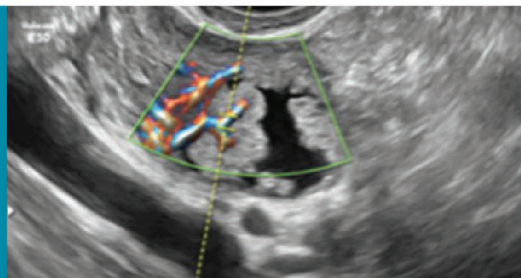
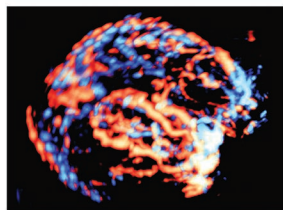




# *Donald School* Textbook of **Transvaginal Sonography**



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**4<sup>th</sup>**  
**Edition**



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# Transvaginal Assessment of the Cervix

Zorancho Petanovski

## ■ INTRODUCTION

The cervix is the anatomical part of the uterus, the topographically distal part of the body of the uterus. Histologically, the cervix is composed of predominantly fibrous tissue, unlike the muscular tissue of the uterus. The endocervical canal runs from the internal ostium to the external ostium of the cervix. Transvaginal ultrasonography (TVU) is a great tool in the hands of gynecologists in detecting pathology of the cervix either in obstetrics or in gynecology. Measuring the length of the cervix and detecting its shortening is essential in the early diagnosis of possible preterm labor (PTL). On the other hand, pathology of the cervix in gynecology, such as inflammatory changes but also malignant changes, is increasingly evolving TVU as an initial diagnostic method.

## ■ OBSTETRICS

According to the World Health Organization, the definition of premature birth is when it comes before 37 completed weeks of gestation. The problem of prematurity is very serious all over the world, namely prematurity significantly increases perinatal mortality and morbidity. Prematurity is a risk factor for more than half of neonatal deaths. Children born prematurely have a higher risk of developing pathologies in the neonatal period and in early childhood, such as vision problems, cerebral palsy, lung problems, and mental retardation.<sup>1</sup> Factors for the risk of occurrence of premature birth are not only very young age of the pregnant woman but also the age of the pregnant woman over 35 years, socioeconomic conditions, and life habits.<sup>2</sup>

Bleeding during pregnancy, spontaneous rupture of the amniotic sac, infections during pregnancy, infection due to chorioamnionitis, bacteriuria, current bacterial vaginosis, cervical insufficiency, uterine congenital

anomalies, fibroids, previous excisional cervical treatment,<sup>3</sup> multifetal gestation, fetal anomaly, and polyhydramnios<sup>4</sup> are risk factors for PTL.

All this speaks of the importance of preventing the occurrence of PTL, i.e., recognizing the risk factors for its occurrence and selecting pregnant women in the risk group for the occurrence of PTL.

The role of the cervix during pregnancy is to keep the distal part of the uterus closed and in addition to the fact that the uterus grows enormously during pregnancy compared to the period before pregnancy. Under the influence of biochemical endogenous substances at the end of pregnancy, the cervix also changes its elasticity, becomes softer, and shortens its length. These changes are necessary for the next phase, which is the dilation of the cervix, the beginning of childbirth, which results in the birth of a new individual. In certain situations (infections during pregnancy are the most frequent), this process takes place even before the due date and thus, PTL occurs.

## ■ ULTRASOUND

Studies conclude that the shortening of the length of the cervix and its softening are very important signs that indicate the risk of PTL. There are several explanations about the mechanism for the shortening of the cervix. One is the weakness of the cervix itself, i.e., cervical insufficiency, which can be the result of trauma, surgical procedures, congenital anomalies, and/or weakness of the connective tissues of the cervix. It is difficult to detect cervical shortening in early pregnancy, except in some cases (surgical treatment, trauma, etc.), because by the 14th week of gestation, almost all women, even the most high risk, have a normal cervical length (CL) in the first trimester.<sup>5</sup>

Secondly, another hypothesis is that a short CL is due to an inflammatory or infectious process as there

is a strong association between a short CL on TVU and infection. Despite the fact that the shortening of the cervix is an indicator for PTL, the exposure of the membranes to ascending infection seems to be the crucial precipitating factor as even a short closed cervix with a length of <10 mm can result in a term pregnancy.<sup>6</sup>

The recent studies have shown that the majority of asymptomatic women with CL <25 mm before 24 weeks have some contractions, more than controls with a normal cervix. It is unclear whether contractions cause the short CL, or are a result of the short cervix, or whether these two factors are working synergistically.<sup>5</sup>

