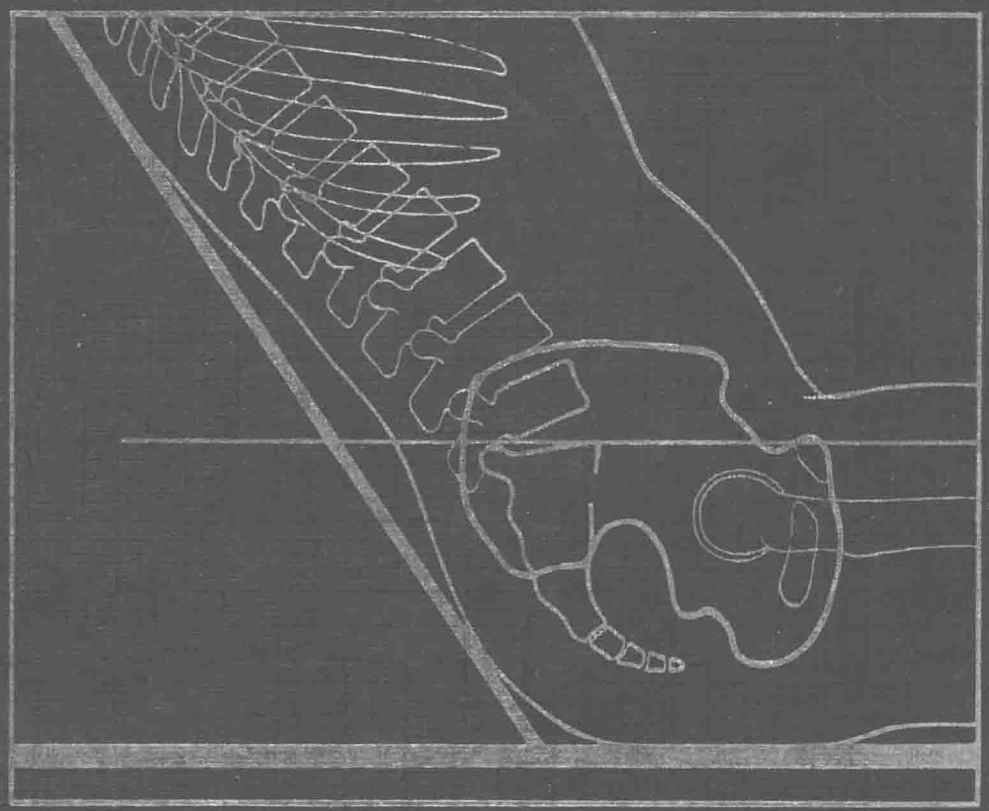
CLARK'S POSITIONING IN RADIOGRAPHY

LOUIS KREEL
ANN PARIS



VOLUME ONE:
ROUTINE RADIOGRAPHY

10TH EDITION

CLARK'S
POSITIONING IN
RADIOGRAPHY

TENTH EDITION
Volume One

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INTRODUCTION to the TENTH EDITION

The last ten years have seen considerable advances in radiography, radiology departments and hospital practice. Rare-earth screens are now widely used with a marked reduction in radiation exposure making slow exposure times possible without recourse to high kilovoltage or high output generators.

Many old procedures have been modified and new procedures introduced, now being an integral part of normal practice. Angiography is available in all but the smallest departments, double contrast barium meals and enemas performed routinely as well as arthography, renal cyst puncture, antegrade pyelography, mammography and endoscopic retrograde cholangio-pancreotography (ERCP).

Automatic processing is currently so widespread that 'wet processing' is not only unknown in many departments but can hardly be remembered while radiographic equipment with automatic exposure control is gaining wider acceptance. Radiography has consequently become easier and pleasanter with cleaner and more efficient dark rooms, fewer repeat examinations and a saving in cost and radiation.

Fluoroscopy has also become simpler and pleasanter with the universal introduction of image intensification and television viewing. Gone are the old days of red goggles, dark adaptation and barium examinations in the dark. Moreover, the new caesium iodide intensifier tubes produce images of very high quality. Even the films are in the process of change with the acceptance of 70 and 100 mm films, storage by miniaturisation and the use of Xerography.

Central sterilisation departments provide sterile angiographic, aspiration, myelographic and hystersalpingography packs. Emergency examinations are now readily organized with a minimum of fuss and bother, and have consequently become safer and more tolerable for the patient. A more important reason for the increased safety is that the newer contrast agents for these invasive procedures are less toxic and more easily managed.

Intensive Care and Coronary Care units (ITU/CCU) are an accepted part of general hospital practice and many more hospitals move patients to radiology departments in their beds. Mobile examinations are therefore more confined and are of much better quality especially with the new higher output units.

