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Quality control in diagnostic ultrasound siemens acuson 1000

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ABSTRACT
This study was conducted to know the results of a routinely quality control of ultrasound that was done every month and it will later be used as a reference for the next quality control in diagnostic ultrasound. In this study, Multi-Purpose Multi-Tissue Ultrasound CIRS Phantom Model 040GSE was used to test the image quality on the Siemens Acuson 1000 ultrasound. The parameters that were used to evaluate the quality control of the Siemens Acuson 1000 ultrasound were uniformity, dead zone, depth of penetration, vertical distance, horizontal distance, axial resolution, and lateral resolution. The results that were obtained from this study showed that there were no artifacts on the ultrasound images. Five targets were seen in the dead zone area. Depth penetration of the images was 16 cm. Vertical and horizontal distances were 1 cm. Axial and lateral resolution of the images were 0.4 and 0, 3 cm. From the results that have been achieved, it can be concluded that the quality control test of the Siemens Acuson 1000 ultrasound at our department still in good performance and complied all parameters that was recommended

Keywords: Quality Control, Ultrasound, Uniformity, Axial Resolution, Lateral Resolution

INTRODUCTION

Ultrasonography (USG) is a common modality and is most widely used for medical imaging methods in soft tissue, circulatory system, and nervous system with applications that continue to develop. One of the main advantages of ultrasound is that it does not use ionizing radiation [1]. With a spatial resolution of up to 0.5 mm, USG is able to display good image quality while still paying attention to quality control systematically. Martensson et al. reported that 40% of 676 ultrasonographic transducers used in 32 hospitals in southern Sweden showed poor results [2].

Ultrasonography (USG) is a diagnostic imaging technique that uses ultrasonic sound waves with frequencies exceeding the range of human hearing and propagating through a medium. When the medium is in the form of a patient, the interaction of waves with various types of human body tissue as a basis for ultrasound diagnostic imaging. Examination using ultrasound is very beneficial, because it is non-invasive, low cost, does not emit ionizing radiation and the image of soft tissue images produced is clearer than conventional x-rays. Some other advantages are that ultrasound is safer compared to Computed Tomography Scanning (CT Scan) and Magnetic Resonance Imaging (MRI) examinations [3]. In its use, it is necessary to control the quality of the ultrasound because the image quality produced by the ultrasound plane will affect the results of the scan of the patient, ensuring that the ultrasound used operates well and if there is damage it can be used to find out the source (Goodsitt et al, 1998). Periodic quality control needs to be done to ensure the condition of the tool working optimally because the occupational level of ultrasound is quite high [4]. The results of ultrasound images can be processed digitally. Three obstacles that are often encountered in digital image processing including in the USG examination are image uniformity, mechanical check, and image display soft / hard copy quality. Disturbances in the uniformity of this image will bring up artifacts that increase false negatives in ultrasound examination. Some QC procedures carried out by the American Association of Physics Medical (AAPM) group include physical and mechanical inspection, monitor display set up and accuracy, image uniformity, depth of penetration, photographic accuracy and distance accuracy. The QC procedure on image uniformity is done by scanning phantoms and freeze images when the transducer moves. Analyzing image uniformity on USG means conducting a QC program that has an effect on health services. Because the level of occupation of this tool is quite high, to ensure that this tool works optimally, periodic quality control is needed.

METHODS

This research was conducted at the Radiology Installation Dr. Kariadi Semarang. In this study, Phantom Multi Purpose Multi-Tissue CIRS Model 040GSE ultrasound is used to test the image quality on the Siemens Acuson 1000 ultrasound. The transducers used in this study are convex transducers and linear transducers. Ultrasound transducers are first smeared using gel material so that there is no air noise between the transducer and the phantom surface. Then the transducer is placed on the surface of the phantom ultrasound and then directed to the material that is on the phantom to see the quality control test of the ultrasound used as shown in Figure 1.

Figure 1. Multi-Purpose Multi-Tissue Ultrasound CIRS Phantom Model 040GSE was used to test the image quality on the Siemens Acuson 1000 ultrasound.

