The Çepni modification: using bilateral vascular clamps during caesarean section for intrapartum hemorrhage, a randomized controlled trial

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Abstract

Objective: Our aim was to reduce blood loss during C-section through the intraoperative temporary occlusion of the bilateral uterine vascular bundles.

Material and Methods: This randomized controlled study included 99 singleton pregnant patients at 37 weeks of gestation or later, with normal fetal development and no obstetric complications, attending a university hospital. In the intervention group (n=45), bilateral occlusion of the uterine vascular bundles at their entry point to the uterus was performed using atraumatic Darmklemmen clamps after the delivery of the baby. In the control group (n=54), routine C-section was performed. Our primary outcome was the amount of blood loss, measured using the suction canister, gauze and abdominal mops and underpads after the operation, along with the comparison of preoperative and postoperative hemoglobin and hematocrit values. Our secondary outcomes were operative time, transfusion rate, maternal outcomes (including postoperative complications during follow-up), and neonatal outcomes.

Results: In the intervention group, blood loss measured in gauze, abdominal compress pads, underpads and total blood loss were significantly lower than in the control group (p=0.031, p=0.001, p=0.003, and p=0.010, respectively). The mean decrease in hematocrit value was 5.3±2.67% in the intervention group and 4.85±2.53% in the control group (p>0.05). Operative time and neonatal outcomes were similar between the two groups. No perioperative or postoperative complications were observed during follow-up.

Conclusion: Bilateral temporary occlusion of the uterine vascular bundles using atraumatic clamps was a feasible and safe technique for reducing blood loss during cesarean section without adverse maternal and neonatal outcomes. Trial registration number and date of registration: NCT05948436- July 10, 2023 [J Turk Ger Gynecol Assoc.2025; 26(2): 73-81]

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Introduction

Obstetric hemorrhage, the most common obstetric complication, occurs in 1-3% of births and accounts for 25% of pregnancy-related maternal deaths (1). Although the World Health Organization (WHO) recommends limiting the cesarean section rate to 10-15 per 100 live births, global cesarean section rates continue to rise (2). The classic definition of postpartum hemorrhage is an estimated blood loss (EBL) exceeding 500 mL following vaginal delivery and 1000 mL following cesarean section. Cesarean delivery increases the risk of obstetric hemorrhage compared to vaginal delivery. However, in 2017, the American College of Obstetricians and Gynecologists revised this definition of blood loss to: an EBL of ≥1000 mL, regardless of delivery mode, or blood loss accompanied by symptoms of hypovolemia within 24 hours of delivery (3).

The incidence of severe postpartum hemorrhage has risen due to an increased risk of placenta previa and placenta accreta spectrum, conditions strongly associated with rising cesarean section rates, which currently account for 18.6% of all deliveries (4). To date, no cesarean section technique has been found to be superior in reducing uterine bleeding (5). Pharmacological, mechanical, and surgical methods can be employed to minimize uterine bleeding (6). Surgical approaches, performed after placental delivery, include compression sutures, bilateral uterine artery ligation, hysterectomy, and pelvic tamponade. However, permanent vessel ligation can lead to complications, such as uterine synechiae following uterine artery ligation (7) and ischemic complications, like buttock and bladder necrosis after internal iliac artery occlusion (8). Therefore, new and less invasive methods are necessary to reduce postpartum hemorrhage-related morbidity and mortality during cesarean section.

At term, uterine blood flow reaches to 600-900 mL/minimum (min), accounting for approximately 10% of cardiac output (9). Following delivery through a Munro-Kerr incision during cesarean section, reducing uterine blood flow from the uterine arteries is crucial to prevent intra- and postpartum bleeding. Therefore, the aim of this study was to decrease intraoperative bleeding during classical cesarean section by temporarily occluding the bilateral uterine vascular bundles with atraumatic clamps externally after the baby was delivered.

Material and Methods

This study was designed as a randomized controlled trial following the CONSORT guidelines. It was registered on clinicaltrials.gov.tr with the NCT number of NCT05948436. The full trial protocol can be accessed at https://clinicaltrials.gov/study/NCT05948436.

The study was approved by the Ethics Committee of Cerrahpaşa Faculty of Medicine, İstanbul University-Cerrahpaşa Ethics Committee (approval number: 37612, date: 04/02/2020).

