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Original Article

Evaluation of uterine artery recanalization and doppler parameters after bilateral uterine artery ligation in women with postpartum hemorrhage

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Abstract: Aim: The evaluation of the uterine artery recanalization rate and color Doppler parameters during follow-up after bilateral uterine artery ligation (BUAL) for postpartum hemorrhage (PPH) related to uterine atony. Material and method: A total of 40 female patients who underwent BUAL for PPH related to uterine atony and 96 females who gave birth without complication at Hatay Obstetrics and Gynecology Hospital between January 2009 and December 2012 (48 months) were included in the study. The patients' uterine artery recanalization rate and all subjects' color Doppler ultrasonographic parameters (PI, RI, PSV and EDV) were evaluated at the 6th and 12th months. Result: No statistically significant difference was found between the age, obstetric history (gravida and parity), BMI, type of delivery, birth weight and gestational age when the demographic data of the groups were evaluated. The patient group UtA recanalization rate was 32.5% and 37.5% for the left and right UtA respectively at the 12-month follow-up. No statistically significant difference was found in the comparison of 6- and 12-month right and left uterine artery diameters and color doppler parameters of the patient group (UtA diameters P=0.322 and P=0.787, RI index P=0.390 and P=0.094, PI index P=0.949 and P=0.374, PSV P=0.335 and P=0.085, EDV P=0.173 and P=0.418, respectively). However, right and left ovarian volume was found to significantly increase during follow-up in patient group (P<0.001 for both right and left ovary). On the other hand, a statistically significant difference was found between the patient group and the control group in the comparison of the 6- and 12-month right and left uterine artery values (6th month; P<0.001 for both UtA diameters, RI, PI, PSV, EDV; 12th month; P<0.001 for right UtA diameter, RI, PI, PSV, EDV and P=0.002 for left UtA diameter). A statistically significant difference was found only in right ovary volume in the 6th month evaluation of the patient and control group ovary volumes (P=0.011). Discussion: The recanalization rate and isolated uterine blood supply during low-term follow-up are low following the BUAL technique. The evaluation of future fertility results will be helpful in determining the reliability of this procedure in a definite manner.

Keywords: Postpartum hemorrhage, bilateral uterine artery ligation, recanalization, doppler parameters

Introduction

Postpartum hemorrhage (PPH) is a serious and life-threatening obstetric complication. The most common cause is uterine atony [1]. Known risk factors for the occurrence of atonic PPH include a history of PPH, history of retained placenta, placental abruption, placenta praevia, uterine fibroids, hydramnios, multiple pregnancies, augmentation of labour, prolonged labour and instrumental delivery. Other causes of PPH include lower genital tract lacerations and uterine rupture. However, no etiologic risk factor is identified in most cases [1, 2].

The conventional treatment for uterine atony is to initiate medical treatment containing uterotonic agents. Additional surgical interventions are used if medical treatment is not adequate. The desire of the patient to bear children, the amount of bleeding and the experience of the surgeon influence the surgical method selected and the result at this stage. The surgical treatment should primarily be an organ-sparing approach since the patients are in reproductive age group. The most widely used organ-sparing surgery involves selective uterine devascularization or embolization, bilateral iliac artery ligation (BIIAL), uterine compression sutures and