Phantom USG Multi Purpose Multi-Tissue CIRS Model 040GSE consists of various materials and different sizes according to the parameters of the test to be performed. The phantom scheme used to evaluate ultrasound planes is shown as in Figure 2.

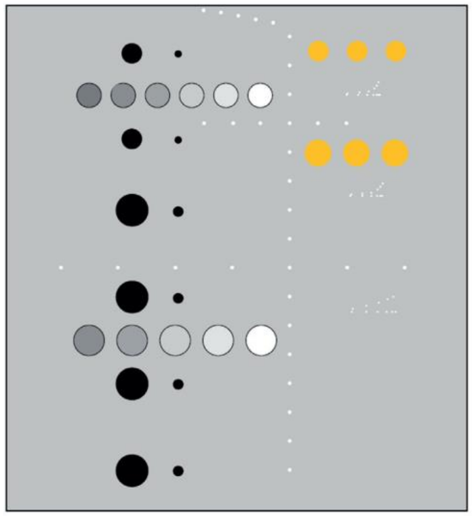

Figure 2. Scheme of the Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

The conditions for the ultrasound quality control test depend on the settings made namely using the same preset when used clinically. The parameters used to evaluate the quality control of the Siemens Acuson 1000 ultrasound are used namely by taking measurements to test uniformity (uniformity), dead zone, depth of penetration (depth of penetration), vertical distance (horizontal distance), horizontal distance (horizontal distance), axial resolution, lateral resolution. The measurement refers to AAPM Ultrasound Task Group No. 1 and Multi-Purpose Phantom CIRS User Guide, Multi Tissue Ultrasound Phantom Model 040GSE.

RESULTS AND DISCUSSION

The results of the studies conducted can be seen in table 1.

Tabel 1. The results of the quality control of ultrasound Acuson 1000

QC Parameter	Reference	Result	Action Level
Weight Phantom [kg]			Δ = 0.015
Image Uniformity			
Vertical banding (y/n)		Yes	y
Horizontal banding (y/n)		Yes	y
Misc. artifacts? (y/n)		No	y
Change in output print ? (y/n)		No	y
Dead Zone/Near Field			
Number of actual 5 target			
measured target	5	5	< 4
Depth of Penetration			
Actual distance 16 cm / 16 target			
measured [cm]	16	16	Δ = 0,6 cm
Vertical Distance Accuracy Actual distance 1 cm			
measured [cm]	1	1	Δ = 1.5
Horizontal Distance Accuracy Actual distance 1 cm			
near field [cm] (depth 4 cm)	1	1	Δ = 2.0
Lateral Resolution			
measured [mm]		0.4	> 1 mm
Axial Resolution			
near field [mm]		0.3	> 2 mm

Routine QC measurements include measurements:

The purpose of measuring uniformity or uniformity is to see disturbances in the image that will bring up artifacts that increase false negatives in the examination. This disruption can be caused by hardware malfunctions, for example, bad element transducers, improperly installed cables, or due to malfunctioning of the software itself. From the results of Image Uniformity measurement, the following results are obtained:

Figure 3. The uniformity of the ultrasound image quality control

From Figure 3. Image Uniformity obtained the results of vertical banding clearly visible, horizontal banding clearly visible, no visible artifacts on the image and there is no difference between the image on the monitor display and print results (hardcopy).

Dead zone or ringdown which is the distance from the surface of the transducers to the first identifiable echo. From the Dead Zone measurement results obtained as follows:

