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ESSENTIALS OF Dental Radiography and Radiology

SIXTH EDITION



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Essentials of Dental Radiography and Radiology

SIXTH EDITION

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Table of Contents

Cover image

Title page

Dedication

Copyright

Preface

Acknowledgements

Part I. Introduction

1. The Radiographic Image

Introduction

Nature of the Traditional Two-Dimensional Radiographic Image

Quality of the Traditional Two-Dimensional Radiographic Image

Perception of the Radiographic Image

Types of Traditional Dental Radiographs

Part II. Radiation Physics, Equipment and Radiation Protection

2. The Production, Properties and Interactions of X-rays

Introduction

Atomic Structure

X-Ray Production

Interaction of X-Rays with Matter

3. Dental X-ray Generating Equipment

Introduction

Ideal Requirements

Main Components of the Tubehead

Other X-Ray Generating Apparatus

4. Image Receptors

Introduction

Digital Receptors

Radiographic Film

Characteristics of Radiographic Film

Background Fog Density

Intensifying Screens

Cassettes

Important Practical Points to Note

5. Image Processing

Computer Digital Processing

Chemical Processing

6. Radiation Dose, Dosimetry and Dose Limitation

Dose Units

Dose Limits

Dose Rate

Dose Limitation

7. The Biological Effects Associated with X-rays, Risk and Practical Radiation Protection

Radiation-Induced Tissue Damage

Classification of the Biological Effects

Practical Radiation Protection

Footnote

Part III. Radiography

8. Dental Radiography – General Patient Considerations including Control of Infection

General Guidelines on Patient Care

Specific Requirements When X-Raying Children and Patients with Disabilities

Control of Infection

Micro-Organisms That May Be Encountered

Standard and Transmission-Based Precautions

Infection Control Measures

Footnote

9. Periapical Radiography

Main Indications

Ideal Positioning Requirements

Radiographic Techniques

Anatomy

Bisected Angle Technique

Comparison of The Paralleling and Bisected Angle Techniques

Conclusion

Positioning Difficulties Often Encountered in Periapical Radiography

Assessment of Image Quality

10. Bitewing Radiography

Main Indications

Ideal Technique Requirements

Positioning Techniques

Resultant Radiographs

Assessment of Image Quality

11. Occlusal Radiography

Introduction

Terminology and Classification

Upper Standard (or Anterior) Occlusal

Upper Oblique Occlusal

Lower 90° Occlusal

Lower 45° (or Anterior) Occlusal

Lower Oblique Occlusal

12. Oblique Lateral Radiography

Introduction

Terminology

Main Indications

Basic Technique Principles

Positioning Examples For Various Oblique Lateral Radiographs

Bimolar Technique

13. Skull and Maxillofacial Radiography

Equipment, Patient Positioning and Projections

14. Cephalometric Radiography

Introduction

Main Indications

Equipment

Main Radiographic Projections

Cephalometric Posteroanterior of the Jaws (PA Jaws)

15. Tomography and Panoramic Radiography

Introduction

Tomographic Theory

Panoramic Tomography

Selection Criteria

Equipment

Technique and Positioning

Normal Anatomy

Advantages and Disadvantages

Assessment of Image Quality

Assessment of Not Acceptable Images and Determination of Errors

Footnote

16. Cone Beam Computed Tomography

Main Indications

Equipment and Theory

Technique and Positioning

Normal Anatomy

Radiation Dose

Advantages and Disadvantages

Assessment of Image Quality

Quality Assurance

Footnote

17. The Quality of Radiographic Images and Quality Assurance

Introduction

Quality Assurance (QA)

Digital Image Quality

Quality Control Procedures for Digital Receptors, Computer Processing and Monitors

Film-Based Image Quality

Quality Control Procedures for Film, Chemical Processing and Light Boxes

Patient Preparation and Positioning Technique Errors in Both Digital and Film-Based Imaging

Patient Dose and X-Ray Generating Equipment

Working Procedures

Staff Training and Updating

Audits

Footnote

18. Alternative and Specialized Imaging Modalities

Introduction

Contrast Studies

Radioisotope Imaging

Computed Tomography (CT)

Ultrasound Examinations

Magnetic Resonance Imaging (MRI)

Part IV. Radiology

19. Introduction to Radiological Interpretation

Essential Requirements for Interpretation

Conclusion

20. Dental Caries and the Assessment of Restorations

Introduction

Classification of Caries

Diagnosis and Detection of Caries

Other Important Radiographic Appearances

Limitations Of Radiographic Detection of Caries

Radiographic Assessment of Restorations

Limitations of the Radiographic Image

Suggested Guidelines for Interpreting Bitewing Images

Cone Beam Computed Tomography

21. The Periapical Tissues

Introduction

Normal Radiographic Appearances

The Effects of Normal Superimposed Shadows

Radiographic Appearances of Periapical Inflammatory Changes

Treatment and Imaging in Endodontics

Other Important Causes of Periapical Radiolucency

Suggested Guidelines for Interpreting Periapical Images

22. The Periodontal Tissues and Periodontal Disease

Introduction

Selection Criteria

Radiographic Features of Healthy Periodontium

Classification of Periodontal Diseases

Radiographic Features of Periodontal Disease and the Assessment of Bone Loss and Furcation Involvement

