventional tools. Patients were classified into LIECH or CSECH groups based on instrument choice, driven by LigaSure availability and surgeon preference. Preoperative cystoscopy and ureteric stents were used selectively for suspected urinary tract involvement. Blood loss was assessed using a cumulative blood loss (CBL) protocol (suction, gauze weight) at 15–30-minute intervals. Transfusion followed 1:1:1 (FFP: platelets: PRBCs) or modified 1:1:2 ratio per resource availability [21]. To confirm PAS diagnosis, all surgical specimens underwent histopathological evaluation by a specialized placental pathologist (fig:1a,b,c,d,e). Classification followed standard criteria based on trophoblastic invasion depth, categorized as accreta, increta, or percreta [5,6].

Comprehensive data were collected on patient demographics (age, parity, BMI, gestational age) and preoperative risk factors. Surgical variables included anesthesia type, operative time, cumulative blood loss (CBL), volume of blood transfusion, and major transfusion events. Intra- and postoperative complications were recorded, including injuries to adjacent organs (bladder, ureters, bowel), ICU admissions, reoperations for hemorrhage, and postoperative morbidities such as ileus, bowel obstruction, fever, thromboembolism, and hospital length of stay.

Statistical analysis

Statistical analysis was performed using MedCalc software (MedCalc, Software, Bvba, 2016; www.medcalc.org). Continuous variables were expressed as mean ± standard deviation (SD) along with their range, whereas categorical variables were summarized as frequencies and percentages. Differences between groups for continuous variables were assessed using the unpaired Student’s t-test. Categorical data were compared using either Pearson’s Chi-square test or Fisher’s exact test, as appropriate. To identify independent predictors for the requirement of ≥4 units of packed red blood cell (PRBC) transfusion, binary logistic regression analysis was conducted. A p-value of less than 0.05 was considered statistically significant.