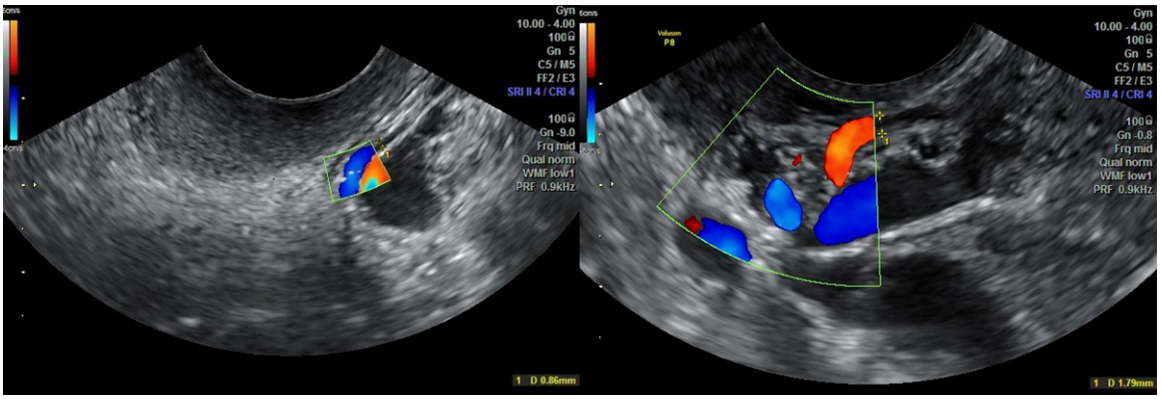

Figure 1. UtA diameters were measured on a perpendicular B-mode view of the longitudinal vessel section at maximum magnification. The lumen of the vessel was identified by colour power angiography and the diameter was measured on a gray-scale image after reducing the colour box by placing the calipers at the inner edges of the vessel itself at the specular reflection (Color doppler flow imaging and measurement of uterine vessel diameter for patient group in left side and for control group in right side).

various combinations [1, 2]. The basic aim is to decrease the uterine blood flow in the shortest time and stop the bleeding with minimum morbidity.

Uterine artery ligation is one of the most common surgical procedure for PPH as it is easy and quick. It can be used alone or with other methods in PPH with a high success rate. No negative effect has been found on routine pregnancy follow-up in the advanced stages of pregnancy. Recanalization is a natural process that may be seen after the ligation of a vascular structure with a suture or radiological embolization. Uterine artery recanalization has been radiologically studied, particularly after uterine artery embolization for uterine myomas. Such recanalization was found in 90% of the patients on magnetic resonance angiography at the post-operative 6th month [3]. However, literature data on the late post-BUAL period uterine artery recanalization rate and blood flow pattern are inadequate.

We evaluated the uterine artery recanalization rate and color Doppler ultrasonography data of patients who had undergone BUAL for uterine atony in this study.

Material and method

Patients who gave birth at Hatay Government Hospital, Department of Obstetrics and Gynecology between January 2009 and December 2012 were evaluated in the present study. A total of 40 patients who were diagnosed with PPH due to uterine atony resistant to medical treatment and who underwent successful BUAL for bleeding control were included in the study. The control group consisted of 96 patients who had given birth without complication during the same period and met the study criteria. The postpartum 6th and 12th month follow-up ultrasonographic data of the patients were recorded. Study approval was obtained from the Hatay Government Hospital Medical Ethics Committee.

Study group inclusion criteria were age 18-35 years, the presence of PPH related to uterine atony after spontaneous birth or cesarean section (CS), and having undergone BUAL as the only surgical procedure for the hemorrhage.

Exclusion criteria were the presence of diabetes mellitus, hypertension, autoimmune disease, morbid obesity, or vascular disease in the history; smoking or the use of alcohol, history of IUGR in previous pregnancies, detection of a uterine anomaly, the presence of additional surgery or a medical disease, and use of a hormonal treatment during the study.

Treatment course: The first step of the treatment consisted of uterine massage and the use of uterotonic agents (oxytocin and methylergonovine) in case of PPH. Oxytocin was administered IV at a rate of 200 cc/hour after adding 40 U to 1000 cc saline. Methylergonovine (Metiler®) was administered 0.2 mg IM and intramyometrial (if not hypertensive). Surgical methods were used in patients where medical

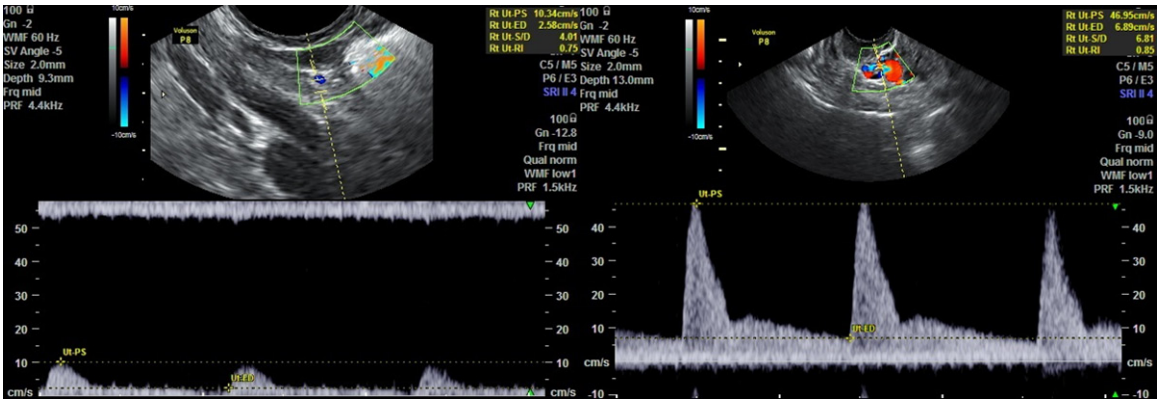

Figure 2. Uterine arterial blood flow velocity vaveforms were obtained by means of color flow imaging to identify the ascending branch of the uterine artery on the left and right sides of the uterine isthmus. For each examination, the mean value of three consecutive waveforms was obtained (Color doppler flow imaging for patient group in left side and for control group in right side).