There has also been a greater awareness of the potential hazard from radiation in the early months of pregnancy and the almost universal implementation of the 10 day rule is especially gratifying. The most dramatic change however is the introduction of ultrasonography in obstetrics which has completely displaced conventional radiography. But it is not only in obstetrics that the new scanning methods are revolutionizing diagnostic radiology. Non-invasive methods including isotope imaging, computed tomography and nuclear magnetic resonance scanning are being applied to all areas of the body and every organ. The new generation of radiographers are likely to be as familiar and unimpressed by these innovations as the present generation are with automatic processors and image intensifiers.

Thus radiology departments have changed radically in the last decade, making exact diagnoses more readily available to larger numbers with less discomfort to the patient and easier for the radiographer. However, radiographers now need a far greater knowledge to cover the increasing scope of the subject. With the new scanning methods being introduced computers and computer technology may yet also find a place in radiographic practice. However, there can be no progress in radiography without the basic skills in patient positioning based on an accurate knowledge of basic anatomy. "Positioning in Radiography" will therefore continue as an essential guide to good radiographic practice.

ACKNOWLEDGEMENTS

We gratefully acknowledge the rôle of the Clinical Research Centre and Northwick Park Hospital. In producing a new Edition to "Kitty" Clark's book; a modern department is obviously essential. The farsighted policy of the Department of Health and Social Security (DHSS) in combining with the Medical Research Council (MRC) under the auspices of the North West Regional Board, helped to conceive and build the institution. Modern equipment and adequate staffing is obviously needed for good radiography.

Our thanks are therefore due to the Staff of the Radiology Department who have developed and maintained high standards since its opening in 1970.

ACKNOWLEDGEMENTS to the NINTH EDITION

Miss K C Clark was principal of the ILFORD Department of Radiography and Medical Photography, Tavistock House, from 1935 to 1958. Her intense interest in teaching and radiographic projections led to an invitation by Ilford Limited to produce 'Positioning in Radiography' which has now reached its 10th edition. Her infectious enthusiasm was most gratifying to all visitors. She was ably assisted by her colleagues, leading to many innovations in radiography, especially in developing mass miniature radiography.

She accepted Honorary Fellowship of the British Society of Radiographers after being President of the Society and in 1959 was made an Honorary member of the Faculty of Radiologists and an Honorary Fellow of the Australian Institute of Radiography.

Miss Clark died in 1968 and the Kathleen Clark Memorial Library established by the Society of Radiographers at Upper Wimpole Street in fitting respect of her contribution.

The ninth edition was produced in two volumes being edited and revised by James McInnes FSR, TE, FRPS, having been involved with Positioning in Radiography from 1946 when he joined the team at Tavistock House. He originated many aspects in radiography and contributed numerous articles to radiographic journals, becoming Principal of Lecture and Technical Services at Tavistock House and lecturing widely to X-ray Societies in Britain, Canada, America, South and West Africa.

Over two hundred new photographic illustrations have been incorporated in this new edition. Renewal of considerable previous illustrations has taken place, to both up-date and improve the accuracy of presentation. Photographic illustration of all additional techniques has also been included.

In the production of these we are indebted to the photographic artistry and skill of Mr Michael Barrington-Martin.

Acknowledgement is also made to the considerable assistance given by GEC Medical Equipment Limited (Wembley) who, on two occasions, installed the necessary X-ray equipment in the photographic studios and to Sierex Limited and Philips Medical Systems Ltd on further occasions. The accuracy and convenience required, to present photographs of radiographic positioning technique, is largely a function of having good X-ray equipment, and on each occasion
We were well served in this respect.

In connection with the above we are also indebted to Leslies Limited (Polyfoam Division) for the use of their Polyfoam positioning aids and foam table mattress, these proved a major factor in comfort, convenience and positional accuracy.

Thanks are also due to Miss H M Fowles MSR, Westminster Hospital X-ray Department for providing the facilities for photographing the tomographic positioning techniques.
Thanks are also due to Miss D M Chesney, Hon FSR, TE, Coventry and Warwickshire Hospital for permission to adapt her article, "Acute Abdomen Emergency" within the format of Positioning In Radiography.

Consultation is a very necessary feature in the preparation of descriptive and accurate text, in this respect we are indebted to the following:
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Miss M England FSR, and Mr Norman Baldock FSR, Royal Northern Hospital, London. Thanks are due to Mr J Coote for making available the X-ray room facilities at Tavistock House, in order to clarify many of the problems associated with positioning technique.
Mr Kenneth Lawley and Mr Michael Smith have been responsible for the design and production of the 9th edition in the new two volume form. We are most grateful for their valued co-operation.

Our thanks are due to the directors of CIBA-GEIGY Limited for making this edition possible and allowing us to be associated with this acknowledged world-wide authoritative work on radiographic positioning.

In preparing the ninth edition of Positioning In Radiography we wish to acknowledge the radiographic illustration content from the following sources:

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PREFACE

The object of this book is to present in as practical a form as possible, the essentials of radiographic technique and to provide students, radiographers and radiologists with a reference book on the more widely used radiographic techniques and procedures. The last ten years have seen profound changes in radiographic practice and the next ten years will see further progress. However, basic radiographic techniques will continue to form the major part of the work of radiology departments.

