

POSSIBLE RADIATION DOSE REDUCTION BY USING DIGITAL X-RAY EQUIPMENTS

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Abstract

The radiation load of population all over the world from medical examinations clearly demonstrates the importance of the introduction of the quality assurance and quality control programmes into the activities of radiology departments.

The basic aim of quality assurance program is to ensure that the radiation dose is kept as low as reasonably practicable while still providing an adequate image quality. As many other fields, the rapid development of techniques brought change-over from the conventional analogue technique to the digital technique. In this process, the conventional X-ray film is being abandoned and images are being viewed on either laser film or monitor. The main advantages of using digital equipment lay in improved image quality and diagnostic accuracy through digital image processing, reduction in patients exposure, cost reduction by reduction of the film usage, more efficient storage and retrieval of radiographic images through picture archiving. Several studies that have been conducted for comparison of various diagnostic examinations show, that there is potential for dose saving in the digital image intensifier technique.

The aim of this study was to compare measured values of dose-area product for colon investigations using different X-ray equipment types, two digital and two analogue. Our material consisted of 169 randomly selected patients, 115 of them were examined with digital equipment and 54 patients with the analogue equipment. The obtained results have confirmed the dose reduction and increase of diagnostic accuracy when using the digital equipment, with the added benefit of a good image quality.

Introduction

The basic aim of any radiology quality assurance programme is to give the required image quality at the lowest absorbed doses. The radiologist performing an examination is able to influence the image quality and to reduce the radiation dose delivered to the patient only in the case that the information about the real doses is available and hence the comparison with acceptable reference dose levels is possible [1].

In recent years digital equipments are replacing the conventional X-rays units, especially for fluorography and fluoroscopy examinations. Some advantages of digital X-ray images are : improved image quality and diagnostic accuracy, saved time, cost reduction, dose reduction, digital storage and picture archivation.

The objective of our study was :

- to asses the impact of digital imaging of patient doses during barium studies
- to compare radiation load during the barium meal and barium enema examinations at 2 digital and 2 conventional radiodiagnostic equipments
- to discuss the conditions of dose reduction by using digital equipment
- to optimize the fluoroscopic examinations, so that the required image quality is obtained at the lowest dose



SK02K0184

Material and methods

Our investigation were carried out in four different radiodiagnostic units (two digital and two conventional). The parameters of X-ray units used for barium meal and barium enema examinations are given in the Table 1.

Table 1: X-ray equipment used for our studies

Hospital	1	2	3	4
Images	digital	digital	conventional	conventional
Generator	Clinodigit ITAL-RAY	SWISS RAY	Chiralux	Chirodur 125 C
Tube	Varian A-292	Comet BX 1018-22	Rok 30/50	Rok-T
Image intensifier	ITH	Piptelan	ZOX 273	Chirooskop 7
Film type	Agfa	Agfa	Agfa	Rétina
Cassette type	Agfa	Swissray	Trimax	Kodak

Measurement of patient doses were performed using dose-area product (DAP) meter Diamantor E (PTW Freiburg) with a flat transparent ionisation chamber No. 57523 (17×18,5×1,7 cm) mounted directly on the X-ray tubes. The ionisation chamber was calibrated at Slovak metrological institute. The cumulative DAP value was recorded and DAP values for each radiograph determined. In the survey following data were collected: name, age, sex, weight and height of patient, kV, time of examination, number of radiograph and the name of radiologist. The data of examined patients are shown in the Table 2 and in Table 3.

Table 2: Description of patient data in barium meal examination

Hospital	No. of patients	Patients (mean (range))	
		Age (year)	Weight (kg)
1	22	43 (20-75)	66 (38-106)
2	29	36 (21-71)	64 (46-100)
3	16	58 (23-82)	71 (53-97)
4	38	50 (18-79)	71 (47-120)

Table 3: Description of patient data in barium enema examination

Hospital	No. of patients	Patients (mean (range))	
		Age (year)	Weight (kg)
1	22	43 (18-68)	69 (45-98)
2	32	62 (34-83)	71 (50-105)

The images quality in all cases was evaluated by the same senior, well experienced radiologist.

Results

The total DAP values recorded in barium enema and barium meal examinations, the fluoroscopic time and the number of radiographs are summarised in Figure 1 and Figure 2.

