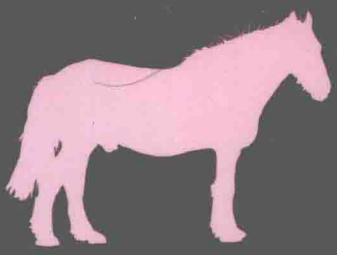


Radiography in VETERINARY PRACTICE at a Glance

(including Diagnostic Imaging Techniques)

A.K. Gangwar
Kh. Sangeeta Devi
Naveen Kumar

DAYA

ASTRAL

Radiography in Veterinary Practice at a Glance

(Including Diagnostic Imaging Techniques)

A. K. Gangwar
Khangembam Sangeeta Devi
Naveen Kumar

2015
Daya Publishing House®
A Division of
Astral International Pvt. Ltd.
New Delhi – 110 002

ISBN 9789351305408

Published by : **Daya Publishing House®**
A Division of
Astral International Pvt. Ltd.
– ISO 9001:2008 Certified Company –
House No. 96, Gali No. 6,
Block-C, 30ft Road, Tomar Colony, Burari
New Delhi-110 084
E-mail: info@astralint.com
Website: www.astralint.com

Sales Office : 4760-61/23, Ansari Road, Darya Ganj
New Delhi-110 002 Ph. 011-23245578, 23244987

Laser Typesetting : **Classic Computer Services**, Delhi - 110 035

Printed at : **Replika Press Pvt. Ltd.**

PRINTED IN INDIA

Radiography in Veterinary Practice at a Glance (Including Diagnostic Imaging Techniques)

About the Authors

Dr. A.K. Gangwar, a graduate from the College of Veterinary Science & Animal Husbandry, Mathura and got ICAR-JRF for completing M.V.Sc. in Veterinary Surgery and Radiology from Indian Veterinary Research Institute, Izatnagar. Dr. Gangwar joined College of Veterinary Science & Animal Husbandry, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (UP) in the year 2002 and established the Department of Veterinary Surgery & Radiology. Presently Dr. Gangwar is working as Associate Professor in the Department of Veterinary Surgery & Radiology of the same college. Dr. Gangwar is working on Biomaterials and Regenerative medicine in veterinary practice. Dr. Gangwar published a textbook, more than 70 research/clinical articles in different peer reviewed international and national journals and presented more than 25 scientific papers in international and national seminars.

Dr. Khangembam Sangeeta Devi, completed M.V.Sc. in Veterinary Surgery and Radiology from Ranchi Veterinary College, Ranchi. Dr. Sangeeta joined College of Veterinary Science & Animal Husbandry, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (UP) as Teaching Associate in the year 2005 and from 2012 onwards she holds the position of Assistant Professor in the Department of Veterinary Surgery & Radiology of the same college. Dr Sangeeta published a textbook, more than 40 research/clinical articles in different peer reviewed international and national journals and presented more than 15 papers in international and national seminars.

Dr. Naveen Kumar joined Indian Veterinary Research Institute as a Scientist in the year 1989 and from 2006 onwards he holds the position of Principal Scientist. Dr. Kumar has more than 25 years of research experience in the field of Regenerative Medicine and Biomaterials in Veterinary Practice. Dr. Kumar is a Fellow of National Academy of Veterinary Science, which is given by the apex premier society, National Academy of Veterinary Science, for the development of Veterinary Sciences in India, for outstanding contribution in the field of Veterinary Science.

