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ORIGINAL ARTICLE

Gray-scale and color Doppler US findings of amniotic sheets

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PURPOSE
To identify the gray-scale and color Doppler ultrasonography (US) findings of amniotic sheets.

MATERIALS AND METHODS
Among 1201 pregnant patients who underwent detailed second trimester US, nine had amniotic sheets. An amniotic sheet was defined as a shelf-like structure in the uterine cavity with a free edge not attached to the fetus or umbilical cord. There was no major fetal anomaly observed in any patient. Eight patients had solitary amniotic sheets, and one patient had double sheets. All gray-scale and Doppler US features of amniotic sheets were noted.

RESULTS
The incidence of an amniotic sheet was determined to be 0.75% (ten amniotic sheets were observed in nine patients). On gray-scale US images, amniotic sheets were observed as bands of tissue that originated from the uterine wall with a triangular-shaped base that tapered toward the free edge. A three-layered appearance was identified in seven amniotic sheets. Using Doppler US images, four of ten sheets showed a low-resistance arterial flow, and five of ten sheets showed non-pulsatile venous flows. No vascularization was observed in one patient with a thin, membranous sheet.

CONCLUSION
Gray-scale US is sufficient for the diagnosis of amniotic sheets because of the typical US characteristics; however, Doppler US findings of amniotic sheets are highly variable. Thus, Doppler US may not be beneficial in the diagnosis of amniotic sheets.

Key words: • *uterine synechiae* • *pregnancy* • *ultrasonography* • *color Doppler ultrasonography*

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In 1985, Mahony et al. (1) described amniotic sheets as aberrant sheets of tissue with a free edge visualized within the amniotic cavity and no restriction of fetal motion or subsequent fetal deformity. The sonographical incidence of amniotic sheets is reported as 0.6% (2).

Amniotic sheets are thought to be a result of uterine synechiae and are covered with two layers of chorion and amnion during pregnancy (1, 3, 4). Uterine synechiae can be caused by previous use of instrumentation on the uterus (generally curettage), previous Cesarean sections or endometritis (2).

Although amniotic sheets are generally considered benign structures, some subtypes may be associated with a malpresentation (5) and even intrauterine death (6). However, in most cases pregnancy ends uneventfully. To calm the expectant mother, this benign condition must be clearly differentiated from the amniotic bands seen in amniotic band syndrome (ABS).

The aim of this study was to identify the gray-scale and color Doppler ultrasonography (US) findings of amniotic sheets.

Materials and methods

This is a prospective study held at a single center. In the Department of Radiology of Ankara University School of Medicine, 1201 pregnant patients (excluding those with multiple gestations) underwent a detailed second-trimester US scan between December 2009 and April 2011. Of these patients, nine had amniotic sheets. An amniotic sheet was defined as a shelf-like structure in the uterine cavity that had a free edge not attached to the fetus or the umbilical cord. The amniotic sheet did not restrict fetal movements, and there were no major structural fetal anomalies observed in any patient with amniotic sheets. The age of the patients with amniotic sheets ranged between 24 and 39 years. Gestational ages ranged between 18 and 24 weeks. Detailed obstetrical and gynecological histories as well as patient outcomes are provided in Table.

A single experienced radiologist scanned all patients. US examinations were performed with an SSA 770A or Xario US system (Toshiba, Tokyo, Japan) using 3.5 MHz or 1.9–6 MHz (with a central frequency of 3.5 MHz) broadband curvilinear transducers.

The location, course, and placental implantations on the sheets were recorded. The gray-scale US features of the amniotic sheets were recorded. A color Doppler US with a spectral analysis was also performed on all amniotic sheets.

The ethics committee of our institution approved this study.

