# Uterine artery Color Doppler Parameters after Bilateral Uterine Artery Ligation for Postpartum Hemorrhage

Original Article

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## ABSTRACT

**Introduction:** Bilateral uterine artery ligation (BUAL) is the most popular surgical procedures for quick management of intrapartum hemorrhage (IPH) or postpartum hemorrhage (PPH). We established this study to evaluate the uterine artery (UtA) color doppler parameters after BUAL for PPH.

**Materials and Methods:** This prospective cohort case control study was conducted on 70 women aged between 20 and 35 years old. Cases were classified into two equal groups, study group: cases underwent BUAL after PPH after caesarean section resistant to medical treatment and did not need to hysterectomy, control group: who underwent normal caesarean section without IPH or PPH. Follow up of doppler parameters,1st day,1 week,6 months, and 12 months of BUAL.

**Results:** In study group, color doppler of UtA diameters as resistance Index, UtA pulsatility Index, UtA peak systolic velocity, right and left UtA end diastolic velocity, and right and left ovarian volume of both right and left sides were significantly higher after 1week, and 6 months ,12months compared to 1 day of BUAL (*P value*<0.001). After 24 months, there was 24 women seek to be pregnant in study group while 24 women seek to be pregnant in control group, 70.83% of women get pregnant in the study group, compared to 80% of women get pregnant in the control group. (*P*=0.753)

**Conclusion:** BUAL did not impact color doppler parameters measurements after12 month of follow up, so this surgical management should be used for preserving fertility and avoid hysterectomy in women experiencing PPH.

**Key Words:** Intrapartum hemorrhage, postpartum hemorrhage, uterine artery ligation, uterine artery revascularization.

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## INTRODUCTION

Obstetric hemorrhage is the main reason of maternal death in both countries with high and poor incomes. most these death occurred within the first 24 hours following birth[1]. Placenta accrete, retained placenta, genital tract lacerations, uterine rupture, and coagulation abnormalities are established risk factors for PPH[2]. The management of IPH and PPH relies on numerous considerations: type of delivery (vaginal or caesarean delivery), bleeding etiology (uterine atony, trauma, retained placenta) and hemodynamic stability[3].

In the first stage, early identification, and treatment with uterotonics, suturing the lacerations, and fundal massage are crucial[4]. When bleeding persist, even in the aggressive medical treatment, suitable surgical intervention should be performed[5]. Surgical therapy relies on the patient's desire to maintain fertility, the severity of the bleeding, and the surgeon's experience[6].

Historically, peripartum hysterectomy was the only available management to prevent PPH but in some instances, hysterectomy alone is insufficient to control the bleeding[7]. Also, the desire to preserve fertility have resulted in the development of other techniques, such as pelvic embolization and internal iliac artery ligation (IIAL) and bilateral uterine artery ligation (BUAL)[8].

BUAL is the most popular surgical procedure for quick management of PPH[9]. It may be performed alone or with conjugation with other PPH methods in with success rate exceeds 90 %[10]. Recanalization is a natural process that may occur following vascular structure closure with a suture or radiological embolization[11]. On magnetic resonance angiography conducted six months post-operatively, this recanalization was seen in 90% of patients[12].

There is a paucity of studies that have discussed the outcomes of BUAL on uterine artery (UtA) recanalization and doppler parameters after PPH and IPH[13,14]. Therefore,

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we established this study to assess UtA color doppler parameters after BUAL for PPH.

## MATERIALS AND METHODS

This prospective cohort case control research was established on 70 women aged between 20 and 35 years old. Cases were classified into two equal groups, study group: cases underwent BUAL as the sole surgical technique for the hemorrhage because he was refractory to medicinal treatment after caesarean section resistant to medical treatment and did not need to hysterectomy, control group: who underwent normal caesarean section without IPH or PPH. The research was conducted after approval from the Ethical Committee of Faculty of Medicine at Obstetrics and Gynecology department in Tanta University Hospital, Egypt (Approval code 35873/9/22) and registration of clinicaltrials.gov (ID: NCT05584995) between August 2020 to August 2022. All patients were given their informed written consent.

