

ACCURACY OF MULTI-SLICE 3D-DOPPLER IN DIAGNOSIS OF MORBIDLY ADHERENT PLACENTA IN COMPARISON WITH 2D-DOPPLER

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ABSTRACT:

Background: Morbidly adherent placenta can be diagnosed prenatally by different modalities. 2D, 3D multi-slice Doppler ultrasound and MRI have emerging roles in prenatal diagnosis of morbidly adherent placenta, but histopathological diagnosis is the gold standard.

Aim of the work: To detect the accuracy of multi-slice 3D Doppler ultrasound over 2D-Doppler in diagnosis of placenta accreta in relation to postpartum histopathology and intrapartum findings.

Patients and Methods: This study was conducted at Ain shams university maternity hospital during the period between March 2020 and September 2020. A total of 50 pregnant women having placenta Previa were included in the study. Patients were included in the study according to the following criteria: Pregnant women with history of previous cesarean section or hysterotomy, placenta previa with its lower edge covering the scar of previous cesarean section, From 28 wks – Full term.

Each patient was scanned in a systematic fashion by 2D ultrasonography, 2D-Doppler, Multislice 3D-Doppler preoperatively and results were compared with histopathological examination postoperatively.

Results: Crowded vessels over peripheral sub-placental zone had the highest diagnostic characteristics among multislice 3D Doppler signs in diagnosis of placental invasion compared with postoperative histopathology with (sensitivity 95.2%, specificity 93.1%, PPV 90.9%, NPV 96.4%, LR 270.00).

Hyper vascularity of serosa–bladder interface had the highest diagnostic characteristics among 2D Doppler ultrasonography signs in the diagnosis of placental invasion compared with postoperative histopathology with (sensitivity 90.5%, specificity 89.7%, PPV 86.4%, NPV 92.9%, LR 82.33).

Conclusion: Multi-slice 3D Doppler ultrasound is more accurate than 2D ultrasound in diagnosis of placenta accrete and degree of adherence in relation to postpartum histopathology and intrapartum findings.

Keywords: Morbidly adherent placenta; Multi-slice 3D-Doppler; 2D-Doppler

INTRODUCTION:

In women with placenta previa, the risk of placenta accreta varies from 2% in

women younger than 35 years old with no previous caesarean section to 39% in women at or over 35 years of age with two or more

caesarean sections. In the presence of these risk factors, the obstetrician must have a high index of suspicion for placenta accreta and take appropriate precautions^(2, 3).

The three forms of morbidly adherent placenta (MAP): placenta accreta, increta and percreta, represent a significant obstetric challenge, at times resulting in life-threatening bleeding, bladder injuries and/or peripartum hysterectomy. The increasing rate of cesarean section (CS) deliveries correlates with the rising incidence of MAP⁽⁵⁾.

This condition is often diagnosed during CS, upon placental removal, with unfavorable maternal outcome: attempts to remove the placenta can cause severe uterine bleeding. An accurate prenatal diagnosis is required to reduce the risk of maternal/fetal morbidity and mortality⁽⁶⁾.

3D multislice Doppler is a fast-evolving imaging technique that holds a great potential for use in obstetrics and gynecology. Its sensitivity and specificity is reported to be close to 100% for diagnosing congenital uterine anomalies comparable with those of MRI & laparoscopy, it can also be used for defining and mapping uterine lesions such as fibroids, adenomyosis, intrauterine synechia and initial evaluation of malignancy suspected patients, as well as artifacts in fetal heart scanning during second trimester⁽⁸⁾.

One area in which 3D-ultrasound seems to afford advantages over 2D ultrasound is in the imaging of abnormalities of the placenta, especially when the multislice capability of 3D ultrasound is combined with dynamic assessment of blood flow using power Doppler, considerable success had been found by using 3D multislice ultrasound imaging coupled with power Doppler in the imaging of patients with suspected morbid placentation⁽⁹⁾.

AIM OF THE STUDY:

The purpose of this study was to detect accuracy of multislice 3D Doppler in comparison with 2D Doppler in diagnosis of placenta accreta and degree of adherence.

PATIENTS AND METHODS:

The present study was carried out at Ain Shams University Maternity Hospital during the period from March 2020 to September 2020. Women approached were recruited from Special Care Center of the fetus– Ain Shams University Maternity Hospital.