treatment was inadequate and BUAL was the most common procedure. All patients were in the semi-lithotomy position during the BUAL procedure so that vaginal hemorrhage could be evaluated. A Pfannenstiel incision was performed. The patients were first evaluated for uterine rupture after spontaneous vaginal birth. All uterine procedures were performed by holding the uterus from the fundus and externalizing it as much as possible. BUAL was performed using no. 1 vicryl (Vicryl 1, Ethicon, France, Neuvilly-sur-Seine, France). Uterotonics were administered during and after the procedure in all patients.

The BUAL technique: Uterine artery ligation was performed at a level 2 cm below the uterine incision edge in CS patients and at the level of isthmus as much as possible in vaginal delivery patients. The suture was passed from the anterior to the posterior at a 1 cm distance to the myometrium medial to the uterine artery in all patients and was tied after passing it through the avascular area 1 cm away to the broad ligament section close to the uterus. The same procedure was performed on the other side. Uterine tonus and bleeding were controlled and the procedure was ended. The abdominal layers were then closed anatomically. An abdominal drain was not used in any patient.

Ultrasonographic evaluation: The patients underwent ultrasonographic evaluation for uterine artery dimension and color Doppler measurements at the 6th and 12th months of routine follow-up. Ultrasound with Color Doppler imaging evaluation was performed using a GE Medical Systems Voluson© P8 Doppler ultrasound instrument (GE Healthcare, Waukesha, WI), equipped with transvaginal (5 MHz) probe for imaging and a pulsed Doppler system for blood flow analysis. Uterine arterial blood flow velocity vaveforms were obtained by means of color flow imaging to identify the ascending branch of the uterine artery on the left and right sides of the uterine isthmus. The sample volume was placed on the artery with an angle of about 0°. After detection of blood flow and visualization of the waveform of the uterine artery, five blood flow indices were automatically calculated: the pulsatility index (PI) (PI=PSV-EDV/TAMXV); the resistance index (RI) (RI=PSV-EDV/PSV); the peak systolic velocity (PSV, units of cm/s); and the end-diastolic velocity (EDV, units of cm/s) and time-averaged maximum (TAMXV) velocities. At least three consecutive correctly imaged blood flow velocity waveforms were analysed, Both right and left UtA diameters were measured on a perpendicular B-mode view of the longitudinal vessel section at maximum magnification. The lumen of the vessel was identified by colour power angiography and the diameter was measured on a gray-scale image after reducing the colour box by placing the calipers at the inner edges of the vessel itself at the specular reflection. The average of three consecutive measurements of vessel diameter was used (**Figures 1**, **2**).

Statistical analyses

Statistics were performed using Statistical Package for the Social Sciences software version 13.0 (SPSS Inc., Chicago, Ill., USA).

Table 1. Demographic features and perinatal outcomes of the groups

	Group 1	Group 2	P
	n: 40	n: 96	
Age (years)	25.8±5.1	27.4±4.6	0.070
Gravida	3.6±1.4	3.2±1.4	0.143
Parity	2.3±1.4	2.1±1.3	0.591
BMI (kg/m^2)	29.4±2.5	30±2.1	0.134
Type of delivery			0.864
Cesarean Section (%)	35 (87.5)	85 (88.5)	
Normal Delivery (%)	5 (12.5)	11 (11.5)	
Birthwieght (gr)	3078.7±327.4	3135.7±305.1	0.332
Gestational age (weeks)	38.2±1.1	38.6±1.2	0.083

Group 1: patient group; Group 2: Control group; BMI: Body Mass Index.

Continuous variables were given in means ± standard deviations. Kolmogorov-Smirnov test was used to analyse the data distribution. Comparisons between two groups possessing normally distributed variables were performed with independent samples t test. Comparisons between 6th month and 12th month evaluation of each group parameters were performed with paired sample t test. The differences in two groups which do not show normal distribution were checked with Mann-Whitney U test. Groups comprising categoric variables were compared with Pearson Chi-Square test. The level of statistical significance was defined as P<0.05.

