

IMAGING OF OVARIAN LESIONS

ULTRASOUND: BASIC EXAMINATION

Focal ovarian lesions in children are often discovered accidentally during imaging tests performed for other reasons.

The most common test is the pelvic ultrasound (reproductive organs) through the abdominal wall. Transvaginal (performed only in sexually active girls), transperineal or transrectal ultrasound examinations are performed in case of unavailability/inefficiency of other imaging methods since they are considered invasive.

Ultrasound through the abdominal wall

Ultrasound of the reproductive organs performed through the abdominal wall requires proper preparations: filling up the bladder and removing excess gas from the digestive tract (best done with simethicone). A well-filled bladder moves bowel loops creating a convenient acoustic window enabling proper imaging of the reproductive organs and other structures of the pelvis.

IMPORTANT — preparations for ultrasound

- — In newborns and infants, it is optimal to perform ultrasound approx. 30–45 minutes after feeding, and start with the evaluation of the urinary bladder and the adnexa.
- — in girls between the age of 3 and 5, the test should be performed approx. 30–45 minutes after oral administration of still water (approx. 250–300 ml) or intravenous administration of liquids.
- — in girls over the age of 6, the test is usually performed approx. 45–60 minutes after oral administration of still water (approx. 500–1000 mL) or when the child experiences strong urinary urgency.

Technical aspects

In children, ultrasound of the pelvis minor is performed by means of the following probes:

- — microconvex (usually 5–8 MHz),
- — convex 3–5 MHz.

If pathologies are found, imaging by means of high frequency (7–20 MHz) linear probes is often useful as well. Doppler techniques and, in the case of the newest equipment, tissue blood flow imaging techniques ex. SMI [Superb Microvascular Imaging] (Canon Medical Systems Europe), MVI [Micro Vascular Imaging] (GE Healthcare) and other, which allow to evaluate the flow in small vessels, constitute a significant and valuable tool in the evaluation of the adnexa. Volumetric imaging (3D/4D) is useful in evaluating the ovaries, however, due to rarely available probes, it is not performed frequently. Strain or Shear Wave Elastography (SWE) is also utilized in the process of differentiation be-

tween benign and malignant ovarian lesions. Nevertheless, this method requires further studies. Information about the use of ultrasound contrast agents of the newest generation [e.g. SonoVue® (Bracco Spa, Milan, Italy)] has also been appearing in recent years.

Ultrasound description elements:

- three dimensions: TR x AP x CC;
- volume score (counted with the formula: $V = TR \times AP \times CC \times 0.5236$);
- structural score: cystic/mixed/solid, septa, calcifications;
- Ueland index (see below);
- extent, location of the lesion in relation to other organs;
- presence of ovarian tissue in the lesion (ovarian crescent sign);
- presence or lack of liquid in the pelvis;
- presence and characteristics of vascularization of the ovaries and the lesion (central, peripheral, mixed) and evaluation of flow parameters: end-diastolic velocity (EDV), peak systolic velocity (PSV), pulsatility index (PI), resistance index (RI), and systolic to diastolic ratio (S/D ratio);
- lesions in the pelvic and the retroperitoneal lymph nodes;
- size and volume of the other ovary (the formula above);
- evaluation of the uterus (3 dimensions): TR in the transverse section, AP and CC in the sagittal section, endometrial thickness measured in the sagittal section;
- conclusions from the test: initial diagnosis, indication to a possible differential diagnostics or a necessity to expand diagnostics.

Ueland index (MI, morphology index) — an ultrasound-based scoring system that include the tumor volume along with its structural appearance. In the Ueland scoring system, two descriptive components are evaluated: tumor volume and morphological structure. There is a point scale (0–5) in each category, with the total points varying between 0 and 10 for each tumor.

CHARACTERISTIC FEATURES OF PARTICULAR LESIONS IN AN ULTRASOUND TEST

- Functional lesions — usually up to 8 cm (diameter). It may be a simple cyst (most common), a complex cyst (mixed tumor) and a solid tumor (rare).
- Benign lesions and malignant neoplasms — no fully reliable methods of differentiation between non-neoplastic and neoplastic lesions as well as benign and malignant ones have been found. Nevertheless, many publications emphasize that cystic lesions are usually of benign character. Another feature of a tumor that

| STRUCTURAL SCORE | |
|--|---|
| Smooth wall, sonolucent | 0 |
| Smooth wall, diffuse echogenicity | 1 |
| Wall thickening (< 3mm), fine septa | 2 |
| Papillary projection (≥ 3mm) | 3 |
| Complex, predominantly solid | 4 |
| Complex, solid, and cystic areas with extratumoral fluid | 5 |
| VOLUME SCORE* | |
| < 10 cm ³ | 0 |
| 10–50 cm ³ | 1 |
| > 50 to 100 cm ³ | 2 |
| > 100 to 200 cm ³ | 3 |
| > 200 to 500 cm ³ | 4 |
| > 500 cm ³ | 5 |

