Radiation doses to patients from barium meal and barium enema studies in the Western Cape Province, South Africa

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Introduction

Barium studies are radiographic procedures used to diagnose abnormalities of the digestive system. The ionising radiation used in these procedures is potentially harmful and therefore needs to be monitored.

Study Aim:

1. Investigate radiation dose received from the barium meal (BaM) and barium enema (BaE) examinations
2. Recommend regional Diagnostic Reference Dose Levels (DRLs) for these procedures

Methodology

- Study sites : 3 state hospitals
- Fluoroscopy units: digital and conventional units
- n = 25 BaM and 30 BaE patients
- Measuring Instrument: Dose Area Product meter (DAP)

Key of abbreviations

BaM – Barium meal
BaE – Barium enema
DAP – Dose Area Product meter
DRLs – Diagnostic Reference Levels
D – Digital fluoroscopy units
C – Conventional fluoroscopy units

Figure 1: Barium meal examination demonstrating the stomach
(Source: www.ispub.com)

Figure 2: Barium enema examination demonstrating the colon
(Source: www.imaginggroupde.com)

Figure 3: Example of a fluoroscopic unit

Figure 4: DAP meter mounted onto light beam diaphragm of x-ray tube

Objectives

1. Measure radiation dose for BaM and BaE
2. Compare the radiation doses with those previous international studies
3. Investigate causes for dose variation

Findings

BaM

Mean Dose: 16.6 Gycm^2 Median Dose: 13.6 Gycm^2
First and third quartile DAP values: 10.4 Gycm^2 and 20.1 Gycm^2

Table 1: Mean and third quartile DAP values for BaM

Author	mean	3rd quartile
DWP, 1992 (UK)		25
Broadhead et al, 1995 (UK)	7.75 (D)	
	24.18(C)	
Hart et al, 1996 (UK)		17.1
Warren-Forward et al, 1998 (UK)	11.39 (D)	
	21.26 (C)	
Hart et al, 2002 (UK)		13
Hart et al, 2007 (UK)		**13**
Carroll & Brennan, 2003 (Ireland)		17
Yakoumakis et al, 1999 (Greece)	23.3	
Delichas et al, 2004 (Greece)	25	
Geleijns et al, 1998 (Netherlands)	15 (D)	
	28 (C)	
Ruiz-Cruces et al, 2000 (Spain)	39.85	
Vano et al, 1992 (Spain)		39.90
Ciraj et al, 2005a (Serbia)	23.3	
Ciraj et al, 2005b(Serbia)	15	18
Verdun et al, 2005 (Switzerland)	67	
This study	**16.6**	**20.1**

- Absent direct correlation between dose received and patients' weight (R= -0.06), not statistically significant (p= 0.387)
- Mean fluoroscopy time (FT): 7.67 minutes. No direct correlation between FT and DAP values (R= 0.42) and not statistically significant (p= 0.06).

BaE

Mean Dose: 28.7 Gycm^2 Median Dose: 27.4 Gycm^2
First and third quartile DAP values: 18.8 Gycm^2 and 36.5 Gycm^2

Table 2: Mean and third quartile DAP values for BaE

Author	mean	3rd quartile
DWP, 1992 (UK)		60
Martin & Hunter, 1994 (UK)	24.4	
Broadhead et al, 1995	13.88 (D)	
	25.35 (C)	
Hart et al, 1996 (UK)		32.2
Hart et al, 2002 (UK)		31
Hart et al, 2007 (UK)		**24**
Warren-Forward et al, 1998 (UK)	25 (D)	
	28 (C)	
Engel-Hills, 1997 (SA)		**84**
Carroll & Brennan, 2003 (Ireland)		47
Yakoumakis et al, 1999 (Greece)	35.2 (C)	
Delichas et al, 2004 (Greece)	61 (C)	
Ruiz-Cruces et al, 2000 (Spain)	56.87	
Vano et al, 1992 (Spain)	45.19	
Ciraj et al, 2005b (Serbia)	39	41
Verdun et al, 2005 (Switzerland)	102	
Kemerink et al, 2001 (Netherlands)	51 (D)	
Lampinen & Rannikko, 1999 (Finland)	35.8 (C)	
This study	**28.7**	**36.5**

- Weak direct correlation between dose received and patients' weight (R= 0.55) that was statistically significant (p= 0.00082)
- Mean FT: 5.28 minutes. No direct correlation between FT and DAP values (R= -0.26) and not statistically significant (p= 0.134).

- Correlation between experience of radiologist and reduction of radiation dose
- Lower dose from digital fluoroscopy units as compared to conventional units

Conclusions

1. The median DAP values of 13.6 Gycm^2 and 27.4 Gycm^2 for BaM and BaE respectively are the recommended DRLs as they are less affected by under and over weight of the patients.
2. Radiation dose increased with patients' weight for BaE unlike BaM.
3. There was no direct linear correlation between DAP and fluoroscopy time for both BaM and BaE. This was however attributed to comparing radiologists at different levels of training employing different equipment types.
4. Increased experience of the radiologist resulted in lower dose delivery.
5. Radiation dose savings were realised with digital units as compared to conventional fluoroscopy units.

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