Results

Among the 1201 pregnant patients, only nine had amniotic sheets in the uterine cavity. Thus, the prenatal incidence of amniotic sheets was

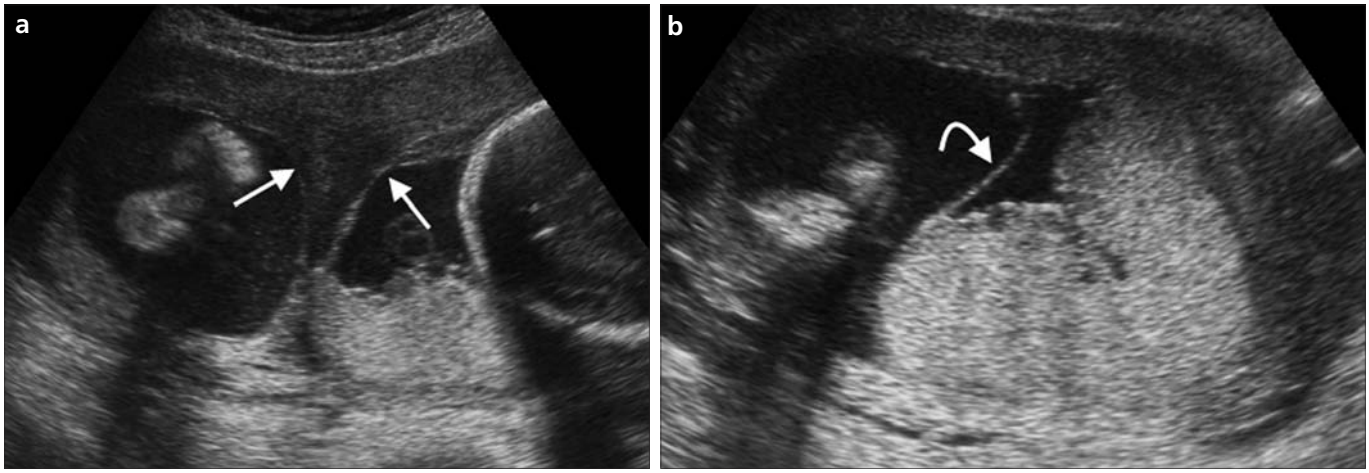


Figure 1. a, b. Sagittal US views of the patient no. 2 showing an amniotic sheet originating from the uterine wall with a triangular-shaped base **(a,** *arrows***)** and a tapered, membrane-like amniotic sheet **(b,** *curved arrow***)**.

determined to be 0.75%. All amniotic sheets were classified as incomplete sheets, according to the classification outlined by Tan et al. (6). Eight patients had solitary amniotic sheets, whereas one patient had two sheets. Five amniotic sheets were located in the transverse plane, whereas five sheets were longitudinally positioned in the uterine cavity.

On the gray-scale US, amniotic sheets were observed as bands of tissue originating from the uterine wall with a triangular-shaped base (Fig. 1a). Amniotic sheets tapered toward the free edge, with some resembling the thinness of a membrane (Fig. 1b). Sonographically, three layers were identified in seven of the ten sheets with two echogenic lines and a hypoechoic line located in between (Fig. 2). Placental extension of

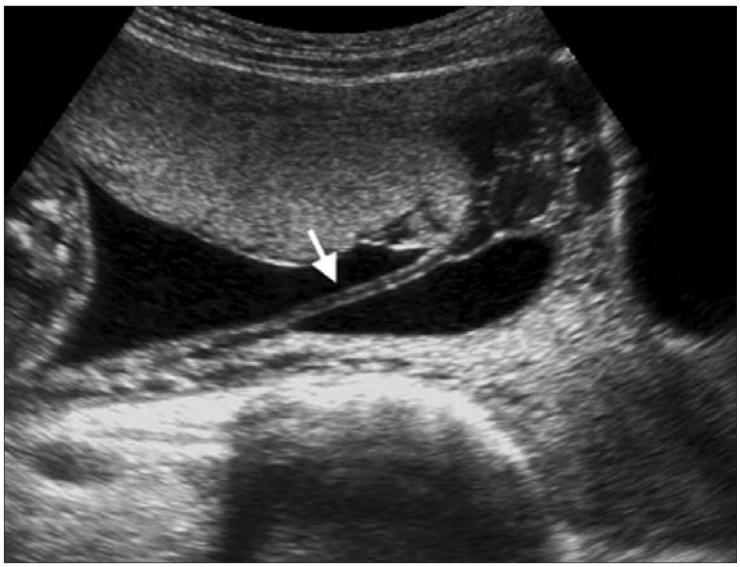


Figure 2. A sagittal US view of the patient no. 3 showing the three-layered amniotic sheet (*arrow*) with two echogenic lines and a hypoechoic line located in between.

