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Veterinary X-Ray Protection

A. H. Wolff, D.V.M.

That there are potential dangers associated with ionizing radiation has been recognized almost from the time of discovery of x-rays by Wilhelm Roentgen in 1895. During the past 50 years there have appeared numerous accounts and warnings of these dangers in the medical literature. In more recent years there have been several authoritative articles in veterinary literature describing x-ray hazards and protection recommendations.

Dangers of X-radiation

It is important for several reasons to reiterate these dangers and review the recommended protection procedures, particularly for the veterinary student and the recent graduate. Over-exposure to x-radiation definitely can produce deleterious effects. The major effects to be considered are: (1) superficial injuries; (2) general effects on the body, particularly the blood and bloodforming organs (e.g. anemia and leukemias); (3) malignant tumors; (4) genetic effects; (5) other effects including cataract, obesity, impaired fertility and reduction of life span. These effects develop slowly and insidiously. Frequently the damage, once produced, is irreversible and will not respond to treatment. The veterinarian, or his assistant, using x-ray equipment may develop a false sense of security because he cannot perceive any exposure to the x-rays or any immediate damage to himself.

X-ray equipment should not be used unless the operator is fully cognizant of the hazards associated with the equipment. Such cognizance requires knowledge of the characteristics of the machine involved, as well as an understanding of the physical principles of x-ray production and the interaction of x-rays with matter.

One aspect of radiation protection frequently overlooked is that there are actually two types of x-radiation to consider from the protection standpoint, namely, direct and scattered. Ideally, direct radiation should consist only of the useful or main beam but many x-ray machines emit a considerable amount of "stray" direct radiation because of inadequate housing around the tube. This is particularly true with the tube housings in older machines and in many of the newer "bargains". Tube housings should be so constructed that the radiation emerging from the tube is confined to the useful beam. Standards for tube housing safety are described in National Bureau of Standards Handbook 41. This publication covers many other details relative to the construction and utilization of x-ray equipment from the safety standpoint.

Scattered radiation is produced when the useful beam strikes any substance. During the production of scattered radiation the original direction of the direct radiation is deviated so that an appreciable intensity of radiation is emitted in

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all directions. Consequently, personnel standing in proximity to the patient will be exposed to scattered radiation even though they may be outside of the useful beam. Although the intensity of scattered radiation will be only a fraction of the incident direct radiation, it, nevertheless, can constitute a significant exposure hazard.

In general, the potential danger of an x-ray machine is directly related to the frequency of use or, more accurately, to the total milliampereseconds (MaS) of operation during a given period of time. To illustrate, occasional radiographic exposures involving about 50 MaS per week would provide relatively little hazard (unless the operator exposes himself to the direct beam). However, in the case of the x-ray installation which conducts many radiographic examinations involving 100 MaS per week then the hazard to the operator becomes proportionately greater. Fluoroscopic and therapeutic utilization of x-rays are particularly hazardous for the careless operators. One minute of fluoroscopic screening entails as much as 300 MaS. Also, the therapeutic utilization of x-rays generally involves several hundred MaS per course of treatment for superficial therapy and appreciably more for deep therapy.

The potential hazard associated with an x-ray machine is not related singularly to its frequency of use. There are numerous other contributing factors: the inherent or built in safety features of an installation; exposure conditions generally used (such as kilovoltage and distance); and operating technique.

Operating Technique Important

X-ray operating technique is of particular importance from the safety standpoint. Even in instances where an x-ray machine is being used only for occasional radiographic work, the operator may receive excessive exposure if his technique completely disregards safety precautions. Personnel exposure to ionizing radiation should always be kept at a minimum through the practice of good “radiation hygiene” regardless of the frequency or nature of x-ray utilization. Otherwise, radiological skills and practice may be developed and expanded with little or no attention being given to the correspondingly increasing hazard. It is recommended that the following safety measures and devices be incorporated into radiological techniques wherever possible:

1. Leaded gloves and aprons should be standard equipment. Special racks should be available for storing them when not in use in order to prevent the development of cracks and fissures which destroy their usefulness. Such protective equipment should be examined periodically, visually and radiographically, to ascertain that it is intact. An important feature of leaded gloves and aprons often overlooked is that they are designed not for protection against direct radiation but against scattered radiation only!

