Analysis quality control (QC) on CT scan in RSUZA Banda Aceh an effort to get the best quality in image

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Abstract. Quality Control (QC) on the Computerized Tomography scanning (CT scan) have been done to ensure the quality of CT scan image. The best quality will improve diagnostic accuracy and ultimately providing maximum services to the patients. QC monitoring has been conducted on the CT scan in the Rumah Sakit Umum Zainal Abidin (RSUZA) Banda Aceh to monitoring the image and measuring the value of Computed Tomography Dose Index (CTDI). The purpose of this study was to determine was dose received by an object and observe the appearance of a clear image. The research was carried out by using pencil ionization chamber detectors to obtain the doses from CT scans and using the phantom to obtain the appropriate image. The results showed that the thickness of slices can affect the dose received at the time of exposure. In this study found no excessive dose received by an object with a very clear picture display

Key words: quality control, CT scan, CTDI, ionization, exposure

Introduction

CT scan is used to define normal and abnormal structures in the body and/or assist in procedures by helping to accurately guide the placement of instruments or treatments. A computerized axial tomography scan is an x-ray procedure that combines many x-ray images with the aid of a computer to generate cross-sectional views and, if needed, three-dimensional images of the internal organs and structures of the body. A large donut-shaped x-ray machine takes x-ray images at many different angles around the body. These images are processed by a computer to produce cross-sectional pictures of the body. In each of these pictures the body is seen as an x-ray "slice" of the body, which is recorded on a film. This recorded image is called a tomogram. "Computerized Axial Tomography" refers to the recorded tomogram "sections" at different levels of the body (Breener, DJ and Hall, EJ, 2007)

RSUZA is the largest hospital in Aceh that have CT Scanning facilities for patients. The use of CT scan for patients in RSUZA has increasing numbers of patients every day. There are more than 30 patients that used this facility per day. Based on the number of patients who use these facilities, it is expected to interfere with the accuracy level of exposure from CT scans. Obviously increasing the used of equipments, it will reduced the level of accuracy of the resulting mage. To avoid this effect, it is highly recommended to periodically perform QA and QC on CT.

There are three basic tenets of an acceptable quality control program. QA must be performed on a regular basis, there must be prompt interpretation of test results, and the third tenet is accurate book keeping. Some test are required daily, others monthly; annually or at equipment acceptance. The CT technologist usually performs daily tests, which means for these tests they must recognize when results are out of range. Test results must be recorded in a logbook, data log, or computerized record for as long as the scanner is in use. Daily, weekly and monthly results can be compared to acceptance data. This can be very useful especially if there appears to be a malfunction of the equipment. Often the CT technologist is too busy to perform daily tests; however, you should always find time to perform daily tests since a properly performing CT scanner eliminates the equipment as the cause of an improper interpretation of CT images.

Quality Control (QC) for the spiral CT scanner consists of these basic required elements of testing: contrast scale and mean (standard deviation), CT number for water, high-contrast resolution, low contrast resolution, laser light alignment and accuracy, image noise, uniformity and artefacts; slice thickness and localization, and patient dose. There is a wide array of tests that may be performed as well as test tools that can be used. The facility's quality assurance manager or medical physicist generally decides this. The selection of these tests should be based upon the type of equipment and the frequency in which the equipment is to be utilized. This will usually limit some of the more complex tests to an annual survey.(Joseph N, Jr and Rose, T, BS, 2010)

Computed tomography(CT) dose index (CTDI) as a metric to quantify the radiation output from a CT examination consisting of multiple contiguous CT scans (i.e., multiple adjacent transverse rotations of the x-ray tube along the patient longitudinal axis). A new dosimetric method was required for CT because the irradiation geometry was quite different from that of other x-ray modalities in use at that time namely, the x-ray tube irradiated only an arrow section of the anatomy while it made a full rotation around the patient and did so for multiple rotations along the length of the patient. The CTDI method sought to create an "index" to reflect the average dose to a cylindrical phantom in the central region of a series of scans. The word "index" was specifically included in CTDI's name to distinguish from the radiation dose absorbed by a patient (CM Collough, et al.; Li X, et. Al. 2011).