Pregnant patients requiring cesarean section who met the inclusion criteria were enrolled between July 2023 and September 2023. Patients were randomly allocated into two groups (intervention and control) using a 1:1 ratio. Detailed information about the procedure was provided, and informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Demographic characteristics, including age, gestational age, gravidity, parity, mode of previous deliveries, and maternal comorbidities, were recorded. In addition, preoperative, intraoperative and postoperative parameters, including (EBL, mL, gr) were recorded.

The EBL was determined using the gravimetric method. All gauzes, abdominal mops (used from the initial uterine incision until peritoneal cavity closure), and underpads (placed under the patient before surgery and removed at the end of the operation) were weighed and their tare weight was subtracted. The weights were measured in each case after the patient was removed from the operating table and taken to the recovery area. Standardized gauzes and abdominal mops were used, and measurements were taken using a precision balance capable of measuring to two decimal places (10). Blood loss in the suction canister was measured in grams and milliliters. To prevent bias due to amniotic fluid contamination, suctioning was performed before the delivery of the baby, and blood loss measurements were taken afterward. Preoperative (measured the day before surgery) and postoperative (measured the day after surgery) hematocrit and hemoglobin levels, as well as systolic and diastolic blood pressure values, were recorded. Patients were followed until discharge, which occurred on the second postoperative day.

Participants

Nulliparous pregnant patients at 37 weeks of gestation or above, with normal fetal development, no obstetric complications and scheduled for cesarean section were included in the study. The indications for cesarean section included malpresentation, cephalopelvic disproportion and non-reassuring fetal status. Patients with were excluded amniotic fluid volume abnormalities, multiple pregnancy, threatened preterm birth, preeclampsia, placenta previa, placental invasion anomalies and those with comorbidities, such as maternal obesity (body mass index >30 kg/m^2), cardiovascular disease, hypertension, or coagulation defects. Patients using anticoagulants for any indication were also excluded. Moreover, patients who underwent cesarean section during active labor, required general anesthesia, or had a history of previous uterine

surgery were also excluded. Furthermore, any patient in either the control or intervention group who required the use of compression sutures or other preventive measures for uterine atony was excluded.

Interventions

All surgical procedures were performed by the same team. A Pfannenstiel incision was used for the skin and a Munro-Kerr was used for the uterus in all patients. The control group underwent a routine cesarean section technique. In both groups, patients received 15 units of intravenous oxytocin as a uterotonic agent, and compression forceps were applied to the uterine wound margins immediately after placental removal. In the intervention group, bilateral mechanical occlusion of the uterine vascular bundles was performed after the delivery of the baby but before placental extraction. This temporary mechanical occlusion was achieved using atraumatic Darmklemmen clamps, which were placed at the entry level of uterine vessels into the uterus, corresponding to the level of the Munro-Kerr incision. The pulsation of the vascular bundle including both uterine artery and veins, was palpated before clamp placement to ensure accuracy. There was no specified angle for the clamps, but the clinical aim was to occlude all uterine vessels at the level of the Munro-Kerr incision. Once the Darmklemmen clamps were correctly positioned, the placenta was extracted, and the uterine incision was closed using a double-layer, non-locking technique with size 1 absorbable multifilament suture (Polyglactin 910). The duration of occlusion was recorded, and the clamps were subsequently removed. The surgical procedure was completed after hemostasis was achieved. The procedure is outlined in Figure 1.

Outcome measures

The primary outcome was the rate of blood loss measured by the suction canister, gauze and abdominal mops and underpads after the operation, as well as the comparison of preoperative and postoperative hemoglobin and hematocrit values. Our secondary outcomes included operative time, transfusion rate, maternal outcomes, including postoperative complications during follow-up, and neonatal outcomes.

Sample size

The sample size was calculated with G*Power 3.1.9.7. Based on the data of the study conducted by Daggez et al. (11) with an effect size of 0.6, margin of error $\alpha=0.05$, power of the study (1-β) of 0.8 and the sample size was determined as 90, with 45 in each group.

