Original Investigation

Educational Effects of Radiation Reduction During Fluoroscopic Examination of the Adult Gastrointestinal Tract

Moon Hyung Choi, MD, Seung Eun Jung, MD, Soon Nam Oh, MD, Jae Young Byun, MD

Rationale and Objectives: This study aimed to evaluate the effects of educating radiology residents and radiographers about radiation exposure on reduction of dose area product (DAP) and fluoroscopy time in diagnostic fluoroscopy of the gastrointestinal (GI) tract in adult patients.

Materials and Methods: In April 2015, we offered 1 hour of education to radiology residents and radiographers on how to reduce radiation doses during fluoroscopic examinations. Fluoroscopic examinations of the GI tracts of adult patients performed from June 2014 to February 2016 were evaluated. A total of 2326 fluoroscopic examinations (779 and 1547 examinations before and after education, respectively) were performed, including 10 kinds of examinations. Fluoroscopy time and DAP were collected. A radiologist evaluated the number of spot images, captured images, cine video, captured video, and the use of collimation or magnification. We used the Mann-Whitney *U* test to assess the difference in fluoroscopy-related factors before and after education.

Results: Median DAP decreased significantly after education, from 21.1 to 18.2 Gy·cm^2 ($P < .001$) in all examinations. After education DAP decreased significantly in defecography ($P < .001$) and fluoroscopy time decreased significantly in upper gastrointestinal series with water-soluble contrast ($P < .001$). Spot and cine images that increased the radiation dose were used less frequently after education than before in some kinds of examinations, especially in defecography ($P < .001$). More images were collimated after education in barium swallow than before ($P < .001$).

Conclusions: Educating radiologist residents and radiographers could reduce DAP in fluoroscopy examinations of the GI tract in adult patients.

Key Words: Fluoroscopy; radiation dose; dose reduction; education.

INTRODUCTION

Radiation exposure from medical examinations has been increasing consistently (1). Although computed tomography is regarded as an important source of radiation, fluoroscopy should also be considered (2). Fluoroscopy is still used for functional evaluations, but radiation exposure from fluoroscopy is often neglected (3). Many studies have focused on radiation exposure from fluoroscopy in children, but few studies have paid attention to radiation exposure in adults (4–8). Fluoroscopy examinations of adult patients should also follow the as-low-as-reasonably-achievable principle to decrease radiation exposure.

A noticeable feature of fluoroscopy examination is that radiation exposure can depend on who performs the examination (9). The protocols for fluoroscopy examinations can be flexible depending on the circumstances of each examination, including patient condition, anatomical variants, and the purpose of the examination. Because radiologists and nonradiologist physicians operate fluoroscopy machines regardless of their experience or knowledge about radiation protection and reduction exposure during fluoroscopy, less experienced trainees and radiographers may not have optimal fluoroscopic technique which could therefore lead to increased radiation dose. Radiographers' awareness of radiation is also important as they assist during fluoroscopic examinations carried out according to nonradiologists' instructions. Different levels of knowledge about radiation have been reported among medical staff from different professions and workplaces, as well as among doctors with different specialties, positions, and experience (10–13).

Many techniques are available to reduce the radiation dose during fluoroscopic examinations. Examiners should keep a small subject to detector distance, use pulsed fluoroscopy rather than continuous fluoroscopy, replace spot or cine images with

Acad Radiol 2017; ■:■■–■■

From the Department of Radiology and Cancer Research Institute, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul, 06591, Republic of Korea. Received July 27, 2017; revised August 30, 2017; accepted September 6, 2017. **Address correspondence to:** S.E.J. e-mail: sejung@catholic.ac.kr

https://doi.org/10.1016/j.acra.2017.09.009

images captured digitally, avoid magnification, and use collimation (6,9,14). Therefore, education for fluoroscopy examiners could be useful to decrease radiation exposure or fluoroscopy time during fluoroscopy (8,15,16).

The purpose in this retrospective study was to evaluate the effects of educating radiology residents and radiographers about radiation exposure on reduction of dose area product (DAP) and fluoroscopy time in diagnostic fluoroscopy of the gastrointestinal (GI) tract in adult patients.

