Apparative Quality Assurance of Ultrasound Imaging Equipment

Test methods for daily checks („5 min-checks“)

AUStrian Test kit™

Type: Basic

developed by

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Introduction

The methods used in the following checks are able to give the user a rough survey of the status and function of the ultrasound device („5-min Check“). These checks should be performed daily before the first patient is examined to get to know potential damages or deteriorations of the device including the transducers, the monitor and the hardcopy-unit (printer) to guarantee an optimal image quality.

The listed tests are

- fast to perform (ca. 5 min),
- easy-to-handle,
- need only simple available lab-tools, **but no special test object**, and **are effective and suitable**!

It is possible after performing these tests to quantify the following performance-parameters of an ultrasound device:

- mechan. damages of the device
- element losses of the transducer
- scan line correlation
- size of active element area
- function of monitor
- grey-level comparison monitor/hardcopy-unit

It is allowed to use and copying these test methods and concepts for testing purposes as long as the origin source is named within final publications or within oral announcements (author, institution etc.)

For possible mistakes, errors or consequences, which result out of these methods, no liability will be given.

Upon request we are sending you information or advice you about suitable test devices for Quality Assurance or about further procedures to quantify and measure:

- Aperture
- Dead zone
- Axial/lateral/functional resolution
- Depth- & Measurement calibration
- Scala/Cursor-consistency
- maximum penetration depth
- Contrast range
- Uniformity
- Sensitivity
- Noise limit
- etc.

with the **AUStrian Test kit™ (Type Standard)**

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Which tools are needed for these checks?

- **a ruler** (Test 2)

- **a non-permanent marker** (Test 2)

- **a paperclip or a thin wire** (diameter ca. 1 mm)

A complete composition of suitable tools (and more) for performing Quality Assurance checks can be found in our *AUStrian Test kit™*
The „5-min Tests“

1 Visual Inspection (images)
   (this will be performed before each other check !)

Fig.1: essential items of the visual inspection: housing of transducers and coloured protection foil of the transducer (1), cables (2,3), trackball (4)
1. **Visual Inspection**  
(this will be performed before each other check !)

*Test devices*: none  
*Pre-Settings*: none  

*Procedure*:  
1. Check cables of transducers and other units (printer etc.) for damages.  
2. Are the cables connected faultlessly ?  
   Are some connections damaged ?  
3. Look for cracks or split-offs at the transducer housings and at the active transducer zone (colored protection foil on the transducer surface).  
4. Is the transducer clean/ free of coupling gel or other substances (otherwise clean it !)  
5. Are the keyboard and trackball working faultlessly ?  
6. Are the air filters of device cleaned (at the back of the device)?

*Tolerance*: none  
*Test interval*: daily  
*Evaluation*: note down errors or problems in a data sheet  
*Remarks*: Method listed in [1,10,11]

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**Technical Relevance**: To protect patient and user of electrical risks.  
**Clinical Relevance**: To protect patient and user of damaged cables or housings and infections.
Checking the working of the transducer elements, scan line correlation, and detection of the size of the active scanning area (images)

Fig. 2a: Representation of the test procedure

Fig. 2b: Resulting ultrasound image of the test performed above
2 Checking the working of the transducer elements, scan line correlation, and detection of the size of the active scanning area

Test devices: paperclip or thin wire, coupling gel

Pre-Settings: none

Procedure:
1. Turn on the ultrasound device. repeat (2-3 times)
2. Take the thin wire or paperclip and move it along the active scanning zone of the transducer (optionally with gel, Fig. 2). Be aware of the scanning order direction of the transducer (arrow marking on the housing to prevent reversed display of object). Move the object along the appropriate direction.
3. Look for losses or changes of echo display within the B-Mode image (Reverberations of the wire) or changes in moving. A good coupling should be guaranteed (Fig. 2b)!
4. If the thin wire reaches the edges of the transducer (left and right), look at which location the image is displayed and where not (mark these positions with a marker).

