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Abdominopelvic ultrasonographic findings after uncomplicated delivery

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Ultrasonography;
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Post-partum;
Cesarean section;
Uterus

Abstract
Purpose: To prospectively determine the range of abdominopelvic ultrasonographic findings, including Doppler resistance index (RI) of uterine arteries, 2 and 24 hours after uncomplicated delivery.
Method: Women who delivered vaginally or after cesarean section without complication from January 2012 to April 2012 in a tertiary care hospital were prospectively included. Abdominopelvic ultrasonography, including uterine artery resistance index (RI) at duplex Doppler ultrasonography, was performed 2 hours and 24 hours after delivery.
Results: Ninety-two women (mean age, 32.7 years) were included. Sixty-one (66%) delivered vaginally and 31 (34%) had cesarean section. Twenty-four hours after vaginal delivery, endometrial and anterior wall thicknesses dropped and uterine width increased ($P < 0.001$). No changes in uterine length and posterior wall thickness were observed between 2 and 24 hours after delivery. Transient pelvic free-fluid effusion was observed in 1/92 woman (1%). Uterine artery RI increased significantly from 2 to 24 hours (0.50 vs 0.57, respectively; $P < 0.001$).
Conclusion: Pelvic free-fluid effusion is exceedingly rare in the early course of uncomplicated delivery. A significant increase in uterine artery RI during the 24 hours following uncomplicated delivery is a normal finding. It can be anticipated that familiarity with these findings would result in more confident diagnosis of complications.

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Ultrasonography is the front line imaging examination in woman with suspected pelvic postpartum complications either after vaginal delivery or after cesarean section [1—4]. In addition, ultrasonography may have a pivotal role in a subset of women with postpartum hemorrhage to help decide on the most appropriate therapeutic strategy in case of major bleeding [5]. However, to avoid inappropriate decision and to best depict abnormalities, knowledge of normal appearance of the pelvis at ultrasonography after delivery is mandatory [2].

So far, the majority of papers that described the ultrasonographic appearance of the pelvis after delivery have focused on complications [5—11]. In the same time, those reporting normal findings have predominantly focused on the uterine cavity in the late post-partum period [12—16]. In addition, the majority of researchers have described relatively late pelvic ultrasonographic findings after cesarean section [11,17,18] whereas only one study has described early ultrasonographic findings after cesarean section [19]. Finally, uterine artery resistance index (RI) as measured at duplex Doppler ultrasonography early after delivery has received little attention [20,21]. Accordingly, it becomes evident that a study that comprehensively describes the normal ultrasonographic appearance of the pelvis of women after either cesarean section or vaginal delivery, including the uterus, the pelvic cavity and the uterine arteries, after an uneventful delivery is currently lacking.

This prospective study was performed with two goals in mind. First, we wanted to report the normal range of ultrasonographic abdominopelvic features and uterine artery RI at 2 hours and 24 hours after uncomplicated delivery. Second, we wished to determine if differences in ultrasonographic findings between these two time points exist.

Materials and methods

Study Population

This prospective study was conducted between January 2012 and April 2012 inclusively in our institution. Data collection was approved by our Institutional Review Board and informed consent was obtained from all women. We included all women who had an uneventful vaginal delivery (group 1) or uncomplicated cesarean section (group 2). Uneventful delivery was defined using the following criteria:

- singleton pregnancy;
- pregnancy > 35 weeks' gestation;
- no late pregnancy;
- no postpartum hemorrhage;
- no requirement for blood transfusion;
- no administration of prostaglandins;
- no need for pelvic arterial embolization;
- no associated surgical procedures during or following cesarean section.

Exclusion criteria were as follows:

- blood loss > 500 mL;
- multiple pregnancy;
- preterm delivery;
- hemostasis disorders;
- pre-eclampsia;
- abnormal placentation;
- presence of uterine leiomyoma.

Delivery procedures

All cesarean sections were performed using a low transverse incision followed by either Pfannenstiel or Joel-Cohen techniques. Manual examination of the uterine cavity was performed in all women. If any, placental remnants and blood clots were removed from the uterine cavity and lateral and posterior abdominal spaces using absorbent gauze sponge. All women received oxytocin (Syntocinon®; Sandoz, Rueil-Malmaison, France); those who had cesarean section received 5 units immediately after placental removal, 20 units during surgery and 30 units over the first 12 hours following surgery and those who had vaginal delivery received 5 units just after placenta removal and 10 units during the first 2 hours.