Based on the importance of the monitoring efforts of the entire instrument QC of RSUZA, the QC measurement have been performed on a CT scan to measure the value of CTDI. The measurements were performed in collaboration with PTKMR Electrometer (Technology Centre for Radiation Safety And Metrology) BATAN (Agency for Nuclear Technology) Jakarta. The results of measurements will provide an overview of the imaging quality and measurement of radiation effects that arise from the CT scan plane. This effort is expected to be one way of monitoring the radiation protection of radiation-induced external.

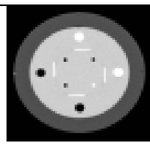
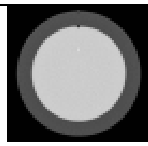
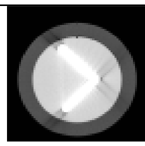
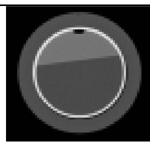
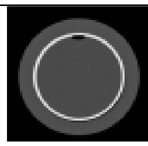
Materials and Methods

The head phantom on the head holder or the body phantom is placed on the table top, position the phantom so that one of the surface dosimeter holes is located at the point of maximum exposure as described in the manufacturer's literature. Acrylic rods should be placed in all the dosimeter holes with at least four acrylic alignment rods placed in surface holes. Using the light localizer or laser alignment lights align and centre the dosimetry phantom axially and in the center of the x-ray slice width. Make sure that the phantom is level and aligned with the central axis of the scanner in all directions (minimal pitch and yaw). Alignment can be assessed by viewing a lateral scout view of the phantom. Initiate one scan of the phantom using a typical clinical technique to check centering accuracy. Place the cursor in the image of the center hole of the phantom and Place the cursor in the image of the center hole of the phantom and determine itslocation using the CT software. If the center hole of the phantom is within ±5 mm of the center of the scan field proceed with the following steps. If it is not within this tolerance, re-center the phantom. Place the CT ion chamber in the center hole of the phantom. The center of the ion chamber should be in the center of the x-ray slice. Select a typical clinical head or body technique and record the kVp, mA or mAs, filters (both tube filtration and beam shaping filter), scan diameter. nominal slice thickness, scan time, number of x-ray pulses and pulse length, or notation that radiation is continuous. Initiate a single CT scan and record the results.

Results and Discussion

The Phantom of CT image that processing in RSUZA have been obtained by performing tests on the device with the selection parameters of 120 kV and 300 mA and 1s. Table 1 is obtained from the overall image quite, clearly. The whole of objects contained in the phantom in each slice can be observed clearly from the resulting image. Observation is made by counting and observing the position of existing objects in the phantom. Similarly, the fluid that fills in the phantom is detected, and there is a contrast of about 20% of image when filled with water and 100% contrast if it filled with air.

Tabel. 1. Phantom measurements in RSUZA

No	Depth (cm)	Images
1	10	
2	7	
3	5	
4	3	
5	1	

The result of the CT scanner with low contras images is shown in Table 1. Factors that influencing this low contrast image are photon flux, slice thickness, layer thickness (patient size, in phantom model) and detector sensitivity depends on the contrast of the phantom (phantom used contrast volume will appear depending) on the slice thickness and area of objects in the picture. Besides the increase in the value of mA in this technique will reduce the noise in the image so that the smallest hole in the phantom can be seen resolution of the phantom image scanner gray-scale of an image is done by using a computer or other equipment and film densitometer. Depth of the image at step wedge can show grayfish scales. Each step in the step wedge image is the result of x-ray beam that penetrates the phantom with a large amount.

The more absorbing the x-ray CT value number of step the smallest image and produce a picture of gray. After the resulting picture of the step will be stored and used as a standard. The greater the voltage applied to the test phantom, it will be clearer image that will be observed on the computer screen. But in the treatment of human object of measurement with a high voltage can not be given because it can affect the radiation in humans are irradiated.

Determination of value of CTDI on CT scan in RSUZA

The graphics images of CTDI measurements of the graph (Figure 1 (a) and (b)) are shown the exposure to radiation at position of -0.2033 to 3.1418 and 0.1733 to 2.50503 with a time of radiation exposure of approximately 1 s. It can be observed that the peak of the radiation exposure occurred at the time of 25-35 ms and 50-60 ms. In the process of radiation exposure, the dose values is obtained between the thickness of the phantom and the radiation dose given, that is calculated by software to obtained the CTDI values.