Table. The obstetrical and gynecological history of study patients

No.	Gravidity	Parity	Previous D/C	Previous C/S	Previous uterine surgery	Spontaneous abortion	Fetal outcome	Mode of delivery (indication)
1	4	1	1	0	0	1	N	C/S (cephalopelvic disproportion)
2	3	2	0	0	0	0	N	C/S (breech presentation)
3	2	0	1	0	0	0	N	Vaginal delivery
4	1	0	0	0	0	0	N	Vaginal delivery
5	3	1	1	0	0	0	N/A	N/A
6	1	0	0	0	0	0	N/A	N/A
7	3	1	1	0	0	0	N	Vaginal delivery
8	3	1	0	0	0	1	N	C/S (previous C/S)
9	2	0	1	0	0	0	N/A	N/A

D/C, dilatation and curettage; C/S, Cesarean section; N, normal; N/A, not available (two patients were lost during follow-up, and one has not yet delivered)

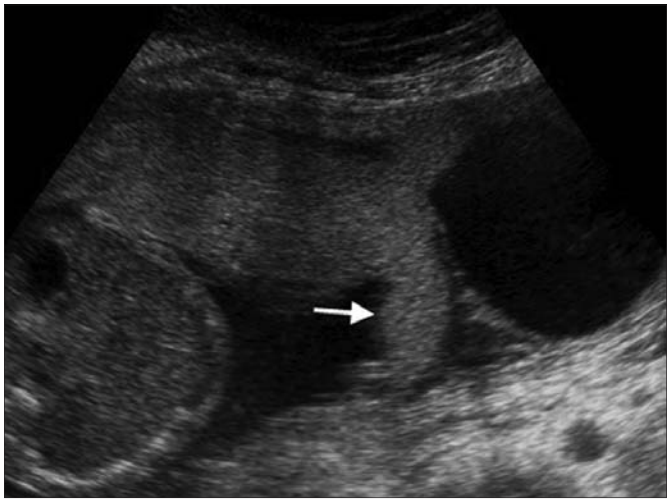


Figure 3. A sagittal US view of the patient no. 1 showing the placenta (*arrow*) extending into the amniotic sheet.

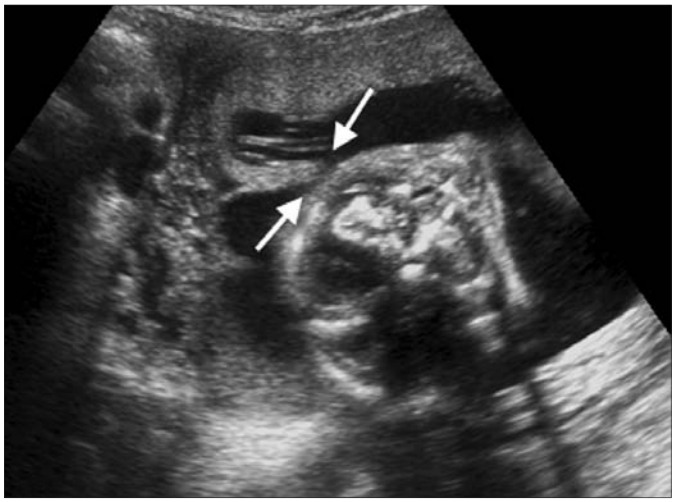


Figure 4. A sagittal US view of the patient no. 5 showing the "thick" free edge of the incomplete amniotic sheet (*arrows*).

