ENDOVASCULAR TREATMENT OF ABDOMINAL AORTIC ANEURYSMS: WHAT ABOUT THE DOSES?

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1. ABSTRACT

Entrance surface doses and dose-area products to patients and fingerdoses to vascular surgeons and interventional radiologists has been measured during endovascular treatment of abdominal aortic aneurysms. The doses to the patients have potential to be high, but it is possible to keep the fingerdose to the operators low with a good working technique.

2. INTRODUCTION

Endovascular treatment of abdominal aortic aneurysms (AAA) was first reported in 1989 [1] and gained popularity in the 1990s. The procedure is still experimentally. The aim is to increase the survival rate and improve the quality of life for the patients. The procedure reduces the surgical stress and there is minimal need for intensive care. The patient is early mobilised and maybe discharged from hospital as early as the second or third day postoperatively.

The procedure may give rise to significant patient doses, due to potentially long fluoroscopy times, frequently use of different magnification modes together with a large number of exposures, and are therefore associated with both deterministic and stochastic risks. The patients will receive additional radiation doses from the preoperative angiography and computed tomography (CT) evaluation and the postoperative follow-up that comprise CT five times the first following year and angiography one year postoperative. High skin doses may result in deterministic effects such as erythema, epilation, tissue necrosis or ulceration [2-5]. The severity of these effects can be quantified by the entrance surface dose (ESD), which can be estimated using, for example, thermoluminescent dosimeters (TLD).

The vascular surgeons and interventional radiologists performing the procedure may receive large occupational doses, for instance to their hands. They are working close to the primary beam not only during fluoroscopy but also during the exposures, since the field of operation is located in the groin and near the image intensifier.

Because of potential high doses to both patient and staff, which are associated with endovascular treatment of AAA, dose monitoring is of great importance.

In the present study, doses to the patients and staff associated with endovascular treatment of AAA were examined.

3. MATERIAL AND METHODS

8 patients (7 male) with a mean age of 66 (56-79) years were treated with a bifurcated stent-graft (Aneuryx Medtronics Inc.). The main body with the fixed limb was introduced via arteriotomi from one groin and the second limb from the other. Some of the patients had aneurysms in the common iliac arteries and there was a need for limb extensions to the external arteries. All patients were included according to the Eurostar protocol [6].

All the procedures were performed in a newly designed vascular operating theatre having a special designed operating table (Ko-ordinat O.R.) [7]. In addition the operating room was equipped with all facilities found in an ordinary angiographic laboratory. The X-ray equipment used in this study was a Siemens Multistar Plus equipped with a ceiling mounted C-arm with a four-field (14/20/28/40 cm) image intensifier (Sirecon 40-4 HDR). The X-ray generator used was a Polydoros IS-A.

Dose-area product (DAP) was measured with a transmission ionisation chamber (DAP meter) (Diamentor K1, PTW, Freiburg, Germany) permanently attached to the collimator. For each patient the total DAP was separated into contributions from fluoroscopy and exposure.

Lithium thermoluminiscent dosimeters (TLDs) (LiF:Mg,Ti, Harshaw TLD-100 chips) were used to measure the entrance surface dose (ESD). Patient skin doses were obtained by placing 14 TLDs in the median plane on the patients back (n=4). The TLDs were placed with 2 cm spacing and centred at the level of crista iliaca.

Finger doses to the staff performing the procedure were obtained by placing a sterilised TLD ring dosimeter on the middle phalanx of the middle finger bilaterally under the surgical gloves. All TLDs were read within one day after irradiation. Vascular surgeons and interventional radiologists were all well experienced in the stent-graft technique. In addition the surgeons received education in basic radiation protection before the study started.

4. RESULTS

The endovascular procedure was completed for all patients without any problems. There was no 30-days mortality and no serious surgical complications were observed. The use of one limb extension in patient 2, 5 and 8 and even two extensions in the case of patient 1 and 7, matches the variations observed in DAPs, fluoroscopy times and number of exposures taken (Figure 1). Even though the fluoroscopy times were relatively long, typically 30 minutes, the exposures contributed mainly to the total DAP. A mean total DAP of 338 Gycm^2 and an average number of 310 exposures were obtained for these eight patients.

