

Doses From Fluoroscopic Procedures

The purpose of this circular is to inform interventional radiologists, cardiologists and radiographers of the potential hazards associated with cardiology and other interventional procedures using fluoroscopy, and to suggest methods to reduce patient and operator exposure.

Introduction

The Department of Human Services was made aware of an incident in New Zealand where a patient has received a serious X-ray induced skin injury. The patient developed a skin lesion a few weeks after a coronary angiogram followed by a complicated angioplasty and stenting procedure. In addition there have been reports of similar incidents occurring in the USA. These cases are summarised in table 1.

This circular is directed to specialists and radiographers carrying out fluoroscopy for the following procedures:

- Radiofrequency cardiac catheter ablation.
- Vascular embolisation.
- Transjugular interhepatic portosystemic shunt.
- Percutaneous endovascular reconstruction.
- Renal angioplasty.
- Any other procedures that professional and medical specialty organisations suggest may cause x-ray induced skin injuries.

The types of injuries to the skin and adjacent tissues which result from X-ray irradiation are summarised in table 2.

Methods to Reduce Patient and Operator Exposure

The dose to the skin of the patient is related to the dose rate during the fluoroscopic procedure, the dose per frame of any recording system used, and the number of frames recorded. The dose rate during fluoroscopy is affected by the following factors:

- The field size used. In general, using the largest field size available, and collimating down to the area of interest reduces patient dose.
- The use of pulsed fluoroscopy and low dose fluoroscopy mode reduces the dose rate to the patient.

The Australian Standard AS/NZS 3200.1.3:1996 recommends a maximum dose rate of 50 mGy/minute for manual equipment, 100 mGy/minute for equipment with automatic brightness control, and 150 mGy/minute for equipment with a high level boost. In addition, this standard sets out maximum input dose rates to the image intensifier. The registered owner of the fluoroscopy equipment should ensure that the equipment complies with these requirements.

The dose per frame of the recording system

can vary considerably, and is much higher for DSA systems than for cinefluorography systems. Operators should be aware of the dose per frame for each system used.

It should also be noted that the operator exposure is related to the patient exposure. The radiation dose received by the operator is due predominantly to radiation scattered from the patient. Therefore, the higher the dose to the patient, the higher the dose to the operator. Reducing patient exposure will also reduce the exposure of the operator.

Recommendations

The following recommendations are made to avoid serious X-ray induced skin injuries during fluoroscopically-guided procedures:

1. The licensee needs to establish standard operating procedures and clinical protocols for each specific type of procedure performed. The protocols should address all aspects of the procedure, such as patient selection, normal conduct of the procedure, actions in response to complications and consideration of limits on fluoroscopy exposure times.
2. The licensee and clinicians working under the licensee should know typical radiation dose rates for the specific fluoroscopic system for each mode of operation used during the clinical protocol. These dose rates must be derived from measurements performed at the facility.
3. The licensee must assess the impact of each procedure's protocol on the potential for radiation injury to the patient.
4. The licensee must modify the protocol, as appropriate, to limit the cumulative absorbed dose to any irradiated area of the skin. The dose should be the minimum necessary for the clinical tasks. Approaching cumulative doses that would induce unacceptable adverse effects must be avoided.
5. The licensee should enlist a qualified health physicist to help in the implementation of these principles in ways that do not adversely affect the clinical objectives of the procedure.
6. The licensee should give consideration to rotating the tube and the image intensifier through 180° during prolonged neuroradiological procedures.
7. The licensee should give consideration to carrying out those cardiology procedures where multiple stenting is necessary over a period of weeks to fractionate the radiation dose.
8. When purchasing new equipment, the licensee should give due consideration to features offered by the manufacturer that may aid in reducing patient dose.

Concluding Remarks

Cardiologists, interventional radiologists and radiographers should be aware of the potential for X-ray induced skin injuries from fluoroscopic procedures. They must always adopt procedures which minimise the dose to their patients and themselves.

Further Information:

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Table 1

Reported cases of skin injuries following fluoroscopy.

Patient Sex and Age, country	Procedure	Nature of Injury	Fluoroscopic Exposure Time and Skin Dose
Female, 53, New Zealand (1996)	coronary angiography followed by coronary angioplasty	skin lesion	101 minutes, 78 cinefluorography runs, 18 Gy
Male, 40, USA	coronary angiography and PTCA followed by second coronary angiography	skin necrosis requiring 12 cm x 10 cm skin graft	unknown, estimated to exceed 120 minutes
Female, ?, USA	RF cardiac catheter ablation	7.5 cm x 12.5 cm second degree burn	unknown
Female, 25, USA	RF cardiac catheter ablation	skin breakdown 3 weeks post procedure	unknown, procedure time of 325 minutes
Female, 34, USA	RF cardiac catheter ablation	draining skin lesion on back 5 weeks post procedure	unknown, procedure time of 190 minutes
Female, 62, USA	balloon dilation of bile duct anastomosis	burn-like back injury on back requiring skin graft	unknown
Female, 61, USA	renal angioplasty	skin necrosis requiring skin graft	unknown, procedure time of 165 minutes

Note:

Victorian Department of Human Services received a report of the New Zealand case in May 1996. The USA cases were reported to the Food and Drug Administration in the USA and the data presented in a paper presented by T.B. Shope at the 1995 Annual Meeting of the Radiological Society of North America.

Note:

RF is radiofrequency; PTCA is percutaneous transluminal coronary angioplasty.

Table 2

Typical threshold doses for radiation-induced skin injuries.*

Effect	Typical Threshold Dose (Gy)	Fluoroscopic on time (minutes) to reach threshold dose at a dose rate of 50 mGy/minute	Fluoroscopic on time (minutes) to reach threshold dose at a dose rate of 100 mGy/minute	Time to onset of the effect
Early transient erythema	2	40	20	hours
Temporary epilation	3	60	30	~ 3 weeks
Main erythema	6	120	60	~ 10 days
Permanent epilation	7	140	70	~ 3 weeks
Dry desquamation	10	200	100	~ 4 weeks
Invasive fibrosis	10	200	100	---
Dermal atrophy	11	220	110	> 14 weeks
Telangiectasia	12	240	120	> 52 weeks
Moist desquamation	15	300	150	~ 4 weeks
Late erythema	15	300	150	~ 6-10 weeks
Dermal necrosis	18	360	180	> 10 weeks
Secondary ulceration	20	400	200	> 6 weeks

* Adapted from Rosenstein M., *Practical Approaches to Dosimetry for the Patient and Staff for Fluoroscopic Procedures*, IRPA, International Congress on Radiation Protection: Proceedings. International Radiation Protection Association (1996).