Patients with male factor, tubal factor, absence of lactation, diabetes mellitus, hypertension, morbid obesity, autoimmune disease, or vascular disease in the history, smoking, intrauterine growth restriction in previous pregnancies history, detection of a uterine anomaly or a medical condition, as well as administration of a hormonal treatment during the study, and uncontrolled bleeding needed for hysterectomy were excluded.

PPH was classified as blood loss over 1 liter. PPH is considered intractable if it persists despite of traditional medical treatment (methylergonovine maleate, oxytocin, and misoprostol), and bimanual compression.

Patients were classified into two equal groups control group: who gave delivery without complications throughout the same time and matched the study's inclusion criteria, case group: cases underwent BUAL after PPH or IPH after caesarean section.

All patients underwent the following: demographic data, clinical examination, and laboratory investigations.

Color Doppler parameters for measuring the UtA diameters as resistance Index (RI (, UtA pulsatility Index (PI), UtA peak systolic velocity (PSV), right and left UtA end diastolic velocity (EDV), and right and left ovarian volume of both right and left sides after 1st day, 1week, 6-month and12 month of BUAL were recorded.

### *Treatment course*

In cases of PPH, the first therapy was involved uterine massage and the uterotonic drugs (oxytocin and methylergonovine) were administrated. Intravenous (IV) oxytocin was supplied at 200 cc/hour after adding 40 U to 1000 cc of saline at a rate of 200 cc/hour. 0.2 mg of methylergonovine was injected intramuscularly and intramyometrially (if not hypertensive). When medicinal therapy was insufficient, surgical procedures were used, and BUAL was the most prevalent surgery. Depending on the requirements of the patients, blood transfusions, plasma expanders, and fibrinogen were provided.

### *Bilateral Uterine Artery Ligation Technique*

All uterine surgeries were conducted by externalizing the uterus as much as possible and holding it by the fundus. The BUAL was done using absorbable suture no. 1 Vicryl (Vicryl 1, Ethicon, France, Neuvilly-sur-Seine, France) was placed through an avascular space in the broad ligament and tied from the anterior to posterior aspects of the myometrium 2–3 cm medial to the descending portion of the uterine vessels. In all patients, the suture was carried from the anterior to the posterior at 1 cm to the myometrium medial to the UtA and was knotted after passing it through the avascular region at 1 cm to the wide ligament section adjacent to the uterus in both sides. All patients were examined for uterotonics during and after the surgery. The ovarian arteries were assessed at the level of the ovarian hilum.

### *Doppler scanning*

After 1 day, 1 week, 6 months, and 12 months of standard follow-up, the patients had ultrasonographic assessment for UtA size and color Doppler assessments. The Voluson© P6 Doppler ultrasound device (GE Healthcare, Waukesha, WI) with transvaginal (5 MHz) probe for imaging a pulsed Doppler system was used to analyze blood flow. The ascending branch of the UtA on the left and right sides of the uterine isthmus was identified by means of colour flow imaging to obtain uterine arterial blood flow velocity vaveforms. Standardized ultrasound settings included a pulse repetition. Frequency of 1.3 kHz for the uterine and ovarian arteries and 1.1 kHz for the spiral artery assessed the minimal flow velocity of 5 cm/sec. Using an endovaginally probe, transverse and sagittal imaging of the uterus and ovaries were conducted by the same technique. Color Doppler was used to evaluate the spiral arteries within a 1-mm area parallel to the myometrium–endometrium border. The uterine artery's descending branches were measured at the level of the internal os of the uterine cervix.