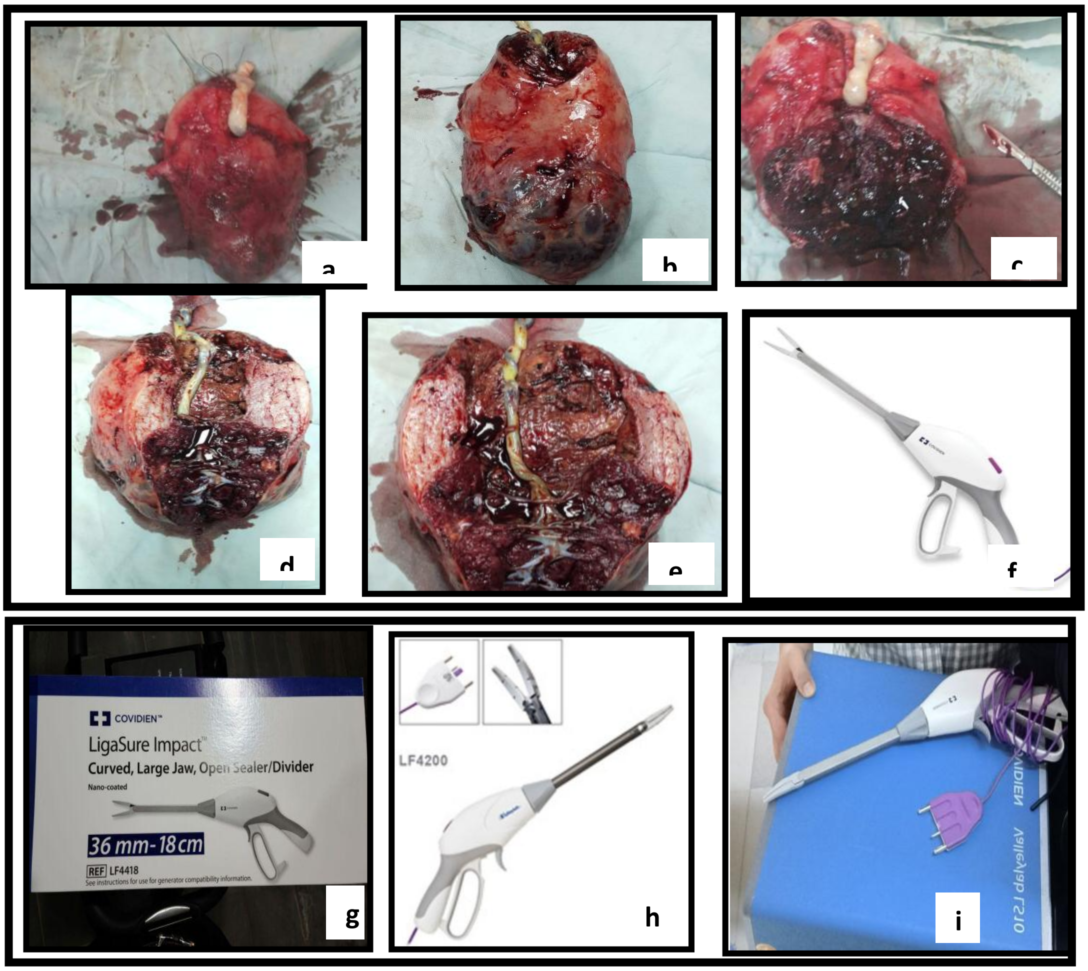

Figure 1: A: PostOperative(PO) Elective Cesarean Hysterectomy (ECH) - PO ECH-specimen: preplanned CS through uterine fundus then cord sceuring with sutures tie followed by simultaneous postpartium hystrectomy (PH) for placenta previa (Pl/Pr) placenta accreta spectrum disorders (PASD) leaving the placenta in situ during hysterectomy; B: PO ECH-specimen: preplanned CS through uterine fundus followed by simultaneous PH for Pl/Pr PASD leaving the placenta in situ during hysterectomy; C: PO ECH-specimen: preplanned CS through uterine fundus then cord sceuring with sutures tie followed by simultaneous PH for Pl/Pr PASD leaving the placenta in situ during hysterectomy showing deroofing of lower uterine segment to specimen for patholgical examination, D: PO ECH-specimen: preplanned CS through uterine fundus followed by simultaneous PH for Pl/Pr PASD leaving the placenta in situ during hysterectomy showing deroofing of lower uterine segment to specimen for patholgical examination and speecimen longitudinally open showing that upper segment is empty and placenta was Pl/Pr PASD E: Last version of Ligasure Impact ™ Curved, Large Jaw, Open Sealer/Divider, 36mm-18cm G: Packed Ligasure Impact ™ Curved, Large Jaw, Open Sealer/Divider, 36mm-18cm H: unPacked Ligasure Impact ™ 14° Curved, Large Jaw, Heany style, Open Sealer/Divider, 36mm-18cm, rouned tip, 180° rotated shaft, 13.5mm shaft oval diameter, 34mm sealing length, 5mm sealing width at the base ; I : unPacked Ligasure Impact ™ 14° Curved, double action Large Jaw, Heany style tiped, Open Sealer/Divider, 36mm jaw length -18cm shaft length, rouned tip, 180° rotated shaft, 13.5mm shaft oval diameter, 34mm active sealing lentgh, 5mm sealing width at the base and COVIDIEN Valleylab LS10 compatible generator.

Results

A total of 160 women were included, among them, 104 (65%) women underwent conventional surgery elective cesarean hysterectomy (CSECH) group (reference group) while 56 (35%) women underwent LigaSure Impact™ elective cesarean hysterectomy (LIECH) cohort (investigational group).

Table 1 displays the clinical and demographic data of participants who had ECH for PASD categorized as CSECH (control group) and LIECH (study group). There were no statistical differences between groups regarding age, BMI, Gravidity, predominance of placenta previa either anterior or posterior, gestational age(GA) at diagnosis of PASD, time since last C-section(years), GA at TOP(weeks), tools used for diagnosis of PASD either ; Ultrasonography with Doppler both Transabdominal Ultrasonography and Transvaginal Ultrasonography[US±D(TAU/TVU)]or/and MRI, number of prior C-sections, Pre-operative HB (gm/dl), Pre-operative HCT(%), days of preoperative hospital stay(DOPOHS) , Pre-operative (PO) blood transfer, PO intravenous iron, PO erythropoietin, Neonatal birthweight (Kg), comorbidity as HNT, DM and PO-HBA1C % (p≥0.05), but we found that number of prior curettages as well as Parity were significantly higher in CSECH than LIECH as p-values were < 0.05.

Table 2 shows an assessment of intraoperative (IO) results of 160 PASD patients who underwent ECH either in LIECH or in CSECH cohorts. PASD women underwent LIECH needed shorter means of total operative time (OR) time (min) 70 ± 28 (45-120) vs 90±30 (50-180), Δ(95% CI)= 20 (10.4 to 29.5), p=0.0001), with significantly lower estimated intraoperative (IO) blood loss (ml) (2150 ±540(800-3200) vs 2750±790(900-4000), Δ(95% CI)= 600 (367 to 833), p=0.0001) as well as lower needed IO transfusion rate(31 (55.4%)vs87 (83.7%), Δ(95% CI)= 28.3% (13.52% to 42.52%), p=0.0001)including both IO transfer PRBCs (units) 1.9±1.6 (0-4)vs4.4±1.4 (0-7) , Δ(95% CI)= 2.5 (2.02 to 2.98),p=0.0001and IO transfer FFP (units) 1.5±0.9 (0-3) vs 3.4±1.9 (0-6), Δ(95% CI)= 1.9 (1.37 to 2.43), p=0.0001). Also, PASD women underwent LIECH (study cohort) were associated with lower need for Concomitant procedures as internal iliac artery (IIA) ligation (25/56 (44.6%) vs79/104 (76%), Δ(95% CI)= 31.4% (15.6% to 45.6%), p=0.0001) as well as the need for surgical revision (5 (9%)vs 30 (29%), Δ(95% CI)= 20% (7.01% to 30.64%), p=0.004).

