

Submitted: 17.07.2016  
Accepted: 23.08.2016  
Published: 31.03.2017

## Current standards in abdominal cavity ultrasound examination in children

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DOI: 10.15557/JoU.2017.0006

### Key words

ultrasonography,  
standard,  
child,  
newborn

### Abstract

Technological progress forces us to present after several years the updated standards in ultrasound examination of newborns, infants and older children. It should be emphasized that the examination of the youngest patients requires one to use high-class equipment. Lack of cooperation on the part of the child and imaging small structures constitute a huge challenge for the examiner. The work presents equipment requirements, the technology of examining the abdominal cavity in children and the manner of preparing the examination result. Moreover, modern expectations as regards ultrasound surgery equipment, where children are subject to examination have been presented. The minimum set of transducers the ultrasound apparatus should be equipped with has also been pointed out as well as the minimum requirements concerning image recording. Extending the scope of transducers over "minimum" significantly raises the imaging possibilities in pediatrics. Standard preparation of children for ultrasound has been discussed, taking into consideration the age of the patient and indications. It is essential to understand that it differs from standard preparation for examination in the case of adults. The technique of examining the abdominal cavity has been described, which enables the repeatability of examinations and ensuring making all the available structures visible. It proves imperative especially in the case of a large number of examinations. Attention should be paid particularly to the urinary system imaging – owing to the greatest incidence of congenital diseases in that system.

### Apparatus

Examination of children requires a high-class equipment with wide range of frequencies – minimum 3.5–12 MHz. The device should be equipped with factory software for pediatric and neonatal examinations and make it possible to record own user settings. It is essential to equip it with Doppler methods, including Color Doppler and Power Doppler<sup>(1–5)</sup>.

Required parameters:

- 1) measurements of the distance, circumference, cross-section area, volume;
- 2) Doppler measurements package – at least the velocity of flow, resistance index (RI), pulsatility index (PI), curve increase time;
- 3) automatic outline of the Doppler curves;
- 4) enlarging the image in real time and stopped time;
- 5) cine-loop option (recording the last few dozens of images);

- 6) archiving the images in the built-in hard disk, export to the hospital network;
- 7) the possibility to save images in another standard than DICOM, e.g. JPG, flash memory;
- 8) printing pictures on the attached printer.

### Transducers

The apparatus used for abdominal cavity examination in children must be equipped with a wide range of transducers making it possible to assess the abdominal cavity of a newborn, older child and a teenager.

Minimum set of probes<sup>(2–4)</sup>:

- 1) convex abdominal transducer, frequency 3.5–6 MHz;
- 2) microconvex transducer to examine newborns and small children, minimum 5–7 MHz;
- 3) linear transducer 5–12 MHz.

Transducers with the specified frequencies should be treated as the minimum required equipment. Expanding the range of frequencies, in any type of transducer, is highly recommended.

All transducers should feature imaging option in Color Doppler.

## Examination technique

### Child preparation for examination

The child being examined should have full bladder, therefore 30–60 minutes prior to the examination, they should be provided with a still drink. Newborns are examined after being breast-fed. Examination on an empty stomach is not required, unless the pathology being diagnosed is related to the gall bladder and the bile ducts<sup>(1,3)</sup>. In such cases, fasting for 3 hours is enough.

### Examination scheme

The examination should be repeatable. It covers a series of cross-sections of abdominal cavity organs. The examination is performed in a recumbent position, on the back, on both sides, or possibly on the stomach. Examining small children sitting on the parents' lap is admissible<sup>(1-3)</sup>.

Examination in the case of children usually starts with the assessment of the urinary bladder in transverse and longitudinal cross-sections.

The next step is the examination of the upper part of the abdominal cavity from right to left:

- 1) longitudinal cross-sectional study from the right hepatic lobe and the right kidney towards the spleen and the left kidney;
- 2) transverse cross-section under the xiphoid process – show the lower section of the right vestibule, hepatic veins, liver, bile ducts, gall bladder, portal system, pancreas, aorta and the inferior vena cava;
- 3) sagittal cross-sections going through the inferior vena cava and the aorta;
- 4) oblique cross-sections are utilized for best imaging of the examined structures (e.g. liver, gall bladder, celiac trunk).

The next stage of the examination is the assessment of the mesogastrum and epigastrium. In this case, high-frequen-

cy transducers are used, especially useful to assess intestinal walls. The Puylaert graded compression technique is useful at this point. Linear transducers are recommended to assess intestinal walls.

In the case of lack of the possibility to measure the length of the kidneys in the above cross-sections, the assessment of kidneys and their measurement are performed in a recumbent position on the stomach. It should be borne in mind that repeatable measurement results are obtained in the case of children in repeatable positions and using the same transducers<sup>(3-5)</sup>.

Ultrasound imaging of the abdominal cavity in children with urinary system diseases should be completed with the assessment of the volume of urine residue after micturition. The youngest children may be "excluded" from that part of the examination.

### Examination description

Examination results are composed of two parts:

- 1) written;
- 2) image.

The written part should include the naming of imaged organs and their structure assessment. In the case of observing a pathology, their location and structure should be described and the impact on the neighboring organs. Each examination of a child should determine the size of the kidneys. Other measurements (of the liver, spleen, pancreas, intestinal walls) are performed in the case of clinical indications or the observed lesions in the examination. The written part should be finished with a conclusion and possibly containing suggestions for further procedure.

Image documentation is necessary in the case of observing a pathology. The images are supposed to contain important elements of the lesion, show its location and the relation to the adjoining organs. The image documentation must contain clearly recorded patient's data as well as the time of the examination.

### Conflict of interest

*Author do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.*

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