PREFACE

The goal of thé authors is to provide latest information of radiology, radiotherapy and modern diagnostic imaging techniques to undergraduate and postgraduate students, professors, field veterinarians and radiographers who are actively involved in radiography of the animais. Although the book has been framed mainly as per syllabus approved by Veterinary Council of India but it is of great use for postgraduate students, professors involved in radiology and radiotherapy, veterinary surgeons, radiographers, radiologists, field veterinarians and researchers. The book is relevant, concise and easy to read describing general principles of radiology, radiotherapy and modern diagnostic techniques. The authors feel a great privileged in bringing out the first edition of the book entitled "Radiography in Veterinary Practice at a Glance (Including Diagnostic Imaging Techniques)". The book has been prepared by consulting several standard textbooks and journals of related field. A number of illustrations and more than 100 good quality photographs of positioning of animals, normal and contrast radiographs of different body parts and radiographs of diseases in animais hâve been incorporated at places to make the text more meaningful. We are indebted to Dr. A.K. Sharma, Dr. Adarsh Kumar, Dr. J. Mohindroo, Dr. J.Y. Waghaye, Dr N.K. Singh, Dr. M. Hoque, Dr. R. P. Pandey, Dr. S.K. Tiwary, Dr. A.K. Das, Dr. R. B. Kushwaha, Dr. R. N. Chaudhary, Dr. J.K. Das, Dr. S.P. Tyagi, Dr. Kiranjeet, Dr. Ashwathy, Dr. S.K. Maiti, Dr. Vineet Kumar, Dr. Ramesh Tiwary, Dr. G.D. Singh, Dr. Arvind Sharma, Dr. Himanshu Singh, Dr. Rahul Udehiya, Dr. Surbhi Gupta, Dr. Jasmeet Singh, Dr. Rukmani Dewangan, Dr. Anil Bishnoi, Dr. A. K. Majhi, Dr. Samar Halder, Dr. Amit Bisla. , Dr. Dayamon D. Mathew, Dr. Warson, Dr. Irawati Sarode and Dr. Kaarthick, D.T., who have made helpful suggestions. We also appreciate our students, Dr. Ajeet Kumar Singh, Dr. Ghanshyam Patel, Dr. Nitesh Katiyar, Dr. Nishant Yadav and Dr.S.S.Kale who hâve directly or indirectly helped with this project. Finally, Dr. A.K. Gangwar and Dr. Kh. Sangeeta Devi are exceedingly grateful to our lovely child (Ansi and Sanskriti) for their support, patience, and encouragement. We shall be grateful to the professionals and colleagues for thé constructive suggestions for the betterment of this book. Authors are hopeful that this book will serve the intended goal.

Dr. A. K. Gangwar
Dr. Kh. Sangeeta Devi
Dr. Naveen Kumar

CONTENTS

1 Timeline of Radiology and Other Diagnostic Imaging Techniques

TIME LINE

November 8, 1895	Wilhelm Conrad Roentgen	Discovered electromagnetic radiation, which he called X-rays, as he didn't know the nature of these rays.
1896	Weker	Develops the first skull radiograph
	Konig and Morten	Developed the first dental radiograph
	Trowbridge	Developed first oil immersed X-ray tube
	Pupin	Made first intensifying screen
	Wright	Developed photographic paper for recording of X-ray image
	Paton and Duncan	Published first veterinary radiograph of equine foot
	R. Eberlin,	**Father of Veterinary Radiology**
		Use of X-ray in veterinary practice
1898	Cannon	Contrast studies of GIT using Bismuth
1901	Wilhelm Conrad Roentgen	First Nobel Prize in Physics
1902	G. Holtz Knecht	Developed first dosimeter for radiation therapy
1905		First roentgenological congress held at Berlin under the chairmanship of R. Eberlin, a Veterinarian
1913	Coolidge	Introduces cathode tube/ high vacuum X-ray tubes
	Gustav P. Bucky	Invented grid to check the scatter radiation
1914	W.H. Bragg and W.L. Bragg	Discovered that X-rays could be reflected
1916	Wilhelm Trendelenburg	Developed red adaptation goggles
1918	Walter Dandy	Develops ventriculography
	Eastman	Introduces radiographic film
		Line focus principle was discovered
1920		Double coated X-ray films were developed
		Use of iodine based contrast agents started
	Dr. Hollis potter	Discovered moving grid
1921	Andre Bocage	Creates the first tomography (body-section imaging)
1927	Moniz	Cerebral Angiography using contrast media
1928		International recommendations on radiation safety precautions were published
1930	C.C. Lauriston	Developed supervoltage single section X-ray tube
1934	Joliot and Curie	Discover artificial radionuclides
1935	Ziedes de Plantes	Developed substraction technique
1937	Chester F. Carlson	Invented Xeroradiography
1942	Karl Theodore Dussik	Published the first paper on medical ultrasonics

Contd...

Contd...

1945	Gray Schnelle	Wrote first American Book on Veterinary Radiology
1946	Schoenander	Develops the film cassette changer which allowed a series of cassettes to be exposed at the rate of 1.5 cassettes per second
1950's		Development of the image intensifier and X-ray television
1951	Benedict Cassen	Scintillation camera
1954	Hertz and Elder	Echocardiographic
1957	Ian Donald	• Developed the first contact scanner • First ultrasound of the uterus during pregnancy
1958	Hal Anger	Gamma camera with the technetium radioisotope
	Alois Pommer	Published treatise on Veterinary Radiotherapy
1960		Use of first radiographic film with polyester base
	American Veterinary Radiological Society	Started Journal Veterinary Radiology. Now Veterinary Radiology and Ultrasound
1962	Kuhl	Developed single positron emission computed tomography (SPECT)
1972	Godfrey Hounsfield and Allan McLeod Cormack	Invented X-Ray Computed tomography. Both scientists were rewarded Nobel Prize in Physiology or Medicine in 1979
	Paul Lauterbur	Magnetic Resonance Imaging (MRI)
	Pupin	Rare earth intensifying screen developed
1975	M. M. Ter-Pogossian, and M. E. Phelps	Positron Emission Tomography (PET)
1977	Raymond Damadian	Designs and invents the first MRI scanner
1980's	Fuji	Develops CR technology
1987	Charles Dumoulin	MRA (Magnetic Resonance Angiography)
1992		International radiology Association was changed from Veterinary Radiology to Veterinary Radiology and Ultrasound
1993		Functional MRI (fMRI).