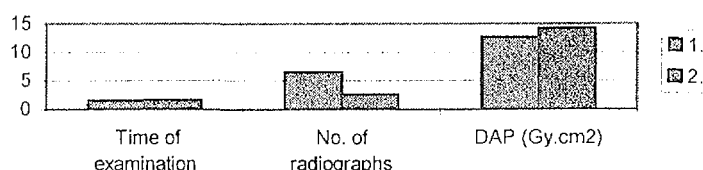


Figure 1: Distribution of DAP, fluoroscopic time and No. of radiographs for barium enema examination

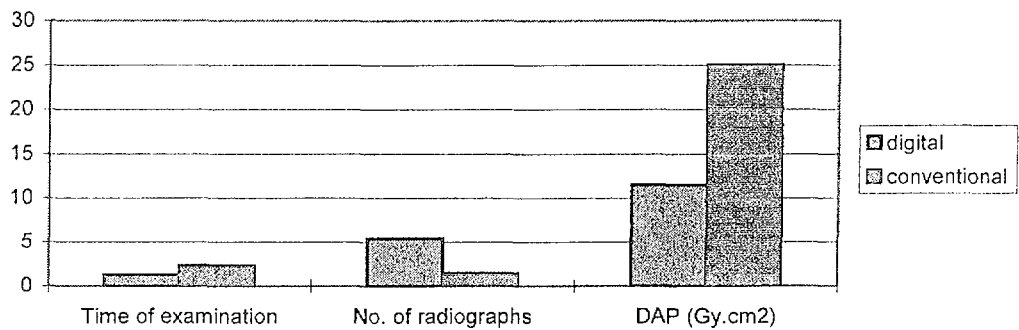


Figure 2: Distribution of DAP, fluoroscopic time and No. of radiographs for barium meal examination

From the figure 2 it can be seen that the DAP value is lower inspite of more radiographs performed during the digital examinations.

The summary of the results for barium meal and barium enema examinations can be seen in the Table 4 and Table 5. The statistical analysis of the obtained results show the dynamic nature of this type of diagnostic examination. Therefore the significant statistical uncertainty is observed in the given mean values.

Table 4: Summary of the results for barium meal examinations

Hospital	No. of patients	Dose-area product (Gy cm^2)					
		min.	1st quartile	mean	median	3rd quartile	max.
1	32	2,44	5,21	9,71	6,71	9,54	39,51
2	29	2,99	8,94	13,3	12,16	15,93	26,71
3	16	1,72	12,1	39,5	26,26	48,18	154,22
4	38	1,45	5,92	10,55	8,61	12,29	46,47

Table 5: Summary of the results for barium enema examinations

Hospital	No. of patients	Dose-area product (Gy cm^2)					
		min.	1st quartile	mean	median	3rd quartile	max.
1	22	3,75	8,09	12,65	10,54	16,66	26,23
2	32	3,73	9,21	14,19	12,17	15,66	33,38

In the Figures 3 the dependence of DAP values from the patient's weight during barium meal examination in digital system is shown.

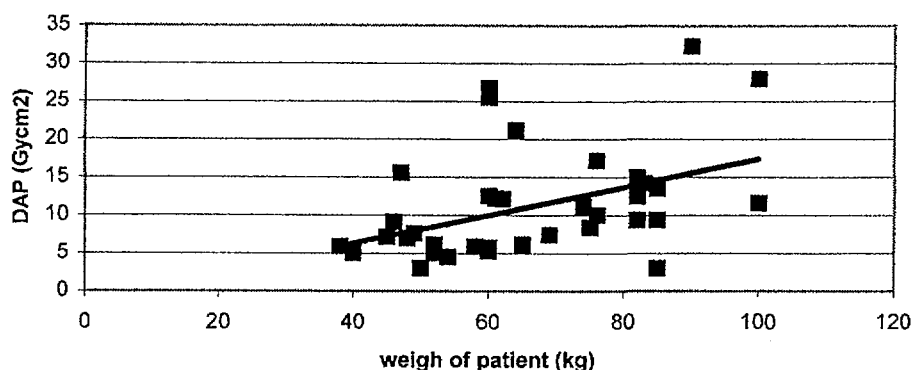


Figure 3: DAP vs weight of patient for barium meal examination (digital)

Conclusions

The preliminary results, presented in our paper for comparison of radiation load of patients examined by digital and non digital X-ray units, have shown:

- significant reduction of DAPs can be achieved using digital equipment for fluoroscopy and fluorography examinations;
- the mean DAP value in the 3rd quartile for barium meal examination (12,8 Gy.cm²) for digital equipment is less by a factor of two comparing with DAP value for conventional unit;
- the DAP measured during our survey have shown substantial variation and it is not easy to quantify and to standardize all parameters influencing the patient's dose
- barium enema and barium meal examinations represent about 14% of all examinations in Slovakia. Considering the radiation load connected with this examination it is worth to continue in its optimisation.

References

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