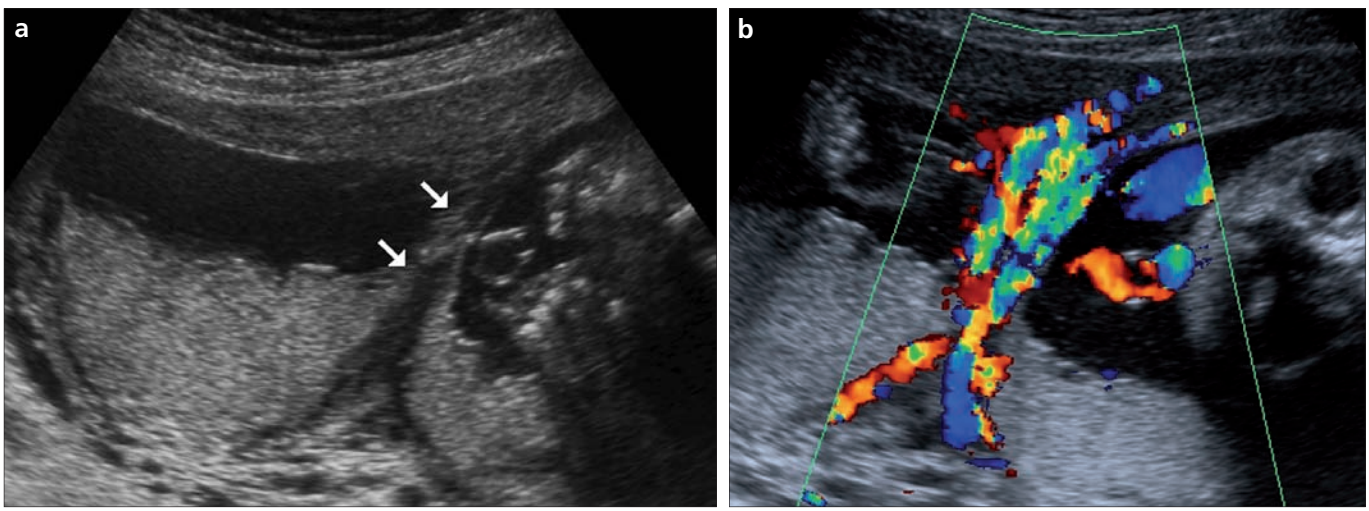


Figure 5. a, b. A sagittal US view **(a)** of the patient no. 2 showing a relatively thick amniotic sheet (*arrows*) with placental extension. A color Doppler US view **(b)** shows substantial arterial vascularization. Spectral analysis is not shown.

the amniotic sheets was noted in three of the nine patients with amniotic sheets (Fig. 3), and we did not observe any "bulbous tips" (Fig. 4). Fetuses always moved freely, independent of the amniotic sheets, and no major malformations were noted in any fetus.

On the color Doppler US, the patients with relatively thick sheets also had placental implantations on the amniotic sheets, and substantial arterial vascularization (similar to that observed at the uteroplacental junction) was also noted (Fig. 5). However, thin parts of the sheets showed poor vascularization on the color and power Doppler US images. A spectral analysis of these thin sheets revealed a low-resistance arterial flow (in four of ten sheets) (Fig. 6) or non-pulsatile venous flow (in five of ten sheets) (Fig. 7). The heart rates obtained from the arterial flows were always of maternal origin, suggesting that the amniotic sheets are of a maternal rather than fetal origin (Fig. 6b). No vascularization was noted on the Doppler US in one patient with a thin, membranous sheet.

Discussion

In our study, the incidence of amniotic sheets was 0.75%. This percentage is comparable to those reported in previous retrospective studies (2, 5–7). There are a few reasons for the negligible difference. First, a single radiologist with 10 years of experience in obstetrical US imaging performed all US scans in our study; thus, there were no interobserver variations. Furthermore, amniotic sheets were specifically examined for during all US scans.

Tan et al. (6) classified amniotic sheets into complete and incomplete sheets. A complete sheet only has a small perforation that is not visible on US scans, whereas an incomplete sheet has a free-floating edge. They suggested that although the incomplete sheets are benign, complete amniotic sheets may be associated with intrauterine death. The authors hypothesized that the small defects on the complete sheets may predispose the mother and fetus to cord prolapse and intrauterine death (6). None of our patients had a complete sheet or poor pregnancy outcome, which suggests that complete sheets are extremely rare.