After proper counseling, all women who were chosen for enrollment agreed to participate.

Assuming sensitivity & specificity of 2D Doppler accuracy of 81.8% & 94.9% respectively compared to sensitivity & specificity of 3D Doppler accuracy of 90.9 % & 68.8% respectively based on previous study (**Moniem et al., 2015**); a sample size of 50 patients was enough to detect such figures of true, at 0.05 alpha & 0.80 power of the test.

Patients were included in the study according to the following criteria: Pregnant lady with history of previous cesarean section or hysterotomy, placenta previa with its lower edge covering the scar of previous cesarean section, From 28 wks – Full term.

All patients underwent the following: History taking e.g. (Personal history, current problem / complaint (bleeding, pain), history of current pregnancy (details of the 1st, 2nd & 3rd trimester), menstrual & gynecological history, past obstetric history, past medical surgical history, drug History, family History); General examination; Local examination; and Investigations e.g., (complete blood picture (CBC), Rhesus factor (RH), Blood group and blood sugar, Urine for: glucose, protein and bacteruria, kidney function tests, liver functions tests.

Ultrasound: It was carried out in the special care center of the fetus unit (Ain Shams University Maternity hospital). Apparatus used 4-7 MHZ Multifrequency transabdominal convex transducer and VR5-9 three-dimensional endovaginal probe (Samsung WS80A Ultrasound machine)

For each patient, the whole placenta was scanned in a systematic fashion to determine whether those patients suspected of having advanced invasive morbid placentation. The placenta was imaged with a sufficient bladder volume to clearly visualize the serosa-bladder interface,

2D grayscale ultrasonography criteria of morbidly adherent placenta: Loss of retroplacental sonolucent zone, Irregular retroplacental sonolucent zone, Thinning or disruption of the hyperechoic serosa-bladder interface, Presence of focal exophytic masses invading the urinary bladder, Abnormal placental lacunae

2D Doppler ultrasonography criteria of morbidly adherent placenta: Diffuse or focal lacunar flow, vascular lakes with turbulent flow, hypervascularity of serosa-bladder interface, markedly dilated vessels over peripheral subplacental zone

Multislice 3D Doppler ultrasonography: The multislice 3D mode allows simultaneous display of multiple sequential parallel views of a reference (sagittal, transverse or coronal) plane of an object. The reference plane, the number of images displayed within one screen (1×1 , 2×1 , 3×2 , 4×3 or 6×4), the orientation and rotation of an image, the magnitude of magnification and slice depth and interval (0.5 to 5 mm) can be adjusted according to the region of interest (ROI), data set to create a cube that can be sliced and displayed in various ways using intuitive interfaces and the resulting data can be extracted along a flat plane⁽⁴⁾.

Criteria of Multislice 3D Doppler morbidly adherent placenta: Numerous

coherent vessels involving the whole uterine serosa-bladder junction, Disruption of serosa bladder interface, Abnormal lacental lacunae

Decision making for the planned date of termination all were delivered by cesarean sections (Either elective at term (36-37 wks) or emergency in case of attack of antepartum hemorrhage).

Perioperative preparations: Preoperative CBC, Preoperative preparation of cross matched at least 4 units of packed RBCS, Counseling the patient and her family for the possibility of incidence of C.S hysterectomy, together with taking written high risk consent and consent for hysterectomy, At least 2 wide pore venous accesses were required, Senior obstetricians and anesthesiologists.

Operative Details: Either radical surgery in the form of cesarean hystrectomy was done or conservative surgery in the form of removal of the placenta with the adherent myometrium and reconstruction of the lower segment and hence either the whole uterus or part of myometrium was sent to histopathology for confirmation of the morbidly adherent placenta.

Operative findings of invasive morbid placentation were obtained from the obstetricians at the time of delivery and from histopathologic reports after either conservative surgery or cesarean hysterectomy.

Intraoperative signs suggestive of placental invasion was looked for and suspected by^(2,4): Difficulty in placental separation and removal, Uncontrolled bleeding after placental separation in a well-contracted uterus, Thinning of the lower uterine segment, Abnormal vasculature over the lower uterine segment.

Postoperative histopathological examination was done and compared with ultrasonographic findings.

