Accurate Detection of Retained Products of Conception after First- and Second-trimester Abortion by Color Doppler Sonography

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Received 23 June 2014; accepted 22 September 2014
Available online 7 December 2014

Objective: The aim of this study was to identify the role of transvaginal color Doppler and grayscale ultrasonography findings in managing first- and second-trimester miscarriages.

Methods: A prospective interventional study was conducted from March 2009 to April 2010 in our center in which 77 women with first- and second-trimester abortion were recruited. All women were evaluated by transvaginal grayscale and color Doppler ultrasonography. Blood flow within the endometrium was measured using color Doppler. Pulsed Doppler was performed to evaluate blood flow impedance by calculating the resistance index (RI).

Results: Forty-six patients underwent dilation and curettage of which 67.4% were proven to have retained products of conception (RPOC). Thirty-one patients were followed up through expectant management. Endometrial thickness (ET) was greater in the group with RPOC (p < 0.001). The sensitivity, specificity, and positive and negative predictive values with 95% confidence intervals of vascularity for detecting RPOC were 88% (72–97%), 68% (52–81%), 67% (51–81%), and 88% (73–97%), respectively. RI was significantly lower (p = 0.004) among these patients. Echogenic mass was detected in 93.9% of women with RPOC, but only in 22.7% of the cases without retained tissues (p < 0.001). Transvaginal grayscale ultrasonography was 100% sensitive in detecting RPOC when ET was >10 mm. The combination of vascular pattern and endometrial echogenic mass was the most sensitive and specific ultrasonographic feature for detecting RPOC (88%; 95% confidence intervals: 79–95%).

Conflicts of interest: All contributing authors declare no conflicts of interest.
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http://dx.doi.org/10.1016/j.jmu.2014.10.006
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Introduction

Retained products of conception (RPOC) are common complications of spontaneous miscarriage, which can potentially be life threatening. The retention of placental products can cause extended bleeding and infection [1]. Clinical manifestations of RPOC are not specific and clinical diagnosis is difficult. Dilation and curettage (D&C) are the usual treatments of choice for RPOC. However, these procedures are associated with serious complications such as uterine perforation, bowel damage, or uterine adhesions. To avoid unnecessary surgery and select patients for expectant management, a reliable diagnostic method is necessary.

Transvaginal ultrasonography has been introduced as a helpful technique to assess abnormal uterine bleeding and RPOC [2–4]. However, sonographic appearance of blood clot and retained products is similar, and therefore, RPOC are difficult to identify sonographically. Most published data are based on endometrial appearance and thickness [5–7]. Doppler sonography combined with grayscale ultrasound can improve the accuracy of diagnosing retained products. However, only limited data are available on color Doppler for detecting RPOC. Atri et al [8] proposed that the image of focal vascularity in Doppler ultrasound is likely to represent more accurate diagnosis of retained products. Achirom et al [9] evaluated the diagnostic accuracy of transvagal pulsed Doppler sonography to identify post-partum and postabortion patients with excessive hemorrhage who are suspected to have RPOC. They concluded that this technique is useful for such patients.

In this study, we hypothesized that the presence of focal color Doppler vascularity in the endometrium improves the accuracy of sonography in detecting RPOC. In a previous retrospective study at our center, ultrasound findings of hyperechoic materials were proven to be the best predictor of RPOC [7]. The aim of this study was to determine whether transvaginal color Doppler ultrasonography could play a role in managing patients with RPOC.

Methods

This was a prospective interventional study to investigate the presence of RPOC after spontaneous first- or second-trimester miscarriage. Ethics approval was obtained from the Institutional Review Board of Tehran University of Medical Sciences, Tehran, Iran prior to conducting the study. All pregnant women who had symptoms of vaginal bleeding and/or lower abdominal pains were evaluated for the presence of RPOC. The patients underwent uterine evacuation or conservative management based on their clinical manifestations. Patients managed conservatively underwent weekly transvaginal sonography and their serum beta subunit of human chorionic gonadotropin levels were monitored for 4 weeks. The specimens were sent for histopathologic analysis on the same day. The presence of chorionic villi confirmed a diagnosis of RPOC. Patients who had elective termination of pregnancy or unstable hemodynamic were excluded. The study population consisted of 77 patients who were evaluated by transvaginal grayscale and color Doppler ultrasound. Ultrasound examinations were performed using a 5-MHz transvaginal transducer (Sequoia 512; Acuson, Mountain View, CA, USA) by three attending staff trained in ultrasound scanning. Informed consent was obtained from all patients prior to their participation in the study.