The sample volume was positioned on the artery at an angle of about 0 degrees. Five blood flow indicators were automatically generated after detection of blood flow and observation of the waveform of the UtA: the PI (PI=PSV-EDV/ TAMXV); RI (RI=PSV-EDV/ PSV); PSV, units of cm/s; and EDV, units of cm/s and time-averaged maximum (TAMXV) velocities. At least three successive blood flow velocity waveforms were assessed, and the right and left

UtA diameters were evaluated on a perpendicular B-mode view of the longitudinal vessel segment at maximal magnification. The lumen of the vessel was identified using colour power angiography, and its diameter was measured on a grayscale image by lowering the colour box and positioning the calipers at the specular reflection of the vessel's inner margins. All women were followed up till 24 m for evaluation of BUAL effect on pregnancy outcome.

### *Sample size*

G. power 3.1.9.2 (Universitat Kiel, Germany) was performed to calculate the sample size. The mean (±SD) of right ovarian volume was 6.46±1.34 in BUAL and 7.44±1.35 after six month according to a previous study[15]. 35 patients were allocated in each group based on the following: 95% confidence limit 80% power of the study, and effect size: 0.728.

### *Statistical analysis*

To conduct statistical analysis, SPSS v26 was used (IBM Inc., Chicago, IL, USA). Repeated measure ANOVA can be used to compare the mean and standard deviation (SD) of quantitative variables between two groups. Qualitative variables were presented as frequency (percentage) and were compared using the Chi-square test. Statistical significance was defined as two-tailed *P values* less than 0.05.

## RESULTS

Demographic data were insignificantly different between case and control groups (Table 1).

In study group, color doppler of UtA diameters as UtA RI, UtA PI, UtA PSV, UtA EDV, and right and left ovarian volume of both right and left sides were significantly higher after 1week, and 6 months ,12months compared to 1 day of BUAL (*P value*<0.001) (Table 2, Figures 2,3).

After 24 months, there was 24 women seek to be pregnant in study group while 24 women seek to be pregnant in control group, 70.83% of women get pregnant in the study group, compared to 80% of women get pregnant in the control group. (P=0.753). Women who become pregnant were insignificantly different between study and control group (Figure 1).

**Table 1:** Patient characteristics of the studied groups

| | | Study group (n=35) | Control group (n=35) | *P value* |
|---|---|---|---|---|
| Age (years) | | 27.57±4.92 | 28.31±4.2 | 0.499 |
| Weight (Kg) | | 73.2±7.92 | 72.17±7.04 | 0.568 |
| Height(m) | | 1.60±0.06 | 1.58 ±0.06 | 0.241 |
| BMI(Kg/m$^2$) | | 22.63±2.47 | 23.19±2.81 | 0.377 |
| Gestational age (weeks) | | 38.34±1.3 | 37.91±0.85 | 0.108 |
| Parity | | 2.17±0.75 | 2.03±0.86 | 0.460 |
| Parity | Primipara | 12(34.29%) | 28(80%) | 0.282 |
| | Multi para | 23(65.71%) | 7(20%) | |
| Mode of delivery | C.S | 28 (80 %) | 30 (85.7%) | 0.751 |
| | Vaginal delivery | 7 (20%) | 5 (14.3%) | |

Data presented as mean ± SD, frequency (%), BMI: body mass index. C.S: caesarean section