Ultrasonographic protocol

Percutaneous ultrasonography was performed twice, at 2 hours and again at 24 hours after delivery, with the woman in dorsolithotomy position. Before the first ultrasonographic examination, each woman had clinical examination to detect abnormal bleeding. Before the second ultrasonographic examination, the operator confirmed that blood transfusion, further surgery or pelvic arterial embolization was not required. All ultrasonographic examinations were performed and interpreted by five board-certified gynecologists, using a commercially available ultrasonographic unit (Logiq-R ultrasound system, General Electric-Medical Systems, France) using a 3.5-MHz curvilinear probe. To limit interobserver variability, 10 ultrasonographic examinations were initially performed by the five observers to define four standard and reproducible ultrasonographic planes. These 10 cases were excluded from the study.

Mid-sagittal (Fig. 1) and/or axial planes of the uterus were used to measure the uterine length (i.e., the distance between the uterine fundus and the internal cervical os), the thickness of the anterior and posterior uterine wall (halfway between the uterine fundus and the cervix), the endometrial thickness and the uterine width (Fig. 2). Presence of free-fluid effusion between the bladder and the uterus and in the Douglas pouch was searched for. Mid-sagittal planes of the pelvis were performed to scrutinize the entire abdominal cavity with parietocolic gutters. Parasagittal plane of Morrison pouch (Fig. 3) was used placing the transducer in the region of the right mid-axillary line in order to visualize the interface between the liver and anterior renal fascia (Gerota fascia). The blood flow of the uterine arteries was also studied on both sides. The color and pulsed Doppler evaluation of the uterine arteries was carried out in the longitudinal plane. The uterine artery was visualized lateral to the cervix. After detection of blood flow and visualization of the waveform of the uterine artery, the uterine artery RI, calculated as (S-D)/S was automatically calculated on four to five consecutive cycles [22]. At least 3 consecutive correctly imaged blood flow velocity waveforms were analyzed, and mean values were calculated and taken as the final result.

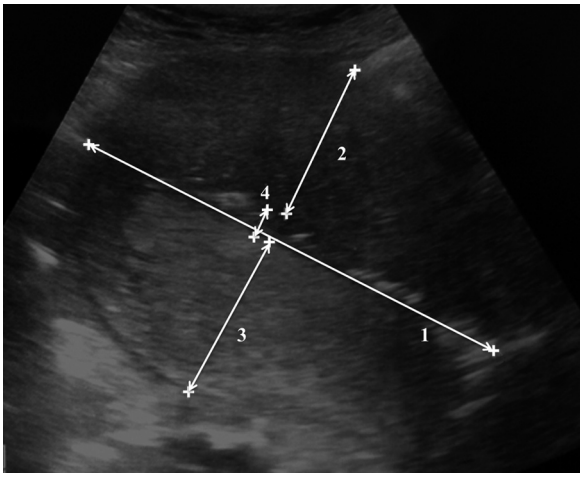

Figure 1. Pelvic ultrasonographic image obtained the mid-sagittal plane of the uterus shows measurement of various uterine dimensions. (1) corresponds to uterine length; (2) corresponds to thickness of anterior uterine wall; (3) corresponds to thickness of posterior uterine wall; (4) corresponds to endometrial thickness. No free-fluid effusion is visible.

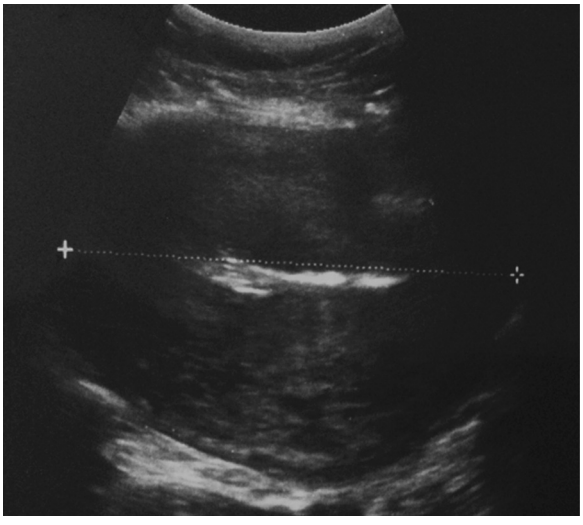

Figure 2. Pelvic ultrasonographic image obtained the axial plane of the uterus shows measurement of uterine width between the two calipers.