RADIOGRAPHY

Making a radiographic record of internal structures of the body by exposure of the film by X-rays is known as radiography.

Types of Radiography

1. **Spot film radiography:** Making of localized instantaneous radiographic exposures during fluoroscopy.
2. **Stress radiography:**
   - Stress (traction, rotation or wedge forces) is placed on structures being radiographed.
   - Most commonly used in the diagnosis of joints and spinal disorders such as lumbo-sacral instability, wobbler syndrome and atlanto-axial instability.

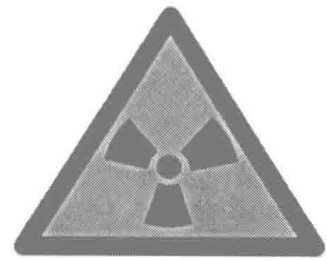
3. **Serial radiography:** Making of more than one exposure of a particular area at different intervals.
4. **Mucosal relief radiography:** Performed for revealing any abnormality of the intestinal mucosa.
5. **Intra-oral radiography:**
   - Small non-screen film is placed in the mouth and x-rays are directed from outside the mouth.
   - Used in dental radiography.
6. **Body section radiography:** e.g. Laminography or tomography.
7. **Contrast radiography:** Radiograph is taken after introduction of contrast agents.
8. **Xeroradiography:** The process of making a type of dry x-rays in which a picture of the body is recorded on paper rather than on the film.
9. **Interventional radiography:** In Interventional radiography the medical procedures (usually minimally invasive) are performed with the guidance of imaging technologies.
10. **Teleradiology:** Teleradiology is the transmission of radiographic images from one location to another for interpretation by a radiologist.
    - X-rays were discovered by Wilhelm Conrad Roentgen on November 8, 1895 and got the first Nobel Prize for physics in 1901.

Radiology (Roentgenology): It is the branch of medical/veterinary science that employs the use of imaging for diagnostic and therapeutic purpose.

Radiologist: Any person qualified in veterinary/medical science and radiological physics who uses an array of imaging technologies such as X-ray radiography, ultrasound, computed tomography (CT), nuclear medicine, positron emission tomography (PET) and magnetic resonance imaging (MRI) to diagnose or treat diseases.

Radiographer or radiologic technologist: The acquisition of imaging is usually carried out by the radiographer or radiologic technologist. The radiologist then interprets or "reads" the images and produces a report of their findings.

Radiograph / roentgenograph / skiagram: Radiograph is produced on silver-impregnated films by transmitting X-rays through the patient. It is the photographic record of the extent of penetrability of X-rays through the exposed tissue part.



Radiation

2 Establishment of A Veterinary Radiology Section

RADIOLOGY SECTION

The overall set up of radiology section should consider the following requirements

1. Space
2. X-ray machines
3. Electric supply
4. Accessory equipments

1. SPACE

The site for construction of building for installation of X-ray unit should be located

A. Within the premises of clinic and surgery area and from which all unnecessary persons could be excluded when the x-ray unit is under operation to minimize radiation hazards.

B. Where the animals to be radiographed can easily be brought to the exposure room.

The area should have space for-

(a) X-ray room or exposure room
(b) Control panel area
(c) Dark room
(d) Radiologist and radiographer room
(e) Interpretation room
(f) Store room for keeping unexposed films and other accessories
(g) Waiting area
(h) Film file room
(i) Teaching hall

(a) X-ray room or exposure room

- It should have large space which reduces radiation exposure of personnel due to decreased scatter radiation.
- It should have restraining devices like travis, casting trolley etc.
- The floor should not be slippery.
- The windows and doors should be covered with thick curtain.

- Thick concrete walls (15 cm thick) should be painted with white lead paint.