Correct positioning for routine examinations is illustrated photographically together with resulting radiographs and occasional explanatory line diagrams and photographs of dry bones as well. There are a limited number of abnormal radiographs, mostly of fractures, which are described in the text to show how positioning and exposure require modification. Suitable exposure factors are shown for each position.

Radiographers must know basic anatomy, particularly as shown on radiographs in various projections. The anatomical appearances will obviously change as the position of the patient changes, but also with changes in tube angulation. However, it is not just the change in position but in radiographic density with variation of the overlying soft tissues and bone.

Radiographic anatomy is therefore not just a simple translation of named parts from one view to another but an imaginative step in projection to allow for changed tissue density. Similarly physiological changes must also be taken into account. Not only must respiratory, cardiac and gastro-intestinal movements be recognized, understood and their effects circumvented, but on occasion even used to good effect in radiographic examinations.

The development of new techniques often introduces new factors which previously may have been irrelevant. Contrast agents and various drugs are now commonly used in X-ray diagnosis and radiographers must familiarize themselves with these as well. But above all radiography is about radiation which must be used efficiently. Radiation dose to patients must be kept at its lowest consistent with accurate diagnosis which can only be done with correct location, positioning and exposure to avoid repeat examinations.

While radiographers are not expected to be responsible for the interpretation of radiographs, their expert opinions, when requested, can be most helpful. However, a familiarity with clinical conditions given on request forms is essential for the translation of very brief instructions into high quality radiographs.

The care and comfort of the patient is paramount not only for the sake of the patient but also to ensure an adequate examination. General comfortable relaxation in the correct position for a particular projection, encourages local relaxation and immobility. Radiographic rooms must be warm, and the parts of the patient not being examined, well covered. Apprehensive patients must be reassured and asked to co-operate. A clear explanation of what the examination entails will help to gain the patient's confidence and co-operation.

Every radiograph must be clearly labelled with the patient's name, date and X-ray or hospital number. It is also absolutely essential that the labels as to right or left must be clearly visible on the film and correspond with the request as shown on the request form. When relevant the position of the patient must also be indicated on the film, particularly whether erect, supine, right or left side up or head or feet down. Without this information it may be impossible to interpret the films correctly.

Radiographic Appearances

Living anatomy is portrayed on each film taken but is limited by the physical properties of X-rays and current technology. Good radiographic practice tries to avoid any further downgrading of the anatomical image by a meticulous attention to detail especially in using the correct projection for the part of the body or particular organ being examined. But internal organs change their position with regard to each other and to their surface relationships with changes of patient position. A knowledge of these changes is absolutely essential in radiographic practice. The most marked changes in the position of internal organs occurs with a change from the supine to erect.

There are also significant differences between supine and prone and right and left decubitus positions and quite marked changes in position of organs also occurs with respiration. A three dimensional appreciation of anatomy is therefore extremely important in radiography.

Radiographic appearance is the term used in this book for what is seen on the resulting film and takes into account the many factors which contribute to the result. For a better appreciation of technique required to produce these films many radiographs are annotated, especially those of bones and joints and projections are further illustrated by line drawings and photographs.

The radiographic illustrations have been reproduced from negative prints to keep their appearances as close as possible to that of the actual radiographs, except of course in size.

A high speed Bucky grid with a ratio of 10:1 is used for all areas of the body other than arms, hands and feet to eliminate scattered radiation and yet keep short exposure times. Fine-lined stationary grids (100 lines to the inch) have also been used but cross hatched grids tend to increase exposures by a factor of $\times 2$ or $\times 3$.

Technical Factors

Exposure factors are given for each projection shown, namely kilovolts (peak) milliampere-seconds and focus-film distance (FFD) as well as the type of intensifying screens, film and type of grid when relevant and assumes that all films will be developed under recognized standard conditions for automatic or manual processing. These factors will be suitable for a patient of average physique.

Each factor associated with exposure technique is a variable because of the wide range of radiological equipment in

use and the various combinations of film and intensifying screen possible. The exposure factors given are for a full wave rectified X-ray unit. However for any particular unit the factors will need to be increased or decreased due to unit output difference but the same percentage difference can be applied to all exposure throughout the book.

The focus-film distance may vary according to the type of examination but should wherever possible be kept constant and at 120 cm (48 ins). For Bucky exposures it ranges from 100 cm (40 ins) to 120 cm (48 ins), however when using a Bucky the FFD must be within the limits specified for the grid in use. For teleradiography it ranges from 150 cm (60 ins) to 180 cm (72 ins) except for high kV chest radiography using an air gap when it may be increased considerably. Radiation must be restricted to the smallest possible area of the region being examined, and the genital organs must be protected by lead shields of suitable size and shape. The conventional 2 mm aluminium filter at the tube aperture reduces radiation exposure to the patient and extra filters should be added when kilovoltages over 150 kV are used. Every possible care must be taken to minimize radiation hazards both to the patient and to the operator.