Statistical Methods: Demographic data of included women was presented as descriptive statistics (using range, mean and standard deviation for metric data, and range, median and interquartile range for discrete data). Demographic data, and outcomes of both groups were compared using t-test (for quantitative measures), and chi-squared and Fischer’s Exact tests (for categorical measures). Microsoft® Excel®

(version 2007) and SPSS® for Windows® version 16.0 were used for data presentation and statistical analysis.

RESULTS:

As regard the demographic data, 50 patients were included with mean age 29.6, BMI 28.1, gestational age 35.7 & parity 3 as shown in table 1

Table (1):

Variables	Mean±SD	Range
Age (years)	29.6±5.7	20.0–42.0
BMI (kg/m ²)	28.1±2.4	23.4–34.2
GA (week)	35.8±1.2	32.0–38.0
Median (1st–3rd IQ)		Range
Parity	3.0 (2.0–3.3)	1.0–4.0

Total=50. IQ: Interquartiles

Regarding diagnostic characteristics of 2D ultrasonography, 2D Doppler, multislice 3D Doppler among studied cases:

Loss of retroplacental sonolucent zone had the highest diagnostic characteristics among 2D ultrasonography signs in the diagnosis of placental invasion with sensitivity 90.5%, specificity 69%, PPV 67.9%, NPV 90.9% as shown in table 2.

While hypervascularity of serosa–bladder interface had the highest diagnostic characteristics among 2D Doppler

ultrasonography signs in the diagnosis of placental invasion with sensitivity 85.7% & specificity 69%, PPV 68.4%, NPV 92.9% as shown in table 3.

Crowded vessels over peripheral sub-placental zone had the highest diagnostic characteristics among multislice 3D Doppler signs in the diagnosis of placental invasion with sensitivity 95.2% & specificity 93.1%,PPV 90.9%, NPV 96.4% as shown in table 4.

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Table (2): Diagnostic characteristics of 2D Ultrasonography in the diagnosis of placental invasion:

Characters	Value	95% CI	Value	95% CI	Value	95% CI
	Loss of retroplacental zone		Irregular retroplacental zone		Disruption of bladder interface	
Sensitivity	90.5%	69.6%–98.8%	66.7%	43.0%–85.4%	57.1%	34.0%–78.2%
Specificity	69.0%	49.2%–84.7%	58.6%	38.9%–76.5%	93.1%	77.2%–99.2%
DA	78.0%	64.0%–88.5%	62.0%	47.2%–75.3%	78.0%	64.0%–88.5%
YI	59.4%	38.4%–80.4%	25.3%	1.7%–52.3%	50.2%	27.2%–73.3%
PPV	67.9%	47.6%–84.1%	53.8%	33.4%–73.4%	85.7%	57.2%–98.2%
NPV	90.9%	70.8%–98.9%	70.8%	48.9%–87.4%	75.0%	57.8%–87.9%
LR+	2.92	1.67–5.10	1.61	0.95–2.73	8.29	2.07–33.19
LR-	0.14	0.04–0.53	0.57	0.29–1.12	0.46	0.28–0.76
LR	21.11	4.03–110.57	2.83	0.88–9.13	18.00	3.37–96.22
	Mass invading the bladder		Abnormal placental lacunar			
Sensitivity	42.9%	21.8%–66.0%	66.7%	43.0%–85.4%		
Specificity	96.6%	82.2%–99.9%	34.5%	17.9%–54.3%		
DA	74.0%	59.7%–85.4%	48.0%	33.7%–62.6%		
YI	39.4%	17.2%–61.6%	1.1%	25.4%–27.7%		
PPV	90.0%	55.5%–99.7%	42.4%	25.5%–60.8%		
NPV	70.0%	53.5%–83.4%	58.8%	32.9%–81.6%		
LR+	12.43	1.70–90.76	1.02	0.68–1.52		
LR-	0.59	0.41–0.86	0.97	0.44–2.12		
LR	21.00	2.39–184.63	1.05	0.32–3.45		

CI: Confidence interval, **DA:** Diagnostic accuracy, **PPV:** Positive Predictive value, **NPV:** Negative Predictive value, **LR+:** Positive likelihood ratio, **LR-:** Negative likelihood ratio, **LR:** Diagnostic odd ratio