Evaluation of Treatment Measures

Limitations of Radiographic Diagnosis

23. Implant Assessment

Introduction

Main Indications

Main Contraindications

Treatment Planning Considerations

Radiographic Examination

Peri-operative Imaging

Post-operative Evaluation and Follow-Up

Footnote

24. Developmental Abnormalities

Introduction

Classification of Developmental Abnormalities

Typical Radiographic Appearances of The More Common and Important Developmental Abnormalities

Radiographic Assessment of Mandibular Third Molars

Radiographic Assessment of Unerupted Maxillary Canines

25. Radiological Differential Diagnosis – Describing a Lesion

Introduction

Detailed Description of a Lesion

Footnote

26. Differential Diagnosis of Radiolucent Lesions of the Jaws

Introduction

Step-By-Step Guide

Typical Radiographic Features of Radiolucent Cysts and Tumours

Typical Radiographic Features of Tumours

Typical Radiographic Features of Allied Lesions

Footnote

27. Differential Diagnosis of Lesions of Variable Radiopacity in the Jaws

STEP I

STEP II

STEP III

STEP IV

STEP V

Typical Radiographic Features of Abnormalities of the Teeth

Typical Radiographic Features of Conditions of Variable Opacity Affecting Bone

Summary

Typical Radiographic Features of Soft Tissue Calcifications

Typical Radiographic Features of Foreign Bodies

28. Bone Diseases of Radiological Importance

Introduction

Developmental or Genetic Disorders

Infective or Inflammatory Conditions

Hormone-Related Diseases

Blood Dyscrasias

Diseases of Unknown Cause

29. Trauma to the Teeth and Facial Skeleton

Introduction

Injuries to the Teeth and Their Supporting Structures

Skeletal Fractures

Fractures of the Mandible

Fractures of the Middle Third of the Facial Skeleton

Other Fractures and Injuries

30. The Temporomandibular Joint

Introduction

Normal Anatomy

Investigations

Main Pathological Conditions Affecting the TMJ

Footnote

31. The Maxillary Antra

Introduction

Normal Anatomy

Normal Appearance of the Antra on Conventional Radiographs

Antral Disease

Investigation and Appearance of Disease Within the Antra

Infection and Inflammation

Other Paranasal Air Sinuses

32. The Salivary Glands

Salivary Gland Disorders

Investigations

Bibliography and Suggested Reading

Index

Dedication

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Preface

It is now nearly 30 years since the first edition of *Essentials* was published and nearly 6 years since the first co-authored fifth edition. This sixth edition is again co-authored with my friend and colleague Nicholas Drage and marks the last edition that I will be directly involved with, given that I am in the twilight of my career. It is reassuring to know that *Essentials* will be in Nicholas' safe hands.

I am delighted that we have been given this final opportunity to update and refresh *Essentials* together and to be able to introduce colour images throughout – we hope this has given the book a completely new and modern feel. In addition to the new photographic material, we have revised and updated nearly every chapter. We have tried to align the content and terminology more closely with the new international classifications in relation to cysts, tumours, bone lesions and diseases, caries and periodontal diseases. Many new radiographs have been added and we have placed greater emphasis on examples showing normal radiographic anatomy, working on the principle that the main reason for radiographic imaging is to be able to distinguish the difference in appearance between normal and abnormal, to determine the presence or absence of (hard tissue) disease. Another major change has been to reorder the contents of several chapters so that digital imaging is described first, recognising the switch from film-based imaging to digital imaging.

The website created with, and linked to, the previous edition proved popular with students, particularly the online self-assessment questions relating to each chapter, so these have also been reviewed and new questions added as appropriate.

Despite the various updates and revisions, the aims and objectives of this book remain the same, namely to provide a basic, but comprehensive, practical account of what we consider to be the essential subject matter of both dental radiography and radiology as required by undergraduate and postgraduate dental students. As in previous editions, some things have had to be omitted, or sometimes, over-simplified. However, the book remains first and foremost a teaching manual (albeit more colourful) rather than a comprehensive reference. We believe that the content remains sufficiently broad, detailed and up-to-date to satisfy the requirements of most undergraduate and postgraduate examinations and the needs of most general dental practitioners. Students are encouraged to build on the information included here by using the excellent and more comprehensive textbooks available.

We hope that once again the result is a clear, logical and easily understandable textbook that continues to make a positive contribution to the challenging tasks of teaching and learning dental radiology.

EW

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As with previous editions, this edition has only been possible thanks to the enormous amount of help and encouragement that we have received from our various friends and colleagues in both London and Cardiff.