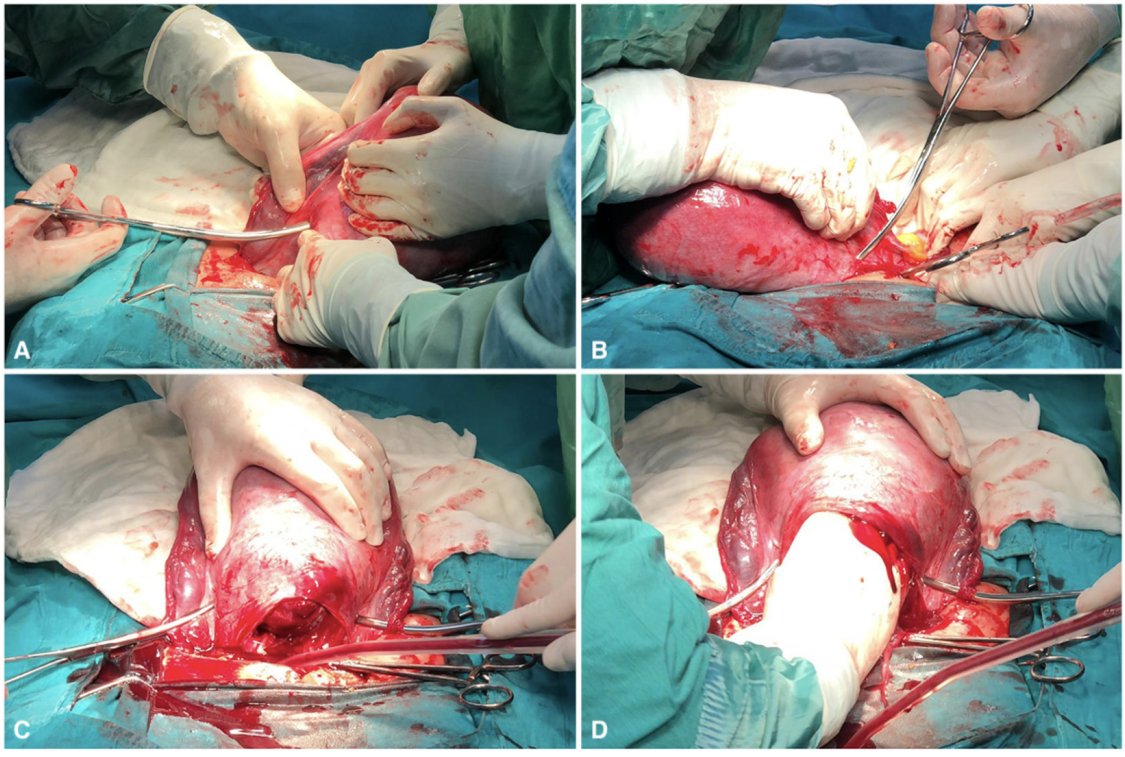

Figure 1. The steps of the Çepni technique during caesarean section: (1) Pfannenstiel incision; (2) Munro-Kerr incision and delivery of the fetus; (3) Temporary exteriorization of the uterus from the abdominal cavity; (4) The bilateral placement of the Darmklemmen clamps to the uterine vascular bundles at the level of Munro-Kerr incision which corresponds to the entrance level of the vessels to the uterus (A, B); (5) The extraction of the placenta (C, D); (6) The double-layer closure of the uterine incision; (7) The removal of the Darmklemmen clamps and control of any injury to the vessels; (8) Bleeding control

Randomization

Patients were randomized in a 1:1 ratio into either the intervention or control group based on their admission order, following a predetermined alternating sequence (first patient to intervention, second to control, third to intervention, and so on). However, to avoid losing participants, patients who declined the intervention were re-assigned to the control group, and recruitment continued until the target sample size for the intervention group (n=45) was reached.

Statistical analysis

Statistical Package for the Social Sciences for Windows, version 21.0 was used for data evaluation and analysis (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies (n) and percentages (%), and numerical variables are presented as the mean ± standard deviation (SD) and median (Q1-Q3). The Shapiro-Wilk test and Kolmogorov-Smirnov test were applied for normality analysis. The chi-square test and Fisher's exact test were used to compare the distribution of the categorical variables between groups. The independent samples-t test and Mann-Whitney U test were used to compare continuous variables between two independent groups. Spearman's correlation was used to assess the relationship between two continuous variables. Finally, a multivariate linear regression analysis was conducted to identify the risk coefficients of the factors for total bleeding. A $p<0.05$ was accepted as statistically significant.