Table 3 displayed the early and late postoperative (PO) consequences of 160 PASD patients who underwent ECH either in LIECH or in CSECH cohorts. PASD women underwent LIECH associated with significant lower need for surgical intensive care unit (SICU) (p=0.0001), shorter duration of SICU admission if occurred (1.2 ± 0.6(0-5) VS 3.2 ± 1.6(0-13), Δ(95% CI)= 2 (1.56 to 2.44), p=0.0001), lesser amount of PO fluid loss in drains (ml) (p=0.0001), fewer need PO transfer PRBCs (units) (p=0.0001), PO transfer FFP (units) (p=0.0001), as well as total transfer PRBCs (units) (p=0.0001) and total transfer FFP (units) (p=0.0001). The sever PO pain at 12 h (p=0.0002) as well as the analgesic requirements over 24h including both total narcotic (mg) (p=0.0001) and total parental NSAID (mg) (p=0.0001), were significantly lower in study group. Also, PAS women underwent LIECH associated with significant shorter length of postoperative hospital stay [LOPHS (days)] (8.3 ± 5.6 (4-24) vs 13.5± 9.8 (5-45), Δ(95% CI)= 5.2 (2.39 to 8.01), P=0.00030 and lower incidence of PO Vesicovaginal fistula (1 (1.8%) vs 5 (4.8%), Δ(95% CI)= 3% (2.61% to 3.39%), P=0.0001). However, there were no significant differences in terms of total PO complications according to Clavien–

Dindo–Strasberg's classification(C-D-Sc) as well as PO infections, HB, HCT levels and decline in 48h PO HB levels (P≥0.05).

Table (1): Comparison of clinical and demographic properties of 160 PASD patients who underwent ECH either in LIECH or in CSECH cohorts.

Variable	LIECH (n=56) (35%)	CSECH (n= 104) (65%)	Δ(95% CI)	P value
- Age (year)	32.5 ± 4.6 (28-42)	33.1 ± 5.6 (29-43)	0.6 (1.13 to 2.33)	0.5
- BMI (kg/m^2)	29.9 ± 6.7 (22-45)	30.4 ± 7.2 (23-41)	0.5 (1.8 to 2.8)	0.67
-Gravidity	5.6 ± 1.7 (3-8)	6.1 ± 1.8 (3-9)	0.5 (0.08 to 1.08)	0.1
- Parity	4.3 ± 1.3 (2-7)	4.9 ± 1.7 (2-6)	0.6 (0.1 to 1.11)	0.02
-NO. of prior CSs	3.9 ± 1.4 (1-5)	3.7 ± 1.2 (1-5)	0.2 (0.62 to 0.22)	0.34
-NO. of prior other USs	1.8 ± 0.9 (0-4)	2.1 ± 0.8 (0-5)	0.3 (0.03 to 0.57)	0.03
- Placenta previa	56 (100%)	104 (100%)	0% (3.56% to 6.42%)	
Anterior predominance	48 (86%)	77 (74%)	12% (1.63% to 23.41%)	0.08
Posterior predominance	8 (14.3%)	27 (26%)	11.7% (1.97% to 23.16%)	0.1
-Time since last CSs (years)	3.4 ± 1.4 (1.5-6.5)	3.8 ± 1.9 (2.5-7.5)	0.4 (0.17 to 0.94)	0.17
- GA at diagnosis (weeks)	34.5 ± 10.4 (23-38)	35.5 ± 12.4 (25-39)	1 (2.84 to 4.84)	0.61
- GA at TOP (weeks)	37.2 ± 2.5 (30-39)	37.6 ± 4.5 (28-39)	0.4 (0.88 to 1.68)	0.54
- Diagnostic tool used				
US±D(TAU/TVU)	50 (89.3%)	88 (84.6%)	4.7% (-7.46% to 14.65%)	0.41
MRI	6 (10.7%)	16 (15.4%)	4.7% (-7.46% to 14.65%)	0.41
-Pre-operative HB (gm/dl)	10.7 ± 1.2 (9.8-12.6)	10.6 ± 1.6 (9.9-12.8)	0.1 (0.58 to 0.38)	0.68
- Pre-operative HCT (%)	35.5 ± 4.5 (30-40)	35.8 ± 4.9 (31-41)	0.3 (1.26 to 1.86)	0.7
- DOPOHS (days)	7.8 ± 2.8 (1-40)	8.2 ± 3.2 (1-45)	0.4 (0.6 to 1.4)	0.43
-PO blood transfer	12 (21.4%)	35 (33.7%)	12.3% (2.64% to 25.21%)	0.1
-PO intravenous iron	39 (70%)	65 (62.5%)	7.5% (8.12% to 21.65%)	0.35
-PO erythropoietin	20 (35.7%)	45 (43.3%)	7.6% (8.35% to 22.39%)	0.35
- Neonatal birthweight (Kg)	2.9 ± 1.2 (1.8-3.4)	2.8 ± 1.4 (1.7-3.5)	0.1 (0.54 to 0.34)	0.65
- Comorbidity	8 (14.3%)	20 (19.2%)	4.9% (8.23% to 15.92%)	0.44
DM	6 (10.7%)	13 (12.5%)	1.8% (10.1% to 11.4%)	0.74
HTN	6 (10.7%)	14 (13.5%)	2.8% (9.18% to 12.53%)	0.61
POHBA1C %	6.5 ± 2.3 (4.6-8.9)	6.8 ± 2.6 (4.5-8.5)	0.3 (0.52 to 1.12)	0.47