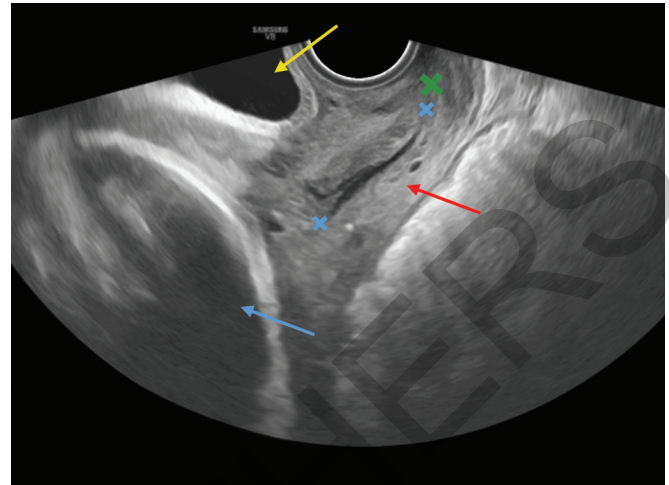
Regarding the measurement of the length of the cervix by ultrasound, there are generally two approaches, i.e., length measurement by abdominal ultrasound or endovaginal ultrasound.

The negative side of abdominal ultrasound in measuring the length of the cervix is that the bladder often needs to be filled to obtain a good image, resulting in elongation of the cervix and patient discomfort; fetal parts can obscure the cervix, especially after 20 weeks; the distance from the probe to the cervix results in degraded image, especially in obesity patients with sensitivity in the detection of PTL of 8.2%.<sup>7,8</sup>

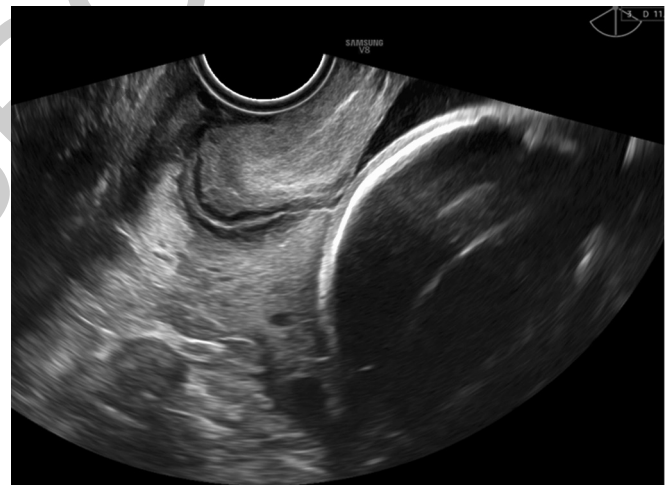
Transvaginal ultrasound in measuring the length of the cervix is superior to transabdominal ultrasound and has a significantly higher sensitivity.<sup>7,8</sup>

Certain specifics in performing transvaginal ultrasound are very important to avoid unnecessary mistakes. A longitudinal view of the cervix should be obtained and the image of the cervix needs to fill at least one half of the ultrasound screens (**Fig. 16.1**). The amniotic fluid in the lower uterine segment is assessed and then the lowest edge of the empty maternal bladder. It is very important to allow enough time for examination to view dynamic changes like uterine contractions which likewise may mimic the appearance of funneling of the internal cervical os with a normal residual CL (**Figs. 16.2 and 16.3**). Early pregnancy can cause difficulty in differentiating lower uterine segment from the endocervical canal because the gestational sac has not reached a sufficient size to completely expand the lower part of the uterus<sup>9</sup> (**Fig. 16.4**).

In the sagittal section, the length of the cervix is measured longitudinally from the internal ostium to the external ostium of the cervical canal. In the sagittal section, the length of the cervix is measured longitudinally from the internal ostium to the external ostium of the cervical canal (**Fig. 16.5**). The situation of curved



**Fig. 16.1:** Two-dimensional (2D) transvaginal view of the cervix and lower uterine segment; cervical canal length (blue Xs) right position of external os (green X); cervix (red arrow); fetal head (blue arrow); and bladder (yellow arrow).