When calculating the EBL, the amount of bleeding measured in mL at the suction canister was multiplied by the density of the blood to standardize the results in terms of units (12).

Results

After 114 patients were assessed for eligibility, 15 patients were excluded because they entered the active phase of labor or required general anesthesia. In total, 99 patients were randomized. Recruitment continued until the required number of patients was achieved in the intervention group, as per the calculated sample size (Figure 2). Of the patients, 54.5% (n=54) were in the control group, and 45.5% (n=45) were in the intervention group (Figure 2). No patients experienced massive

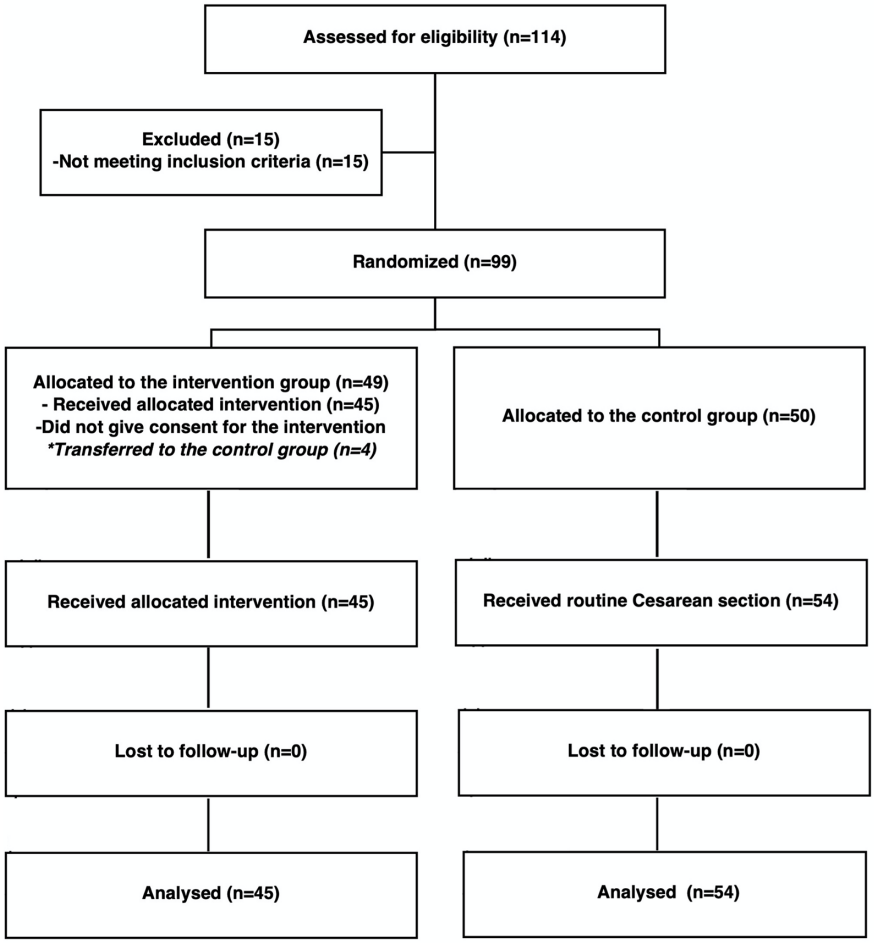

Figure 2. The flow diagram

uterine bleeding that required additional interventions. No patients were lost to follow-up. Recruitment lasted from July 10, 2023 to September 30, 2023. The trial was concluded when the target number of patients was reached.

The demographic and clinical characteristics of both groups are shown in Table 1. Age, gravidity, parity, previous number of deliveries, presence of maternal disease and gestational week were similar between the two groups. The mean age was 30.26±5.67 years in the control group and 29.82±6.35 years in the intervention group.