ECH: Elective Cesarean Hysterectomy; **PASD:** placenta accreta spectrum disorders; **LIECH:** LigaSure Impact™ Elective Cesarean Hysterectomy; **CSECH**: Conventional Surgical Elective Cesarean Hysterectomy; **BMI:** Body Mass Index; **CSs:** cesarean sections; **USs**: uterine surgeries including curettages; **MRI:** magnetic resonance imaging; **US±D(TAU/TVU):** Ultrasonography ± Doppler(Transabdominal Ultrasonography/ Transvaginal Ultrasonography); **HB:** Hemoglobin; **HCT:** Hematocrit; **APH:** antepartum hemorrhage; **IPH:** intrapartum hemorrhage; **PPH:** postpartum hemorrhage; **GA:** Gestational Age; **TOP:** termination of pregnancy, DOPOHS: Duration of Preoperative Hospital Stay, HTN: Hypertension, DM: Diabetes Mellitus, POHBA1C: Preoperative Glycated Hemoglobin A1C; **Δ(95% CI)**: Point estimate difference with 95% confidence interval; Values were given as mean ± standard deviation (range) or number (percent); *P<0.05: Statistically significances.*

Table (2): Comparison of intra-operative (IO) outcomes of 160 PASD patients who underwent ECH either in LIECH or in CSECH cohorts.

Outcome	**LIECH (n=56) (35%)**	**CSECH (n= 104) (65%)**	**Δ(95% CI)**	**P value**
-Total **OR** time (min)	70 ± 28 (45-120)	90 ± 30 (50-180)	20 (10.4 to 29.5)	0.0001
-Estimated **IO** blood loss (ml)	2150 ± 540(800-3200)	2750 ± 790(900-4000)	600 (367 to 833)	0.0001
-The transfusion rate	31 (55.4%)	87 (83.7%)	28.3% (13.52% to 42.52%)	0.0001
-IO transfer PRBCs (units)	1.9 ± 1.6 (0-4)	4.4 ± 1.4 (0-7)	2.5 (2.02 to 2.98)	0.0001
-IO transfer FFP (units)	1.5 ± 0.9 (0-3)	3.4 ± 1.9 (0-6)	1.9 (1.37 to 2.43)	0.0001
-Concomitant procedures				
-**IIA** ligation	25 (44.6%)	79 (76%)	31.4% (15.6% to 45.6%)	0.0001
-Bladder repair	5 (9%)	18 (17.3%)	8.3% (3.69% to 18.12%)	0.16
-Vascular repair	2 (3.6%)	11 (10.6%)	7% (2.71% to 14.83%)	0.12
- Intestinal injuries	1 (1.8%)	8 (7.7%)	8.9% (0.04% to 16.45%)	0.04
-Surgical revision	5 (9%)	30 (29%)	20% (7.01% to 30.64%)	0.004

ECH: Elective Cesarean Hysterectomy; **PASD:** placenta accreta spectrum disorders; **LIECH:** LigaSure Impact™ Elective Cesarean Hysterectomy; **CSECH**: Conventional Surgical Elective Cesarean Hysterectomy; **Δ(95% CI)**: Point estimate difference with 95% confidence interval; **IO:** intraoperative; **OR:** operative room; **PRBCs:** packed red blood corpuscles, **FFP:** fresh frozen plasma; **IIA**: Internal iliac artery; Values were given as mean ± standard deviation(range) or number (percent); ***P<0.05:*** *Statistically significances*

Table (3): Comparison of early and late postoperative (PO) results of 160 PASD patients who underwent ECH either in LIECH or in CSECH cohorts.

Outcome	**LIECH (n=56) (35%)**	**CSECH (n= 104) (65%)**	**Δ(95% CI)**	**P value**
- Admission to SICU	12 (21.4%)	56 (53.8%)	32.4% (16.76% to 45.13%)	0.0001
- Duration in SICU (days)	1.2 ± 0.6(0-5)	3.2 ± 1.6(0-13)	2 (1.56 to 2.44)	0.0001
- Fluid loss in drains (ml)	590 ± 165 (300-2400)	1190 ± 245 (500-2500)	600 (528 to 672)	0.0001
- PO transfer PRBCs (units)	1.1 ± 0.9 (0-3)	1.8 ± 0.8 (0-4)	0.7 (0.43 to 0.97)	0.0001
- PO transfer FFP (units)	0.9 ± 0.6 (0-3)	1.9 ± 0.7 (0-4)	1 (0.78 to 1.22)	0.0001
- Total transfer PRBCs (units)	3 ± 2.5(0-8)	6.2 ± 2.2(0-9)	3.2 (2.44 to 3.96)	0.0001
- Total transfer FFP (units)	2.4 ± 1.5(0-6)	5.3 ± 2.6(0-6)	2.9 (2.15 to 3.65)	0.0001
- PO pain - severe at 12h	32 (57.1%)	87 (83.7%)	26.6% (11.95% to 40.87%)	0.0002
- severe at 48 h	23 (41.1%)	48 (46.2%)	5.1% (10.91% to 20.36%)	0.54
-Analgesic requirements over 24h	17.8 ± 9.2 (10-60)	29.9 ± 15.8 (30-80)	12.1 (7.56 to 16.64)	0.0001
-Total narcotic (mg) -Total parental NSAID (mg)	140.8 ± 59.5 (100-400)	250.5 ± 48.6 (400-900)	109.7 (92.46 to 126.94)	0.0001
-PO HB (g/dl)	9.8 ± 1.1 (9.2-11.3)	9.5 ± 1.8 (9.1-11.1)	0.3 (0.82 to 0.22)	0.26
-PO HCT (%)	32.3 ± 10.3 (27-36)	31.7 ± 11.5 (28-37)	0.6 (4.23 to 3.03)	0.74
-decline in HB at (48h) (g/dl)	0.9 ± 0.6 (0.4-2.4)	1.1 ± 0.9 (0.6-2.6)	0.2 (0.06 to 0.46)	0.14
-PO infection	13 (23.2%)	34 (32.7%)	9.5% (5.52% to 22.66%)	0.21
- Total PO complications	24 (42.9%)	57 (54.8%)	11.9% (4.24% to 27.11%)	0.15
Grade I (C-D-Sc)	15 (26.8%)	36 (34.6%)	7.8% (7.5% to 21.5%)	0.31
Grade II (C-D-Sc)	5 (9%)	12 (11.5%)	2.5% (8.9% to 11.6%)	0.63
Grade III (C-D-Sc)	4 (7.1%)	8 (7.7%)	0.6% (9.91% to 8.62%)	0.9
Grade IV (C-D-Sc)	0 (0%)	1 (1%)	1% (5.47% to 5.31%)	0.45
Grade V (C-D-Sc)	0 (0%)	0 (0%)	0% (6.42% to 3.56%)	
-LOPHS (days)	8.3 ± 5.6 (4-24)	13.5 ± 9.8 (5-45)	5.2 (2.39 to 8.01)	0.0003
-Vesicovaginal fistula	1 (1.8%)	5 (4.8%)	3% (2.61% to 3.39%)	0.0001