Images in the sagittal and axial planes were obtained. The grayscale sonographic diagnosis of RPOC was based on the appearance of hyperechoic materials or endometrial thickness (ET) > 10 mm. The ET in the anteroposterior dimension was assessed on sagittal midline views. Echogenicity, size, and location of an intrauterine mass were recorded. Color Doppler appearances of the endometrium were assessed.

Two features of vascular and avascular signals were defined. Endometrial vascularity was based on the presence of a color Doppler signal of the endometrium. Pulsed Doppler was used to obtain a flow velocity waveform and to interrogate color signals. The vascular impedance was estimated by calculating the resistance index (RI = peak systolic velocity minus end diastolic velocity divided by peak systolic velocity). The lowest RI of different arterial signals was used for analysis. The high pass filter was set at 100 MHz. The sample volume of pulsed Doppler was set at a width of 1.2–2 mm. The power output of < 80 mW/cm² was considered in system setting. An RPOC was suspected when RI was < 0.45.

Statistical analysis

Data were analyzed with SPSS, version 17 (SPSS Inc., Chicago, IL, USA). Independent t test was used to compare continuous variables, and Chi-square test was used to compare dichotomous variables between women with and without RPOC diagnosis. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for color and pulsed Doppler ultrasound findings with 95% confidence intervals. Significance level was set at α = 0.05.

Results

The median of gestational age was 13.5 weeks (range 6–24). D&C were performed on 46 women (59.7%); among...
these women, RPOC was confirmed by pathologic examination in 31 (67.4%). Follow-up visits indicated that two of the 31 patients (6.5%) who received expectant management had RPOC. In total, RPOC was found in 33 of 77 (42.9%) cases. Table 1 demonstrates that all patients with RPOC had ET of ≥ 10 mm.

In this study, 39% of cases without RPOC had vascular pattern and 23% had hyperechoic material (p < 0.001). The hyperechoic material had the highest accuracy rate (84%) to detect RPOC with 94% sensitivity and 77% specificity. It also had the highest PPV (76%) and NPV (94%). The sensitivity and specificity of vascular pattern were 88% and 68%, respectively, with 67% PPV and 88% NPV. The concurrent sonographic evidence of vascular pattern and hyperechoic material also predicted RPOC. In this condition, the accuracy and specificity of vascular pattern were 88% and 68%, respectively. The NPV of vascular pattern and hyperechoic material was 93% (Table 2).

The pathologic analysis did not confirm any retained products of pregnancy if ET was < 10 mm (NPV, 100%). Other combinations of Doppler ultrasound findings did not achieve a better diagnostic value compared with the combination of vascular pattern and hyperechoic material.

Table 3 demonstrates the diagnostic performance of different cutoff levels of RI. The sensitivity, specificity, PPV, NPV, and diagnostic accuracy have been reported for the different cutoff levels. The best RI cutoff level for diagnosing RPOC was 0.45 (Fig. 1). At the cutoff level < 0.45, the diagnosis of RPOC could be made with a sensitivity of 48%, specificity of 82%, PPV of 67%, NPV of 68%, and accuracy of 67%. A flowchart of participants who enrolled in the study is shown in Fig. 2.

### Discussion

The diagnosis of RPOC in patients after miscarriage is an important clinical challenge. Transvaginal sonography is a helpful method for assessing RPOC and limiting unnecessary surgeries. Adding color Doppler features provide further information in this regard. This study was designed to assess the accuracy of transvaginal color and pulsed Doppler sonography in patients suspected of having RPOC following spontaneous first- or second-trimester miscarriage. Both grayscale and color Doppler imaging were used in all patients.