2. The ideal x-ray technique should be such that the operator is never exposed to the direct beam even when wearing protective equipment. It is recommended that wherever practical the owner of the patient should provide assistance in restraining the animal. Such a procedure is ethical so long as the owner is provided with protective gloves and aprons. The infrequent exposure the animal owner would receive under these circumstances is negligible. An occasional limited exposure to x-rays is not in itself deleterious, but it is repeated exposures and their accumulative effect wherein lies the danger.

3. Exposure to the stray and scattered radiation should be kept to a minimum. The cheapest and one of the best safety principles to employ is distance. The operator should attempt to remain at maximum distance from the x-ray tube and the patient. If it is not feasible for the operator to remain several feet away from the center of the field of radiation then protective shielding should be installed. For therapeutic equipment this latter consideration is a “must”! The specific distances and/or shielding involved would vary depending on the type and usage of the x-ray equipment; expert advice should be sought on this matter.

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The use of cones is a practical and often overlooked means of minimizing stray radiation. A cone narrows the field of direct radiation to within useful beam limits. In addition to the extra factor of safety provided by the use of the cone, it will also tend to increase the sharpness of an image in radiographic or fluoroscopic work and to confine a therapeutic beam to a desired circumscribed area.

Filters are another means of improving radiological techniques and at the same time providing an extra safety factor. Filters will effectively absorb much of the softer radiations which for some radiological procedures are useless, and also will effectively reduce the intensity of radiation received by personnel in the immediate vicinity.

The use of portable equipment is exceptionally hazardous to the operator and his assistant. The practice of holding an x-ray tube should be discontinued for, as has been previously pointed out, there may be appreciable stray radiation coming from the tube housing. Similarly, the holding of a cassette or film should be avoided as this practice frequently results in exposing an individual to the direct beam.

Fluoroscopic Hazards

The improper use of the fluoroscope presents the greatest hazard to veterinarians as a group. The foregoing safety considerations where applicable should be followed in utilizing the fluoroscope and, in addition, there are several recommendations which apply specifically to fluoroscopic equipment. Fluoroscopy should be performed utilizing the minimum intensity and kilovoltage consistent with good results. The fluoroscopic examiner who depends on prior dark adaptation is able to screen with a much lower intensity and kilovoltage than is the operator working under daylight or lighted room conditions. Dark adaptation can be inexpensively accomplished by wearing dark adaptation goggles for 10 to 15 minutes prior to the examination. These goggles permit enough vision for the performance of various tasks in the hospital while the eyes are becoming dark adapted. It logically follows that the fluoroscopic examination room should be darkened during examination.

The fluoroscopic screen and the tube should be so constructed that they are both on a common mount so that the screen moves always in accordance with the movement of the tube. The center of the useful beam should be centered on the screen. The x-ray tube should be equipped with a diaphragm so designed that when it is wide open and with the fluoroscopic screen at its greatest distance from the tube there still remains a margin of about \( \frac{1}{4} \) inch of unilluminated screen. The fluoroscopic screen should be equivalent in thickness to 1.5 mm. of lead, thus blocking off virtually all direct beam radiation, and it should be ascertained that the screen is intact. It is apparent that if all of these precautions are followed the use of the hand fluoroscope becomes impossible. It would be well if hand fluoroscopes were discarded as their use is extremely hazardous.

Monitoring Service

All personnel utilizing x-ray equipment should periodically monitor themselves and/or employees. There are a number of commercial firms which provide film badge personnel monitoring service at a reasonable cost. Such firms provide various types of holder-devices for x-ray sensitive film which are worn on the wrist, fingers or clothing for prescribed period. These films are developed by the company and the degree of darkening of the film is correlated to the personnel exposure received. A report is provided in terms of milliroentgens of exposure received during the prescribed period. Veterinarians can perform their own survey, in less quantitative manner, by utilizing dental film packets with an ordinary metal paper clip on it. These films should be worn for a period of about 2 weeks of representative x-ray operating conditions and then developed. If, after developing, the paper clip is outlined on the film, this indicates that ex-

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to simulate the cornea. Tantalum gauze is fixed around the neck of the prosthesis to provide attachment for the ocular muscles.