*measurements in three perpendicular planes, volume score counted with the formula: TR x AP x CC x 0.523

may influence the final diagnosis is its size. An analysis of available literature suggests that most malignant lesions are larger than 8–10 cm in diameter. Few of the publications analyze the sizes of benign lesions in comparison with malignant ones in detail, however, all of them emphasize the difference in size. Therefore, a solid or mixed lesion of a considerable size should always be suspected of malignancy. There are also algorithms utilizing specific ultrasound imaging methods (e.g. ovarian crescent sign) that allow, according to the authors, to confirm malignancy with a high degree of efficiency. Such studies seem very promising, nevertheless, these are still single works conducted by single centers that require verification involving a large and diverse group of patients. Even so, OVARIAN CRESCENT SIGN has been determined together with a so-called Ueland index (where the size and character of a lesion are collectively evaluated) in published recommendations of the American Pediatric Surgical Association as a recommended form of imaging diagnostics differentiating between malignant and benign lesions.

- c) A specific type of an ovarian lesion with characteristic features in an ultrasound test is a teratoma.

Mature teratoma: an image of the cyst may present as a classic cystic lesion with an echogenic solid nodule projecting into its interior (Rokitansky nodule) or as a complex lesion, in which hyperechogenic solid masses, composed most frequently of fat and hair, create an acoustic shadow. Sometimes, the hair component floats freely in the cyst's fluid projecting an image of hyperechogenic lines known as dermoid mesh. If a cyst contains teeth or bone elements, they may also be visible as strongly hyperechogenic elements. A rare visual phenomenon characterized

by the presence of hyperechoic, spherical areas of various sizes suspended freely and movable in the hypoechoic fluid within the cystic component of the tumor constitutes ovarian "floating ball sign". Numerous balls in one lesion might be visualized but even a single ball referred as the "Pokeball sign" is considered pathognomonic for mature ovarian teratoma.

Summarizing, teratomas are lesions containing fat and calcifications with various amounts of the liquid component. However, in the case of large lesions and in prepubescent girls, the diagnosis may be hindered. A large lesion may obscure the image of the ovary. It is also difficult to examine the whole lesion. In the case of very large lesions, the evaluation of the other gonad can be hampered as well. Moreover, transabdominal examination is usually more difficult than transvaginal one. The same restrictions apply in the case of other ovarian pathologies in children.

Immature teratoma: in an ultrasound examination, the image of an immature teratoma is non-specific, however, it is believed that the dominance of solid elements constitutes a differentiating factor. These lesions are also examined for a possible presence of fat, mural nodules and calcifications.

- d) Ultrasound examination in malignant epithelial neoplasms:
- multilocular lesions;
 - solid foci in the tumor (nodular or papillary);
 - presence of metastases;
 - ascites;
 - bilateral lesions;
 - increased vascular flow.

COMPUTED TOMOGRAPHY (CT) AND MAGNETIC RESONANCE IMAGING (MRI)

Ultrasound is undoubtedly a basic examination providing various significant information. Nevertheless, in the case of large lesions and those of complex structure (mixed and solid), it may be non-specific. Expanding the diagnostics to include MRI or CT may be useful if malignancy is suspected. Computed tomography, despite its wide availability, is not commonly used in the initial evaluation of pelvic organs, especially in girls. It is more useful in the process of staging.

Magnetic resonance imaging remains an examination of choice in the imaging diagnostics of the pelvis in the case of lesions found on ultrasound. MRI, together with the use of Apparent Diffusion Coefficient (ADC) maps, Diffusion Weight Imaging (DWI) sequences and MR spectroscopy (MRS), enables a precise determination of the starting point of a neoplasm, the extent of a process and the character of a lesion. In proper sequences, it is possible to make a more efficient distinction of the tissue compounds, e.g. the presence of fat tissue, hemosiderin deposits, etc. However, as is the case with the other imaging techniques, it does not

ensure the ultimate determination of malignancy. It should also be noted that MRI requires time and sedation in younger children. That is why the success of the application of these additional methods also depends on the availability of anesthesia or the reliability and experience of the radiologist describing the examination. As far as teratomas are concerned, there are publications confirming the usefulness of CT or MRI examinations, however, characteristic features of a teratoma may be more clearly visible in the case of the mature teratoma rather than the immature one. Therefore, they are more often recommended in the process of staging and the assessment of a lesion's suitability for resection (including a determination of the place of resection: the border between ovarian tissue and a neoplastic lesion).

In order to increase the level of clarity of the recommendations and treatments algorithms we have decided to concentrate on ultrasound test descriptions as the most available and standard imaging technique. A detailed description of MRI and CT techniques goes beyond the framework of this study.

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