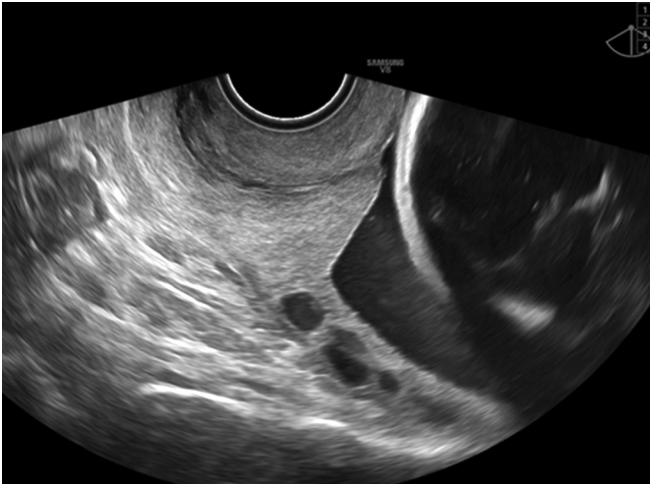


**Fig. 16.2:** Transvaginal ultrasound in measuring the length of the cervix—curved cervix.

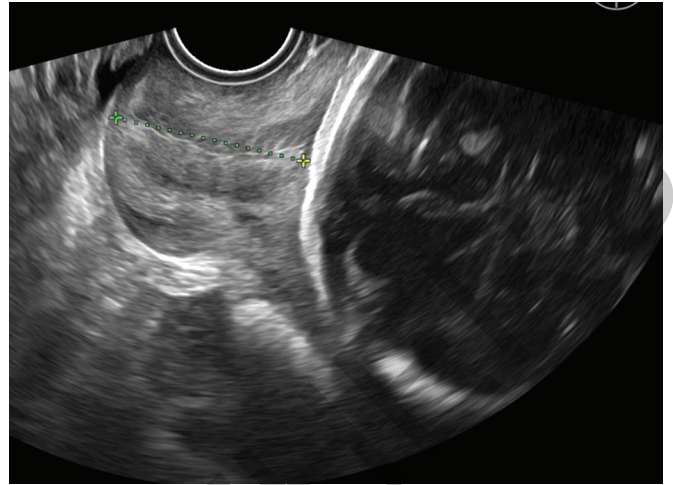
cervix is different. Then the line of the cervical canal is measured from the internal ostium to the curve and then to the external canal and the sum is taken as the final line (**Fig. 16.6**). This is often the case with long cervixes, while it is not the case with shortened ones, which are important in the assessment of PTL.<sup>9</sup>

The CL varies according to the gestational age. The median CL is 38.5 mm before 21 weeks versus 37–35 mm at 21–32 weeks versus 33 mm after 32 weeks of pregnancy.<sup>9,10</sup>

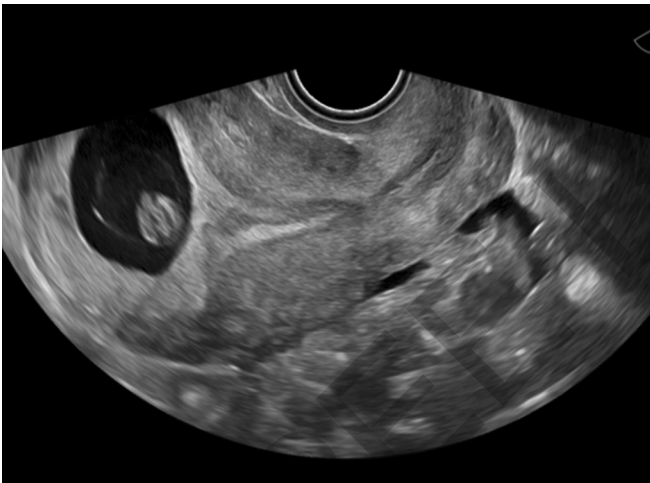
Measurement of CL by transvaginal ultrasound is a good predictor of preterm birth (PTB). From a clinical point of view, a cutoff of <25 mm in the length of the