Pre-, peri- and postoperative parameters are shown in Table 2. All the patients had regional anesthesia. The median dose of intravenous oxytocin was 15 units in both groups (p=0.376). Although not significant, more patients required methylergonovine in the control group (11.1% vs. 8.9%). Not other uterotonic agent, such as carbetosin or misoprostol, were used. The mean drop in hematocrit values was comparable between the two groups, as were the preoperative and postoperative hemoglobin and hematocrit values. While preoperative and postoperative systolic blood pressure and mean arterial pressure values were comparable between the two groups, preoperative and postoperative diastolic blood pressure values were significantly lower in the control group compared to the intervention group (76±10.99 mmHg vs. 81.33±12.11 mmHg, p=0.031 and 70.3±10.3 mmHg vs. 74.72±9.17 mmHg, p=0.048, respectively). No patients in the intervention group required blood transfusion, while two patients (3.7%) in the control group received blood transfusion. The median operative time was 40 (35-45) minutes across the entire cohort and was comparable between the two groups. The median duration of occlusion by the clamp was 11.5 (8-14) min. There was no statistically significant difference between the groups in terms of birth weight or APGAR scores at the 1st and 5th minute. No perioperative or postoperative complications were observed in any patient after the removal of the clamps and during follow-up.

In the intervention group, except for the amount of blood in the suction canister, the amount of bleeding in the gauze, abdominal mops, underpads and total bleeding were significantly lower than in the control group (p=0.031, p=0.001, p=0.003, and p=0.010, respectively) (Table 3). In the intervention group, the median bleeding amounts were 63 g (45-108 g), 99 g (81-135 g), 153 g (126-180 g), 214.65 g (143.1-286.2 g) in the gauze, abdominal mops, underpads and suction canister, respectively. The median total bleeding amount was 535.5 g (437.4-781.2 g) in the intervention group. In the control group, the median bleeding amounts were 99.75 g (63-126 gr), 147 g (105-241.5 gr), 199.5 g (157.5-241.5 gr) and 255.99 g (187.82-389.55 gr) in the gauze, abdominal mops, underpads and suction canister, respectively. The median total bleeding was 728.7 gr (610.05-919.01 gr) in the control group.

There was no statistically significant correlation between total bleeding and preoperative hemoglobin and hematocrit levels. However, a weak negative correlation was observed between total bleeding and postoperative hemoglobin (r=-0.395, p<0.001) and hematocrit (r=-0.386, p<0.001) levels. A weak positive correlation was observed between total bleeding and the magnitude of drop in hemoglobin and hematocrit (r=0.360, p<0.001 and r=0.270, p=0.007). There was no significant correlation between total bleeding and duration of occlusion by the clamp (r=-0.239; p=0.119), whereas a significant correlation was observed between total bleeding time and total operative time (r=0.211; p=0.039).

Table 4 shows the linear regression analysis of the factors that affect total bleeding amount. The intervention and total operative time emerged as independent factors. The

Table 1. The demographic and clinical characteristics of the cohort

		Whole cohort		Control group (n=54; 54.5%)		Intervention group (n=45; 45.5%)		
		Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	p
Age (years)		30.06±5.97	29 (26-34)	30.26±5.67	29 (26-34)	29.82±6.35	30 (25-34)	0.719[a]
Gravidity		2.05±1.37	2 (1-2)	2.13±1.44	2 (1-2)	1.96±1.28	2 (1-2)	0.512[b]
Parity		0.7±0.95	0 (0-1)	0.83±1.06	1 (0-1)	0.53±0.79	0 (0-1)	0.127[b]
Gestational week		38.57±1.21	39 (38-39)	38.56±1.14	39 (38-39)	38.58±1.31	39 (38-39)	0.692[b]
Mode of previous delivery	**ND (n, %)**	11, 29.7 %		5, 22.7%		6, 40.0%		0.295[c]
	CS (n, %)	26, 70.3%		17, 77.3%		9, 60.0%		
Presence of maternal disease	**Absent (n, %)**	50, 50.5%		30, 55.6%		20, 44.4%		0.271[d]
	Present (n, %)	49, 49.5%		24, 44.4%		25, 55.6%		

[a]Independent sample-t test, [b]Mann-Whitney U test, [c]Fisher's exact test, [d]Chi-square test, ND: normal delivery, CS: Cesarean section, SD: Standard deviation

