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Ultrasound of the female internal genitalia

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Introduction

To investigate the female pelvis by transabdominal sonography (TAS) the bladder should be kept distended by a sufficient amount of urine. In this way, the uterus can be clearly detected as a pear-shaped organ located in the middle of the pelvis. Owing to its dimensions and central position, the uterus is the point of reference from where to start investigating the internal female organs. The principal planes are the longitudinal [Figure 1] and the transverse ones [Figure 2].

Figure 1 Transabdominal longitudinal section of a female pelvis with a full bladder. The uterus can be easily visualized as a peer-shaped organ behind the posterior bladder wall.

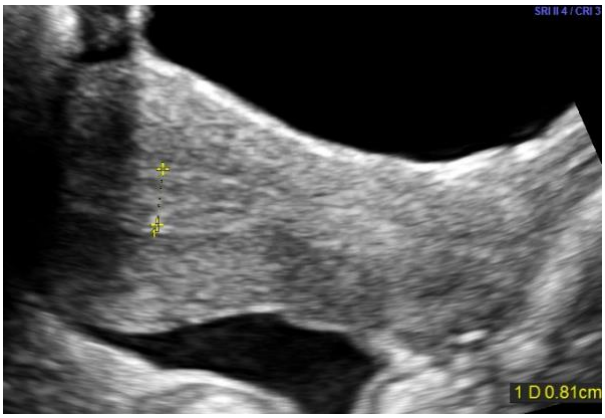
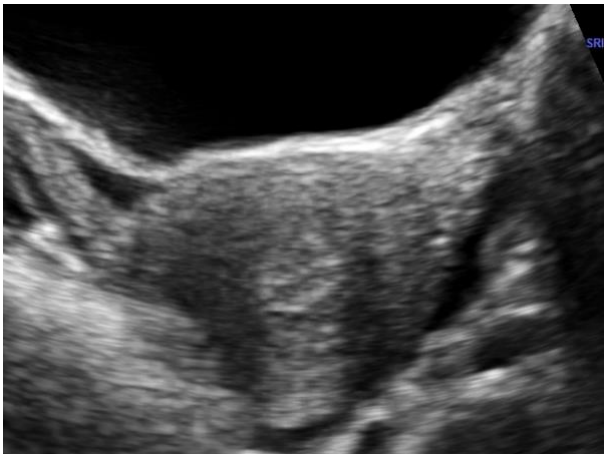


Figure 2 Transabdominal transverse section of the uterus.



In some cases it is possible to obtain a variety of intermediate planes, such as a semicoronal section. The version and flexion angles of the uterus are easy to recognize. Transvaginal ultrasound (TVS) can provide additional support for TAS because of the proximity of the probe to the pelvic organs and the use of high frequencies, which can produce better ultrasound images. The three main parts of the uterus clearly distinguished on TAS are the body, the isthmus and the cervix [Figure 3].

Figure 3 Transabdominal section of an antiverted uterus in the case of an empty bladder. The uterus can be measured in two orthogonal diameters (longitudinal and anteroposterior), and the body, the isthmus and the cervix can be easily recognized.

The volume of the uterus varies depending on age, parity and the hormonal status of the patient [(1-3)] (Table 1 and 2).

Table 1. Normal dimensions of the uterus before puberty (Modified from Orsini, 1984).

		Uterine diameter (cm)		Uterine volume (cm^3)
Age	No. Pts.	**Longitudinal**	Anteroposterior	Anteroposterior

(years)		diameter	diameter of the body	diameter of the cervix	
2	7	33.1±4.4	7.0±3.4	8.3±2.0	1.98±1.58
3	8	32.4±4.3	6.4±1.3	7.6±2.2	1.63±0.81
4	15	32.9±3.3	7.6±1.8	8.6±1.8	2.10±0.57
5	7	33.1±5.5	8.0±2.8	8.4±1.8	2.36±1.39
6	9	33.2±4.1	6.7±2.9	7.5±1.8	1.80±1.57
7	9	32.3±3.9	8.0±2.2	7.7±2.5	2.32±1.07
8	11	35.8±7.3	9.0±2.8	8.4±1.7	3.12±1.52
9	11	37.1±4.4	9.7±3.0	8.8±2.0	3.70±1.62
10	13	40.3±6.4	12.8±5.3	10.7±2.6	6.54±3.78
11	13	42.2±5.1	12.8±3.1	10.7±2.6	6.66±2.87
12	6	54.3±8.4	17.3±5.3	14.3±5.2	16.18±9.15
13	5	53.8±11.4	15.8±4.5	15.0±2.4	13.18±5.64

Before menarche the uterine body is approximately half the length of the cervix, at menarche the uterine body and cervix are similar in dimensions, and in women of fertile age the body is approximately double the length of the cervix.