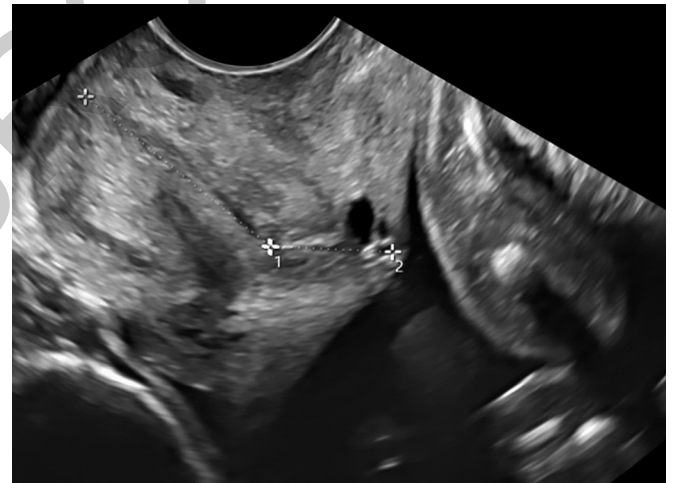
**Fig. 16.3:** Transvaginal ultrasound in measuring the length of the cervix—same case but excessive pressure on the anterior cervical lip, resulting in elongation of the cervix due to compression.



**Fig. 16.5:** Transvaginal ultrasound in measuring the length of the cervix in the sagittal section—the length of the cervix is measured longitudinally from the internal ostium to the external ostium of the cervical canal.



**Fig. 16.4:** Transvaginal ultrasound in measuring the length of the cervix at early pregnancy—difficulty in differentiating lower uterine segment from the endocervical canal because the gestational sac has not reached a sufficient size to completely expand the lower part of the uterus.



**Fig. 16.6:** Transvaginal ultrasound in measuring the length of the of curved cervix—the line of the cervical canal is measured from the internal ostium to the curve and then to the external canal and the sum is taken as the final line.

cervix after 24 weeks of pregnancy is indicative of PTB. The greater the shortening of the length of the cervix, the greater the chances of developing PTB. Women with a CL <25 mm and contractions have twice the incidence of PTB than women with a CL <25 mm but no contractions.<sup>11,12</sup>

Regarding the measurement of the length of the cervix during pregnancy, the patients are divided into two groups: Low-risk women are screened once at 18–24 weeks

of gestation and high-risk population usually begins screening at about 16 weeks of gestation and the frequency depends on the measurement result and serial screening is effective in this population.<sup>13</sup>

## ■ FUNNELING

The definition of funneling is detected separation of the internal axis of the cervical canal. The funneling width >5 mm is a significant risk factor for adverse perinatal

outcome. There are findings from the literature that funneling can be an early sign of cervical insufficiency.<sup>14,15</sup>

The role of vaginal ultrasound is to define the type and shape of cervical funneling in order to detect the risk of developing PTL. There are two forms of cervical funneling, V shape or U shape, taking into account that the T shape of the area between the endocervical zone and the uterine cavity is taken as a normal finding. The differences between these two types are that V-shaped funnel has a depth without significant width, unlike the U-shaped funnel that has the width as an important parameter and represents almost complete endocervical effacement. U-shaped funneling has higher risk of preterm delivery. However, when funneling is present with a normal residual CL, it is usually related to a contraction of the lower uterine segment and has little to no clinical significance<sup>9,16</sup> (Figs. 16.7 to 16.9).

### ■ SLUDGE

By definition, sludge is presence of hyperechogenic material floating freely within the amniotic fluid near the cervix observed by vaginal ultrasound.<sup>17</sup>

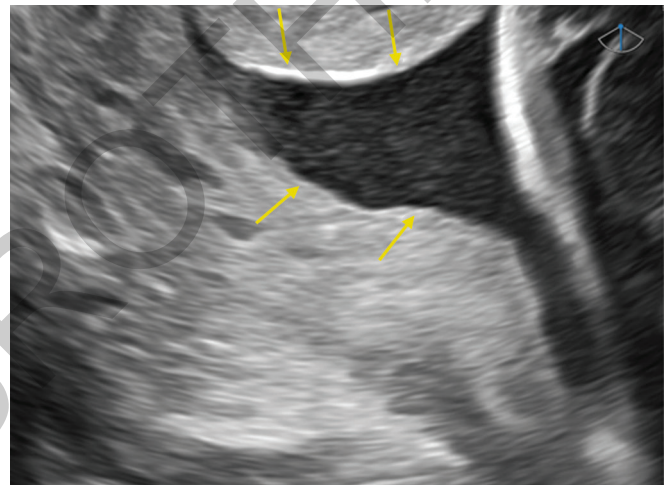
It is considered that in the first half of pregnancy, the material that is detected comes from blood clots or inflammatory process (intra-amniotic microbial biofilm has been proposed before), unlike the second half of pregnancy when the material can come from a maturational process (meconium and caseous vernix).<sup>18,19</sup>

The intra-amniotic sludge is related to unfavorable neonatal outcomes. That sludge is a risk marker for PTL, as well as an independent risk factor for high-risk patients, such as those with short cervix<sup>20</sup> (Fig. 16.10).