Table 2. Pre-, per- and postoperative parameters of the cohort

		Whole cohort		Control group (n=54; 54.5%)		Intervention group (n=45; 45.5%)		
		Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	p
Intravenous oxytocin (IU/mL)		15.91±2.71	15 (15-15)	15.93±2.19	15 (15-15)	15.89±3.25	15 (15-15)	0.376[a]
Need for methylergonovine	No (n,%)	89 (89.9%)		48 (88.9%)		41 (91.1%)		0.752[b]
	Yes (n,%)	10 (10.1%)		6 (11.1%)		4 (8.9%)		
Preoperative hemoglobin (g/dL)		11.69±1.27	11.8 (10.8-12.7)	11.77±1.26	12 (11.1-12.7)	11.59±1.29	11.7 (10.4-12.6)	0.477[c]
Postoperative hemoglobin (g/dL)		10.13±1.26	10 (9.3-11)	10.04±1.19	10.05 (9.1-10.9)	10.24±1.34	10 (9.5-11.2)	0.418[c]
Drop in hemoglobin (g/dL)		1.62±0.88	1.7 (0.9-2.1)	1.74±0.92	1.75 (1-2.4)	1.46±0.8	1.45 (0.8-2)	0.124[c]
Preoperative hematocrit (%)		35.1±3.34	35.4 (32.7-37.7)	35.16±3.31	35.4 (33.1-37.9)	35.01±3.41	35.2 (32.6-37)	0.824[c]
Postoperative hematocrit (%)		30.12±3.53	29.8 (27.9-32.2)	29.86±3.3	29.6 (27.8-32)	30.42±3.8	29.8 (28-32.7)	0.438[c]
Drop in hematocrit (%)		5.1±2.61	5 (3.3-6.7)	5.3±2.67	5.1 (3.3-7)	4.85±2.53	4.9 (3.1-6.6)	0.397[c]
Preoperative maternal SBP (mmHg)		122.11±13.16	121.5 (111-130)	120.68±14.1	120 (110-130)	123.67±12.02	125 (116-133)	0.284[c]
Postoperative maternal SBP (mmHg)		119.05±10.83	119 (111-126)	118.45±10.03	118.5 (112-124)	119.67±11.69	120 (110-127)	0.621[c]
Preoperative maternal DBP (mmHg)		78.54±11.78	80 (70-86)	76±10.99	77 (68-82)	81.33±12.11	82 (71-90)	0.031[c]
Postoperative maternal DBP (mmHg)		72.48±9.95	71 (66-80)	70.3±10.3	70 (65-75)	74.72±9.17	75 (70-80)	0.048[c]
Preoperative MAP (mmHg)		93.09±11.08	93.33 (84.67-101.33)	90.88±10.79	91.67 (84-96.67)	95.44±11.03	94.67 (87.67-104)	0.052[c]
Postoperative MAP (mmHg)		88.05±9.58	87.17 (82.17-95)	86.47±9.77	86.33 (80.67-91)	89.7±9.21	90.33 (83-97.33)	0.133[c]
Transfusion	No (n, %)	97 (98.0%)		52 (96.3%)		45 (100.0%)		0.499[b]
	Yes (n, %)	2 (2.0%)		2 (3.7%)		0 (0%)		
Operative time (min)		40.6±10.5	40 (35-45)	40.25±9.18	40 (35-45)	41.02±11.96	40 (35-50)	0.766[a]
Duration of occlusion by the clamp (min)		5±5.96	0 (0-10.5)	0±0	0 (0-0)	11.01±3.28	11.5 (8-14)	<0.001[a]
APGAR score (1 min)		7.48±1.31	8 (7-8)	7.5±1.31	8 (7-8)	7.47±1.32	8 (7-9)	0.852[a]
APGAR score (5 min)		8.76±0.92	9 (8-9)	8.78±0.88	9 (9-9)	8.73±0.96	9 (8-9)	0.667[a]
Birth weight (g)		3260.48±490.53	3305 (2955-3560)	3305.42±455.51	3330 (3060-3640)	3207.56±529.1	3265 (2950-3500)	0.328[c]

[a]Mann-Whitney U test; [b]Fisher's exact test; [c]Independent sample t test, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, Min.: Minute, SBP: Systolic blood pressure

intervention decreased total bleeding by 217 units when adjusted for operative time, age, preoperative hematocrit, and systolic blood pressure. When adjusted for group, age, preoperative hematocrit, and systolic blood pressure, each 1-minute increase in operative time increased total bleeding by 7.1 units.