Table 2 Main uterine diameters during different stages of life (Modified from Platt, 1990.)

	Longitudinal diameter	Anteroposterior diameter	Transversal diameter	Volume
Prepubertal	**1–3 cm**	**0.5–1 cm**	**0.5–1 cm**	**10–20 ml**
Multiparous	**8 cm**	**4 cm**	**5 cm**	**60–80 ml**
Nulliparous	**6 cm**	**3–4 cm**	**3–4 cm**	**30–40 ml**
Post-menopausal	**4–6 cm**	**2–3 cm**	**2–3 cm**	**14–17 ml**

Normal endometrium

The endometrium is easily seen on TAS. The endometrium appears as a hyperechoic line within the anterior and posterior myometrial walls. To evaluate the endometrium accurately and measure its thickness, the optimal technique is TVS, which permits a better spatial and contrast resolution. On a longitudinal scan through the uterine corpus the entire length of the endometrium can be seen. In this scan, with the uterus magnified to occupy >75% of the screen and the focus towards the endometrial stripe, the correct measurement of the endometrial thickness can be obtained by positioning the callipers proximally and distally at the level of the myometrial-endometrial junction. The probe should be then tilted laterally in both directions to visualize the endometrium from one tubal ostium to the contralateral. If the uterine cavity is deformed by myomas or adenomyosis the endometrial stripe may not be recognisable.

Pre-pubertal age

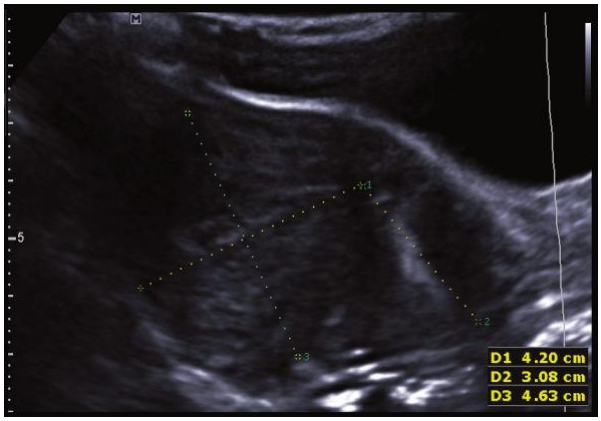
In patients of pre-pubertal age, the study of the endometrium is only possible transabdominally, and therefore is always difficult. The endometrium of the neonate is thick and hyperechogenic because of the effect of maternal placental hormones. After the first week of life the endometrium becomes atrophic and appears as a thin line (<1 mm) until ovarian hormonal activity begins, when it begins to proliferate and thicken [(4)]. The study of the endometrium and ovarian volume and morphology are important during this period for diagnosing delayed or precocious puberty [(5)]. In cases of delayed puberty the endometrium appears atrophic and thin, indicating a lack of ovarian hormonal activity; in comparison, in cases of early puberty the endometrium appears thickened and hyperechogenic.

Reproductive age

In women of reproductive age the cyclical production of ovarian hormones induces histological modifications to the endometrium, which are shown on TAS as variations in thickness and echostructure.

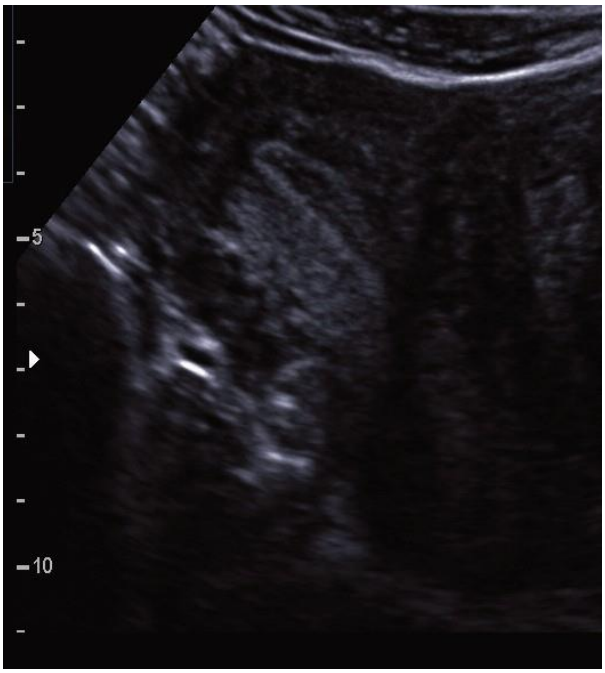
During the menstrual phase, inhomogeneous material can be seen inside the uterine cavity [Figure 4] due to the presence of blood mixed tissue from the shedding of the functional layer. Therefore, this phase of the cycle is not recommended for the study of endometrial pathologies.