### ■ “MOON SIGN”

An orderly status of the cervix in the second trimester of pregnancy is a very important prerequisite for term labor. In contrast to this, the findings of cervical scarring and funneling is a risk factor for PTL and preterm premature rupture of membranes (PPROM), even about half of these patients will still deliver at term.<sup>21,22</sup>

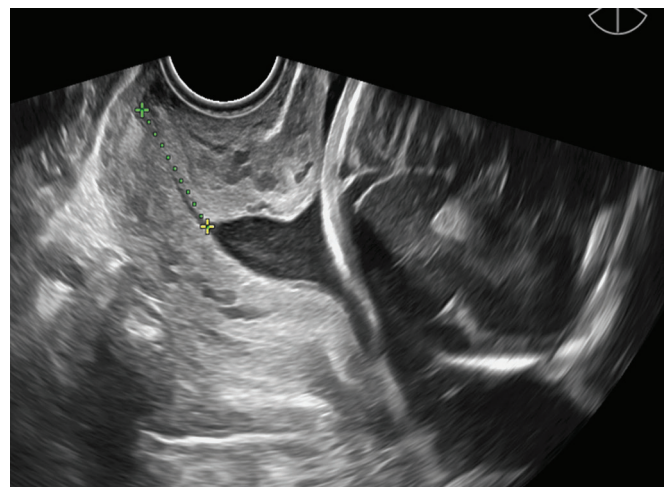
The ultrasound finding of separation of the fetal membranes, i.e., the finding that the fetal membranes do not descend into the funneling but remain at the level of the internal ostium is a very important sign that shows the



**Fig. 16.8:** Transvaginal ultrasound of cervical funneling: the U-shaped funnel has the width as an important parameter and represents almost complete endocervical effacement (yellow arrows).



**Fig. 16.7:** Transvaginal ultrasound of cervical funneling.



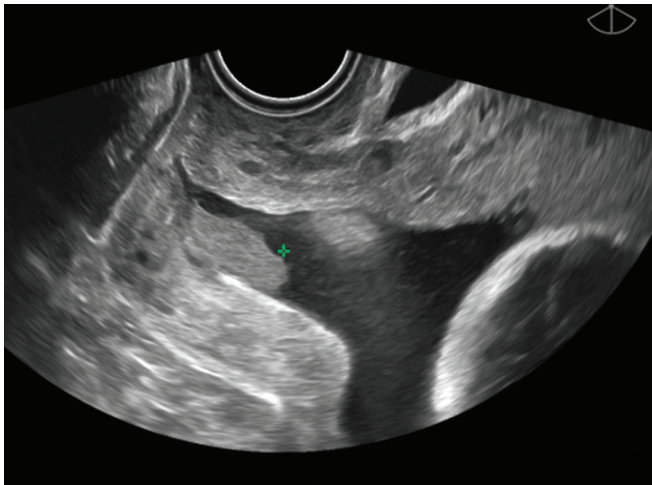
**Fig. 16.9:** Transvaginal ultrasound of cervical funneling: the U-shaped funnel and rest cervical length <2.5 cm.

risk of premature rupture of membrane (PROM). This can be especially detected in large funnels.<sup>22,23</sup>

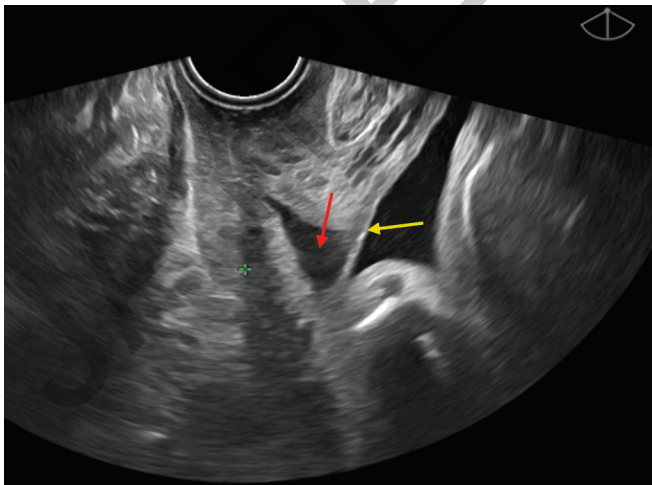
The space between the cervix and the fetal membranes resembled a moon crescent and we, therefore, propose the term “moon sign” to describe the sonographic finding of localized fetal membrane separation in combination with U-shaped funneling of the cervix and shortened CL<sup>21,24</sup> (Fig. 16.11).