MATERIALS AND METHODS

Radiology residents and radiographers received a 1-hour education course about fluoroscopy in April 2015. A GI radiologist with 7 years of experience taught 68 radiographers and 39 radiology residents each once. The information provided included (1) radiation exposure from fluoroscopic examinations, (2) the importance of radiologist and radiographer knowledge about reducing radiation exposure during fluoroscopy, and (3) how to reduce patient radiation dose during fluoroscopy.

We evaluated fluoroscopic examinations of the GI tract performed in consecutive adult patients between June 2014 and February 2016. A total of 2326 fluoroscopy examinations were performed during the study period, 779 and 1547 examinations before and after the education, respectively. We considered 10 kinds of examinations: (1) colon study with water-soluble contrast (WSC), (2) colon study with barium, (3) defecography, (4) esophagography with WSC, (5) esophagography with barium, (6) small bowel series (SBS) with WSC, (7) SBS with barium, (8) upper gastrointestinal series (UGI) with WSC, (9) UGI with barium, and (10) barium swallow. Barium swallow was an examination to evaluate swallowing function and it was performed by physical medicine and rehabilitation residents with radiographers who operated the fluoroscopy machine. Other examinations were performed by radiology residents who operated the fluoroscopy machine by themselves.

DAP was collected from an external DAP meter (VacuDAP fluoro, Vacutec, Dresden, Germany) inserted into the retention rails of the x-ray tube. Fluoroscopy time was recorded from the fluoroscopy unit. All fluoroscopy examinations except defecography were performed using the same fluoroscopy unit (Axiom Iconos R200, Siemens Healthcare, Erlangen, Germany); defecographies were performed using another fluoroscopy unit (Axiom Artis, Siemens Healthcare, Erlangen, Germany). Age, body weight, and height were collected from electronic medical records. A GI radiologist who presented the education about radiation reduction reviewed all examinations and recorded the numbers of spot images, captured images, cine videos, and captured videos. The frame per second rate for cine video was recorded. The radiologist also assessed the use of collimation or magnification and counted the number of images with collimation or magnification. We calculated the percentage of spot images and captured images from the sum of spot and captured images, along with the percentage of time for cine video and captured video from the total time for cine and captured video.

Statistical Analysis

The differences in patients' demographic characteristics for examinations before and after education were evaluated using an independent *t* test. We used the Mann-Whitney *U* test to assess the difference in fluoroscopy-related factors in each examination before and after education.

Statistical analysis was performed with SPSS Statistics 24.0 (IBM Corporation, Armonk, NY). *P* values <.05 were considered statistically significant.

The institutional review board approved this retrospective study and waived the requirement for informed consent.

RESULTS

We found no significant difference in patient demographic factors for fluoroscopy examinations before and after education (Table 1). Variable numbers of GI fluoroscopy examinations were performed during the study period (Table 2). The most frequently performed examinations were barium swallow and UGI with WSC.

Median DAP decreased significantly after education, from 21.1 to 18.2 Gy•cm^2 ($P < .001$) in all examinations. DAP was significantly decreased after education in defecography,

TABLE 1. Demographic Factors of Patients Who Received Fluoroscopy Examination Before and After Education for Radiology Residents and Radiographers

	Before	After	*P* Value
Age (y)	62.7 ± 15.4	63.7 ± 15.4	.137
Weight (kg)	59.4 ± 12.0	59.6 ± 11.6	.283
Height (cm)	163.0 ± 8.5	163.4 ± 8.6	.596
BMI (kg/m^2)	22.3 ± 3.7	22.3 ± 3.5	.872

BMI, body mass index.

TABLE 2. Number of Examinations Before and After Education

	Before	After	Total
Colon study, WSC	39	35	74
Colon study, barium	4	50	54
Defecography	47	20	67
Esophagography, WSC	55	62	117
Esophagography, barium	104	173	277
SBS, WSC	90	109	199
SBS, barium	8	16	24
UGI, WSC	143	180	323
UGI, barium	6	20	26
Barium swallow	283	882	1165

SBS, small bowel series; UGI, upper gastrointestinal series; WSC, water-soluble contrast.