Table (3): Diagnostic characteristics of 2D Doppler ultrasonography in the diagnosis of placental invasion:

	Diffuse or focal lacunar flow		Vascular lakes with turbulent flow	
	Value	95% CI	Value	95% CI
Sensitivity	85.7%	63.7%–97.0%	81.0%	58.1%–94.6%
Specificity	69.0%	49.2%–84.7%	69.0%	49.2%–84.7%
DA	76.0%	61.8%–86.9%	74.0%	59.7%–85.4%
YI	54.7%	32.2%–77.2%	49.9%	26.1%–73.7%
PPV	66.7%	46.0%–83.5%	65.4%	44.3%–82.8%
NPV	87.0%	66.4%–97.2%	83.3%	62.6%–95.3%
LR+	2.76	1.56–4.88	2.61	1.46–4.66
LR-	0.21	0.07–0.61	0.28	0.11–0.69
LR	13.33	3.12–57.04	9.44	2.46–36.20
	Hypervascularity of serosa–bladder interface		Markedly dilated vessels over peripheral subplacental zone	
	Value	95% CI	Value	95% CI
Sensitivity	90.5%	69.6%–98.8%	71.4%	47.8%–88.7%
Specificity	89.7%	72.6%–97.8%	48.3%	29.4%–67.5%
DA	90.0%	78.2%–96.7%	58.0%	43.2%–71.8%
YI	80.1%	63.4%–96.9%	19.7%	6.8%–46.2%
PPV	86.4%	65.1%–97.1%	50.0%	31.3%–68.7%
NPV	92.9%	76.5%–99.1%	70.0%	45.7%–88.1%
LR+	8.75	2.97–25.76	1.38	0.89–2.15
LR-	0.11	0.03–0.40	0.59	0.27–1.28
LR	82.33	12.51–541.98	2.33	0.71–7.70

CI: Confidence interval, YI: Youden's index, DA: Diagnostic accuracy, PPV: Positive Predictive value, NPV: Negative Predictive value, LR+: Positive likelihood ratio, LR-: Negative likelihood ratio, LR: Diagnostic odd ratio

Table (4): Diagnostic characteristics of multislice 3D Doppler in the diagnosis of placental invasion

Characters	Value	95% CI	Value	95% CI	Value	95% CI
	Crowded vessels over peripheral sub-placental zone		Disruption of the bladder interface		Abnormal placental lacunae	
Sensitivity	95.2%	76.2%–99.9%	85.7%	63.7%–97.0%	76.2%	52.8%–91.8%
Specificity	93.1%	77.2%–99.2%	89.7%	72.6%–97.8%	55.2%	35.7%–73.6%
DA	94.0%	83.5%–98.7%	88.0%	75.7%–95.5%	64.0%	49.2%–77.1%
YI	88.3%	75.4%–100 %	75.4%	56.7%–94.0%	31.4%	5.7%–57.0%
PPV	90.9%	70.8%–98.9%	85.7%	63.7%–97.0%	55.2%	35.7%–73.6%
NPV	96.4%	81.7%–99.9%	89.7%	72.6%–97.8%	76.2%	52.8%–91.8%
LR+	13.81	3.61–52.77	8.29	2.80–24.54	1.70	1.06–2.72
LR-	0.05	0.01–0.35	0.16	0.06–0.46	0.43	0.19–0.99
LR	270.00	22.86–3189.2	52.00	9.41–287.34	3.94	1.14–13.64

CI: Confidence interval, DA: Diagnostic accuracy, PPV: Positive Predictive value, NPV: Negative Predictive value, LR+: Positive likelihood ratio, LR-: Negative likelihood ratio, LR: Diagnostic odd ratio

DISCUSSION:

The current study showed that there were no significant differences according to placental invasion (invasion =21 & no invasion =29) regarding age, BMI, and GA (p= 0.085, 0.256, and 0.061). There was significant difference regarding parity (p<0.001).