ECH: Elective Cesarean Hysterectomy; **PASD:** placenta accreta spectrum disorders; **LIECH:** LigaSure Impact™ Elective Cesarean Hysterectomy; **CSECH**: Conventional Surgical Elective Cesarean Hysterectomy; **SICU**: surgical intensive care unit ; **Δ(95% CI)**: Point estimate difference with 95% confidence interval; **IO:** intraoperative; **OR:** operative room; **PRBCs:** packed red blood corpuscles, **FFP:** fresh frozen plasma; **NSAID:** Non-steroidal anti-inflammatory drugs, **VTE:** venous thromboembolism**, LOPHS:** length of postoperative hospital stay, **HB:** Hemoglobin, **HCT:** Hematocrit, **PO:** Postoperative, **C-D-Sc:** Clavien–Dindo–Strasberg's classification; Values were given as mean ± standard deviation or number percent; ***P<0.05:*** *Statistical significances.*

Discussion

PASD represents a range of conditions from abnormal placental adherence (accreta) to deep invasion (increta, percreta), now understood as a spectrum rather than a single pathology [2,5,6]. Abnormal neovascularization and anchoring, rather than malignant-type trophoblastic invasion, underpin its pathogenesis, resulting in high hemorrhagic risk and potential injury to adjacent organs [2,5,6]. To mitigate these risks, leading bodies including FIGO [22], IS-AIP [23], ASGO [24], ACOG, and SMFM [5] recommend elective, preplanned cesarean hysterectomy (ECH) via midline laparotomy without placental removal at least for major PASD cases [5,6,22–24], this approach minimizes emergency interventions and improves maternal outcomes. As surgical planning and skill advances, the necessity of older hemorrhage control methods such as internal iliac artery ligation and interventional radiology is increasingly debated [25]. A five-step protocol for ECH in PASD includes: 1- midline laparotomy with fundal hysterotomy, 2- superior devascularization by early vascular control, 3- retroperitoneal dissection, 4- bladder dissection, and 5- colpotomy with specimen removal [5,6,22–26]. Steps 2–5, particularly bladder dissection, pose high hemorrhagic and technical risks due to dense adhesions and neovascularization. This has led to the integration of vessel sealing systems (VSS), such as LigaSure™, to enhance safety and efficiency in vascular control and tissue dissection. These surgical refinements promote anatomy-based, morbidity-reducing strategies, especially in settings where interventional radiology is unavailable, such as in many low- and middle-income countries [25,26]. A Texas-based team pioneered longitudinal fundal hysterotomy using a linear stapler placed at the uterine fundus, avoiding placental disruption in PASD cases and achieving minimal blood loss (<20 mL) during fetal extraction [27]. Later, a Maryland group advanced this by integrating LigaSure Exact™ into the approach, developing the linear cutter vessel sealing system (LCVSS). This technique involved uterovesical dissection and vascular sealing with LigaSure™ prior to uterine artery ligation to enhance hemostasis [16,17,27]. Uterovesical dissection and bladder flap preparation may be performed using either conventional clamp-cut-ligate techniques [28] or VSS [16,17], before [28] or after [16,17] fetal delivery. Despite longer preparation time with pre-delivery dissection, neonatal outcomes appear comparable. VSS offers improved hemostasis and safer dissection in the highly vascular uterovesical space, particularly post-delivery during ECH [16,17]. In our study, both pre- and post-delivery uterovesical dissections were employed across both arms, with no observable difference between approaches, although this variable was not formally assessed.

In our study, PASD patients were largely comparable across groups, except for incidental differences in parity and prior uterine surgeries, likely due to a larger control group proportion (104/160; 65%) vs. LIECH (56/160; 35%). The LIECH group had significantly shorter operative times, less blood loss, and reduced transfusion needs (PRBCs and FFP) compared to the CSECH group. Fewer LIECH cases required internal iliac artery ligation (IIAL)or surgical revision. Postoperatively, LIECH patients had lower SICU admission rates, shorter SICU stays, reduced drain output, and decreased transfusion needs. Pain scores at 12 hours and 24-hour analgesic use were also lower. LIECH was associated with shorter hospital stays and fewer vesicovaginal fistulas. No significant differences were found in total postoperative complications, infections, hemoglobin/hematocrit values, or hemoglobin drop at 48 hours.