Statistical Analyses

Descriptive statistics were calculated for all variables evaluated at ultrasonography. Categorical variables were described with raw numbers, proportions and percentages. Quantitative (continuous) data included means, standard deviation (SD), and ranges. Data were analyzed in the general study population and further stratified according to delivery mode and parity. Categorical variables were compared with the Fisher exact test. Quantitative variables were compared with the Wilcoxon rank sum test for paired data or the Student *t*-test.

Statistical analysis was performed using software (R, version 3.1.1 for Windows, R Foundation, http://www.r-project.org/). All statistical tests were two-tailed and a

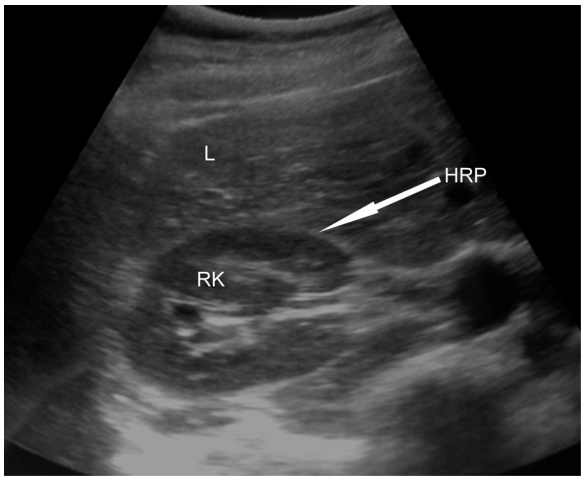

Figure 3. Ultrasonographic image of the parasagittal plane of Morrison's pouch shows no free-fluid effusion. HRP: hepatorenal pouch; L: liver; RK: right kidney.

P-value < 0.05 was considered to indicate a significant difference.

Results

Ninety-two women, with a mean age of 32.7 years ± 5.4 (SD) (range, 21—42 years), were prospectively included and ultrasonographic examination was feasible in all women.

Sixty-one women (61/92; 66.3%) delivered vaginally and 31 (31/92; 33.7%) had cesarean section for dystocia or non-reassuring fetal cardiotocography. Thirty-two women (32/92; 34.8%) were primiparous and 60 (60/92; 65.2%) were multiparous. Mean term at the time of delivery was 37.7 weeks' gestation ± 1.1 (SD) (range, 36—39.5 weeks). Mean birth weight was 3,457 g ± 450 (SD) (range, 2,210—4,425 g) (Table 1). All presentations were cephalic.

All measurements were possible in all women. The results of descriptive analysis for quantitative and binary data obtained 2 hours and 24 hours after delivery in the general population, in group 1 and in group 2 are reported in Table 2.

No significant difference in uterine length was found between uterine length obtained at 2 hours and that obtained at 24 hours after delivery in any group of women. Uterine length in women with vaginal delivery was greater at 2 hours and 24 hours after delivery by comparison with the uterine length obtained in women with cesarean ($P < 0.001$ and $P = 0.006$, respectively). A uterine length > 170 mm was observed in four women (4/92; 4%) 2 hours after delivery and in one woman (1/92; 1%) 24 hours after delivery.

The anterior wall at mid-length of the uterine body was thicker at 2 hours than at 24 hours after delivery in the general population ($P < 0.001$) and in group 1 ($P < 0.001$) but the difference was not significant in group 2 ($P = 0.33$) (Table 2). Similarly, the endometrial thickness at mid-length of the uterine body was greater at 2 hours than at 24 hours after delivery in the general population ($P < 0.001$) and in group 1 ($P < 0.001$), but the difference was not significant in group 2 ($P = 0.55$).