In this matched studies, Fathy et al.⁽¹⁰⁾ study agreed with current study and stated that age, BMI, and GA had no significant difference, But disagreed regarding parity with current study and stated that parity had no significant difference. While D'Antonio et al.⁽¹¹⁾ study agreed with current study regarding parity & concluded that the incidence of abnormal invasive placentation (AIP) increased in the past decades as a consequence of increasing caesarean section

rates. As well; Guleria et al.⁽¹²⁾ study concluded that the risk factors of abnormal invasive placentation (AIP) were placenta previa and a past history of cesarean delivery. On the other hand, Wright et al.⁽¹³⁾ study agreed with current study and stated that there was no significant relation between degree of placental invasion, and massive blood loss, But disagreed regarding parity and stated that there was no significant relation between parity and massive blood loss, and Thia et al.⁽¹⁴⁾ study concluded that the depth of invasion in MAP is increased with multiple previous surgeries or excessive curettage or infection causing defective decidua basalis.

Agreement between 2D and placental invasion, Loss of retro-placental sono-lucent zone and hyper-vascularity of serosa bladder interface had the highest diagnostic

characteristics among 2D ultrasonography signs in the diagnosis of placental invasion with sensitivity and specificity 90.5%, 69.0% and 90.5%, 89.7% respectively.

There was significant moderate agreement to loss of retro-placental sono-lucent zone, thinning or disruption of the hyperechoic serosa-bladder interface, focal exophytic mass invading the bladder ($p < 0.001$) and non-significant low agreement to irregular retro-placental sono-lucent zone, abnormal placental lacunar ($p = 0.077$ and 0.933).

Moniem et al. ⁽¹⁵⁾ study agreed with current study and stated that the best 2D gray-scale ultrasound parameter for the detection of difficult placental separation and considerable intraoperative blood loss was loss of the retro-placental sonolucent zone (74.2% NPV). In addition, the best 2D gray-scale ultrasound parameters for the detection of emergency hysterectomy in the subjects were disruption of the hyperechoic uterine serosa-bladder interface (81.8% sensitivity) and exophytic mass invading the bladder (94.9% specificity, 66.7% PPV, and 84.1% NPV).

In addition, Shi et al. ⁽¹⁶⁾ study found that the most prominent grayscale sign to diagnose placenta accreta was dilated vessels extending from the placenta to the myometrium.

Wong et al. ⁽¹⁷⁾ study agreed with current study and concluded that the loss of the placental-uterine interface and the presence of abnormal vessels crossing this interface were the most specific criteria to diagnose MAP using 2D gray-scale ultrasound scan.

Japaraj et al. ⁽¹⁸⁾ study agreed with current study and found that the prominent gray-scale ultrasound sign to diagnose placenta accreta was dilated vessels extending from the placenta to myometrium, and the most prominent color Doppler sign to diagnose placenta accrete was abnormal vessels connecting the placenta to bladder.

Comstock et al. ⁽¹⁹⁾ study disagreed with current study & found that the absence of the space between the placenta and myometrium is not a diagnostic sign for MAP because the space may be normally absent without MAP. They recommended the use of the color Doppler to identify placental sinuses crossing the uterine wall to the bladder.

Regarding agreement between 2D Doppler and placental invasion there was significant high agreement to diffuse or focal lacunar flow and markedly dilated vessels over peripheral sub-placental zone; ($p < 0.001$), significant moderate agreement to vascular lakes with turbulent flow; ($p < 0.001$) and non-significant low agreement to hyper-vascularity of serosa-bladder interface; ($p = < 0.001$).

Hussein et al. ⁽²⁰⁾ stated that regarding 2D color Doppler can increase the accuracy of prediction of massive hemorrhage in cases of PAS disorders and only the presence of numerous coherent vessels involving the bladder-serosal interface ($p = 0.002$) was proven to be independent predictor of major hemorrhage during hysterectomy which is due to different inclusion and exclusion criteria than current study.

Also, Shi et al. ⁽¹⁶⁾, Japaraj et al. ⁽¹⁸⁾ studies found that the most prominent color Doppler diagnostic sign was the presence of abnormal vessels connecting the placenta to the bladder which is due to different methodology than current study.

Regarding agreement between multislice 3D Doppler and placental invasion, crowded vessels over peripheral sub-placental zone had the highest diagnostic characteristics among multi-slice 3D Doppler signs in the diagnosis of placental invasion with sensitivity and specificity 95.2% and 93.1%.

