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Optimisation of the Defecating Proctogram

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1. Introduction

The Defecating Proctogram is a useful dynamic fluoroscopic examination for investigating bowel dysfunction, for example rectal prolapse. The examination is performed by recording X-ray images of voluntary evacuation of barium paste, while a patient is sitting on a custom designed PMMA commode. [1]

The aim of this project was to optimise this procedure. The main problems were:

i. The position of the patient resulted in a variation of attenuation across the field of view, (air in the lower part - tissue in the upper part) and image quality was severely affected by flaring. (Figure 1)

ii. The automatic brightness control system of the fluoroscopy unit was reducing the dose as a result of the inhomogeneity and thus image quality was significantly affected

Hence, placement of a copper sheet on the side of the commode in order to homogenise the attenuation across the field of view was suggested as a potential solution.

Figure 1. Defecating Proctogram of female patient without copper sheet attached to the commode. Flaring in the lower part of the image can clearly be seen.

2. Materials and methods

In order to determine the optimum thickness of copper, a range of thicknesses was tested. The use of copper was likely to result in an increase in radiation dose and thus supplementary measurements of dose were undertaken. Measurements for 0 mm, 1 mm, 2 mm, 3 mm and 4 mm of copper sheet were performed in order to determine the ideal thickness and evaluate the increase in dose. Initially a simple phantom consisting of saline bags (representing human tissue) and a plastic bag filled with barium paste was used. (Figure 2)

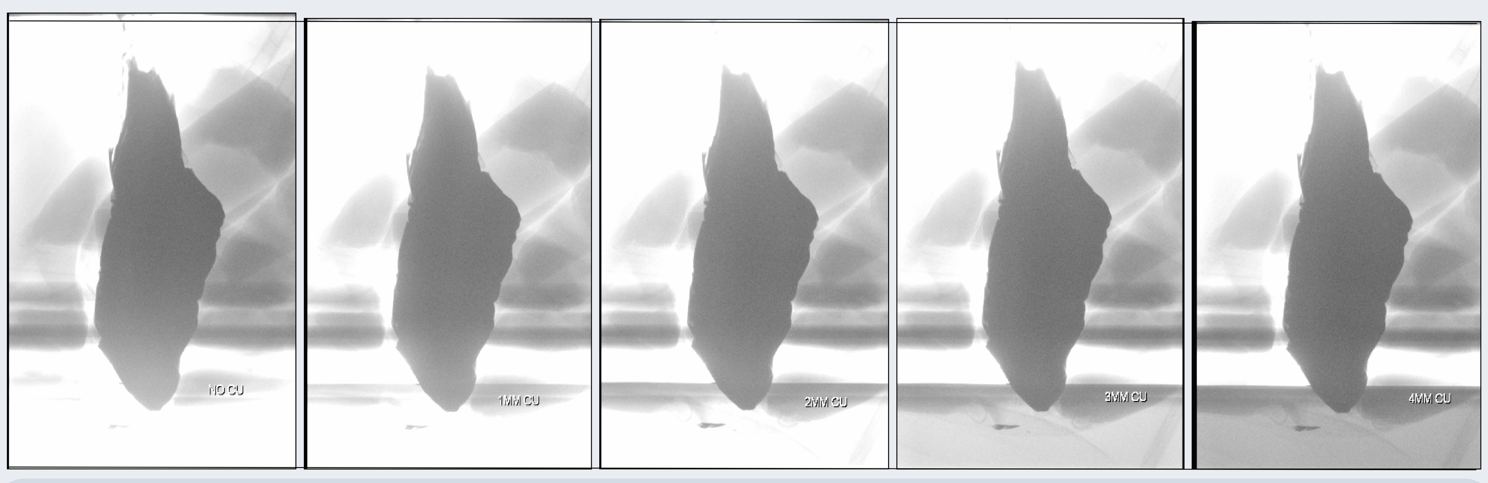

Figure 2. Phantom images for 0 mm, 1 mm, 2 mm, 3 mm and 4 mm of copper from left to right. It can be seen that flaring is reduced and better soft tissue contrast is achieved as the copper thickness is increased.

A secondary investigation was undertaken using a second simple phantom consisting of a cotton pillow case filled with saline bags (representing human tissue) and a plastic tube, filled with barium paste, placed inside (representing bowel filled with barium).

Measurements for each thickness of copper were undertaken both for smaller and larger areas of copper sheet within the field of view, which depended on the position of the commode.

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3. Results

The typical energy range was 73 - 80.5 kVp. The dose for 1mm thickness of copper was 1.58 times higher than the initial dose for 0 mm, while the average increase for 2mm, 3mm and 4mm of copper was 1.80, 1.85 and 1.89 times higher respectively for a smaller area of copper in the field of view. (Table 1) For the larger area of copper in the field of view, the increase was 2.25, 3.20, 3.54 and 3.86 times the initial dose for 1mm, 2mm, 3mm and 4mm of copper respectively

Average dose rates and increase in dose for a range of thicknesses for the smaller area of copper in field of view. Three dose measurements of 10 seconds each were acquired for all thicknesses

Cu thickness (mm)	0	1	2	3	4
Energy (KV)	73	73	74.3	75.3	75.8
mA	51.5	70.7	74.9	74.9	74.9
ms per pulse	8.9	9.3	10	10	10
Mm Cu additional filtration	0.2	0.2	0.2	0.2	0.2
Average dose rate (µGy/sec)	0.94	1.486	1.693	1.746	1.776
Average dose increase	**Do**	**1.58 x Do**	**1.80 x Do**	**1.85 x Do**	**1.89 x Do**

4. Discussion

The average dose increase for a larger area of copper in the field of view was significantly higher compared to dose increase for a smaller area. The increase was attributed to the automatic brightness control system which increases the radiation intensity in order to compensate for the additional attenuation of the copper sheet (rather than air). Hence, for less copper in the field of view and therefore less copper in the automatic brightness control sampling area the increase in dose was lower.