Discussion

In the present study intraoperative bilateral temporary occlusion of the uterine vascular bundle was performed using atraumatic Darmklemmen clamps after fetal delivery. This procedure significantly reduced the amount of intraoperative and early postpartum bleeding during cesarean section.

Table 3. Estimated blood loss for the whole cohort

	All groups		Control group (n=54; 54.5%)		Intervention group (n=45; 45.5%)		
	Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	p[a]
Gauze (g)	93.95±59.28	84 (52.5-117)	105.58±63.56	99.75 (63-126)	80±50.96	63 (45-108)	**0.031**
Abdominal mops (g)	158.05±117.75	115.5 (90-189)	190.26±131.42	147 (105-241.5)	119.4±85.3	99 (81-135)	**0.001**
Underpads (g)	188.45±94.21	171 (126-220.5)	208.83±105.31	199.5 (157.5-241.5)	164±72.73	153 (126-180)	**0.003**
Amount of bleeding in suction canister (mL)	271.52±185.49	225 (135-367.5)	282.04±189.73	241.5 (177.19-367.5)	258.9±181.59	202.5 (135-270)	0.346
Amount of bleeding in suction canister (g)	287.81±196.62	238.5 (143.1-389.55)	298.96±201.12	255.99 (187.82-389.55)	274.43±192.48	214.65 (143.1-286.2)	0.346
Total (g)	728.28±329.85	665.49 (503.1-898.8)	803.64±361.36	728.7 (610.05-919.01)	637.83±264.01	535.5 (437.4-781.2)	**0.010**

[a]Mann-Whitney U test, mL: Milliliter, g: Grams, SD: Standard deviation

Table 4. The linear regression analysis of the factors affecting total bleeding amount

	B	95% CI	p
Group	-217.074	-355.596/-78.553	**0.003**
Operative time	7.094	0.466/13.723	**0.036**
Age	-3.145	-14.755/8.465	0.591
Preoperative hematocrit levels	-17.205	-39.036/4.626	0.121
Preoperative maternal systolic blood pressure	0.537	-4.861/5.935	0.844

CI: Confidence interval

Although the rate of postpartum hemorrhage has recently risen in developed countries, the rate of peripartum hysterectomy has decreased (13,14). This suggests that the prevention of peripartum hysterectomy due to postpartum hemorrhage is possible with improved facilities and surgical techniques. This new technique was developed to reduce the blood supply to the uterus, which is known to increase during the last weeks of pregnancy. Our technique reduced the total amount of bleeding without increasing the operative time, postoperative complications, and worsening maternal and neonatal outcomes. However, the drop in hemoglobin and hematocrit values and transfusion rates were not affected by using our technique. Sudden changes in hemoglobin and hematocrit values may not be evident immediately after a cesarean section due to the hemodynamic changes that occur as pregnancy ends. The resolution of edema, changes in heart rate, stroke volume, and other factors all affect the hemodynamic stability of patients. Therefore, the decrease in intraoperative total bleeding may not be reflected in postoperative hemoglobin and hematocrit values.

This is the first study where the uterine vascular bundles were temporarily clamped during a cesarean section to reduce the amount of bleeding. There are studies describing the clamping of the internal iliac artery in patients diagnosed with abnormal placental invasion (11,15,16). In the study of Yang et al. (15), clamping was performed after fetal delivery. Although it was shown to reduce the amount of bleeding in cases of placenta increata, its benefit was limited for cases of placenta percreta. Like our technique, Daggez et al. (11) temporarily clamped the internal iliac artery after the delivery of the baby but before the extraction of the placenta and found that the amount of bleeding was reduced in cases with abnormal placental invasion. In contrast, our aim was to reduce the amount of bleeding by clamping the uterine vascular bundle in uncomplicated cesarean sections of singleton pregnancies without any severe obstetric complications.