Results

A total of 18288 births took place in our clinic during the study period and our CS rate was 21.59%. PPH developed in a total of 451 patients (2.46%) according to hospital records. BUAL was used in 40 PPH cases where medical treatment had been unsuccessful. The CS rates in the patient and control group were 87.5% and 88.5% respectively. There was no statistically significant difference between the groups for demographic data. **Table 1** presents the demographic data of the patients. Similarly, there was no statistically significant difference between the groups for the birth weight and gestational week (P=0.332, P=0.083 respectively).

6th month evaluation of the groups

The right uterine artery was found to be recanalized in 15 (37.5%) patients and the left uterine artery in 13 (32.5%) patients in the patient group. A statistically significant difference was found between the uterine artery diameters of the patient group and control group (P≤0.001 for both sides). A statistically significant difference was also found between the PSV, EDV, RI and PI indexes of the groups in the evaluation of patient and control group color doppler parameters (P<0.001). There was a statistically significant difference between the patient and control group for the right ovarian volume (P=0.011) but not for the left ovarian volume (P=0.134) (**Table 2**).

12th month evaluation of the groups

There was no change in the right and left uterine artery recanalization rate in the patient group. The difference between the patient and control group for uterine artery diameter continued (P<0.01 for right UtA and P=0.002 for left UtA). A statistically significant difference was found between the groups for the PSV, EDV, RI and PI values of the right and left UtA in the evaluation of color Doppler parameters (P<0.001). There was no statistically significant difference between the patient and control groups for right or left ovarian volume (P=0.466, and P=0.595, respectively) (**Table 2**).

6th and 12th month evaluations of each group

There was no significant change in uterine artery diameters in the patient group (right uterine artery diameter P=0.322, left uterine artery diameter P=0.787). Similarly, no significant change was found between the color Doppler parameters of PSV (P=0.335 and P=0.085, respectively), EDV (P=0.173 and P=0.418, respectively), RI (P=0.390 and P=0.094, respectively) and PI (P=0.949 and P=0.374, respectively) for the right and left uterine artery. A statistically significant difference was found between the right and left uterine artery diameters of the control group (P=0.028 and P<0.001, respectively). A statistically significant difference was also found between the 6 months and 12 months color doppler parameters for the right and left UtA except for the right UtA RI value as follows: PSV (P=0.002 and P<0.001, respectively), EDV (P<0.001 and P<0.001, respectively), RI (P=0.201 and P<0.001, respectively), and PI (P=0.002 and P<0.001, respectively).

Table 2. Color doppler parameters of the groups

	6 months			12 months			
	Group 1	Group 2	P	Group 1	Group 2	P	P
Right UtA diameter	1.04±0.18	1.53±0.17	<0.001	1.21±0.15	1.48±0.17	<0.001	1. 0.322 2. 0.028
Left UtA diameter	1.22±0.12	1.52±0.12	<0.001	1.26±0.17	1.41±0.14	0.002	1. 0.787 2. <0.001
Right UtA RI	0.38±0.05	0.63±0.13	<0.001	0.43±0.08	0.62±0.14	<0.001	1. 0.390 2. <0.001
Left UtA RI	0.39±0.03	0.61±0.12	<0.001	0.43±0.04	0.66±0.11	<0.001	1. 0.094 2. <0.001
Right UtA PI	0.73±0.12	1.54±0.42	<0.001	1.06±0.33	1.68±0.15	<0.001	1. 0.949 2. 0.002
Left UtA PI	0.90±0.10	1.36±0.33	<0.001	1.02±0.29	1.65±0.25	<0.001	1. 0.374 2. <0.001
Right UtA PSV	10±2.67	56.68±6.33	<0.001	12.95±2.92	54.97±7.16	<0.001	1. 0.335 2. <0.001
Left UtA PSV	13.80±3.64	59.7±5.54	<0.001	11.52±2.69	56.75±5.75	<0.001	1. 0.085 2. <0.001
Right UtA EDV	5.57±0.56	20.33±9.0	<0.001	6.72±1.87	18.21±6.53	<0.001	1. 0.173 2. <0.001
Left UtA EDV	6.28±1.63	22.67±7.16	<0.001	6.03±1.61	19.19±6.98	<0.001	1. 0.418 2. <0.001
Right ovarian volüme	6.46±1.34	7.44±1.35	0.011	6.91±1.50	7.20±1.37	0.466	1. <0.001 2. <0.001
Left ovarian volume	7.03±2.42	7.73±1.41	0.134	7.18±2.37	7.51±1.30	0.595	1. <0.001 2. 0.154

Groups 1. patients group; Groups 2, control group. 1., statistically evaluation of 6-12 months between patients group; 2., statistically evaluation of 6-12 months between control group. RI, Resistance Index; PI, Pulsatility Index; PSV, Peak Systolic velocity; EDV, End diastolic velocity.