**Table 2:** Color doppler parameters of the case group in different periods of measurements

| | 1 day (n=35) | 1week (n=35) | 6 months (n=35) | 12 months (n=35) | *P Value* |
|---|---|---|---|---|---|
| Right UtA RI | 0.34±0.04 | 0.74±0.07 | 0.61±0.05 | 0.48±0.03 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left UtA RI | 0.33±0.02 | 0.76±0.04 | 0.56±0.05 | 0.46±0.05 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Right UtA diameter | 1.03±0.02 | 1.52±0.04 | 1.41±0.05 | 1.14±0.04 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left UtA diameter | 1.13±0.02 | 1.53±0.03 | 1.42±0.05 | 1.23±0.06 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Right UtA PI | 0.80 ±0.04 | 1.73±0.03 | 1.34±0.11 | 1.02±0.05 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left UtA PI | 1.15±0.02 | 1.74±0.03 | 1.43±0.05 | 1.26±0.04 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Right UtA PSV | 14.28±2.42 | 53.42±1.44 | 39.72±2.57 | 26.81±3.86 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left UtA PSV | 15.41±1.98 | 56.47±3.54 | 41.72±3.74 | 28.51±3.75 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Right UtA EDV | 5.56±0.59 | 21.92±1 | 15.37±1.89 | 6.48±0.56 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left UtA EDV | 6.06±0.25 | 22.6±1.44 | 15.32±1.69 | 6.61±0.63 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Right ovarian volume | 4.6±0.05 | 6.99±0.26 | 5.75±0.26 | 4.86±0.08 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |
| Left ovarian volume | 4.69±0.05 | 7.13±0.43 | 5.74±0.26 | 4.94±0.09 | P1 <0.001*<br>P2 <0.001*<br>P3 <0.001* |

UtA: Uterine artery. RI: resistance index, PI: pulsatility index, PSV: peak systolic velocity, EDV: end diastolic velocity, P1: P value between 1day and 1week, P2: P value between 1day and 6 months, P3: P value between 1day and 12 months.

**Table 3:** Color doppler parameters between control and case group after 12 months.

| | study group (after 12 months) (n=35) | Control group (n=35) | *P Value* |
|---|---|---|---|
| Right UtA RI | 0.74±0.07 | 0.77±0.07 | 0.149 |
| Left UtA RI | 0.72±0.04 | 0.74±0.05 | 0.077 |
| Right UtA diameter | 1.52±0.04 | 1.51±٠,٠5 | 0.611 |
| Left UtA diameter | 1.53±0.03 | 1.54±0.03 | 0.091 |
| Right UtA PI | 1.73±0.03 | 1.74±0.04 | 0.487 |
| Left UtA PI | 1.74±0.03 | 1.75±0.03 | 0.462 |
| Right UtA PSV | 53.42±1.44 | 54.13±1.68 | 0.064 |
| Left UtA PSV | 56.47±3.54 | 58.05±3.42 | 0.061 |
| Right UtA EDV | 21.92±1 | 22±1.09 | 0.761 |
| Left UtA EDV | 22.6±1.44 | 23.03±1.45 | 0.217 |
| Right ovarian volume | 6.99±0.26 | 7.1±0.42 | 0.202 |
| Left ovarian volume | 7.13±0.43 | 7.2±0.45 | 0.513 |

UtA: Uterine artery. RI: resistance index, PI: pulsatility index, PSV: peak systolic velocity, EDV: end diastolic velocity, P value: between study group and control group