A review of clinical set ups showed that typically the field of view included more patient tissue and less copper.

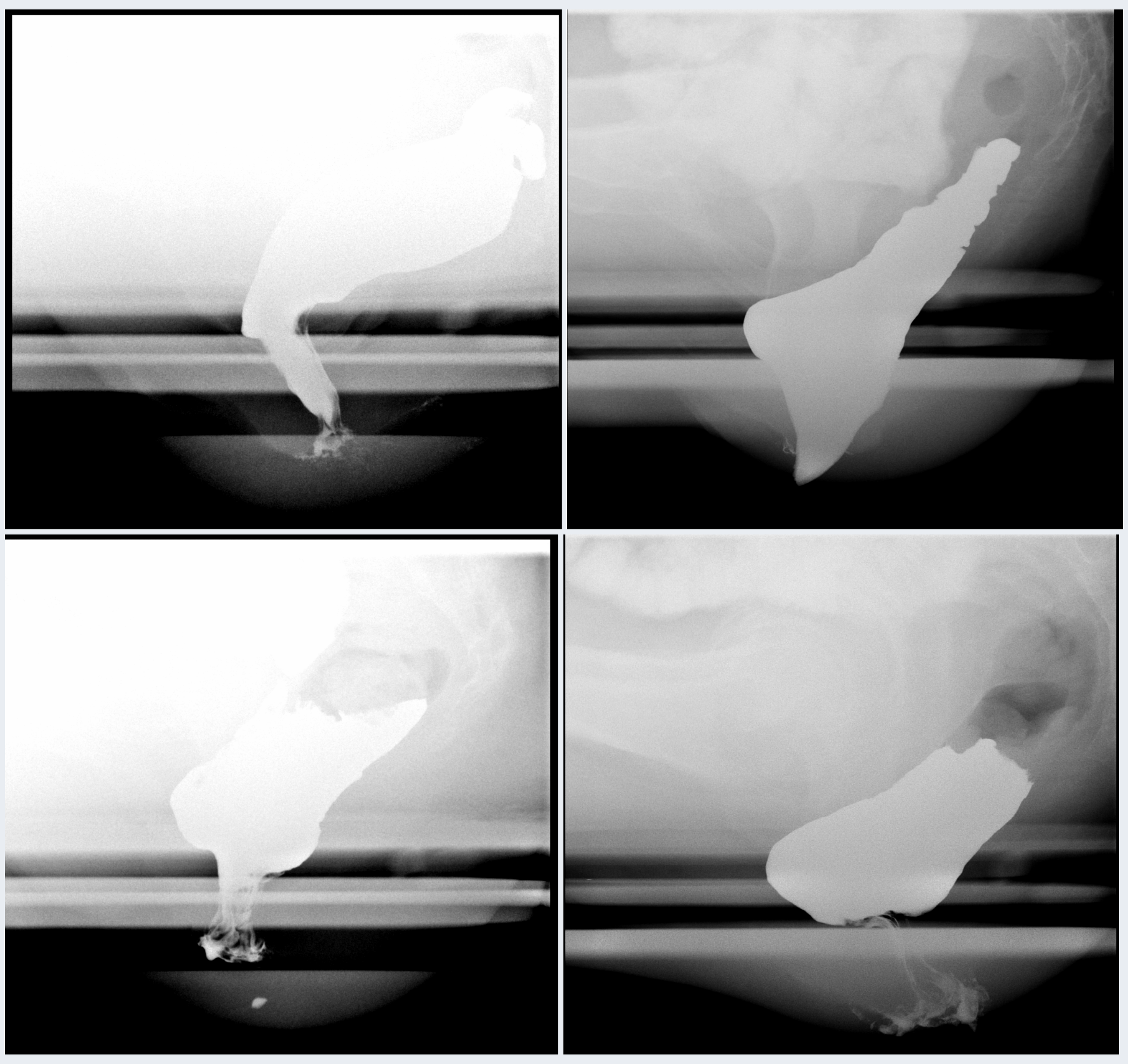

Figure 3. Left: Defecating Proctogram without copper sheet attached to the commode. Flaring affects image quality and soft tissue such as rectum, small intestine and mucosa are not clearly visible. Right: Defecating Proctogram with 4mm of copper filtering attached on the commode. Flaring is reduced and thus imaging of soft tissue is improved.

It was determined that 4mm of copper was the optimum thickness for a range of patient sizes, a conclusion in agreement with other published results. [1, 3, 4]

A discussion with the Radiation Protection Adviser and the Radiologists involved with this procedure suggested that the increase in radiation dose (using 4 mm of copper) (Table 1) was acceptable due to the significant improvement in image quality. (Figures 2,3)

5. Conclusion

The modified commode was placed into routine clinical use and a substantial improvement in diagnostic accuracy was reported. Improvement in soft tissue contrast was achieved due to flare reduction and thus the mucosa structures of the rectum were more visible. (Figure 3) Furthermore, the movement of the small and large intestines during evacuation could be seen more clearly and estimation of evacuation times could be achieved more accurately.

References

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