This study revealed that echogenic mass in grayscale ultrasound could be valuable in diagnosing RPOC. The NPV and PPV reached 94% and 76%, respectively. Durfee et al [10] presented similar findings from a comparable study. Another study carried out by Kamaya et al [11] showed results that were inconsistent to the results of the present study. Sadan et al [12] reported 29% false-positive rates using echogenic mass as a diagnostic tool. They also suggested a more conservative approach to treat RPOC. The discrepancies between these results can be due to the different methods applied for measuring echogenic mass or

### Table 1 Obstetric characteristics and sonographic findings; comparison between the patients with and without retained products of conception.

<table>
<thead>
<tr>
<th>Findings</th>
<th>RPOC (n = 33)</th>
<th>No RPOC (n = 44)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age (y)</td>
<td>28.1 (4.8)</td>
<td>28.1 (4.7)</td>
<td>0.945</td>
</tr>
<tr>
<td>Gestational ages (wk)</td>
<td>13.3 (5.0)</td>
<td>14.4 (4.8)</td>
<td>0.307</td>
</tr>
<tr>
<td>ET (mm)</td>
<td>19.1 (5.8)</td>
<td>12.7 (7.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ET ≥ 10 mm (%)</td>
<td>100.0</td>
<td>52.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Vascularity (%)</td>
<td>87.9</td>
<td>39.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hyperechoic mass (%)</td>
<td>93.9</td>
<td>22.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RI</td>
<td>0.50 (0.16)</td>
<td>0.61 (0.15)</td>
<td>0.004</td>
</tr>
<tr>
<td>RI &lt; 0.45 (%)</td>
<td>48.5</td>
<td>18.2</td>
<td>0.004</td>
</tr>
</tbody>
</table>

ET = endometrial thickness; RI = resistance index.

### Table 2 Diagnostic performance of colored Doppler ultrasound findings in detecting retained products of conception.

<table>
<thead>
<tr>
<th>Findings</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET ≥ 10 mm</td>
<td>100 (89–100)</td>
<td>48 (32–63)</td>
<td>59 (45–72)</td>
<td>100 (83–100)</td>
<td>70 (59–80)</td>
</tr>
<tr>
<td>Vascularity patterns</td>
<td>88 (72–97)</td>
<td>68 (52–81)</td>
<td>67 (51–81)</td>
<td>88 (73–97)</td>
<td>77 (66–85)</td>
</tr>
<tr>
<td>Hyperechoic mass</td>
<td>94 (80–99)</td>
<td>77 (62–89)</td>
<td>76 (60–88)</td>
<td>94 (81–99)</td>
<td>84 (74–92)</td>
</tr>
<tr>
<td>RI ≥ 0.45</td>
<td>48 (31–66)</td>
<td>82 (67–92)</td>
<td>67 (45–84)</td>
<td>68 (54–80)</td>
<td>67 (56–78)</td>
</tr>
<tr>
<td>Vascularity and hyperechoic mass</td>
<td>88 (72–97)</td>
<td>89 (75–96)</td>
<td>85 (69–95)</td>
<td>93 (76–99)</td>
<td>88 (79–94)</td>
</tr>
<tr>
<td>Vascularity and ET ≥ 10 mm</td>
<td>88 (72–97)</td>
<td>80 (65–90)</td>
<td>76 (60–89)</td>
<td>100 (79–100)</td>
<td>83 (73–91)</td>
</tr>
<tr>
<td>Vascularity and hyperechoic mass and ET ≥ 10 mm</td>
<td>88 (72–97)</td>
<td>89 (75–96)</td>
<td>85 (69–95)</td>
<td>100 (79–100)</td>
<td>88 (79–94)</td>
</tr>
</tbody>
</table>

Data are presented as percentage (95% of CI).

CI = confidence interval; ET = endometrial thickness; NPV = negative predictive value; PPV = positive predictive value; RI = resistance index.

### Table 3 Diagnostic performance of different cutoff levels of resistance index for the diagnosis of retained products of conception.