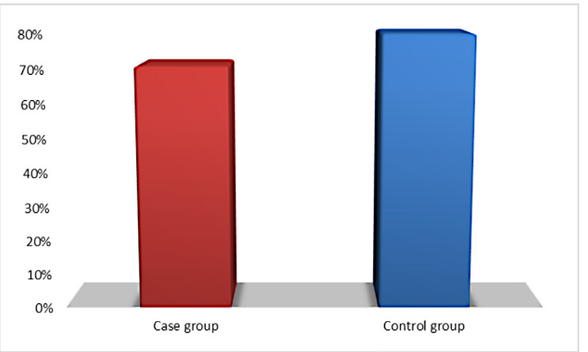


**Fig. 1:** Pregnancy outcome between both groups

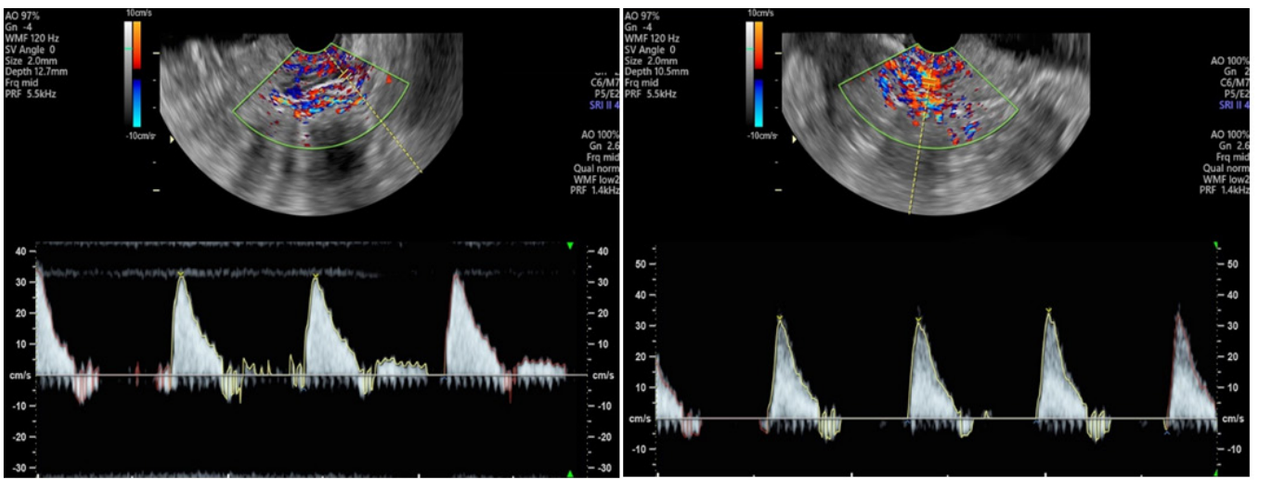

**Fig. 2:** Resistance index one year after BUAL

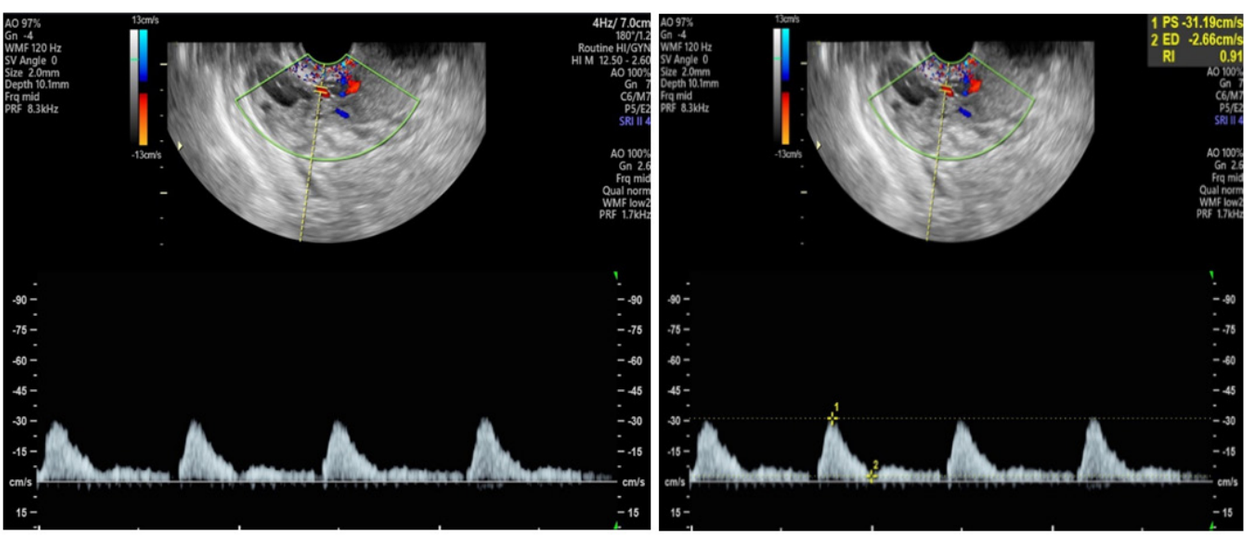

**Fig. 3:** Resistance index one week after BUAL

## DISCUSSION

PPH is a significant factor in maternal mortality and morbidity. When faced with uncontrolled PPH, doctors have limited alternatives[16]. Among these are IIAL and selective UtA embolization that can need laparotomy. Moreover, IIAL also has high failure rates. BUAL is the initial stage in a uterine devascularization strategy that can control bleeding in PPH patients, and it could be used prophylactically to minimize the incidence of PPH in high-risk cases with a high success rate and low risk of complications[17].

Our study showed that artery diameters measurements and blood flow by color doppler enhanced after one week, 6 months and12 months compared to the 1st measurements after one day. Artery diameters measurements in the study group at 12 months showed normal values with no significant difference with control group.

For at least three weeks, Vicryl is an absorbable synthetic suture material made of polyglactin polymer, which is resorbed in 60 to 90 days. This could explain why uterine blood flow was returned six months following surgery. The uterus collateral circulation ensures that the uterus is adequately nourished during this period. After this time, recanalization, and blood flow in the UtA should begin. Consequently, we re-evaluated the patients six months following the procedure, when the resorption of suture material has been occured, and compared color doppler characteristics with those of the control group.

In the postpartum phase, the UtA diameter and colour doppler parameters of the control group recover to their pre-pregnancy values. This resulted from the hormonal changes that boost blood flow during pregnancy returning to normal in the postpartum period, as well as vascular adaptation[15].

Similarly with our results,, Verit *et al*[9], reported that the blood flow to the UtA was not impaired following BUAL. Uterine blood flow is vital for advancing a receptive endometrium, embryo implantation, trophoblast invasion, and a successful pregnancy; thus, these findings are particularly critical for young women who are planning future pregnancies[18].