Kilovoltage and Radiographic Appearances

Increasing the kilovoltage increases the energy of the X-rays, decreases their wavelengths and increases their penetration. There is however a loss of contrast on the more penetrated films taken at higher kV exposures. Some simple rules can therefore be used to obtain good quality films.

For good bone detail the kV should not be increased above 100 and a kV of 60–70 is preferred. However, for very thick parts such as the pelvis, higher kV's may be needed.

For soft tissue detail particularly in mammography, very low kV's in the order of 20–30 kV are used requiring a special X-ray tube, screens and film.

For opaque contrast agents high kV is needed for penetration. However, most contrast examinations have now been so profoundly modified that kV's in the range of 60–80 give the best results. Fine detail in double contrast barium examinations are most easily shown in this range which is also recommended for the demonstration of small vessels on arteriography.

However, exposure times must be kept wherever possible within the 0·04–0·06 range to avoid movement blurring.

Qualities Desirable in a Radiograph

A good image requires good definition which is a function of both contrast and sharpness of the image. Contrast is determined by the radiographic density of adjacent areas and is adequate when the different radiographic densities between adjacent areas are visible. Increasing the film contrast makes these differences in radiographic densities more readily visible. Sharpness on the other hand depends on (a) eliminating 'subject movement' (μm) by keeping the patient still and using the shortest possible times for an adequate exposure; (b) using the smallest focal spot size, longest focal film distance and shortest object-film distance (μg) consistent with an adequate exposure and (c) choosing a film screen combination compatible with the X-ray unit which minimizes movement unsharpness (μm) and equipment unsharpness (μg).

Positioning terminology usually describes the projection from the tube towards the film but also still occasionally from the film towards the tube. The latter is still used because radiologists describe projections from fluoroscopic examinations which are accepted by long standing tradition especially the oblique views of the heart and aorta.

POSITIONING TERMINOLOGY

Patient Aspect

Anterior aspect, is the view of the patient from the front and posterior aspect, the view of the patient from the back.

Antero-posterior (AP) and postero-anterior (PA) describe the direction of the central ray from the portal of entry towards the exit. In the antero-posterior (AP) position the front of the body faces the X-ray tube, and in the postero-anterior (PA) position the X-ray tube is closest to the back of the body.

In projections for the upper and lower limbs, AP, PA and oblique views are described from the tube side as well as for skull projections. The AP and PA terminology also applies to all prone, supine and erect positions, e.g. chest postero-anterior or lumbar spine antero-posterior.

In examinations of the abdomen, vertebral column and pelvis, oblique positions are described from the patient's aspect (anterior or posterior) nearest to the film, together with the side (left or right) of the subject nearest the film.

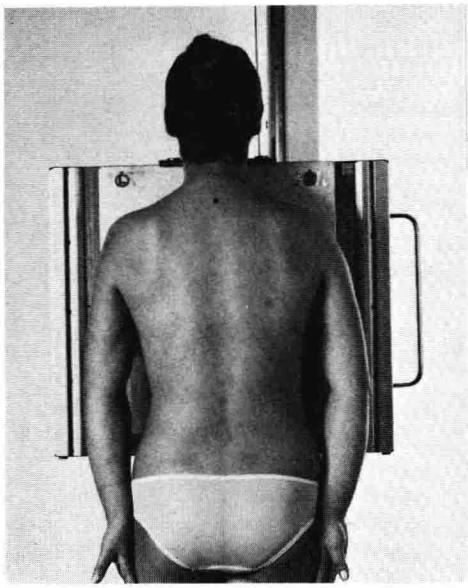
Thus, if the patient is supine with the right side raised and left side toward the film, it is called a left posterior oblique.

Oblique Positioning

Right Anterior Oblique—anterior aspect of patient is towards the film, right side of the patient in contact, left side raised.
Left Anterior Oblique—anterior aspect of patient is towards the film, left side of patient in contact, right side raised.
Right Posterior Oblique—posterior aspect of patient is towards the film, right side of patient in contact, left side raised.
Left Posterior Oblique—posterior aspect of patient is towards the film, left side of patient in contact, right side raised.

Lateral Positioning

Right lateral indicates the right side of patient in contact with film. Left lateral indicates the left side of patient in contact with film.



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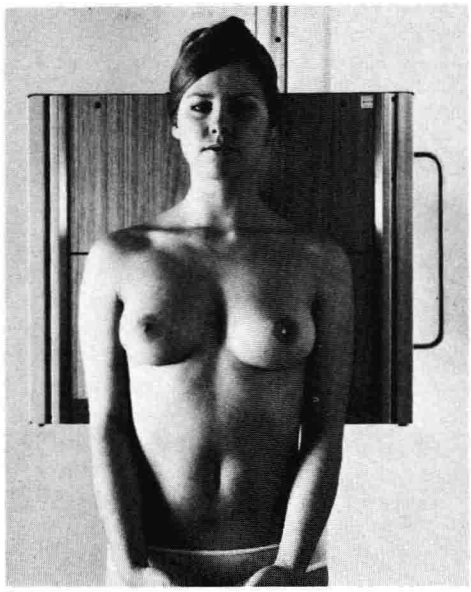