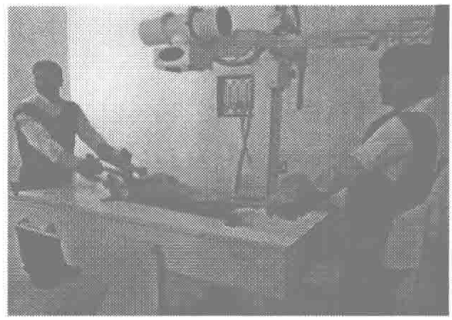


Fig. 2.1: Posture of persons for positioning of animal during exposure

(b) Control panel area

- The area should be located in such a way that it is seldom in line with the primary X-ray beam. There should be a protective partition with a lead glass window (30x30cm) to view animal and machine during exposure (**Fig. 2.2**).

Fig. 2.2: Handling of control panel

(c) Dark room

- The dark room should be adjacent to the X-ray room and must be light proof
- It should have well demarcated dry bench and wet bench in orderly sequence of successive stage of work. Each bench should be fitted with safe light (low watt frosted bulb, maximum 10 watt, covered by specific filters) at minimum height of 3 feet from working table.
- There should be provision for sufficient running water.
- It should have a lead box to store unexposed films currently in use.
- Room temperature should not be too cold or too hot.
- It should be fitted with film drying rack.

(d) Radiologist and radiographer room

- It should be located near the X-ray room/dark room.
- It should be fitted with viewing illuminator.

(e) Interpretation room

- A separate interpretation room should be planned
- Provision should be made for at least two viewing illuminator.

(f) Store room for keeping unexposed films and other accessories

- The unexposed sealed packets of X-ray films should be stored away from source of radiation and other accessories can be stored in this room.
- If separate room is not feasible then a portion of dark room can be used for this purpose.

(g) Waiting area

- Waiting area should be located outside the x-ray room.
- The area should have minimum radiation hazards and minimum obstruction in the flow of work.

(h) Film file room

- It should be near the radiologist's office.
- The room should have sufficient provision of storing racks or cabinets for film boxes so that film can be systematically stored year wise, species wise or as in required manner.

(i) Teaching hall

- In teaching institutes, there should be provision for teaching hall for teaching purpose.
- It should be fitted with viewing illuminators.

2. X-RAY MACHINES

X-ray machines are main source of X-ray generation and can be grouped into three main categories:

(i) Portable X-ray Machines

- Easy to transport.
- Maximum output usually varies from 70-110 kV and 15-35mA.

(ii) Mobile X-ray Machines

- Most machines are movable on wheels or on smooth surface within the radiology section.
- Maximum output usually varies from 90-125 kV and 40-300mA.

(iii) Fixed X-ray machines

- These machines are mostly ceiling mounted having telescoping tube.
- Maximum output usually varies from 120-200 kV and 300-1000mA.

3. ACCESSORIES

(i) **X-ray film clip:** These are ordinary stainless steel clips for hanging the processed X-ray film **(Fig. 2.3a)**.

(ii) **Collimators:** They are made from lead and used to limit size of the primary X-ray beam. Commonly used collimators are diaphragm, cone **(Fig. 2.3b)** and cylinder **(Fig. 2.3c)** and used at the window of the X-ray tube. The collimator reduces scatter radiation and patient radiation dose is decreased.

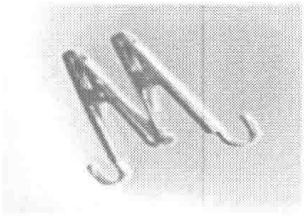


Fig. 2.3a: X-ray film clips

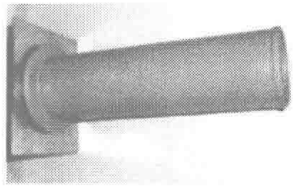


Fig. 2.3b: Collimator (Cyllimator Cylinder)

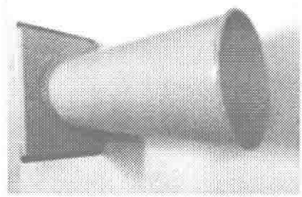


Fig. 2.3c: Colliomator (Cone)

(iii) **Cassette or film holder:** It is a light proof box designed to hold X-ray film for taking an X-ray exposure **(Fig. 2.3d)**.

(iv) **Film drying rack:** film hangers are loaded on this rack for drying of exposed films **(Fig. 2.3e)**.

(v) **Film markers:** These are letters and numbers of lead and used for permanent marking on X-ray film **(Fig. 2.3f)**.

(vi) **Contrast scale:** An instrument to find out a wide range and great number of shades of gray with little difference in the adjacent tones of a radiographic image (**Fig. 2.3g**).