### ■ CERVIX IN GYNECOLOGY PATHOLOGY

Measurement and evaluation of the cervix in gynecology is not as frequent as in obstetrics. However, ultrasound



**Fig. 16.10:** Transvaginal ultrasound of cervical sludge: The U-shaped funnel, sludge (green +), and almost not visible rest of the cervical length.



**Fig. 16.11:** Transvaginal ultrasound of cervical “moon sign”: the space between the cervix and the fetal membranes resembled a moon crescent; fetal membranes (yellow arrow); funneling (red arrow).

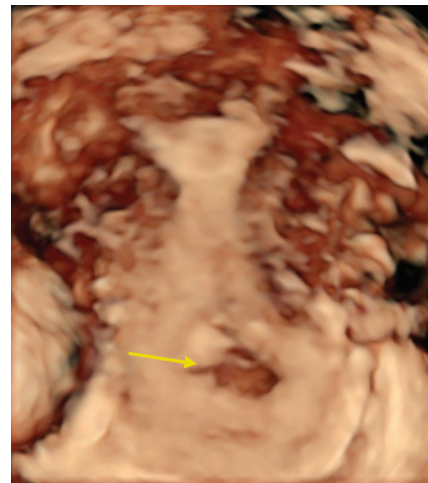
can detect changes in the cervix even during the first examination such as retention cysts on the cervix, i.e., ovule Nabothi nonneoplastic cystic lesions that occur in relation to the uterine cervix. The finding of Nabothian cysts on the cervix is very frequent and around 12% are detected at the first examination. They are most often associated with chronic inflammation of the cervical canal. They are thought to form as a result of the healing process of chronic cervicitis and represent mucinous cysts due to obstruction from an overgrowth of squamous epithelium. The transformation zone of the cervix is in a continuous process of repair and squamous metaplasia and inflammation may block a gland orifice.<sup>25</sup>

On two-dimensional (2D) ultrasound, they appear as round hypoechoic formations, while three-dimensional (3D) ultrasound shows the exact topographic location, while 3D shows that there is no intracystic color Doppler finding, which is differentially diagnostic from other findings, primarily malignant changes of the cervix.

These cysts are usually small and asymptomatic, but in rare cases, they can reach the size of several centimeters and even have the appearance of a multicystic formation on the cervix. There is an association between Nabothian cysts and infertility in women<sup>26</sup> (Fig. 16.12).

### ■ CERVICAL CANCER

According to the Global Cancer Statistics reports, cervical cancer ranks fourth both in terms of incidence and mortality. The most common cause is infection with the human papilloma virus with high-risk strains. This is a



**Fig. 16.12:** Transvaginal ultrasound of cervical Nabothian cyst (yellow arrow).

serious problem today, despite the fact that there is an established system for the prevention and early detection of cervical cancer (PAP).<sup>27-29</sup>

Regarding the histology of cervical cancer, squamous cell carcinoma (SCC) and adenocarcinoma (AC) are the most common histological subtypes.<sup>30</sup>

The spread of cervical cancer is by lymphatic, hematogenous dissemination or direct extension. Preoperative diagnosis and spread status of cervical cancer is essential to choose the appropriate treatment.<sup>31</sup>

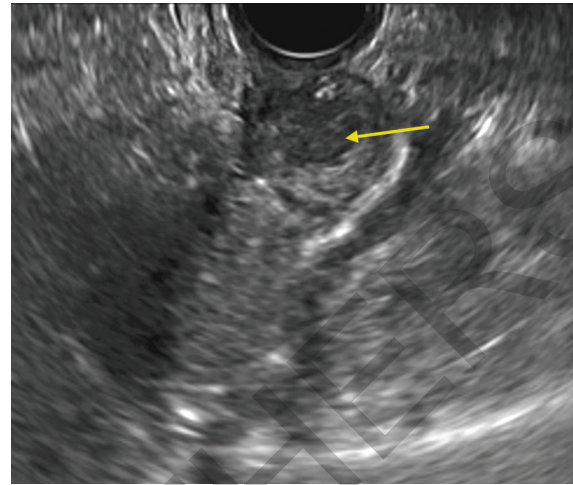
Vaginal or transrectal ultrasound detected different appearances in AC versus SCC. Namely, in AC, the ultrasound image shows an isoechoic or hyperechoic pattern relative to the surrounding stroma, unlike SCC where the image of the change is hypoechoic<sup>32</sup> (Figs. 16.13 and 16.14).