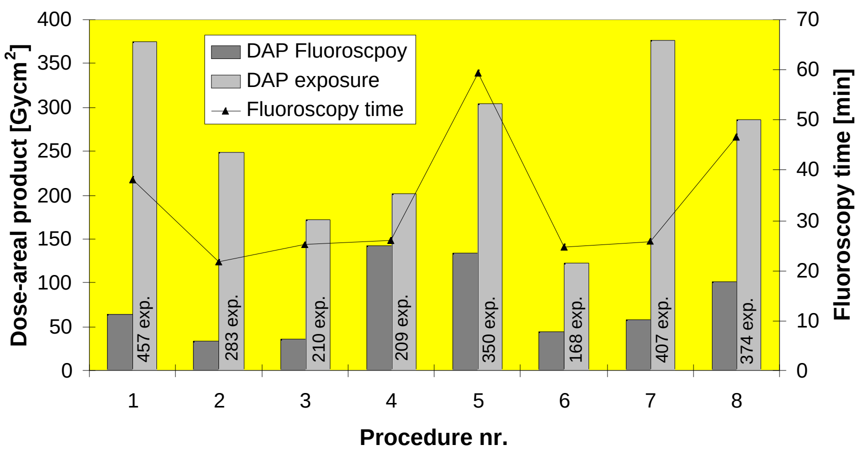

Figure 1. The contributions from fluoroscopy and exposure to the total DAP together with the fluoroscopy time and the number of exposures taken during endovascular treatment of AAA.

Maximum skin doses in the range 1,3-2,4 Gy were obtained and was generally localised somewhere between 6 cm cranial and 10 cm caudal from crista iliaca. Maximum entrance surface dose (MESD) and DAP for the procedures are given in Table I.

Table I. Mean values of total DAP and maximum entrance surface dose (MESD) for the endovascular treatment of AAA. Range is given in brackets.

DAP [Gycm^2]	MESD [Gy]
338 ± 32% (167-439)	1,82 ± 43% (1,35-2,4)

The finger doses to the surgeons and radiologists performing the endovascular procedure are shown in table 2. Average finger dose for all the operators were 170 mGy. The received finger doses, given a normal workload, were below the occupational dose limits of 500 mSv/year proposed by the ICRP [8], indicating a good working practice.

Table 2. Finger doses received by the staff performing the endovascular treatment of AAA.

Fingerdoses [mGy]			
Surgeons (n=6)		Radiologists (n=8)	
Left	Right	Left	Right
54 (20-90)	111 (20-260)	283 (82-876)	169 (53-401)

5. DISCUSSION

Endovascular treatment of AAA has been carried out since the early 90ies. The procedure is now subject of a large randomised trial in the UK.

One of the main purposes with this study was to evaluate the working technique and to investigate the ESD for the patients and the fingerdoses to the operators. No complications were associated with these eight procedures, but potentially much higher skin doses are believed to occur if complications had appeared. Therefore, the monitored DAP should always be registered in the patients records and used in evaluating the need of individual patient follow-ups with respect to skin injuries.

Patients selected for endovascular treatment of AAA will receive additional doses from preoperative evaluations and frequently postoperative follow-up controls. The preoperative evaluations consist of one CT examination and one angiography, while 5 CT examinations and one angiography is carried out the first year after the stent-grafting. The total accumulated skin dose related to endovascular treatment of AAA, although not given as a single exposure, may have the potential for increasing the risk of developing skin injuries.

The postoperative protocol has been changed and the angiographic examinations are only done when complications occur. Duplex scanning has also replaced several of the CT examinations. This will give benefit to the patient in terms of a lower radiation dose and also to the staff performing the angiographic procedures.

Average finger doses to the operating staff were 0,17 mSv, which is surprisingly low. This is mainly due to a good working technique, experience with the stent-graft technique and an offensive attitude to keep the doses low. Poor working technique, however, can have the potential to cause finger doses exceeding the yearly dose limit on 500 mSv to extremities. It is believed that DAP values, skin doses and finger doses will vary significant from hospital to hospital.

One important result from the project is that it has given access to vascular surgical meetings and forums, where it has been able to put radiation protection (RP) on the agenda [9]. This is believed to be important since the work with advanced X-ray equipment is something rather new for many surgeons, and the fact that there is a lack of RP officers in the hospitals in Norway. A good working technique in terms of RP, as found in our study, is much dependent on the skills of the operator but also to a large degree on the attitude to RP.

6. REFERENCES

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