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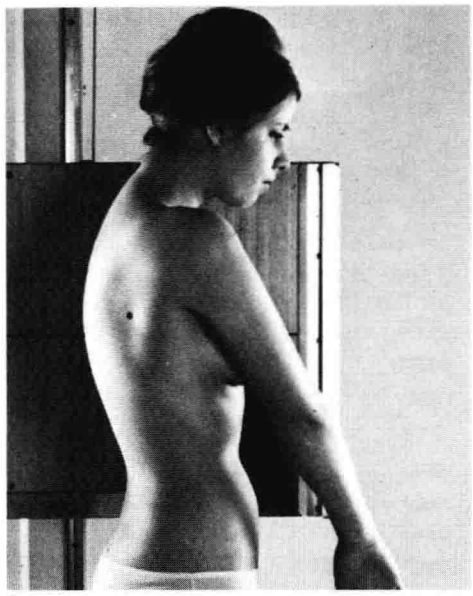

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5 LEFT ANTERIOR OBLIQUE

6 RIGHT ANTERIOR OBLIQUE

Erect Positioning

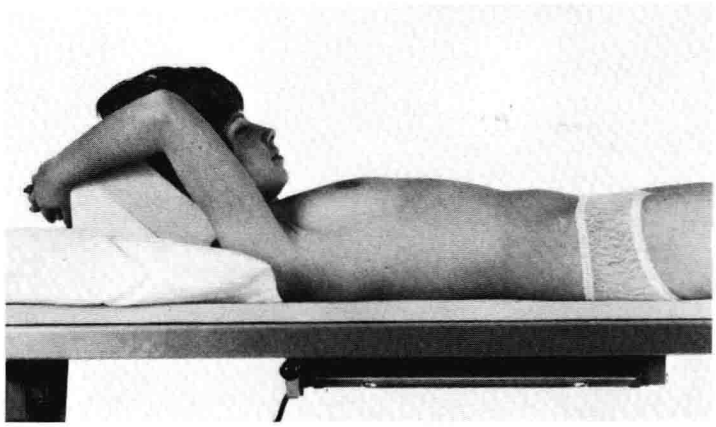
1 Postero-Anterior
2 Antero-Posterior
3 Left Lateral
4 Right Lateral
5 Left Anterior Oblique
6 Right Anterior Oblique
7 Left Anterior Oblique
8 Right Posterior Oblique

Horizontal Positioning

1 Supine
2 Prone
3 Right Lateral
4 Left Lateral
5 Left Posterior Oblique
6 Right Posterior Oblique
7 Right Anterior Oblique
8 Left Anterior Oblique

7 LEFT POSTERIOR OBLIQUE

8 RIGHT POSTERIOR OBLIQUE



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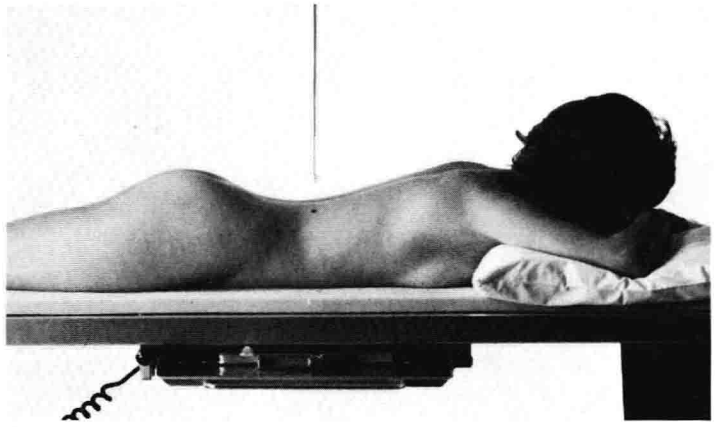

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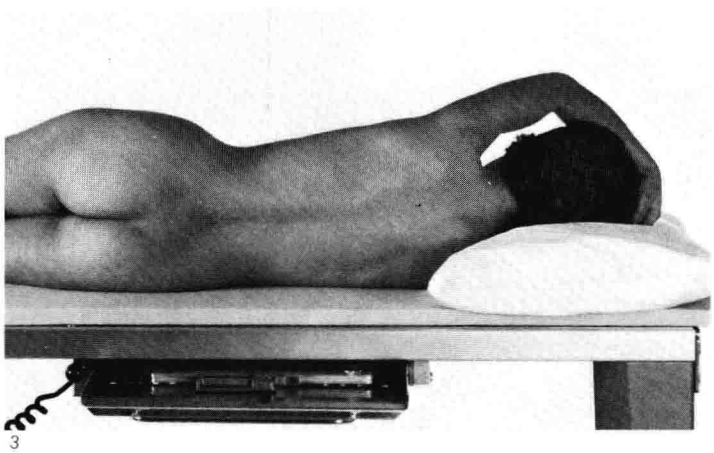