No new pregnancy was detected in the patients during the follow-up period.

Discussion

Uterine artery blood flow shows a significant increase during pregnancy. There is a 3.5 times increase in this flow in the late pregnancy period when compared with the pre-pregnancy period [4]. PPH causes rapid blood loss and can be fatal. Intervention for PPH should be efficient, early, and as quickly as possible. BUAL can be used successfully and does not require additional training or skill as for BIIAL. The main aim is to decrease the blood flow coming to the uterus. Uterine blood flow can be reduced up to 90% with BUAL [5]. On the other hand, adjacent organ injuries during the procedure are not very likely as the intervention is performed with the uterus externalized. The lower requirement for surgical experience, a low complication rate, and minimum intervention in pelvic anatomy are other important advantages.

BUAL was first identified in 1974 by O'Leary as a step of uterine devascularization. ACOG confirmed its use for similar purposes in 2006 [6, 7]. It was used in other areas as well as an easy and effective technique. However, the uterine artery can be difficult to detect and ligate in case of bleeding inside the broad ligament due to uterus rupture. BUAL is also usually inadequate for PPH due to placenta previa or cervical lacerations as A. vaginalis and cervical branches have a direct role in hemorrhages of this region and additional procedures such as BIIAL are necessary in these patients. Uterine artery embolization is another uterine artery intervention for PPH and a 90% success rate has been

reported with this procedure [8, 9]. An important advantage is that recanalization is obtained a few weeks later if absorbable material is used in the procedure. However, the need for technical equipment and a specialist are the most important restrictions [3].

Other organ-sparing surgical methods in addition to uterine devascularization are uterine compression suture and BIIAL. There are a large number of studies with high success rates in the literature. On the other hand, there were no significant effects on subsequent fertility results and the menstrual pattern on long-term follow-ups [10, 11].

A wide range of suture materials, most of them absorbable, are used in the surgery. Vicryl is an absorbable synthetic suture material consisting of polyglactin polymer and is used in our country. It provides tensile strength for recovery from injury for at least 3 weeks and is resorbed in 60-90 days. The collateral circulation of the uterus ensures adequate nutrition of uterus in this period. The start of recanalization and blood flow in the uterine artery could be expected after this duration. The first evaluation of the patients in our study was at 6 months after the procedure when the suture material should theoretically have been completely resorbed.

Our recanalization rate was 37.5% in the right and 32.5% in the left uterine artery during follow-up the patient group. The artery diameters and blood flow were much lower than control group. However, there was no significant change between the 6-month and 12-month uterine artery diameters and color Doppler values of the patient group. The lack of long-term blood flow, especially in the part distal to the ligated area, can result in an adaptive decrease in diameter and fibrosis development in the region. This causes the blood flow to shift to the collateral circulation. However, the control group uterine artery diameter and color Doppler parameters return to the pre-pregnancy period values in the postpartum period, as reflected in the results. This is thought to be due to the hormonal changes that increase blood flow in pregnancy going back to normal in the postpartum period together with vascular adaptation.

Greenwood et al. found no significant change in the uterine artery blood flow pattern compared to the pre-procedure state with the increase of collateral flow during the pregnancies of patients who had undergone BIIAL previously [12]. On the other hand, values close to normal were found in the uterine artery perfusion pressure due to increased collateral blood flow in post-BIIAL pregnancies. However, the lack of uterine artery revascularization after the procedure could lead to infertility [13]. The most important limitation of our study is the lack of long-term follow-up for the evaluation of fertility results. The lack of new pregnancies in the patients could be due to the relatively short duration of the study or the use of effective contraception by the patients, in addition to impaired fertility. This issue will be evaluated in the future with continuing follow-up of the cases and clearer results will be obtained.

In conclusion, BUAL is a surgical method that can be easily used for PPH. There is a significant rate of uterine artery recanalization in the post-procedure follow-ups. However, the blood flow pattern of the control group women was not achieved at one-year follow-up. The most important issue is the effect of the uterus receiving its supply from collateral vascular structures instead of the UtA on the future fertility of the patient. Studies with a large number of cases and long-term follow-ups will be helpful in understanding this potential effect on fertility.

Disclosure of conflict of interest

None.

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