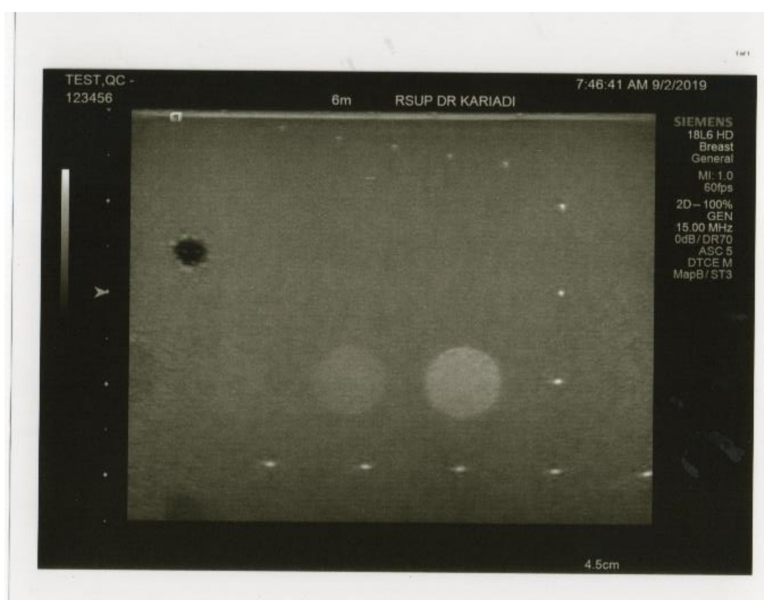

Figure 4. The dead zone that was achieved in the diagnostic ultrasound quality control

From Figure 4. Dead Zone results are obtained from 5 targets in the near field group. Targets at depths of 1 mm, 2 mm, 3 mm, 4 mm and 5 mm. And the distance between targets is 1 mm. Suggested action level is <4.

The purpose of penetration is to show the ability of USG to detect and display objects with the lowest echo signal. From the results of the measurement of Depth of penetration the following results are obtained:

Figure 5. Depth of penetration from Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

Depth of penetration, the distance between the peak of the scan window with the deepest spherical or cylindrical anechoic object is 16 cm and the measurement result is 16 cm. Then the difference in depth is 0 cm. Suggested action level if the difference in depth ≥ 0.6 cm, and suggested defect level if the difference in depth ≥ 1.0 cm.

Vertical and horizontal distance measurement to assess the accuracy of the measurement of the ultrasound device. Scan the Phantom so that the vertical column from the target filament goes to the center of the image and the horizontal column is also visible. Use a transducer with a little emphasis. Vertical distance of 1 cm and measurement results of 1 cm. The difference in distance is 0 cm.

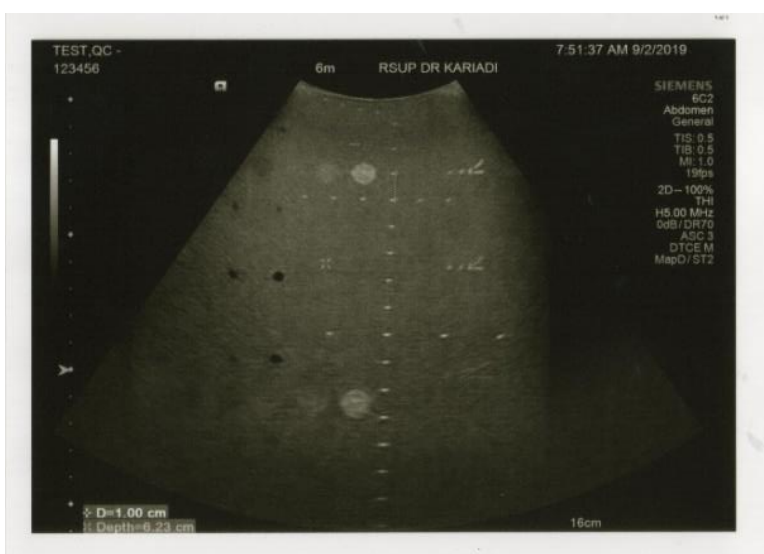

Figure 7. The vertical distance from the Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

Horizontal distance measurement, there are 2 horizontal distance measurements namely at a depth of 4 (there are 6 targets) and 9 cm (there are 7 targets). At a depth of 4 cm the horizontal distance is 1 cm and the horizontal distance between targets is 1 cm, so the difference in distance is 0 cm. At a depth of 9 cm the horizontal distance is 1 cm and the horizontal distance between targets is 2 cm, so the difference in distance is 1 cm Suggested action level vertical distance ≥ 1.5 mm and horizontal distance ≥ 2 mm. Suggested defect level vertical distance ≥ 2 mm and horizontal distance ≥ 3 mm.