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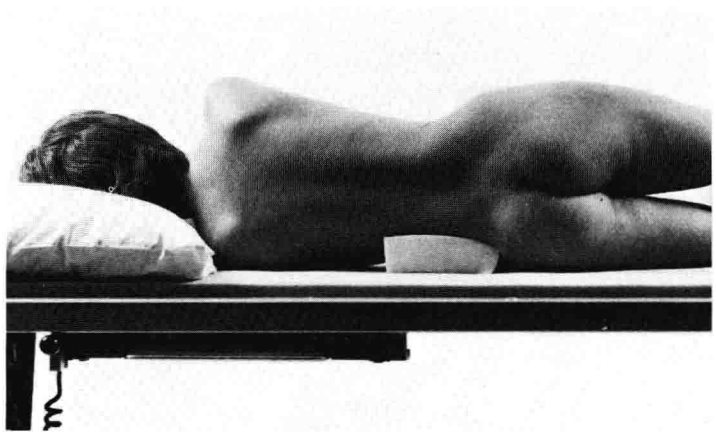

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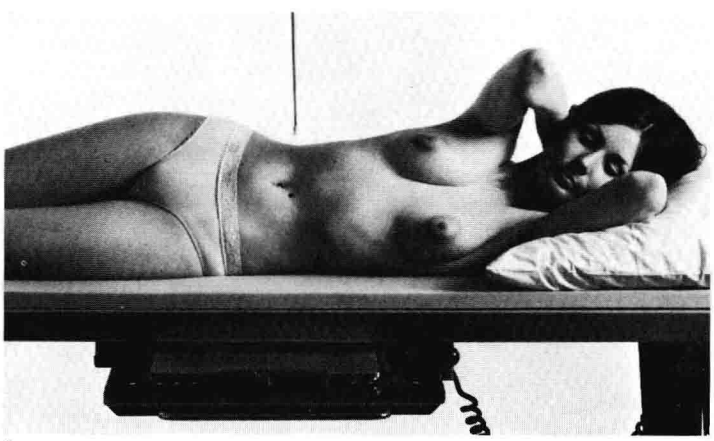

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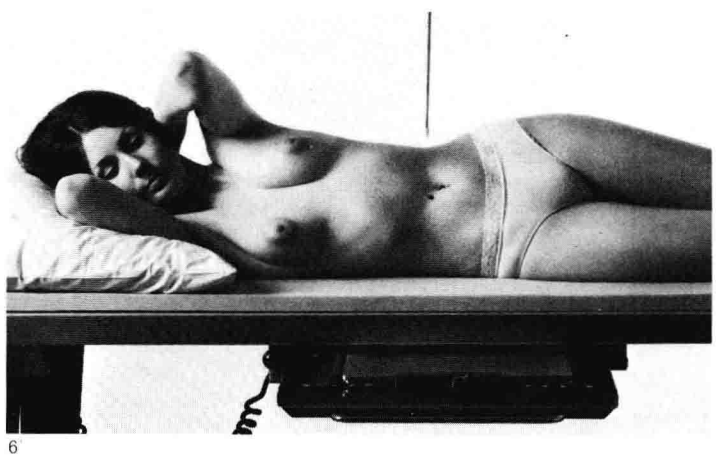

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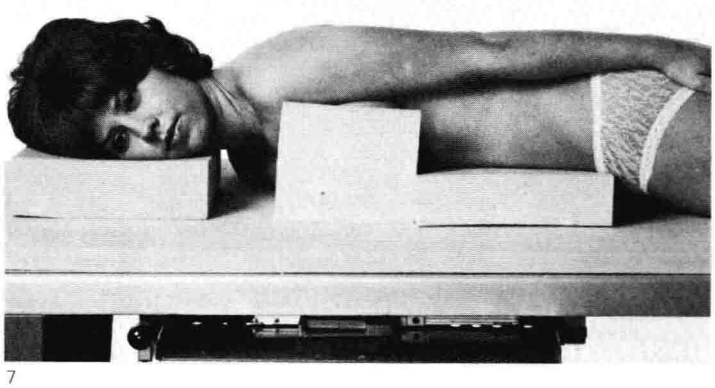

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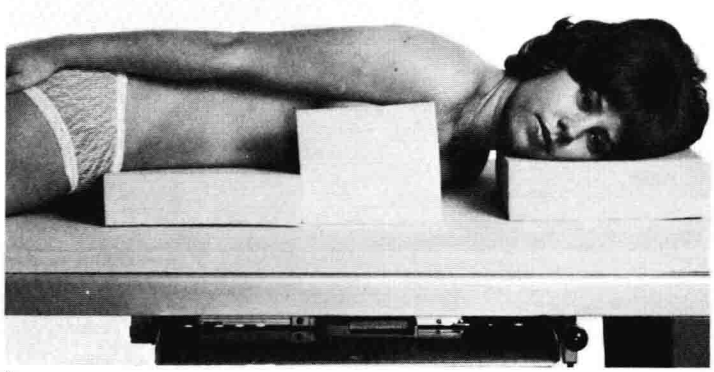

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VOLUME ONE

The Tenth Edition of
Positioning in Radiography
has been produced in two volumes.
An outline of the contents
of volume two is shown below:

CONTENTS

VOLUME TWO

1

UPPER LIMB

1 SECTION 1

UPPER LIMB

General and Technical

Because examinations of the upper limb are elementary and routine the standards of any department can immediately be judged by the quality of films of this region. But more importantly the best possible radiographs are essential as decisions about injuries in the upper limb especially of the elbow and wrist affect the future dexterity, employment and earnings of patient.