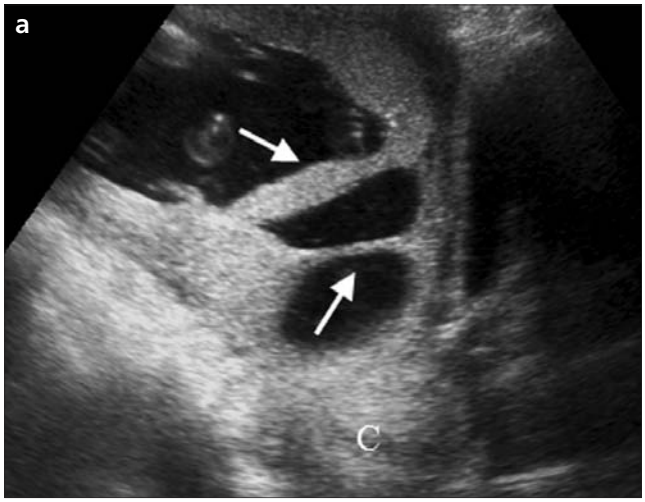
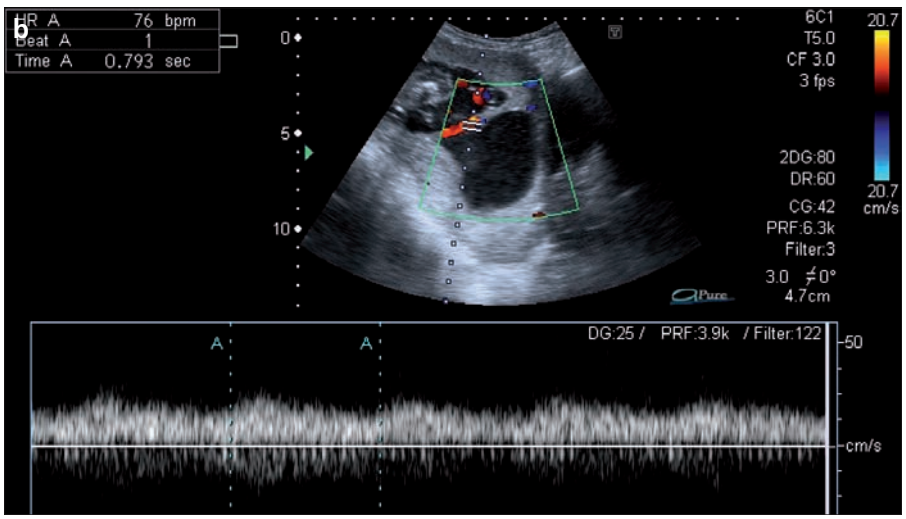


Figure 6. a, b. A sagittal gray-scale US view **(a)** of the patient no. 5 showing the double amniotic sheets (*arrows*), located close to one another (C, cervix). A color Doppler US and spectral analysis **(b)** of the thicker amniotic sheet revealed a low-resistance arterial flow and a heart rate of maternal origin.



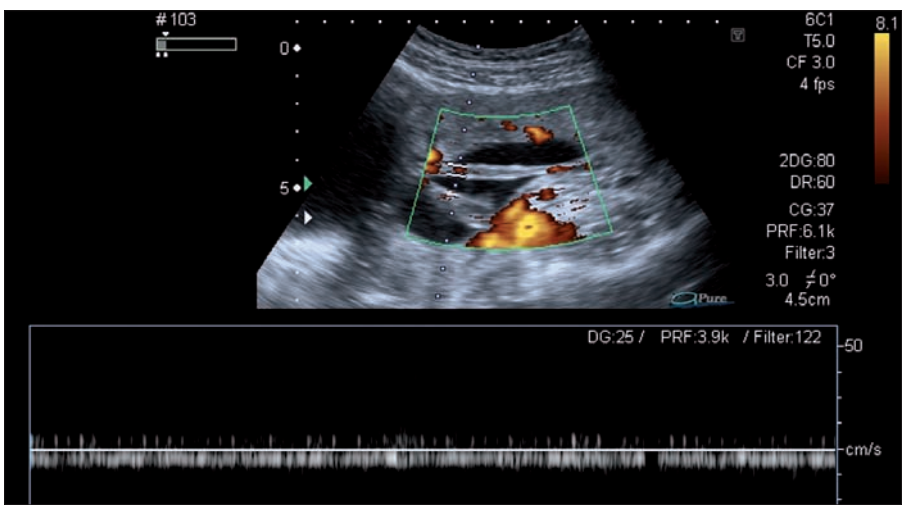


Figure 7. A color Doppler US of the patient no. 6 and spectral analysis of the amniotic sheet showing a non-pulsatile venous flow.