<table>
<thead>
<tr>
<th>Cutoff Level</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI &lt; 0.45</td>
<td>48</td>
<td>82</td>
<td>67</td>
<td>68</td>
<td>67</td>
</tr>
<tr>
<td>RI &lt; 0.50</td>
<td>55</td>
<td>75</td>
<td>62</td>
<td>69</td>
<td>66</td>
</tr>
<tr>
<td>RI &lt; 0.55</td>
<td>70</td>
<td>64</td>
<td>59</td>
<td>74</td>
<td>66</td>
</tr>
<tr>
<td>RI &lt; 0.60</td>
<td>76</td>
<td>54</td>
<td>56</td>
<td>75</td>
<td>64</td>
</tr>
</tbody>
</table>

NPV = negative predictive value; PPV = positive predictive value; RI = resistance index.
variable definitions. Most researchers agreed with an ET cutoff of 8–13 mm in grayscale ultrasound [4,5,12]. The cutoff in our study was set at 10 mm. All patients with histopathologic evidence of RPOC had ET of at least 10 mm. However, 52% of the cases with ET > 10 mm had no RPOC based on pathologic assay (i.e., false positive), making detection of products using ET as a sole measure doubtful.

In a prospective study published in 2007, Sawyer et al [5] could not find an identifiable cutoff limit for ET. Therefore, we tried to test whether using color Doppler ultrasound can boost the accuracy of diagnosis as an additional method.

The results demonstrated a modest improvement once the two techniques were applied. The false-positive rate came down to 20% using a combination of ET > 10 mm and vascularity pattern in color Doppler, in contrast to 52% false positivity using ET alone. In this study, the simultaneous presence of echogenic mass and vascularity was the most accurate (sensitivity of 88%, specificity of 89%), followed by echogenic mass. In 2002 and 2008, Van den Bosch et al [13,14] designed two studies to examine the color Doppler imaging of postpartum uterus. Their findings were similar to this study. However, they did not have histopathologic confirmation for all of the studied population. In addition, Matijevic et al [15] concluded that color Doppler imaging combined with grayscale had a higher accuracy in the diagnosis of RPOC.

Kamaya et al [11] defined endometrium vascularity patterns as minimal, moderate, and marked. The PPV of any vascular pattern in the endometrium was 96% and that all of the cases with moderate and marked vascularity had RPOC. In another study, Atri et al [8] concluded that the best way to predict RPOC is to detect an area of high vascularity with or without an echogenic mass.

Avascular signals in the endometrium were strongly associated with absence of RPOC. Casikar et al [16] tried to predict successful expectant management of miscarriage. They recommended conservative management in cases with avascular endometrium. Durfee et al [10] reported that avascular pattern does not rule out RPOC. In their study, 17% of patients were evaluated by color Doppler, and only 26% of them had histopathologic confirmation.

There is increasing evidence supporting the usefulness of color Doppler in diagnosing RPOC [8,14,16]. However, a physiologic increase in the vascularity of endometrium after spontaneous abortion has also been reported by Dillon et al [17].

Achiron et al [9] studied the role of transvaginal pulsed Doppler sonography in 38 patients with postpartum and postabortal bleeding. Their results showed 100% specificity and 60% sensitivity using an RI cutoff level < 0.35 in myometrial arteries. In this study, we concluded that the accuracy of diagnosis of high vascularity in color Doppler was higher than RI in pulsed Doppler ultrasound. In addition, Alcázar [18] compared color Doppler with pulse Doppler in

**Fig. 1** Receiver operating characteristics curve for resistance index in RPOC. AUC = area under the curve; SE = standard error.

**Fig. 2** Flowchart of participants who enrolled in the study. RPOC = retained products of conception.
diagnosis of RPOC and considered an RI cutoff value of 0.45. In our study also the ideal RI cutoff value calculated according to the receiver operating characteristics curve was 0.45.

**Conclusion**

The findings of this study revealed color Doppler to be an effective method to detect patients with suspected RPOC and the method may also be helpful for selecting patients for conservative management. The presence of endometrial vascularity associated with hyperechoic material is the best predictor of RPOC. More prospective studies with larger sample sizes are needed to further investigate the use of color Doppler ultrasound in the diagnosis of RPOC.

**Acknowledgments**

The authors thank Seyed Muhammed Hussein Mousavinasab for editing this text.

**References**