Table 1 Demographic data of 92 women with uneventful delivery.

Variables	Value
Maternal age (years) (mean ± SD)	32.7 ± 5.4 [21–42]
Previous cesarean section	18 (19.6)
Parity	
I	32 (34.8)
II	41 (44.6)
III	14 (15.2)
IV	4 (4.3)
V	1 (1.1)
Weeks gestation (mean ± SD)	37.7 ± 1.1 [36–39.5]
Mode of delivery	
Vaginal	61 (66.3)
Cesarean section	31 (33.7)
Birth weight (grams) (mean ± SD)	3,457 ± 450 [2,210–4,425]

Note: numbers in parentheses are percentages. Numbers in brackets are ranges. SD: standard deviation.

The uterus width was significantly smaller at 2 hours than at 24 hours after delivery in the general population ($P < 0.001$) and in group 1 ($P < 0.001$) but the difference was not significant in group 2 ($P = 0.06$).

A significant increase in uterine artery RI was found between RI, obtained at 2 hours and that obtained at 24 hours after delivery in the three groups of women for right and left uterine arteries. No differences between right and left uterine artery RI were found in any group either at 2 hours or at 24 hours after delivery.

Transient, limited pelvic free-fluid effusion was observed 2 hours after cesarean section in one woman (1/92; 1%) and in no women (0/92; 0%) 24 hours after delivery.

Table 3 shows the results of ultrasonographic evaluation according to parity. In the group of primiparous women, a significant increase in uterine width ($P < 0.001$) along with a significant increase in uterine artery RI ($P = 0.02$) was observed between 2 and 24 hours after delivery. In the group of multiparous women, significant variations were observed between 2 and 24 hours after delivery, consisting in increased uterine width ($P = 0.002$), increased uterine artery RI ($P = 0.002$ for right uterine artery; $P < 0.001$ for left uterine artery), decreased anterior wall thickness ($P < 0.001$), and decreased endometrial thickness ($P = 0.002$). Two multiparous women had an endometrial thickness of 33 mm 2 hours after vaginal delivery.

Discussion

We have conducted a prospective and descriptive study that reports the early abdominopelvic ultrasonographic findings in women with uneventful delivery. Our results show that free-fluid effusion has a prevalence of 1% in a population of women with uneventful delivery and that such finding is not present 24 hours delivery. In addition, we observed a significant increase in uterine artery RI between 2 hours and 24 hours after delivery, thus suggesting physiological vasoconstriction of the uterine arteries during the same period, presumably due to the presence of subplacental shunts as described by Schaaps et al. [23]. The uterine dimensions found in our study are consistent with those previously reported, although the exact time of measurement with respect to the time of delivery varied among studies or was not clearly mentioned [13,19,24].

Our results reinforce the general assumption that free-fluid effusion is exceedingly rare in women with uneventful delivery. Antonelli et al. found free-fluid effusion in only two women among a population of 145 women (1.4%) four days following cesarean section [11]. Koskas et al. did not observe peritoneal free fluid in any of their patients between 1 and 3 hours after cesarean section [19]. We therefore consider that free-fluid effusion should be considered as an abnormal finding, especially in woman with hemodynamic instability, abnormal bleeding or ineffective response to resuscitation procedures. Such finding may suggest further imaging procedures and a more invasive therapeutic approach [5,25,26].

Regarding the significant difference in uterine length between women with vaginal delivery and those with cesarean section, this might be explained by the different amount of oxytocin given to the two groups (15 vs. 55 units). Our results differ from those by Shalev et al. [8]. Three days after vaginal or cesarean delivery, these researchers found that uterine length was significantly greater following cesarean section by comparison with vaginal delivery (22.5 cm vs. 17.3 cm), so that they hypothesized that the uterus contracts better and stays firmer after vaginal delivery than after cesarean section [8].

In our study, we did not observe any difference in endometrial thickness between women with cesarean section and those with vaginal delivery. The absence of difference might be explained by the systematic manual removal of intra-uterine retained products of conception and blood clots and the relatively small number of women with cesarean section in our study.