The most important differential diagnosis of amniotic sheets is ABS. ABS is thought to result from a defect in the amniotic membrane that exposes the fetus to the chorionic cavity. Serious fetal malformations can occur in ABS, such as limb, trunk, vertebral, cranial, facial, and abdominal abnormalities (1). The amniotic bands in ABS are observed as membranes that flap with fetal movements or attach to the fetus and restrict fetal movement (1). Conversely, amniotic sheets do not attach to the fetus or umbilical cord, and the fetus can move independently. The number of amniotic bands in ABS can range from one to many. Amniotic sheets are usually solitary, but multiple sheets have also been reported (8). There are no major structural fetal anomalies that accompany amniotic sheets. Because amniotic sheets consist of two layers of chorion and amnion, whereas amniotic bands consist of only a single layer of amnion (9), amniotic sheets appear thicker than amniotic bands (3). Amniotic sheets are similar to the inter-twin membrane seen in dichorionic-diamniotic twins (3). This layered and relatively thick shelf-like appearance was noted in all of our patients, with the exception of one patient who had a thin, taut sheet. Additionally, the sheet base was similar to the "twin peak sign" seen in dichorionic-diamniotic twins. Other useful sonographic features of amniotic sheets are the broad base at the origin on the uterine wall and the bulbous free edge or tip (1, 3, 9, 10). In our study, the triangular broad base was always present, except in the one patient with a thin, membranous amniotic sheet; no patients exhibited a bulbous free edge. The free edge was difficult to see and required scanning in different planes. The free edges always appeared thick and taut rather than flapping. Occasionally, the placenta appeared to be implanted on the amniotic sheet (9, 10). Korbin et al. (10) found that the placenta appeared to be implanted on the amniotic sheet in 26.1% of the cases. They also concluded that pregnancy outcomes are similar in patients with and without placental implantation on the amniotic sheet (10). In our study, three of the nine patients had placental implantation on the amniotic sheet.

Previous publications regarding Doppler analysis of the amniotic sheets were case reports (11, 12), thus making this the first original article on Doppler analysis of the amniotic sheets in a series of patients. Some authors claimed that color Doppler US imaging with spectral analysis has an important role in the differential diagnosis of intrauterine membranes of undetermined origin during pregnancy (11, 12). We also showed that

all amniotic sheets that had an arterial flow revealed a maternal heart rate, indicating the maternal origin of these benign structures; however, five of ten sheets showed only venous flows. Because the Doppler findings varied, the use of Doppler US to diagnose amniotic sheets is debatable. Other conditions that can mimic amniotic sheets include chorioamniotic separation, vanished twin, uterine septum, and circumvallate placenta (2, 3). The course of the sheet in the uterus may help to differentiate an amniotic sheet from a septate uterus. The septum of a septate uterus is often in the fundus and is oriented in the sagittal plane (8, 10). Amniotic sheets in our study were oriented either in the transverse or sagittal planes. Korbin et al. (10) suggested that the myometrial tissues can often be seen extending into the base of the septum in a septate uterus and that previous radiological examinations of the uterus may also be helpful in differential diagnosis. Nonetheless, it may not always be possible to differentiate a septate uterus from an amniotic sheet using only US scans.

There were two major limitations in our study. First, the structure of an amniotic sheet has not been proven histopathologically. Second, there was a small number of patients enrolled in our study.

In conclusion, gray-scale US findings alone are sufficient for the diagnosis of amniotic sheets because they have typical US appearances. Doppler US images of amniotic sheets show the variable flow patterns of arterial or venous origins; thus, Doppler US may not be beneficial in the diagnosis of amniotic sheets.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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