HR9700043

QUALITY CONTROL IN DIAGNOSTIC RADIOLOGY -PATIENT DOSIMETRY-

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In order to establish the Quality Criteria for diagnostic radiographic images in the radiology departments in Republic Croatia we have started the several Quality Control projects on the field. The measurements are performed according to some methodology recommendations in our law but the methodology, measurement principles, measurement equipment, phantoms, measurable parameters for the good use by radiographers, statistical and numerical evaluation, dosimetric philosophy etc. where first recognized as a private/or group hazard of each person involved in the procedure of evaluation of diagnostic radiology images/diagnosis. The important quality elements of the imaging process are: the diagnostic quality of the radiographic image, the radiation dose to the patient and the choice of the radiographic technique. This depends on the X-ray unit (tube) radiation quality, image processing quality and final image evaluation quality.

In this paper we will show how the Quality Control measurements can be easily connected to the dose delivered to the patient for the known diagnostic procedure and how this can be used by radiographers in their daily work.

The reproducibility of the X-ray generator was checked before the service calibration and after the service calibration. The table of kV dependence and output dose per mAs was calculated and the ESD (entrance surface dose) was measuremed/calculated for the specific diagnostic procedure. After the phantom calculation where made and the dose prediction for the given procedure was done, the measurements where done on the Patients (digital dosemeters, TLD and film dosemeter combinations). We are claiming that there is no need to measure each patient if the proper Quality Control measurement are done and the proper table of ESD for each particular X-ray tube in diagnostic departments is calculated for the radiographers daily use.

MATERIAL AND METHODS

We have used the Quality Control measurement kit by Victoreen, phantoms (Alderson), film and TLD dosimetric sets, digital dosemeter set and conventional

X-ray units installed in various Radiology departments in Croatia.

The Diagnostic requirements are:

Image criteria, criteria for good imaging performance and good radiographic technique. First one is medical diagnostic requirement based on normal anatomy and expected pathology. Second represents the requirements on the final product, namely image-radiograph in terms of contrast and resolution of details. It depends on the image processing process to. Third one represents the requirements on the X-ray unit and radiation quality of the whole unit system. If all three are fulfilled than the QA of the diagnostic procedure is present in daily practice and the Entrance Surface Dose (ESD) for a standard-sized patient is minimized.

Example 1. Diagnostic requirements for AP/PA Projection LUMBAL SPINE

Normal anatomy
Radiographic voltage
70 - 90 kV

for this image was used:
70 kv
16 mAs
0.2 s
FFD 120 cm
film speed cllas 400

Real kV 0 84,15 (QC)
this means that the ESD will
not be expected by CEC

Real mGy/mAs=0.05823
at 1m FFD distance

Expected mGy/mAs at
1m FFD distance=0.04011

see Fig. 1.

CRITERIA:

Image:

1. Linear reproduction of the upper and lower-plate surfaces in the central beam area and visualization of the intervertebral spaces
2. Visually sharp reproduction of the pedicles
3. Visulaization of the intervertebratal joints
4. Reproduction of the spinous and transverse processes
5. Visually sharp reproduction of the cortex and trabecular structures
6. Reproduction of the adjacent soft tissues, particularly the psoas shadows

Image performance:

1. Important image details	0.3 - 0.5 mm
2. Entrance surface dose for a standard-sized patient	10 mGy

Radiographic technique:

1. Radiographic device	grid, table or vertical stand
2. Focal spot size	£ 1.3 mm
3. Total filtration	^{3} 3.0 mm Al equivalent
4. Anti-scatter grid	r=12(8); 40/cm
5. Film-screen combination	speed class 400
6. FFD	115 (100-150) cm
7. Radiographic voltage	70 - 90 kV
8. Automatic exposure control	Chamber selected-central
9. Exposure time	< 400 ms
10. Remark:	appropriate Radiation protection

If the example image fullfiles the criteria than it is good radiographic practice.

REMARK: For the diagnostic purpose it is totally unexceptable to reject the image if some of the criteria is not fullfiled and the diagnostic data on the image is sufficient for the patient's diagnose.

We have checked the radiographic procedure with the minimum number of ten patients pro procedure trying to find those who were close as possible to the standard sized patient.

All measurements were done while the patients were undergoing regular medical treatment and no patient irradiated for the purpose of this paper.

RESULTS

We are presenting the real situation measured on the X-ray unit.

Fig.1.

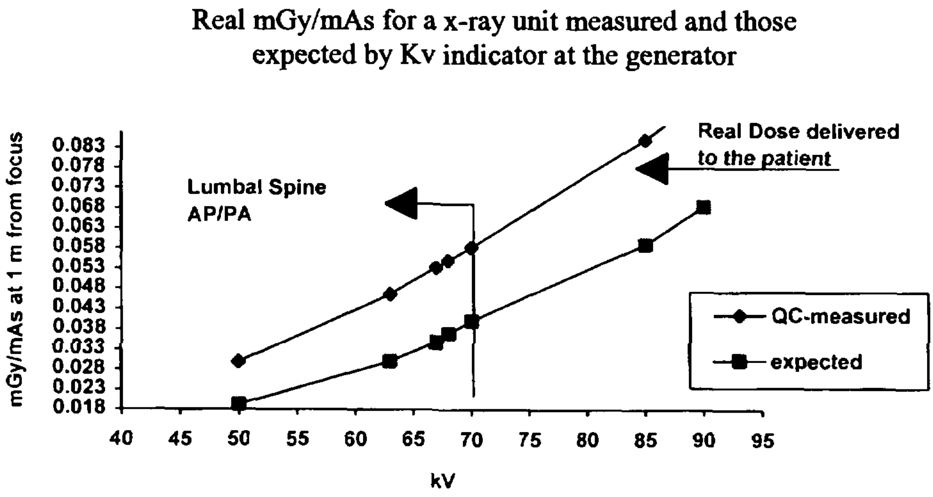

Figure 1. represents the mGy/mAs output of the X-ray unit at the 1 m distance from the focus for the kV which was shown on the generator indicator while performing radiograph and the mGy/mAs output at the same distance which was relay measured for the same mA, filtration and other conditions. This was an indicator that the kV calibration of the generator is not good. The generator was operating at higher kV than indicated and this lead to the considerably higher dose output of the tube. Figure 1. represents the kV values which are recommended and used for the 8 diagnostic procedures listed in Table 1. As the tube output was higher at the 1 m distance from focus the result is that this X-ray unit delivers higher ESD for every diagnostic procedure than necessary just because the generator was not properly calibrated (maintenance failure). If there is some additional image uncertainty the radiographer increases the mAs. The result is even higher ESD to the patient.

In Table 1. we have summarized the results obtained for the one particular X-ray unit: measured data, expected data and defined diagnostic procedures. This unit was after the measurements recalibrated during the maintenance and the ESD was lowered nearly to the expected one stated by CEC. We must say that the film processing equipment and other environmental conditions were satisfactory before and after generator was calibrated.

DISCUSSION

The difference in ESD really delivered and ESD needed for the good diagnostic image is the dose which is totally unnecessary. The aim of the QC is to prevent this. With the good and simple methodology, simple but efficient quality checking kit (phantoms and simple measuring devices), proper user manual and the law regulations it is easy to keep the radiographic equipment under the quality control. The quality data can be used for preventive maintenance and for other management decisions. On the other hand, it is important for the patient to know that the diagnostic procedure he is undergoing to reduce the health risk (illness) will not rise another unnecessary risk - to much ESD for the given diagnostic procedure.

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SUMMARY

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