The thickness values that resulted from software at the scanning process is depending on the result or output that received from Pencil Ion Chamber electrometer. As for the voltage and current that given at scanner process on scanning step from Pencil Ion Chamber electrometer is similar with image processing process (Table 2).

Table 2. Measurement of pencil ionization chamber detectors

No	Slice Thickness (mm)	Acquisition	CTDI	Dose Max (mGy)
1	10	1*10	36,69	3,1418
2	14,4	24*1,2	41,28	2,0503
3	4,8	24*1,2	45,8	0,9959
4	9,0	30*0,6	44,01	0,6363

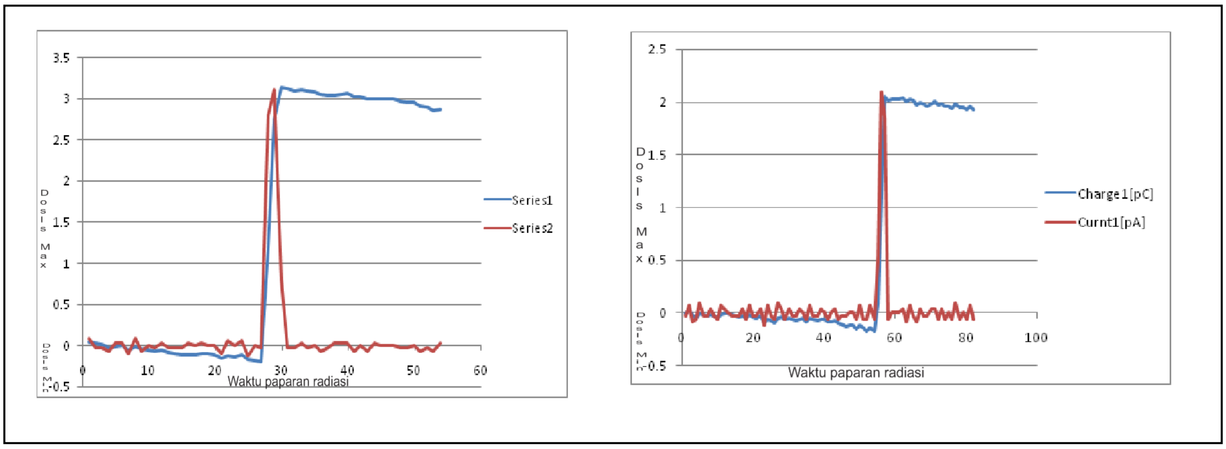


Figure 1. (a). Meaxurement CTDI (mA=300, KV=120, time=1s, Slice thickness= 1mm, Image= 1, Acquisition= 1*10 mm CTDI=36,69 mGy, Electrometer=(-0,2033) (3,1418) and (b). Measurement of CTDI (mA=300, KV=120, time=1s, Slice thickness= 14,4 mm, Image= 2, Acquisition= 24*1,2 mm, CTDI=41,28 mGy, Electrometer =(-0,1733) (2,0503))

Conclusion

The investigation results of quality control of the CT scanner can be concluded that the resulted image is very clear, this is indicated by the results of CT scan image that can monitor entire phantom content perfectly. Similarly, the results of CTDI measurements by using pencil ionization chamber detector, the dose values is obtained between the thickness of the phantom and the radiation dose given, The thickness values is depending on the result or output that received from Pencil Ion Chamber electrometer

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References

David J. Brenner, Ph.D., D.Sc., and Eric J. Hall, D.Phil., D.Sc. 2007. Computed Tomography — An Increasing Source of Radiation Exposure, The new england journal of medicine, 2277-2284

Joseph N, Jr an Rose, T, BS., 2010, Quality Assurance and the Helical (Spiral) Scanner, Online Radiography Continuing Education for Radiologic X-ray Technologist, http://www.ceessentials.net/article33.html

CM Collough , Leng S , Lifeng Yu , Cody, DD, Boone, JM, Gray, MF, CT Dose Index and Patient Dose :They Are *Not* the Same Thing, *Radiology:* Volume 259: Number 2—May 2011

Li X, Zhang Da and Liu B, A practical approach to estimate the weighted CT dose index over an infinite integration length, Phys. Med. Biol, 56 (2011), 5789-5803.