Some studies bring information that new techniques, especially 3D vaginal color Doppler, detect the difference in blood flow in normal women and in women with precancerous lesions or invasive cancers. The time of volume acquisition [flow index (FI)], the number of vessels within the volume of interest [vascularization index (VI)], and both blood flow and vascularization [vascularization flow index (VFI)] were all significantly higher in the cervical precancerous and cancer lesions' groups than in controls ( $p < 0.001$ ).<sup>33,34</sup>

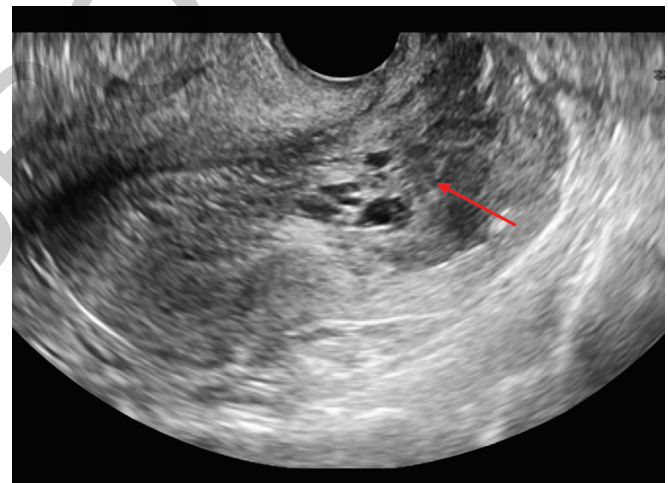
Tumor volume measurement is very important in assessing the staging and prognosis of patients with cervical cancer. 3D vaginal ultrasonography is dominant over the 2D technique. Tumor volume measurement of intratumoral vascularization showed that 3D vocal power Doppler (PD) is superior to 2D ultrasound for calculating tumor volume and vascularization when the tumor is  $>2.5 \text{ cm}^3$  and shows a complex vascularization in women with stage IB1 cervical cancer.<sup>35</sup>

Detection of new angiogenesis and the amount of vessels within the tumor (scanty-moderate or abundant) is very important in the diagnosis, staging, and prognosis of cervical cancer. Tumors with abundant vascularization were significantly associated with parametrial involvement, lymphovascular space involvement, pelvic lymph node metastases, etc.<sup>36</sup> (Figs. 16.15A and B).

Three-dimensional color Doppler provides an excellent image of the vascular network of the tumor. It is interesting that this network of blood vessels is more linear in squamous carcinoma and translesional "water flow" sign in AC<sup>37</sup> (Figs. 16.16 and 16.17).



**Fig. 16.13:** Transvaginal ultrasound of cervical squamous cell carcinoma (SCC): The image of the change is hypoechoic (yellow arrow).

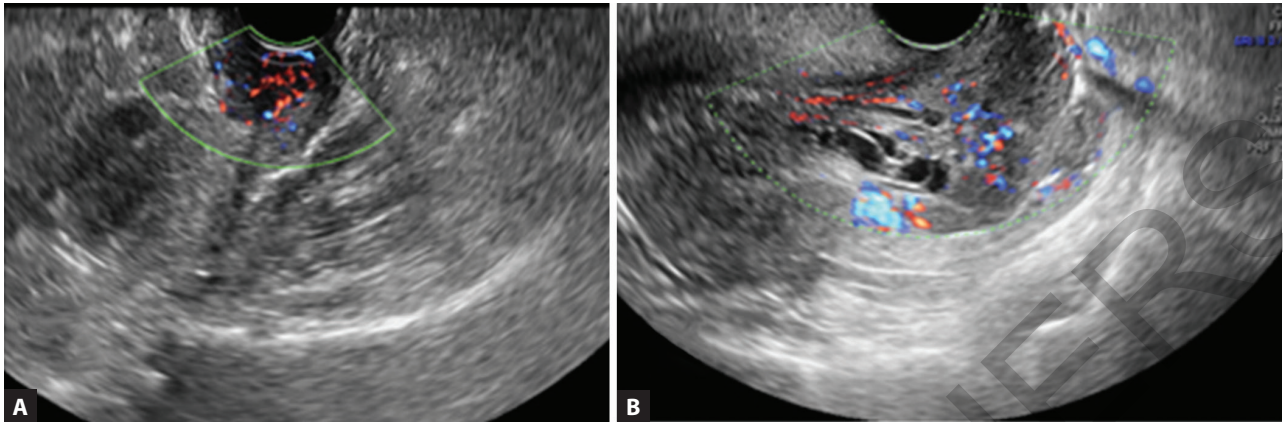


**Fig. 16.14:** Transvaginal ultrasound of cervical adenocarcinoma: The ultrasound image shows an isoechoic or hyperechoic pattern relative to the surrounding stroma (red arrow).