Sentilhes *et al*.,[19] stated that BUAL does not injure the uterus without eventual reproductive function inhibition in females with placenta accreta and can minimize intraoperative blood loss, PPH occurrence, and risk of complications such as hysterectomy[19].

Also, McLucas *et al*.,[20] who conducted a non-randomized, observational study of 89 women who received UAE and found that BUAL did not decrease uterine artery PI and RI values at 3 months after surgery. Also, other research has shown that PI and RI values in the UtA did not change following BIIAL[21,22].

Moreover, Greenwood *et al*[23], showed that patients who underwent BIIAL had no considerable change in the blood flow pattern of their uterine arteries compared to pre-procedure conditions, despite an increase in collateral flow.

On the other hand, Kaplanoglu *et al*[15] showed that following the BUAL technique, 6- and 12-month right and left UtA diameters were comparable between patient and control groups. with no difference between the right and left UtA diameters and color doppler parameters of the patient group. This may be due to a lack of long-term blood flow, particularly in the region distal to the ligated area, which can result in an adaptive reduction in diameter and the development of fibrosis in the region.

Finally, our present trial shown that BUAL did not impact ovarian blood flow, it was suggested that UAL should be utilized to prevent hysterectomy, making it one of the most essential treatments for preserving fertility in PPH patients. However, BUAL technique had some limitation as the UtA may be difficult to distinguish and ligate in the event of internal hemorrhage caused by a ruptured uterus.

Our study had some limitations as it is single-center study with small sample size. Few new pregnancies among patients may be attributable to either the short duration of the study or their consistent usage of contraception.

## CONCLUSION

BUAL is a simple and safe technique that did not impact color doppler parameters.Compared to the control group, the UtA parameters and percentage of women get pregnant in post-procedure follow-ups is comparable. Further studies are needed with larger sample size and long- term follow-up for these cases.

## CONFLICT OF INTERESTS

There are no conflicts of interest.

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