REDUCING RADIATION EXPOSURE IN THE OPERATING ROOM

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Advancements in radiologic imaging have led to the increased use of xrays in departments outside of radiology. A large number of cholecystectomies (gallbladders), orthopedic, endoscopic and pacemaker implants are now performed each year with the aid of fluoroscopic and/or radiographic systems. If the surgeon is unfamiliar with radiation safety precautions or does not require that proper procedures be adhered to, unnecessary exposure can result.

Very often it is impossible for the surgeon to move away from the tableside during exposure. The investigation began therefore with measuring exposure levels at the side of the operating room table with each of the four types of xray equipment available on the surgical floors. Table I indicates the radiation exposure at various distances from the xray tube. The exposure rates at the table side from the fluoroscopy equipment are such that anyone remaining in that location should be provided with a protective lead apron and a radiation monitor.

TABLE I TABLE SIDE EXPOSURE

Type	Technique	Output	Distance (m) 0.5	1.0	2.0
Portable Radiographic	80 kVp	500 mR	4.0 mR	1.0 mR	0.3 mR
Fixed Radiographic	80 kVp	100 mR	0.8 mR	0.2 mR	0.6 mR
C-arm Fluoroscopy	80 kVp	3 R/min	5 mR/min	2 mR/min	0.2 mR/min
Fixed Fluoroscopy	80 kVp	5 R/min	8 mR/min	3 mR/min	0.1 mR/min

During the course of the surgery the staff often moves about the OR suite, making it difficult to estimate their actual exposures using the information presented in Table I. To obtain actual exposure measurements, thermoluminescent dosimeters were attached to the staff during various procedures. Table II shows a summary of the range of exposures from various surgical procedures. The exposure values for both the surgeon and the anesthesiologist indicate that both types of physicians must be required to wear lead aprons as well as film badges. All other persons in the OR during these studies were able to either move at least two meters from the xray tube or out of the OR and therefore received non detectable doses.

TABLE II EXPOSURE TO PERSONNEL DURING SURGERY (mR)

Type	Surgeon	Anesthesiologist	Xray Tech	Other Staff
Cholangiogram	3-49	0-17	0-0	0
Orthopedic	10-31	1-11	0-4	0
Pacemaker	15-45	1-14	0-6	0

Discussion

All the factors which contribute to the exposure to the patient and staff must be considered before radiation exposure guidelines

can be developed. The type of equipment used for the procedure certainly is one of the most important factors. Fixed radiographic machines are usually equipped with phototimers that eliminate guesswork and retakes while keeping the dose to a minimum. Fixed fluoroscopy units, which may have a higher output than portable C-arms usually have shielding to protect the operator and therefore have lower scatter rates. Portable C-arms, however, are the type of fluoroscopy equipment most often used during surgery. Surgeons often are not familiar enough with the device to know which end is the image intensifier and which is the xray tube. Consequently, the equipment is often used in the wrong orientation. If the patient is positioned close to the image intensifier, the exposure is similar to stationary units. If the xray tube is placed next to the patient, however, the skin exposure will be much higher. Outputs as high as 40 R/min were measured at one institution. Gough (G070) has reported skin doses as high as 283 rads from pacemaker implants. The surgeon should be encouraged to place the tube under the table and as far away from the patient as possible.

Image storage devices are now available to use with portable C-arms. The device allows the surgeon to have still images on the video display. This is useful in procedures such as orthopedic surgery where the surgeon needs to look at the location of the pin and does not need continuous fluoroscopy. The image can be obtained in a fraction of a second reducing the fluoroscopy time from minutes to seconds and the skin exposure from thousands of mR to less than one mR. This device is also being used in emergency rooms for quick surveys of accident victims.

Other factors affecting the exposure to both the patient and staff include the patient size. Large or obese patients can increase the scatter by as much as 30%. This is due to a combination of the facts that larger patients require higher outputs and fat tends to scatter radiation farther than muscle tissue. The field size also influences exposure. The state of California requires that the field size be reduced to only the area of clinical interest. Surgeons often need to be reminded to close the collimator. Increasing distance is the easiest method to reduce the exposure to the staff. Personnel in nonsterile attire can leave the OR suite during exposures and eliminate all exposure. Other personnel must be provided with shielding. Portable lead shields can be used for staff who are able to leave the tableside. Lead aprons, however, must be used by surgeon and anesthesiologist. Special break away aprons have been designed to enable the surgeon to remove the apron without breaking sterility.

Finally, the surgeon must be encouraged to become acquainted with interrupted use of the fluoroscopic foot pedals. In order to bring this concept to the attention of the surgeons, a log was kept of the amount of fluoroscopy time used during each procedure. Shortly after beginning this program, the amount of fluoroscopy time for cholangiograms decreased from five minutes to two minutes, thereby reducing the patient exposure by 3 to 15 R. Personnel exposure dropped proportionately.

Table I indicates that it is possible for the surgeon to be exposed to 50 mR during a single procedure. Some surgeons may perform as many as five to ten procedures in a weeks time. It is possible

therefore for a busy surgeon to receive more exposure than the radiologists. In fact, the film badge exposures for surgeons who routinely wear a badge average between 100 to 200 mR per month. The film badges should be stored in an area the surgeons must pass on their way to surgery to encourage use.

Education is the most important aspect of any radiation safety program. The State of California no longer includes the use of xrays as part of the Medical Licence. Each physician must take an exam in order to receive a licence to use xrays. The two hour exam focuses on radiation safety and proper use of equipment. The radiation safety officer of this institution provides a review course to assist the physician in preparing for his exam. For most surgeons, this is the first time they have been exposed to radiation protection concepts as well as the availability of a radiation protection professional with whom they can discuss questions they and their patients have regarding radiation exposure.

In summary, the following list contains the major points that should be included in a radiation reduction program for the surgical staff.

1. Educate the surgeon to the correct orientation of equipment, proper collimation, availability of video storage devices, and especially, interrupted use of the fluoroscopy pedal.
2. Personnel in nonsterile attire should leave the room during exposures.
3. Personnel in sterile attire should stand behind a portable lead shield or move as far away from the xray tube as possible (2m).
4. The surgeon and anesthesiologist must wear lead aprons.
5. Film badges must be provided for the surgeon and the anesthesiologist and stored in a convenient location.
6. An educational program must be developed to address and alleviate the fear of radiation and to educate the staff on the simple methods that can be employed to keep the radiation exposure to the patient and themselves to a minimum.

REFERENCES

(1) California Radiation Control Regulations Title 17 California Administration Code Chapter 5, State of California Department of Health Services, 1980.

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