End
4. Note down changes of widths within the displayed object, flickering or losses of representation together with the object’s position in a protocol.
5. Measure the length of the active scanning area with a ruler according to the marks set by the colored marker and note it down in the protocol.

Tolerance: none

Test interval: daily

Evaluation: note down errors or problems and size of active scanning length in a data sheet

Remarks: Definition in [7]; Method in [5;8]; procedure & test interval new

<table>
<thead>
<tr>
<th>Technical Relevance</th>
<th>Testing the scanning order and detection of separate element losses within the transducer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Relevance</td>
<td>Changes in sensitivity or total losses of elements can reduce the image quality. If elements are lost that are at the edges of the transducer the resulting active scanning area is reduced.</td>
</tr>
</tbody>
</table>
3  Function & Quality of the Monitor (images)

**Fig. 3**: Photo of the monitor being in setting <ext. Video-Input>, no errors are detectable in this example; only the smaller size of image is seen at the lower edge of the display
3  Function & Quality of the Monitor (images)

Test devices : none

Pre-Settings : none

Procedure : 1. Turn on the ultrasound device or press “new patient” knob.
2. Set Monitor-input to < ext. input > or < VCR-input >
3. Are diagonal white lines visible ?
4. Are flickerings visible ?
5. Are horizontal / vertical movements of the image detectable ?
6. Minimize brightness and contrast of the display.
   Are burned-in (dark) areas visible on the display (Fig.3) ?
End
7. Note down changes in a protocol.
8. Finally adjust brightness and contrast of the display correctly :
   the frame of the ultrasound image and the frame of the other
   information given should not be visible any longer (equal in
   brightness) .
End

Tolerance : if the monitor is flickering objectionably -> call the service or mainten-ance

Test interval : daily and after maintenance check,
               monthly : additional checking with SMTPE-Test pattern (Option).

Evaluation : by eye

Remarks : Prescriptions partly given in DIN 6868-57, SMTPE (www.smpte.org)

<table>
<thead>
<tr>
<th>Technical Relevance</th>
<th>Strong flickering or local changes in brightness can indicate ageing or damage of the monitor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Relevance</td>
<td>An optimal diagnosis can not be obtained by using an sub-optimal image quality of the monitor.</td>
</tr>
</tbody>
</table>
4 Grey-level comparison between Monitor and Hardcopy-unit (printer) (images)

Abb. 4: Ultrasound images / Example of a visual evaluation.
middle: image of the monitor
left: a „good“ representation of a Hardcopy (rating factor : 1),
right: a „bad“ representation of a Hardcopy (rating factor : 3)
Grey-level comparison between Monitor and Hardcopy-unit (printer)

**Test devices**: none

**Pre-Settings**: none

**Procedure**:
1. Turn on the ultrasound device and “freeze” the image.
2. Make a hardcopy of the monitor image (print).
   Using X-ray film for ultrasound print-outs evaluate this print-out.
3. Visual evaluation of the grey-level bars:
   compare the number of displayed bars of the monitor and hardcopy image (Fig. 4). Are large differences available?
   **Rating**:
   1 = visual no differences remarkable
   2 = slight differences remarkable
   3 = large differences remarkable
   Note down the rating and the settings of the devices in the protocol.
4. In case of large differences: call the maintenance or:
   Repeat (until visual differences are not seen any longer)
5. Adjust Hard-copy unit (printer) and make print-outs as long as the monitor and hardcopy have an identical (visual) outlook.

**End**

**Tolerance**: visual evaluation with ratings 1-2 are tolerable, vis. evaluation with rating 3 -> call maintenance if adjustments are not working.

**Test interval**: daily and after maintenance

**Evaluation**: by eye

**Remarks**: Procedure, tolerance, and test interval are new

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**Technical Relevance**: The Hardcopy-unit can change and drift; if film material is used the substances can have ageing effects depending on storage and climate conditions.

**Clinical Relevance**: Large differences between monitor and hard-copy should not be detected, to guarantee an optimal diagnosis if performed by the evaluation of the hard-copy.
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or look at our publications :

www.bmtp.akh-wien.ac.at/people/kollch1/kollpub.html