Figure 4 **Transabdominal section of a retrofexed uterus. The fundus is pointing toward the rectum. During menstruation the endometrium can be identified as an inhomogeneus stripe within the two myometrial layers.**



In the early proliferative phase, the endometrial cells increase in number and size and the endometrium appears as a well-defined median line, which is more echogenic than the surrounding myometrium. In the late proliferative phase, and until ovulation, the endometrium is seen as a “trilaminar” structure [Figure 5] due to the presence of two adjacent hypoechogenic layers surrounded by hyperechogenic lines.

Figure 5 Anteverted uterus with a typical “trilaminar” endometrium.



The two hypoechogenic endometrial layers correspond to the mucosa that covers the anterior and posterior walls of the uterus, the external lines are determined by the acoustic interface of the endometrium and myometrium whereas the median line is determined by the juxtaposition of the two endometrial layers inside the uterine cavity.

In the secretive phase the endometrium becomes increasingly hyperechogenic and thickened [Figure 6] due to the effect of progesterone.

Figure 6 Transabdominal section of an antiverted uterus distorted by the presence of an intramural leiomyoma in the posterior uterine wall. During the secretory phase the endometrium is markedly hyperechoic.

Post-menopause

With the cessation of ovarian hormonal activity, the endometrium becomes thin and atrophic. It appears as a thin hyperechogenic median line, contrasting with the myometrium. The normal thickness of the physiological post-menopausal atrophic endometrium is generally less than 5–6 mm [(6-8)].

It is not unusual to see a moderate quantity of anechoic fluid inside the uterine cavity in such a way the atrophic endometrial mucosa of the anterior and posterior walls assumes the appearance of two well distinct lines delimiting a central anechogenic area. In these conditions, the two anterior and posterior endometrial layers are visible because of fluid acting as a contrast medium. The endometrial thickness can be calculated by adding the thicknesses of the two parts.

Pathology of the endometrium

Endometrial hyperplasia

Endometrial hyperplasia is characterised by a continuous spectrum of histological alterations in the number and histological structure of the glands, and the growth and morphology of the cells. On ultrasound, the endometrium usually appears as irregularly thickened and markedly hyperechoic in contrast to the surrounding myometrium. Sometimes small anechoic cystic spaces are visible in the endometrium due to the accumulation of mucus produced by the hyperplastic glands.

Endometrial polyps

Endometrial polyps are ovoid sessile or pedunculated masses of varying size that extend out into the uterine cavity. They can be single or multiple, their consistency is gelatinous and they are compressed by the walls of the uterus to fill a part of the uterine cavity. They can be microscopic or very large, sometimes filling the entire endometrial cavity, which makes a differential diagnosis with hyperplasia and endometrial cancer difficult. In the majority of cases it is possible to see the polyp as a hyperechogenic focal lesion surrounded by endometrium of normal appearance. It is essential to use the maximum magnification of the ultrasound system to look for the oval profile of the polyp inside the, apparently uniformly thickened, endometrium. Visualising endometrial polyps is easier during the proliferative phase of the cycle because the endometrial mucosa is thinner and the surrounding endometrium is hypoechoic, which acts as a contrast agent. In the luteal phase the endometrium assumes the same echogenicity as the polyps, making their visualisation more difficult. The polyps are fed by vessels that can be easily detected on colour Doppler ultrasound as a colour line crossing the endometrial-myometrial interface.

Submucous myomas should always be taken into consideration in the differential diagnosis of endometrial polyps. They are less echogenic than the surrounding myometrium and are round in shape, possibly with internal calcifications and a cone of shadow.