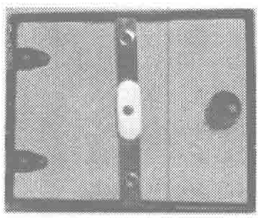


Fig. 2.3d: Cassette or film holder

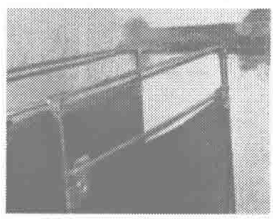


Fig. 2.3e: Film drying rack

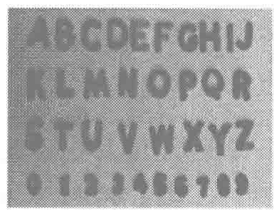


Fig. 2.3f: Film markers

(vii) **Lead gloves and aprons:** During exposure they protect the front portion of the body and hands. They should have 0.25 mm and 0.5 mm lead equivalent, respectively. These items should be kept on a roller slant to prevent it from damage **(Fig. 2.3h and 2.3j).**

(viii) **Caliper:** It is used to measure the thickness of the object to be radiographed **(Fig. 2.3i).**

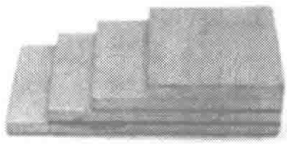


Fig. 2.3g: Constrast scale

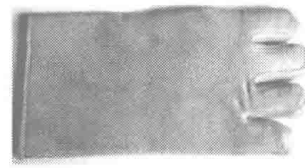


Fig. 2.3h: Lead glove

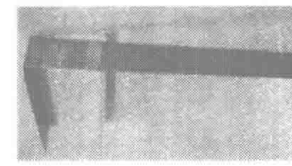


Fig. 2.3i: Caliper

(ix) **Film hangers:** Exposed films are loaded in film hangers for easy processing. Following types of hangers are available- Clip type, channel type and tension type **(Fig. 2.3k).**

(x) **Viewing illuminator:** It is used for proper radiographic interpretation **(Fig. 2.3l).**

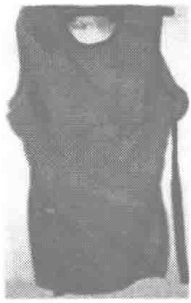


Fig. 2.3j: Lead apron

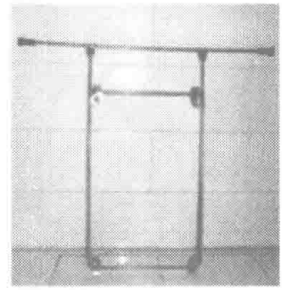


Fig. 2.3k: Film hanger

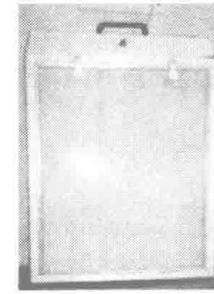


Fig. 2.3l: Viewing illuminator

(xi) **Safe light:** It is a box containing a low watt (10 watt maximum) frosted bulb covered by a specific filter **(Fig. 2.3m).**

(xii) **Cassette holder:** It is used for holding cassette during radiography of large animals in standing position **(Fig. 2.3n).**

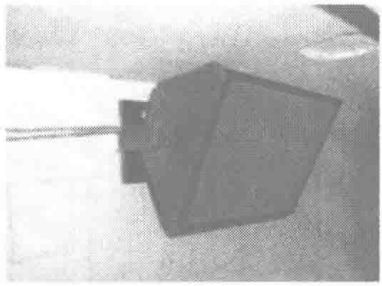


Fig. 2.3m: Safe light

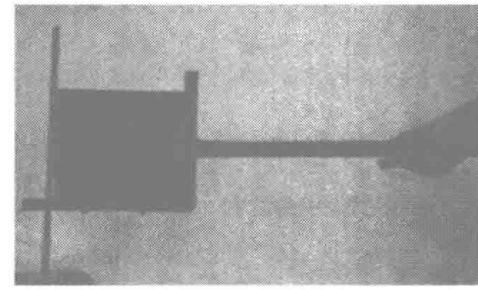


Fig. 2.3n: Cassette holder

(xiii) **Blocks:** These are made of wood and used for positioning of part/ to elevate animal's foot to the centre of X-ray beam. Rickman navicular block is used for radiography of navicular bone of horse.

(xiv) **Cassette pass box:** It is a device fitted in the wall between exposure room and dark room. The exposed cassettes are sent to the dark room through cassette pass box from the exposure room.