There was significant high agreement between multi-slice 3D Doppler regarding disruption of serosa bladder interface) and placental invasion; ($p < 0.001$), significant

low agreement between multi-slice 3D Doppler regarding abnormal placental lacunae and placental invasion; ($p= 0.027$) and non-significant high agreement between multi-slice 3D Doppler regarding numerous coherent vessels involving the whole uterine serosa–bladder junction and placental invasion; ($p= 0.160$).

Moniem et al. ⁽²¹⁾ study agreed with us and stated that the 3D MSV Doppler is a useful adjunctive tool to the 3D power Doppler or color Doppler to refine the diagnosis of MAP. The 3D MSV Doppler increased the accuracy and predictive values of the diagnostic criteria of MAP compared with the 3D power Doppler. The sensitivity and negative predictive value (NPV) (79.6% and 82.2%, respectively) of crowded vessels over the peripheral sub-placental zone to detect difficult placental separation and considerable intraoperative blood loss in cases of MAP using the 3D power Doppler was increased to 82.6% and 84%, respectively, using the 3D MSV Doppler. In addition, the sensitivity, specificity, and positive predictive value (PPV) (90.9%, 68.8%, and 47%, respectively) of the disruption of the uterine serosa-bladder interface for the detection of emergency hysterectomy in cases of MAP using the 3D power Doppler was increased to 100%, 71.8%, and 50%, respectively, using the 3D MSV Doppler.

Silver et al. ⁽²²⁾ study agreed with us and stated that one area in which 3D ultra-sound seems to afford advantages over 2D ultrasound is in the imaging of abnormalities of the placenta, especially when the multislice capability of 3D ultrasound is combined with dynamic assessment of blood flow using power Doppler.

The current study showed that multi-slice 3D Doppler ultrasound is more accurate than 2D ultrasound in diagnosis of placenta accrete and degree of adherence in relation to postpartum histopathology and intrapartum findings.

Conclusion

Multi-slice 3D Doppler ultrasound is more accurate than 2D ultrasound in diagnosis of placenta accreta and degree of adherence in relation to postpartum histopathology and intrapartum findings.

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دقة الفحص بدوبلر متعدد الشرائح ثلاثي الأبعاد عن دوبلر ثنائي الأبعاد في تشخيص المشيمة اللصيقة بشكل مرضي

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الخلفية: تُمثل عملية الولادة القيصرية عملية إنقاذ مهمة لحياة الأم والطفل، وقد زاد اللجوء إليها بشكل كبير خلال العقد الماضي؛ ووفقاً لما بينته الاتجاهات العالمية، فقد ارتفعت معدلات عمليات الولادة القيصرية في مصر بشكل مطرد، حيث وصلت إلى ٥٢٪ بالنسبة لجميع الولادات وفقاً لآخر مسح ديموغرافي وصحي في مصر لعام ٢٠١٤ والذي يمثل زيادة بنسبة أكثر من ١٠٠٪ من معدل الولادات القيصرية منذ عام ٢٠٠٥.

الهدف من العمل هو الكشف عن دقة الفحص بدوبلر الملون متعدد الشرائح ثلاثي الأبعاد لتشخيص المشيمة الملتصقة ودرجة الالتصاق من خلال العلاقة مع النتائج المرضية النسيجية بعد الولادة والنتائج أثناء الولادة.

الطريقة: أجريت هذه الدراسة في مستشفى الولادة بجامعة عين شمس خلال الفترة ما بين مارس ٢٠٢٠ وسبتمبر ٢٠٢٠. تم تضمين ما مجموعه ٥٠ امرأة حامل مصابة بالمشيمة المتقدمة الملتصقة في الدراسة.

النتائج: أظهر التحليل الإحصائي للدراسة الحالية أن الموجات فوق الصوتية دوبلر متعددة الشرائح أكثر دقة من الموجات فوق الصوتية ثنائية الأبعاد في تشخيص المشيمة الملتصقة ودرجة الالتصاق فيما يتعلق بتشريح الأنسجة بعد الولادة ونتائج أثناء الولادة.

الخلاصة: تعد الموجات فوق الصوتية متعددة الشرائح ثلاثية الأبعاد أكثر دقة من الموجات فوق الصوتية ثنائية الأبعاد في تشخيص المشيمة الملتصقة ودرجة الالتصاق فيما يتعلق بتشريح الأنسجة بعد الولادة والنتائج أثناء الولادة.