A FLUOROSCOPY CREDENTIALLING PROGRAMME FOR ORTHOPAEDIC SURGEONS

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We have developed a teaching programme for non-radiologists who use fluoroscopy, which includes techniques for reducing the radiation received by the patient and the surgeon during orthopaedic procedures. The techniques revolve around the radiation protection concepts of time, distance and shielding.

The programme has been very successful in reducing the total fluoroscopy times of orthopaedic surgeons; in our institute, durations have been reduced to about 10% of those before the training started. We review the aims and content of our programme.

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Fluoroscopy delivers some of the highest doses of diagnostic radiation to the patient (National Radiological Protection Board 1990; American College of Radiology 1992) and to the fluoroscopist (Giachino and Cheng 1980; Levin, Schoen and Browner 1987; Goldstone, Wright and Cohen 1993; Sanders et al 1993). Despite this, there is a documented lack of consistency in the training and credentialling of non-radiologist fluoroscopists and this has led to concern about the risks associated with the radiation doses received (Hynes et al 1992; Swayne et al 1994). A recent workshop sponsored by the American College of Radiology and the Food and Drug Administration made it clear that one of the most successful means of reducing radiation doses to both the patient and the operation-room staff is the education of the fluoroscopist in the rudiments of radiation protection (American College of Radiology 1992).

We have found this to be especially true in orthopaedic surgery and have developed a mandatory teaching programme in fluoroscopic techniques for non-radiologists. This aims to minimise the radiation doses received by both staff and patients, while maintaining an optimal balance between diagnostic information and radiation burden. These issues have previously been discussed in relation to orthopaedic patients by Stoker (1993). While credentialling requirements for non-radiologist users of fluoroscopy vary considerably throughout the world (Moore 1994), our programme meets the stringent requirements of the United Kingdom’s Ionising Radiation (POPUMET) Regulations of 1988 (Statutory Instrument No. 778, 1988).

The programme has three components. The first is a half-hour ‘hands-on’ fluoroscopy workshop for the orthopaedic surgeon conducted by a radiologist, a medical physicist and a radiographer. Secondly, we have produced a 12-page booklet which surgeons are required to read. This introduces the basic concepts of radiation physics, radiobiology and radiation protection relevant to fluoroscopy. The third element is continued monitoring of total fluoroscopy times for each surgeon. This allows review of procedures for which fluoroscopy times are deemed excessive.

This programme has been more successful than we expected in reducing orthopaedic fluoroscopy times. We therefore now report the main concepts of radiation protection which we introduce to fluoroscopists.

REDUCTION OF DOSE

Our programme begins by identifying two distinct groups of individuals for radiation protection purposes. The first is ‘radiation workers’, who are subject to a maximum annual dose limit intended to minimise the potentially deleterious effects of radiation. Radiation workers are those employed in work associated with ionising radiation or who have a reasonable possibility of receiving a radiation dose exceeding 30% of the annual dose limit (Department of Health and Social Security 1985). This includes orthopaedic surgeons who use fluoroscopy and certain ancillary staff. In
our institute, all such staff are required to wear radiation dosimeters.

The second group is the orthopaedic patients for whom no dose limit is specified. We instruct the orthopaedic surgeon using fluoroscopy to apply the ALARA (as low as reasonably achievable) principle: patient radiation must be kept as low as reasonably possible commensurate with the expected medical benefit.

We emphasise three basic ways of reducing the fluoroscopy dose to the patient and to the orthopaedic surgeon: time, distance and shielding. We point out that efforts to reduce the patient dose will also reduce the staff dose.

TIME

Intermittent fluoroscopy. This is the simplest and most effective way of reducing doses. Continuous fluoroscopy is rarely necessary: three-second bursts with long ‘off’ intervals are usually acceptable. We recognise that the orthopaedic surgeon using fluoroscopy may initially find this unnatural, but more experience makes it easy to adopt this ‘nervous-foot’ technique.

Pulse mode. Many modern fluoroscopes have an optional pulse mode; this produces a persistent image which changes incrementally approximately every tenth of a second. This can result in dose reductions of up to 70% in some cases and should be used if it is available. Pulse-mode fluoroscopy may initially be visually unsatisfying, but soon becomes acceptable. The dose reduction possible with pulse mode is so significant that it should be used by the surgeon whenever possible.