When examining the upper limb, the whole of the arm should rest on the X-ray couch to bring the adjacent joints level with the area to be radiographed.

(1) In the antero-posterior (AP) position the arm is supine lying with the palm of the hand facing upward, the elbow extended and the shoulder well down, the tube being centred from above the couch.

(2) In the lateral position the elbow is flexed to a right angle and the arm and forearm rest on the table top with the palm of the hand at right angles to the couch.

(3) When a postero-anterior projection is taken for the hand and wrist the elbow is flexed and the hand rotated into the prone position.

(4) Where the arm and forearm of the patient are in Plaster of Paris the examination may be done in the postero-anterior position; for accurate centring use a tape measure to compare affected and unaffected limb lengths. (3)

(5) The AP view to show the long bones of the forearm should be taken with the hand supinated as the radius and ulna are super-imposed when the hand is pronated.

■ Centring points for wrist, forearm and elbow are indicated by black spots (1,2).

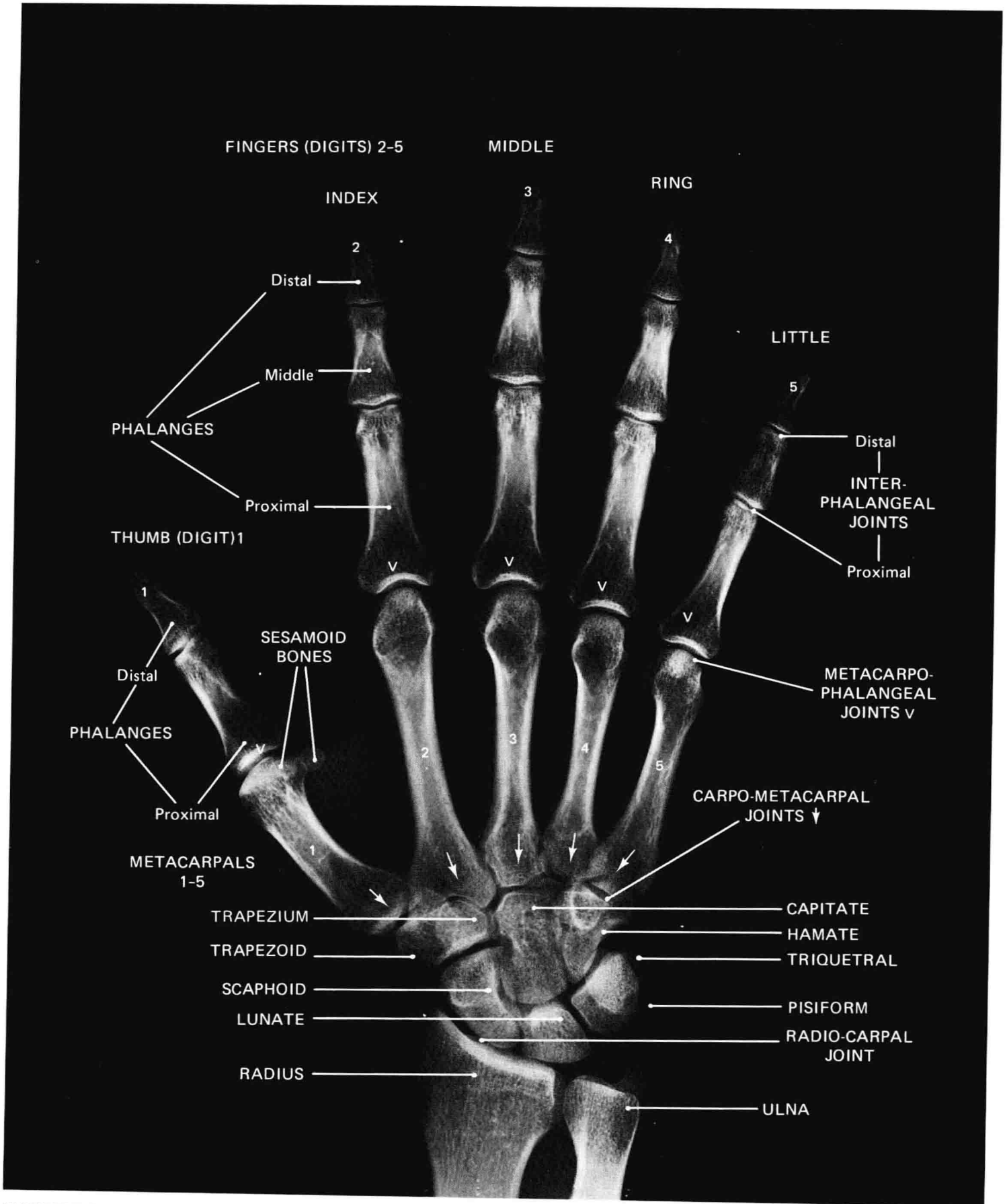
The patient must be relaxed and the arm must be immobilized by the use of non-opaque supports of plastic sponge around the area to be radiographed. Remember the limb will only remain stationary if it is in a comfortable position.

