Dose reduction in evacuation proctography

C. Hare
S. Halligan
C. I. Bartram
R. Gupta
A. E. Walker
I. Renfrew

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Abstract The goal of this study was to reduce the patient radiation dose from evacuation proctography. Ninety-eight consecutive adult patients referred for proctography to investigate difficult rectal evacuation were studied using a digital imaging system with either a standard digital program for barium examinations, a reduced dose digital program (both with and without additional copper filtration), or Video fluoroscopy. Dose-area products were recorded for each examination and the groups were compared. All four protocols produced technically acceptable examinations. The low-dose program with copper filtration (median dose 382 cGy cm²) and Video fluoroscopy (median dose 705 cGy cm²) were associated with significantly less dose than other groups (p < 0.0001). Patient dose during evacuation proctography can be reduced significantly without compromising the diagnostic quality of the examination. A digital program with added copper filtration conveyed the lowest dose.

Key words Defecography · Dosimetry · Rectum radiography · Digital radiography

Introduction

Evacuation proctography (EP) is a radiological technique that images rectal evacuation of a barium paste in order to diagnose structural and functional anorectal abnormalities. Most patients are referred for EP because of constipation, particularly difficult rectal evacuation, and most patients with severe constipation are women. In one series all of the patients considered for colectomy were female [1]. Many of these women are of childbearing age, so that inevitable pelvic irradiation during EP has attracted understandable criticism. Most investigators broadly base their examination on the description by Mahieu et al. [2], but there is considerable variation in filming technique. Video fluoroscopy or 105-mm spot films can be used to record rectal evacuation. Video incurs a lower dose but does not have the spatial resolution of spot film so that a combination of the two is frequently used. Cine radiography has been abandoned because of the radiation penalty. A previous study of the radiation dose during EP using an analogue system concluded that the technique was associated with a “considerable” dose, and 19% of these patients were women under the age of 40 years [3]. Newer digital fluoroscopy systems allow more control over exposure factors, raising the possibility of dose reduction, and are becoming more common in practice [4]. The aim of this study was to compare the dose conveyed by a digital fluoroscopy system with conventional video fluoroscopy during evacuation proctography.

Patients and methods

Ninety-eight consecutive adult patients undergoing EP for the investigation of difficult rectal evacuation were studied prospective-ly. Their mean age was 49.6 years (age range 26–78 years). Twenty-three patients (23.5%) were under 40 years of age. There were only two men.

One hundred millilitres of barium suspension (BariTop 100% w/v, Bioglan Laboratories, Hitchin) was added to 200 ml of water.
Rectal evacuation times would not be expected to be normally distributed because patients with prolonged evacuation tend to skew any large distribution to the right. This was confirmed using the Shapiro-Wilk test statistic. The total dose for patients in each group was therefore compared using the Kruskal-Wallace test statistic, with Dunn’s post-testing to identify differences between individual groups. Calculations were performed using Arcus Quickstat Biomedical 1.2 (Research Solutions, Cambridge, UK) and statistical significance assigned at a probability level of <0.05.

Results

All 98 examinations were deemed to be of acceptable diagnostic quality. In particular, the inevitable loss of spatial resolution in groups C and D (copper plate and video fluoroscopy groups, respectively) was not felt to impair study interpretation. There was no significant difference in the median examination times for each group: group A = 40.5 s; group B = 50 s; group C = 31 s; and group D = 36 s ($p = 0.085$, Kruskal-Wallace test).

The median dose conveyed to individual groups was: group A, 1859 cGy cm$^2$ (range 822–3503 cGy cm$^2$); group B, 1234 cGy cm$^2$ (range 499–3409 cGy cm$^2$); group C, 382 cGy cm$^2$ (range 101–1266 cGy cm$^2$); and group D, 705 cGy cm$^2$ (range 174–1689 cGy cm$^2$). There was a highly significant difference between group medians ($p < 0.0001$), with only the individual comparison between group A (standard program) and B (reduced dose program) failing to reach statistical significance on post-testing (groups A vs C, $p < 0.0001$; groups A vs D, $p < 0.0001$; groups B vs C, $p < 0.0001$; groups B vs D, $p = 0.0002$; groups C vs D, $p < 0.0001$).

Discussion

Evacuation proctography has considerable therapeutic impact in patients complaining of difficult rectal evacuation, and is a pivotal investigation in deciding between surgical or conservative therapy [6]. Many patients are women of childbearing age; thus, there is a natural reluctance to limit pelvic irradiation in this group; 23.5% of our patients were under 40 years of age. Evacuation proctography has been described as “among the radiological procedures associated with a relatively high exposure” [3]. However, the abnormalities of rectal configuration revealed by EP do not need high spatial resolution for diagnosis, allowing spatial resolution to be traded for decreased patient dose.

We found that satisfactory examinations were obtained using all of the exposure protocols investigated. Indeed, before we acquired our digital unit we used an entirely video-based analogue unit for several years. Its spatial resolution was less than any of the protocols tested here but was still adequate for diagnosis. Furthermore, many patients who complain of constipation

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Ten millilitres of Gastrografin was added and this solution was given orally 30–60 min before the procedure in order to opacify the small bowel so that enterocoeles could be diagnosed. Twenty minutes before the procedure, two glycerine suppositories were given rectally and patients were instructed to defecate. Evacuation proctography was then performed using a standard technique [5]. With the patient in the left lateral position on the fluoroscopy table, the rectum was filled with 120 ml of barium paste (E-Z-paste, E-Z-Em, Westbury, N.Y.) instilled via a bladder syringe. The fluoroscopy table was then brought upright. The patient was seated on a specially designed commode placed on the footstep and instructed to defecate as rapidly and completely as possible during imaging.

Consecutive patients were respectively assigned to the following four exposure protocols, using the same digital control unit (Siemens Display Plus and Sireskop 5, Siemens plc, Bracknell, Berkshire, UK; Fig.1) with inherent filtration equivalent to 0.3 mm aluminium: group A, 12 patients were examined using a standard digital program for barium examinations exposed at one frame per second, at 125 kV; group B, 17 patients were examined using a reduced dose digital program, created by altering the automatic exposure curves via software to achieve a 50% dose reduction, and exposed at one frame per second; group C, 41 patients were examined using the reduced dose program exposed at one frame per second with 2-mm copper filtration added to the tube; and group D, 28 patients underwent lateral video recording during fluoroscopy, with the examination saved to S-VHS videotape for review. The tube distance was constant throughout at 1.5 m. For the first three groups screening fluoroscopy at 99 kV was used to image the patient into the correct position before exposure began. Total dose was recorded at the end of each examination from a Diamentor PTW M2 dose area product (DAP) meter measuring centi-Grey per square centimetre (cGy cm$^2$). Since the examination dose was to be related to rectal evacuation time, total examination time was calculated for groups A, B and C by adding positional screening time to the number of spot films taken. For group D, total examination time equalled total screening time. All 98 examinations were reported by a consultant radiologist (S.H. or C.I.B.) and the image quality of each scored as either acceptable or unacceptable.

Fig. 1 Comparison of patient dose during evacuation proctography in patients examined using a standard digital program for barium examinations (group A), a reduced-dose digital program (group B), a reduced-dose digital program with additional copper filtration (group C), and Video fluoroscopy (group D), $p < 0.0001$, Kruskal-Wallace test. Horizontal bars median values.