Ligating or occluding the internal iliac artery would diminish the blood supply to the uterine, cervical, and vaginal vessels due to its branching pattern. Since our goal was to reduce the blood supply to the uterus only, occlusion of the uterine artery would serve this purpose. Thus, we confirmed our hypothesis. In addition, dissection and ligation of the internal iliac artery are complicated procedures that require expertise compared to the clamping of the uterine vascular bundle. In their meta-analysis, which included 795 patients with placenta accreta spectrum, Nabhan et al. (17) concluded that uterine artery ligation significantly reduced the amount of bleeding, while internal iliac artery ligation did not have any significant effect. In the present study, the amount of bleeding was significantly reduced by uterine vascular bundle clamping in elective cesarean sections. The advantage of our technique is that the clamping could be performed temporarily without

requiring dissection, thus avoiding the risk of complications, such as vascular injury. No perioperative and postoperative complications were observed. However, since the success of our technique is highly dependent on the experience of the surgeon, a firm conclusion could only be drawn after more data using this technique becomes available when carried out by other surgical teams and in different populations.

Postpartum hemorrhage is associated with high mortality and morbidity. Since the surgical management of postpartum hemorrhage requires expertise, patients at high risk for bleeding, such as those with placenta accreta spectrum, are recommended to be operated on by gynecological oncologists (9). The occurrence of peripartum and postpartum hemorrhage is, however, unpredictable and can occur not only in high-risk pregnant patients, but also in uncomplicated pregnancies. Therefore, our aim was to reduce intraoperative and early postpartum bleeding with a simple technique that may be performed by any obstetrician without the presence of a gynecological oncologist. However, the success of this technique should also be confirmed in cases with placenta previa and placental invasion anomalies. Even though no cases of thromboembolism were observed, to avoid the complications of prolonged clamping, the optimum duration of clamping should be investigated in animal studies by observing the histological effects and inflammatory responses on a molecular level, in the artery and vein.

The method for measuring EBL during cesarean section is controversial. Various quantitative and semi-quantitative methods have been published, including disposable visual estimation, direct measurement, the gravimetric technique, spectrophotometry, dye dilution technique, radioactive tracer injection, shock-index method, red blood cell counts, and hemoglobin levels (18,19). We opted for the gravimetric technique due to the resources available to us. Previous research has validated this method, demonstrating a correlation with actual EBL (10). Towards the end of pregnancy, maternal adaptation leads to increased blood flow in the uterine arteries, reaching rates of 600-900 mL/min. In light of this, uterine vascular bundle clamping was anticipated to reduce blood loss, which our findings support. However, it will be important to confirm the results of our study with other methods to ascertain the accuracy of blood loss determination.

Study limitations

The strengths of our study include the sufficient sample size to power the study, randomized design, and objective methods for measuring total bleeding. Moreover, we made sure to perform the clamping after the fetus was delivered to avoid any fetal complications. To avoid bias, all surgeries in the study were performed by the same team for planned and uncomplicated cesarean sections (20). However, since the success of this technique is highly dependent on the skill of the surgeon, we could have designed this study as a multi-center project and compared the results of different groups to generalize our findings.

Conclusion

We demonstrated that Çepni modification of cesarean section is safe and effective in reducing the amount of intraoperative and early postpartum bleeding during caesarean section without adverse maternal and neonatal outcomes. Bilateral temporary occlusion of uterine vascular bundle by atraumatic Darmklemmen clamps may be routinely performed as a prophylaxis for intra- and early postpartum hemorrhage in uncomplicated cesarean sections. We believe this technique will reduce postpartum bleeding and, consequently, the rate of peripartum hysterectomy, as well as maternal morbidity and mortality.

Ethics

Ethics Committee Approval: *The study was approved by the Ethics Committee of Cerrahpaşa Faculty of Medicine, İstanbul University-Cerrahpaşa ethics committee (approval number: 37612, date: 04/02/2020).*

Informed Consent: *informed consent was obtained from all participants in accordance with the Declaration of Helsinki.*

Footnotes

Author Contributions: *Surgical and Medical Practices: İ.Ç., K.H.C., İ.B.Ö.E., R.M., K.P.Ö., Concept İ.Ç., Design: İ.Ç., Data Collection or Processing: K.H.C., İ.B.Ö.E., B.Y.Ö., E.Ö., A.M., Analysis or Interpretation: U.S., Literature Search: R.M., K.P.Ö., Writing: İ.Ç., K.H.C.*

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