1

2

Radiation is kept to a minimum by collimating the beam with a light beam diaphragm or by the use of an extension cone. Unless otherwise stated the tube is straight, at right angles to the table top and the central ray at 90° to the film. The carpus, metacarpus, phalanges and their interarticulation at the wrist joint are shown in the three positions of the hand (6,8,10)

3



RIGHT HAND

POSTERO-ANTERIOR

Postero-anterior (basic)

The forearm is placed on the table in pronation, with the fingers extended, but relaxed and separated to bring them into close contact with with film.

■ Centre over the head of the third metacarpal bone (5,6)

Lateral (basic)

From the prone position the hand and forearm are turned into the lateral position so that the palm of the hand is at 90° to the film with the fingers overlapping and the thumb resting on a nonopaque support. (7,8)

■ Centre over the head of the second metacarpal bone.

Note—Although the metacarpal bones overlap, this projection does show forward or backward displacement at the fracture site; it also shows whether a foreign body is on the palmar or dorsal aspect of the hand.

Oblique—postero-anterior (basic)

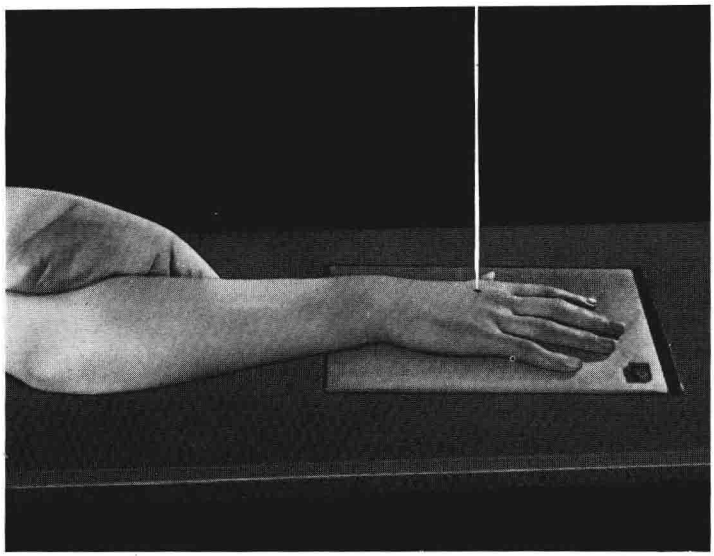
From the lateral position the hand is rotated forward to midway between the postero-anterior and the true lateral. At an angle of approximately 45° to the film, the fingers are separated and rest on a 45° non-opaque pad for immobilization.

■ Centre over the head of the fifth metacarpal bone or angle the tube towards the head of the third metacarpal to reduce the area of irradiation by 50% (9,10).

Note—This projection avoids superimposition of the bones, being used in the diagnosis of crack fractures and in pathological conditions.

Hand

kVp			mAS				Film	Screens	
PA	Lat	Obl	PA	Lat	Obl	FFD	ILFORD	ILFORD	Grid
50	50	50	8	12	10	100 cm (40")	RAPID R	SUPER HD	—

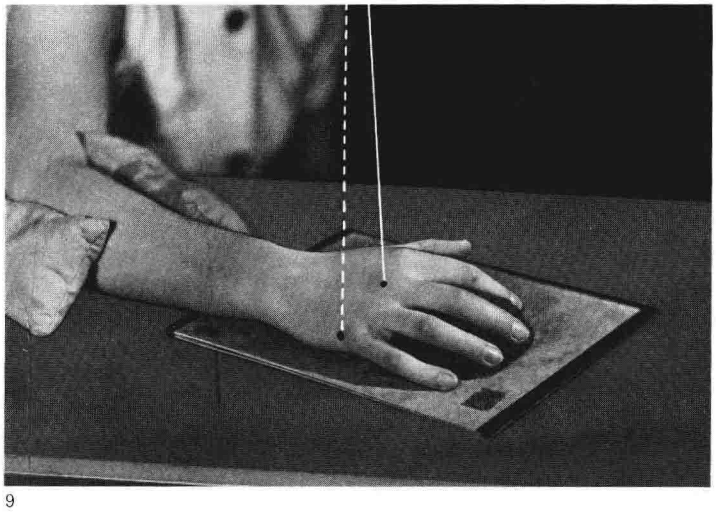


5

6

7

8



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