The efficacy of the LigaSure Impact™ (Covidien/Medtronic) 36 mm curved large jaw was evaluated in five studies on peripartum hysterectomies (PHs) [13–15,18,19]. A 2020 Turkish retrospective study [13] comparing LigaSure Impact™ (n=28) with conventional techniques (n=44) over seven years found significantly reduced operative time, estimated blood loss (EBL), transfusion needs, hospital stay, and a non-significant reduction in IIAL. A French study [14] spanning 13 years (2005–2018) compared PHs using LigaSure™ (LSPHs) (n=29) vs traditional surgical techniques (TSPHs) (n=57), across emergency and scheduled cases. LigaSure™ use was linked to significantly lower EBL and transfusion needs, regardless of indication. However, unlike our findings, no significant difference in operative time was noted (LSPHs: 45 min vs TSPHs: 38 min). Notably, our cohort exclusively involved PASD cases, which require complex dissection due to placental invasion into the uterine serosa, prolonging surgery and increasing bleeding risk. All procedures in our study were elective, using a vertical midline incision to the umbilicus, which typically adds operative time compared to transverse approaches. An Italian retrospective study [15] over 12 years (2001–2013) assessed outcomes of 49 PH cases, comparing 23 performed with LVSS versus 26 without. Indications included placenta accreta (41%), previa (16%), and atony (43%). The LVSS group showed significantly reduced EBL (p=0.001) and fewer massive transfusions (>10 units RBCs; p=0.025). Operative time was shorter but not significant (p=0.06). No differences were noted in postoperative complications (p=0.35), hospital stay (p=0.78), or intraoperative events (p=0.9). This suggests LVSS improves hemostasis without increasing risk. Another Italian retrospective study [19], published in 2023, compared 12 women (40%) undergoing recent LigaSure Impact™-assisted retrograde extraperitoneal ECH for PASD (2018–2021) with 18 women (60%) treated via traditional ECH (2007–2017) by a different team. The classical group had significantly more RBC and plasma transfusions, and classical ECH was an independent risk factor for transfusion (6.6-fold increase). Findings support the hemostatic advantage of LigaSure-assisted retrograde extraperitoneal ECH in complex PASD. A USA teams [16,17,25,27] developed a novel approach for managing PASD during elective cesarean hysterectomy (ECH), combining linear stapler fundal hysterotomy [25,27] with LigaSure Exact™ for uterovesical space dissection—termed the Linear Cutter Vessel Sealing Strategy (LCVSS). In a 2019 single-arm study of 23 ECH cases, they reported reduced blood loss and transfusion needs [16]. In 2021, a retrospective comparison [17] of 44 LCVSS-managed PASD cases vs 25 non-LCVSS cases found significantly lower cumulative blood loss in the LCVSS group (median 1124 mL [300–4100] vs 3500 mL [650–10,600]; p<.001). Urinary tract injury rates were equal (16%), while postoperative complications (9% vs 20%; p=.26) and reoperation rates (0% vs 8%; p=.12) were lower in the LCVSS group, though not statistically significant. Neonatal outcomes were comparable.

This study's strengths include a large, multicenter cohort undergoing complex ECH for PASD, enhancing external validity and generalizability. The retrospective design allows evaluation of real-world practices cost-effectively, with a sufficient sample size for meaningful comparisons. It uniquely focuses on the LigaSure Impact™ device in PASD surgery, comparing it to conventional techniques in demographically similar patients. The study also emphasizes preoperative optimization with intravenous iron and erythropoietin as alternatives to transfusion in resource-limited settings. Limitations include potential selection and reporting biases inherent to retrospective studies, and possible confounding by variations in surgeon expertise. The five-year study period complicates distinguishing the effects of surgical experience from device use. Lastly, while LigaSure Impact™ shows intraoperative benefits, cost remains a challenge, though emerging reusable and reprocessing technologies may offer future solutions.

Conclusion

The use of the curved, double-action large jaw 36 mm/18 cm LigaSure Impact™—including the newer non-stick model—combined with the COVIDIEN Valleylab LS10 energy platform, shows promise in reducing operative time and intraoperative blood loss during elective cesarean hysterectomy for placenta accreta spectrum disorders (PASD). However, further research is needed to assess the efficacy and cost-effectiveness of emerging reusable vessel sealing systems. Given the complexity and ethical constraints in PASD surgery, prospective randomized trials are challenging; thus, future studies utilizing rigorous designs such as propensity score–matched cohort analyses are essential to better understand comparative outcomes.

Funding: This research was entirely funded by the authors without external support.

Conflicts of Interest: The authors report no conflicts of interest.