Image capture. Some fluoroscopy units allow the capture of an image so that the operator can study it without continuously irradiating the patient and the surgeon. Some units can display the captured image on a second screen; this is valuable for comparison with later real-time images.

Surveillance. Most units have an audible alarm which indicates the elapsed fluoroscopy times in increments of about five minutes. If the total elapsed fluoroscopy time has exceeded 20 minutes, we require that the attending radiographer calls for a radiologist to consult with the surgeon. The procedure continues meanwhile and we emphasise that the request for a radiologist should not be taken as a criticism of the surgeon: some problem cases may require longer than normal fluoroscopy times. Since this practice was adopted, however, no single orthopaedic fluoroscopy has exceeded the total elapsed time of 20 minutes.

Additional surveillance is provided by the radiation-monitoring badge worn by the orthopaedic surgeon. The radiation exposure of each surgeon is monitored monthly and any excessive exposures are investigated.

DISTANCE

Three aspects of distance are important in reducing radiation doses:

1) The distance between the X-ray tube and the patient should be maximised to reduce the patient skin-dose contribution to whole-body dose. The distance between the focal spot of the X-ray tube and the surface of the patient should never be less than 30 cm and preferably more than 45 cm. It is recognised, however, that some American regulations allow a focal spot-to-skin distance as low as 20 cm in special circumstances (Zeck and Young 1983).

2) All staff should maintain the maximum possible distance from the patient commensurate with their duties when the X-ray beam is on. For example, movement away from the patient of one to two metres during fluoroscopy will reduce the received dose due to scattered radiation by a factor of about 3 (Bomford and Burlin 1963; National Council on Radiation Protection and Measurements 1976).

3) The distance between the image intensifier and the patient should be minimised. This reduces the staff dose by interposing an absorbing structure between them and the beam exit, and also reduces the patient dose when the fluoroscope is operated under automatic exposure control.

SHIELDING

Collimation. Fluoroscopes have movable shutters (collimators) which alter the size and shape of the fluoroscopic field; reduction of the beam area decreases both patient and staff doses. Collimation of the beam also improves image quality by reducing the amount of scattered radiation: this is demonstrated to surgeons at our workshops by fluoroscoping a phantom under different degrees of collimation.

Direct shielding. The most effective way to protect radiosensitive structures in the patient is to avoid direct irradiation, in the first place by careful collimation. Gonadal and corneal shields for the patient are useful, but can be inconvenient during surgery (Kwong et al 1990).

All operation-room personnel must wear protective devices during fluoroscopic procedures. These include lead aprons, thyroid shields, and protective eyeglasses where they are appropriate. Aprons should have a minimum of 0.25 mm Pb-eq (lead equivalence) for X-ray operation at up to 100 kVp and 0.35 mm Pb-eq above 100 kVp. An increase in thickness above these values is reported to have little effect upon the dose received by the wearer (Huyssens, Franken and Hummel 1994). The surgeon should not turn his back on the fluoroscope when the radiation beam is on: most lead aprons do not afford dorsal protection. We emphasise that radiation badges should be worn underneath the lead apron at about chest level. This provides an accurate measure of the whole-body dose received (McParland, Nosil and Burry 1990; National Radiological Protection Board 1990).

Lead gloves are not designed to protect the surgeon’s hands from the primary radiation beam. At 100 kVp, typical lead gloves will attenuate the primary beam only to 85% of the incident dose. Gloves are intended to afford
protection only from scattered radiation and surgeons should avoid placing their hands in the primary beam.

DISCUSSION

Our accreditation programme, teaching the facts, opinions and methods outlined above, has succeeded in reducing the average fluoroscopy time for an orthopaedic procedure from 8.3 minutes to 0.9 minutes. It is not possible to convert this reduction directly into patient or staff dose reductions, but we consider that the programme has been successful with regard to time, and presumably to the other factors.

Copies of our fluoroscopy instruction booklet may be obtained by writing to the corresponding author.

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