Several findings can be observed at ultrasonography after an uneventful delivery. Gas within the uterine cavity detected at ultrasonographic examination is considered as a normal finding after spontaneous vaginal delivery [27]. In general, the uterine cavity is thin during the first 3 days following uncomplicated vaginal delivery, probably due to the contractions of the myometrium [16]. However, some authors showed that echogenic material can be present within the uterine cavity in up to 40% of asymptomatic women 48 hours following vaginal delivery [13]. After cesarean section, Koskas et al. observed a heterogeneous mixed-echogenicity mass in the uterine cavity in one woman (3.3%) who had an uneventful outcome [19].

A limited number of studies have reported on the use of duplex Doppler ultrasonography for the assessment of uterine arteries after delivery [20,21,28,29]. It is admitted that uterine artery RI is relatively stable from the first day to the 14th day following uncomplicated vaginal whereas an increase in uterine artery RI is observed from the 14th day to the 56th day [21] and also from the 4th day and the end of the first month [28]. By contrast, in women who experience

Table 2 Comparison between ultrasonographic features 2 hours and 24 hours after uncomplicated delivery in the study population and according to delivery mode.

	All women ($n = 92$)			Vaginal delivery ($n = 61$)			Cesarean section ($n = 31$)		
Variable	H2	H24	*P*	H2	H24	*P*	H2	H24	*P*
Uterine length (mm)	138 ± 17.5 [107–201]	136 ± 14.8 [96–175]	0.58[a]	142 ± 18.2 [114–201]	139 ± 13.2 [106–175]	0.48[a]	131 ± 14 [107–163]	131 ± 16.5 [96–158]	> 0.99[a]
Anterior wall thickeness (mm)	42 ± 7.4 [25–59]	38 ± 7.4 [17–57]	< 0.001[a]	42 ± 7.5 [28–58]	37 ± 7 [21–52]	< 0.001[a]	41 ± 7.2 [25–59]	39 ± 8 [15–57]	0.33[a]
Posterior wall thickness (mm)	43 ± 9.2 [21–62]	42 ± 7.6 [25–67]	0.13[a]	44 ± 9.4 [21–61]	42 ± 7.9 [25–67]	0.19[a]	43 ± 8.9 [27–62]	42 ± 7 [27–58]	0.46[a]
Uterine width (mm)	115 ± 12.1 [88–140]	122 ± 13.7 [90–159]	<0.001[a]	115 ± 12.2 [88–140]	124 ± 13 [91–157]	< 0.001[a]	115 ± 12 [97–137]	119 ± 14.4 [90–159]	0.06[a]
Endometrial thickness (mm)	11 ± 6.3 [1–33]	9 ± 5.8 [1–36]	< 0.001[a]	11 ± 6.5 [2–33]	8 ± 5.8 [1–36]	< 0.001[a]	10 ± 5.9 [1–25]	9 ± 5.7 [3–30]	0.55[a]
Right uterine artery RI	0.51 ± 0.12 [0.30–0.88]	0.57 ± 0.13 [0.30–0.87]	< 0.001[a]	0.52 ± 0.12 [0.36–0.88]	0.57 ± 0.12 [0.30–0.81]	0.006[a]	0.49 ± 0.13 [0.30–0.80]	0.56 ± 0.14 [0.30–0.87]	0.02[a]
Left uterine artery RI	0.50 ± 0.12 [0.29–0.85]	0.57 ± 0.10 [0.36–0.79]	< 0.001[a]	0.50 ± 0.12 [0.29–0.83]	0.58 ± 0.10 [0.36–0.79]	< 0.001[a]	0.50 ± 0.13 [0.31–0.85]	0.55 ± 0.10 [0.43–0.74]	0.02[a]
Free-fluid effusion (*n*)	1 (1%)	0 (0%)	> 0.99[b]	0 (0%)	0 (0%)	> 0.99[b]	1 (1%)	0 (0%)	> 0.99[b]

Note: indicates ultrasonographic examination performed 2 hours after delivery. H24 indicates ultrasonographic examination performed 24 hours after delivery. RI indicates resistance index at duplex Doppler ultrasonography.

Data are given as mean ± standard deviation. Numbers in brackets are ranges. Numbers in parentheses are percentages.