References

1-Mousa S, El Gelany S, Gad Al rub M, Gomaa M. Placenta Accreta Spectrum Disorders: Challenges in Diagnosis and Management Strategies: Observational Case Series Study. Minia Journal of Medical Research, 2023; 34(2): 186-194. doi: 10.21608/mjmr.2023.193402.1347

2-Yang R, Zhang L, Sun L, Wu J, Bi S, Hu M, etal . Risk of Placenta Accreta Spectrum Disorder After Prior Non-Cesarean Delivery Uterine Surgery: A Systematic Review and Meta-analysis. Obstet Gynecol. 2025 Jun 1;145(6):628-638. doi: 10.1097/AOG.0000000000005824. Epub 2025 Feb 6. PMID: 39913920; PMCID: PMC12068551.

3-El Gelany S, Mosbeh MH, Ibrahim EM, Mohammed M, Khalifa EM, Abdelhakium AK, etal . Placenta Accreta Spectrum (PAS) disorders: incidence, risk factors and outcomes of different management strategies in a tertiary referral hospital in Minia, Egypt: a prospective study. BMC Pregnancy Childbirth. 2019 Aug 27;19(1):313. doi: 10.1186/s12884-019-2466-5. PMID: 31455286; PMCID: PMC6712589.

4-Zhan Y, Lu E, Xu T, Huang G, Deng C, Chen T, etal . Cesarean hysterectomy in pregnancies complicated with placenta previa accreta: a retrospective hospital-based study. BMC Pregnancy Childbirth. 2024 Oct 2;24(1):634. doi: 10.1186/s12884-024-06834-z. PMID: 39358706; PMCID: PMC11445944.

5- Cahill AG, Beigi R, Heine RP, Silver RM, Wax JR. Society of Gynecologic Oncology; American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine.Placenta Accreta Spectrum. Am J Obstet Gynecol. 2018 Dec;219(6):B2-B16. doi: 10.1016/j.ajog.2018.09.042. PMID: 30471891.

6- Takeda S, Takeda J, Murayama Y. Placenta Previa Accreta Spectrum: Cesarean Hysterectomy. Surg J (N Y). 2021 May 25;7(Suppl 1):S28-S37. doi: 10.1055/s-0040-1721492. PMID: 35036545; PMCID: PMC8752195.

7- Olasehinde O, Owojuyigbe A, Adeyemo A, Mosanya A, Aaron O, Wuraola F, etal . Use of energy device in general surgical operations: impact on peri-operative outcomes. BMC Surg. 2022 Mar 9;22(1):90. doi: 10.1186/s12893-022-01540-z. PMID: 35264141; PMCID: PMC8908598.

8-Giordano S, Kangas R, Veräjänkorva E, Koskivuo I. Ligasure impact™ might reduce blood loss, complications, and re-operation occurrence after abdominoplasty in massive-weight-loss patients: A Comparative Study. Scand J Surg. 2020 Jun;109(2):151-158. doi: 10.1177/1457496919828237. Epub 2019 Feb 14. PMID: 30760107.

9-Zain Eldin AK, Elmantwe AN, Elbanhawy H, El Noury MA, Sabra AS. The Value of Knife Add-on to Vessel Sealing Devices: A Retrospective Comparison of Covidien Ligasure Impact and ERBE Biclamp 200 in Non-descent Vaginal Hysterectomy. Benha medical journal. 2024 Aug 1;41(4):113-25.

10-Kyo S. Radical Abdominal Hysterectomy with Electrosurgical Bipolar Vessel Sealing. In: Alkatout I, Mettler L, editors. Hysterectomy. Cham: Springer; 2018. p. 1183–91. doi:10.1007/978-3-319-22497-8_99.

11-Türkçüoğlu I, Melekoğlu R. Total Abdominal Hysterectomy with Electrosurgical Bipolar Vessel Sealing. In: Alkatout I, Mettler L, editors. Hysterectomy. Cham: Springer; 2018. p. 1111–21. doi:10.1007/978-3-319-22497-8_94.

12- Ellaithy M, Agur W. The Advantages in the Selection and Use of Bipolar Vessel Sealing Devices in Vaginal Hysterectomy, Dependent on the Different Degrees of Operative Difficulty. In: Alkatout I, Mettler L, editors. Hysterectomy. Cham:

Springer; 2018. p. 1391–402. doi:10.1007/978-3-319-22497-8_119 .

13-Bakacak Z, Bakacak M, Uzkar A, Yazar FM, Yaylalı A, Boran ÖF, etal . The efficacy of LigaSure™ open instruments in cases of cesarean hysterectomy due to placenta percreta: a retrospective, record-based, comparative study. J Matern Fetal Neonatal Med. 2021 Mar;34(6):960-965. doi: 10.1080/14767058.2020.1846177. Epub 2020 Nov 30. PMID: 33256477.

14- Lauroy A, Verhaeghe C, Vidal F, Parant O, Legendre G, Guerby P. Perioperative outcomes using LigaSure compared with conventional technique in peripartum hysterectomy. Arch Gynecol Obstet. 2020 Jan;301(1):229-234. doi: 10.1007/s00404-019-05398-0. Epub 2019 Nov 28. PMID: 31781886.

15-Rossetti D, Vitale SG, Bogani G, Rapisarda AM, Gulino FA, Frigerio L. Usefulness of vessel-sealing devices for peripartum hysterectomy: a retrospective cohort study. Updates Surg. 2015 Sep;67(3):301-4. doi: 10.1007/s13304-015-0289-0. Epub 2015 Mar 27. PMID: 25813428.