The one-piece construction was designed to eliminate the necessity of removal for cleansing and to prevent dislodgment by the animal. The muscles, being sutured to the gauze around the neck of the prosthesis, aid in prevention of expulsion of the prosthesis, and also provide motility, which enhances the cosmetic effect.

The tissue reaction to the plastic, so far, is insignificant clinically. The conjunctival secretions appear somewhat more mucoid in nature, but drain readily in a normal manner, and except for a slightly increased susceptibility to conjunctivitis, the tissues involved show very little apparent change.

As these experiments are still in the early stages, no definite conclusions can be drawn. However, results have been encouraging in four cases, and it is hoped that continued research will provide a practical prosthesis to replace the canine eye when enucleation becomes necessary.

ILLINOIS

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herds showing positive reaction to the ring test. Illinois herds are not given a Plan A status on results of the ring test. However, the ring test will be given recognition in conjunction with the blood agglutination test when the Grade A milk law becomes effective July 1, 1955.

Swine Brucellosis Law

Illinois has enacted a Swine Brucellosis Law which became effective in 1953. No female swine, 4 months of age and over, nor any male swine can be sold for breeding purposes unless they are found to be negative to the brucellosis test. This test must be conducted by an approved veterinarian within 60 days of sale. This test is good for one change of ownership or change of premises only.

All swine 4 months of age or over entering Illinois for showing or breeding must be tested within 30 days prior to date of entry by an official laboratory in the state of origin. Illinois swine for exhibition must be negative to a test conducted within 90 days prior to date of showing.

Any swine reacting in a dilution of 1:25, or higher, is considered a reactor. These must be tagged in the left ear. They cannot be sold for breeding purposes.

We have given a rather lengthy detailed explanation in regard to our Bovine Brucellosis Program wishing to emphasize the importance attached to the restriction of the movement of cattle and swine for breeding purposes of unknown brucellosis status. We have a problem of large importation of cattle for grazing and feeding purposes which dairy states such as Wisconsin are not confronted with.

Since the inauguration of our brucellosis program, the incidence of brucellosis in Illinois cattle has been reduced from approximately 7 percent to 3 percent, or less. We feel we now have a very good program which we hope to improve from time to time.

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cessive exposure has been received. In utilizing dental films in this manner, the film should be worn at a point which you suspect is receiving the greatest exposure.

(10) The foregoing remarks have applied primarily to diagnostic uses of x-rays. However, most of the protection principles involved also apply to therapeutic equipment and the necessity for adhering to protection principles when one is using therapeutic equipment is extremely important. No veterinarian should ever utilize therapeutic equipment unless he is thoroughly familiar with its operation, and the associated hazards, and means of protecting against these hazards.

References


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BIDS ACCEPTED FOR DIAGNOSTIC LABORATORY

Bids were received and accepted Nov. 18, 1954, for the construction of the Veterinary Diagnostic Laboratory. W. A. Klinger Company, Sioux City, submitted the low bid, $346,389, for the general construction. Wolin Plumbing and Heating Company, Des Moines, were low bidders for the plumbing and heating, $78,699. Packard and Jenison Electric Company, Belmond, bid $24,950 for the wiring. E. H. Sheldon Equipment Company, Muskegon, Mich., bid $50,000 to furnish the laboratory.

Actual construction is pending upon final approval of the contracts by the State Board of Education and the Budget and Financial Control Committee of the Iowa General Assembly.

If approved, construction is expected to commence in the very near future. The building, to be erected adjoining the Veterinary Quadrangle on the north, will supply ample space for the diagnostic service and the department of pathology and hygiene.

The building program includes extensive remodeling of the existing building. The Department of Anatomy will greatly benefit by the remodeling of its present location.

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