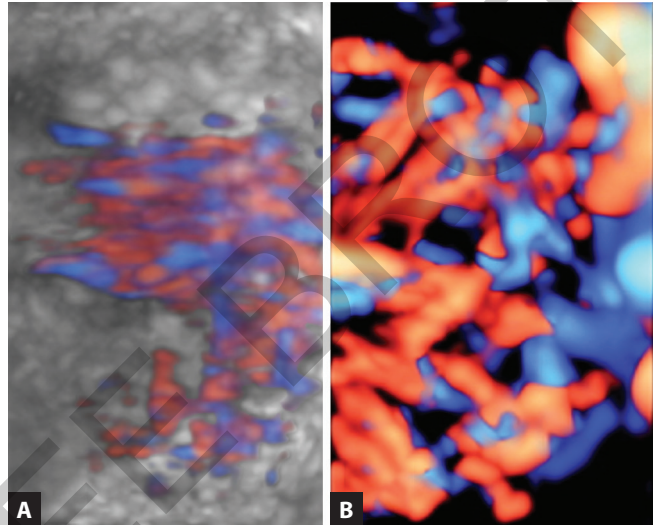
## CONCLUSION

Measuring the length of the cervix up to the 14th week of pregnancy does not have any special significance. After that transition, ultrasound findings of shortening of the cervix, funneling, and sludge bring the moon sign and valid information about the risk of PROM and PTL.

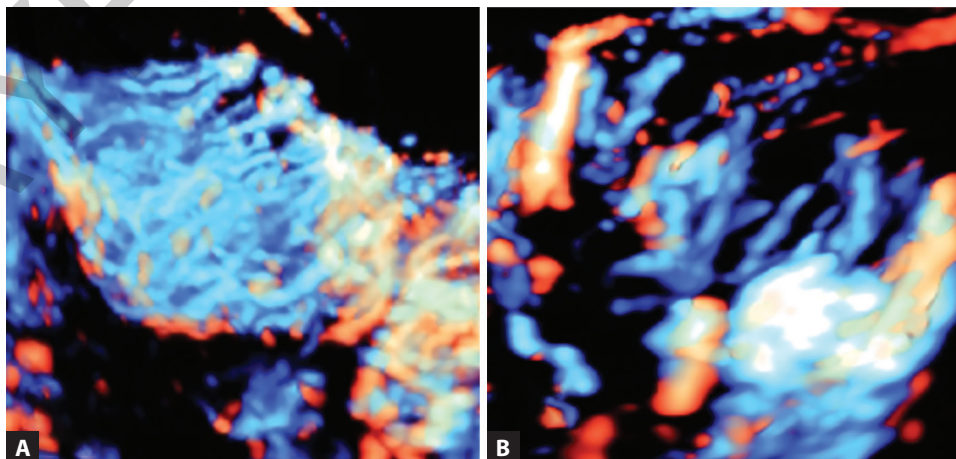
Ultrasound, particularly new techniques such as 3D/four-dimensional (4D) ultrasound and 3D/4D color Doppler, provides excellent insight into the pathology of the cervix. Preoperative examination provides useful data in terms of an adequate therapeutic approach in malignant diseases of the cervix.



**Figs. 16.15A and B:** Transvaginal two-dimensional (2D) color Doppler ultrasound of cervical carcinoma: (A) Rich vascularization with linear, scanty-moderate vascular pattern of the blood vessels in squamous cell carcinoma; (B) Rich vascularization with abundant vascular pattern of the blood vessels in adenocarcinoma.



**Figs. 16.16A and B:** Transvaginal three-dimensional (3D) power color Doppler ultrasound in squamous cell carcinoma: Rich vascularization with linear network of blood vessels.



**Figs. 16.17A and B:** Transvaginal three-dimensional (3D) power color Doppler ultrasound of adenocarcinoma: Rich vascularization with translesional "water flow" sign vascular pattern of the blood vessels.

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