[a] Wilcoxon rank sum test for paired data.

[b] Fisher exact test.

Table 3 Comparison between ultrasonographic variables obtained 2 hours and 24 hours after uncomplicated delivery according to parity.

	Primiparous ($n = 32$)			Multiparous ($n = 60$)		
Variable	H2	H24	*P*	H2	H24	*P*
Uterine length (mm)	135 ± 15.2 [114–198]	136 ± 16.9 [96–175]	0.36[a]	140 ± 18.5 [107–201]	136 ± 13.5 [103–160]	0.18[a]
Anterior wall thickness (mm)	38 ± 6.1 [25–49]	38 ± 8.2 [17–57]	0.68[a]	44 ± 7.3 [30–59]	38 ± 7 [20–59]	< 0.001[a]
Posterior wall thickness (mm)	44 ± 8.7 [28–61]	43 ± 7.2 [28–58]	0.54[a]	43 ± 9.5 [21–62]	42 ± 7.8 [25–67]	0.32[a]
Uterine width (mm)	113 ± 10.4 [97–133]	122 ± 11.1 [104–157]	< 0.001[a]	116 ± 12.7 [88–140]	122 ± 15 [90–159]	0.002[a]
Endometrial thickness (mm)	9 ± 4.3 [1–19]	8 ± 7.2 [1–36]	0.11[a]	12 ± 7.1 [1–33]	9 ± 4.8 [3–29]	0.002[a]
Right uterine artery RI	0.51 ± 0.11 [0.36–0.83]	0.56 ± 0.13 [0.30–0.87]	0.02[a]	0.51 ± 0.13 [0.36–0.88]	0.58 ± 0.13 [0.30–0.85]	0.002[a]
Left uterine artery RI	0.50 ± 0.11 [0.36–0.75]	0.56 ± 0.10 [0.39 ± 0.78]	0.02[a]	0.50 ± 0.12 [0.29–0.85]	0.58 ± 0.10 [0.36–0.79]	< 0.001[a]
Free-fluid effusion (*n*)	0 (0)	0 (0)	> 0.99[b]	1 (1)	0 (0)	> 0.99[b]

Note: H2 indicates ultrasonographic examination performed 2 hours after delivery. H24, indicates ultrasonographic examination performed 24 hours after delivery. RI indicates resistance index at duplex Doppler ultrasonography.
Data are given as mean ± standard deviation. Numbers in brackets are ranges. Numbers in parentheses are percentages.
[a] Wilcoxon rank sum test for paired data.
[b] Fisher exact test.

post-cesarean hemorrhage or partial placental retention, a decreased uterine artery RI is found [20,29]. Although we agree that the use of uterine artery RI cannot be used alone but interpreted with the results of ultrasonographic examination and fully integrated into a comprehensive evaluation [5,29,30], it is however, reasonable to assume that uterine artery RI measurement at 2 and 24 hours following apparently uncomplicated delivery may be a useful diagnostic adjunct to predict potential complications.

Several limitations may be raised with respect to our study. First, ultrasonographic examinations were performed by a panel of five observers, thus potentially introducing bias in data collection. However, studies have found high degrees of agreement for ultrasonography for the presence of pelvic fluid [31]. Second, uterine artery RI was measured only after delivery and not before, so that the baseline RI in our study population was not known. Third, our study included women with normal, uncomplicated delivery, so that it is not possible to determine to which extent ultrasonography along with RI measurement can be used to predict complications. This issue needs further prospective study to be addressed.

In conclusion, the results of our study show that pelvic free-fluid effusion is exceedingly rare in the early course of uncomplicated delivery. In addition, a significant increase in uterine artery RI during the 24 hours following uncomplicated delivery belongs to the range of normal findings. It can be anticipated that familiarity with these findings would result in more confident diagnosis of complications. Moreover, the results of our study should warrant further investigations with respect to the impact of ultrasonography on the management of women with postpartum hemorrhage.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Details of ethics approval

Informed consent was obtained from all women and approval of our Institutional review board (*Comité consultatif sur le traitement de l'information en matière de recherche dans le domaine de la santé* [CCTIRS]) had number 13.061bis.

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