16-Turan OM, Shannon A, Asoglu MR, Goetzinger KR. A novel approach to reduce blood loss in patients with placenta accreta spectrum disorder. J Matern Fetal Neonatal Med. 2021 Jul;34(13):2061-2070. doi: 10.1080/14767058.2019.1656194. Epub 2019 Aug 27. PMID: 31455134.

17-Cojocaru L, Lankford A, Galey J, Bharadwaj S, Kodali BS, Kennedy K, etal . Surgical advances in the management of placenta accreta spectrum: establishing new expectations for operative blood loss. J Matern Fetal Neonatal Med. 2022 Dec;35(23):4496-4505. doi: 10.1080/14767058.2020.1852213. Epub 2020 Dec 3. PMID: 33272057.

18- Hiramatsu Y. Cesarean Hysterectomy for Placenta Previa Accreta Using Retrograde Abdominal Hysterectomy Approaching from the Posterior Vaginal Wall. Surg J (N Y). 2021 Oct 12;7(Suppl 1):S38-S45. doi: 10.1055/s-0041-1728752. PMID: 35036546; PMCID: PMC8752194.

19-Simonetti FM, Algeri P, Ferrante I, Pirola S, Carnelli M, Patanè L, etal . Placenta Accreta Spectrum Disorders: How to reduce maternal transfusion? A center experience on extraperitoneal retrograde hysterectomy. Eur J Obstet Gynecol Reprod Biol. 2023 Aug;287:148-154. doi: 10.1016/j.ejogrb.2023.06.012. Epub 2023 Jun 14. PMID: 37336161.

20- Vuong ADB, Pham TH, Pham XTT, Truong DP, Nguyen XT, Trinh NB, etal . Modified one-step conservative uterine surgery (MOSCUS) versus cesarean hysterectomy in the management of placenta accreta spectrum: A single-center retrospective analysis based on 619 Vietnamese pregnant women. Int J Gynaecol Obstet. 2024 May;165(2):723-736. doi: 10.1002/ijgo.15220. Epub 2023 Nov 27. PMID: 38009657.

21- Holcomb JB, Tilley BC, Baraniuk S, Fox EE, Wade CE, Podbielski JM, etal . PROPPR Study Group. Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. JAMA. 2015 Feb 3;313(5):471-82. doi: 10.1001/jama.2015.12. PMID: 25647203; PMCID: PMC4374744.

22. JauniauxE, Ayres-de-CamposD, Langhoff Roos J, Fox KA, Collins S. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO classification for the clinical diagnosis of placenta accreta spectrum disorders. Int J Gynaecol Obstet 2019;146: 20–4.

23- Collins SL, Alemdar B, van Beekhuizen HJ, Bertholdt C, Braun T, Calda P, etal . International Society for Abnormally Invasive Placenta (IS-AIP). Evidence-based guidelines for the management of abnormally invasive placenta: recommendations from the International Society for Abnormally Invasive Placenta. Am J Obstet Gynecol. 2019 Jun;220(6):511-526. doi: 10.1016/j.ajog.2019.02.054. Epub 2019 Mar 5. PMID: 30849356.

24-Marcellin L, Delorme P, Bonnet MP, Grange G, Kayem G, Tsatsaris V, etal . Placenta percreta is associated with more frequent severe maternal morbidity than placenta accreta. Am J Obstet Gynecol. 2018 Aug;219(2):193.e1-193.e9. doi: 10.1016/j.ajog.2018.04.049. Epub 2018 May 5. PMID: 29733839.

25- Kingdom JC, Hobson SR, Murji A, Allen L, Windrim RC, Lockhart E, etal . Minimizing surgical blood loss at cesarean hysterectomy for placenta previa with evidence of placenta increta or placenta percreta: the state of play in 2020. Am J Obstet Gynecol. 2020 Sep;223(3):322-329. doi: 10.1016/j.ajog.2020.01.044. Epub 2020 Jan 30. PMID: 32007492; PMCID: PMC8725207.

26-Takeda S, Takeda J, Murayama Y. Placenta Previa Accreta Spectrum: Cesarean Hysterectomy. Surg J (N Y). 2021 May 25;7(Suppl 1):S28-S37. doi: 10.1055/s-0040-1721492. PMID: 35036545; PMCID: PMC8752195.

27-Belfort MA, Shamshiraz AA, Fox K. Minimizing blood loss at cesarean-hysterectomy for placenta previa percreta. Am J Obstet Gynecol. 2017 Jan;216(1):78.e1-78.e2. doi: 10.1016/j.ajog.2016.10.030. Epub 2016 Oct 27. PMID: 27984036.

28- Saha PK, Bagga R, Kalra JK, Arora A, Singla R, Suri V, etal . An alternate surgical approach to reduce hemorrhage and complications during cesarean hysterectomy for adherent placenta. Eur J Obstet Gynecol Reprod Biol. 2018 Sep;228:215-220. doi: 10.1016/j.ejogrb.2018.07.004. Epub 2018 Jul 4. PMID: 30007249.

To cite this article: Ahmed M. Ahmed, Aziza A. Negm, Dalia A. Nour, Nada K. Mohammed, Ashraf N. Elmantwe, Fatma F. Darwish. Retrospective Comparison between Ligasure Impact versus Conventional Methods in Elective Cesarean Hysterectomy for Placenta Accreta in Benha University Hospital. BMFJ XXX, DOI: 10.21608/bmfj.2025.409548.2588.