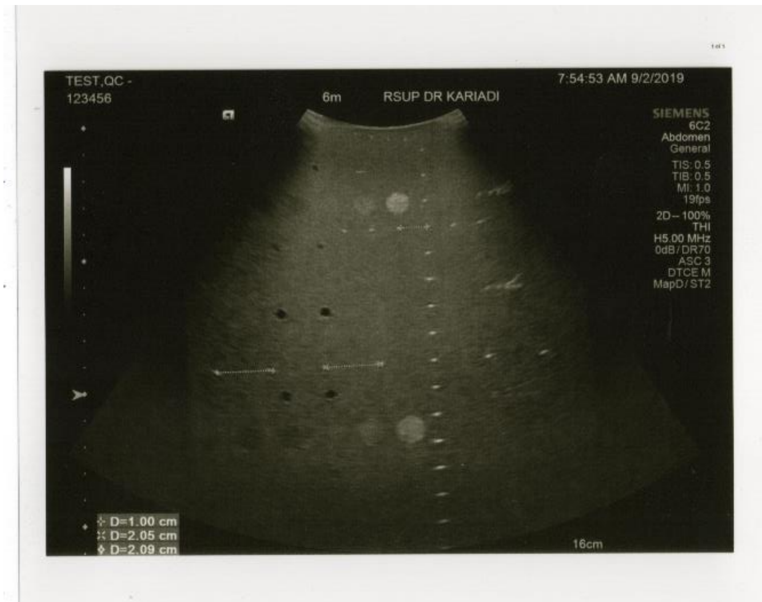

Figure 8. The vertical distance from the Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

Axial resolution shows the ability of ultrasound to detect and display adjacent objects arranged in the beam's axis. There are three axial resolution groups in Phantom CIRS Model 040GSE, namely at a depth of 3 cm, 6.5 cm and 10.5 cm. In groups 1 and 2 the distance between targets is 4; 3; 2; 1; 0.5 and 0.25 mm (6 targets). Whereas in group 3 the distance between targets is 5; 4; 3; 2 and 1 mm (5 targets).

The axial resolution of the Acuson 1000 ultrasound using the Phantom CIRS Model 040GSE using a convection probe is only able to show 2 axial resolution groups at a depth of 3 cm and 6.5 cm. All targets and distances between targets can be clearly seen and can be measured as shown in Figure 8.

Figure 9. The axial resolution of the ultrasound quality control using the Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

Lateral resolution shows the ability of the ultrasound plane to distinguish adjacent structures in the image plane along the perpendicular line on the beam's major axis. There are three lateral resolution groups in Phantom CIRS Model 040GSE, namely at a depth of 3 cm, 6.5 cm and 10.5 cm. In groups 1 and 2 the distance between targets is 4; 3; 2; 1; 0.5 and 0.25 mm (6 targets). Whereas in group 3 the distance between targets is 5; 4; 3; 2 and 1 mm (5 targets).

The lateral resolution of the Acuson 1000 ultrasound using the Phantom CIRS Model 040GSE using a convex probe is only able to show 2 groups of lateral resolution at depths of 3 cm and 6.5 cm. All targets and the distance between targets can be clearly seen and can be measured. As for the third group with a distance of 10.5 cm can not be seen.

Figure 10. The lateral resolution of the ultrasound quality control using the Multi Purpose Multi-Tissue CIRS Phantom Model 040GSE

The measurement refers to AAPM Ultrasound Task Group No. 1 and Multi-Purpose Phantom CIRS User Guide, Multi Tissue Ultrasound Phantom Model 040GSE.

CONCLUSION

From the results, it can be concluded that the quality control test of the Acuson 1000 ultrasound still meets the measurement test criteria for parameters of image uniformity, dead zone, depth of penetration, horizontal and vertical distances, and axial and lateral resolution.

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