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We are very grateful to several colleagues for their help and advice with specific chapters. They include Melanie Wilson, Senior Lecturer in Oral Microbiology in Cardiff for [Chapter 8](#) ; Dirk Bister, Consultant in Orthodontics at Guy's for [Chapter 14](#) ; Simon Harvey, Consultant in Dental & Maxillofacial Radiology at Guy's for [Chapter 18](#) ; Avi Banerjee, Professor of Cariology at King's College London for [Chapter 21](#) ; Francis Hughes, Professor of Periodontology at King's College London for [Chapter 22](#) , George Paolinelis, Consultant in Oral Surgery at Guy's for [Chapter 23](#) and Eddy Odell, Professor of Oral Pathology, King's College London for [Chapters 26](#) and [27](#) . In addition, Dental Radiology Departmental colleagues at Guy's willingly offered their

help and advice – in particular we would like to thank Jackie Brown, Bethan Thomas, John Rout, Niall O’Neill, Amanda Loughlin, Beatrice Cicchetti and Stephen Goss. We are also very grateful to Andrew Gulson, from Public Health England for his permission to allow us to reproduce parts of the 2020 Guidance Notes. Special thanks to Allisson Summerfield for co-ordinating the IT and imagery, the hours she spent photocopying and electronically correcting the proofs, and for always being on hand to ensure the job got done! Many thanks also to Elsevier’s Alison Taylor, our now retired Content Strategist, Fiona Conn for masterminding the manuscript to get it ready for production, and Karthikeyan Murthy and his team for their huge effort in getting the book to final publication.

Last, but by no means least, we would once again like to thank our wives Catriona and Anji and our children Stuart, Felicity and Claudia, and Karisma and Jaimini for their love, understanding and encouragement throughout the production of this edition and for accepting the sacrifice of family time that it has involved.

EW

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PART I

Introduction

OUTLINE

1. The Radiographic Image

1

The Radiographic Image

Introduction

The use of X-rays is an integral part of clinical dentistry, with some form of radiographic examination necessary on the majority of patients. Radiographs are primarily taken to determine the presence or absence of underlying hard tissue disease affecting the teeth and/or bones. As a result, radiographs are often referred to as the clinician's *main diagnostic aid*. Traditional radiography enables the creation of conventional two-dimensional radiographic images, but technological advances in computer generated images – so-called *cone beam computed tomography (CBCT)* - has resulted in imaging in three dimensions and improved diagnostic capability (see Figs. [1.1](#) and [1.2](#)).

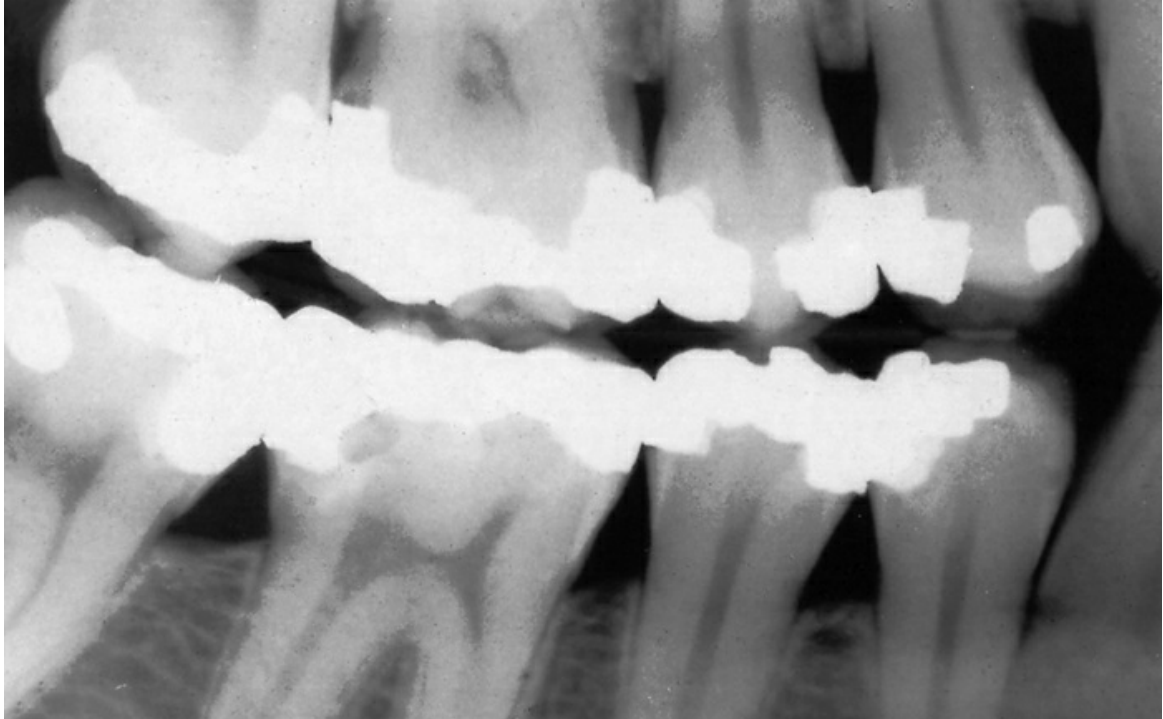


FIG. 1.1 A traditional two-dimensional dental radiograph showing the hard tissues of the teeth, containing metallic amalgam restorations, and the supporting alveolar bone.

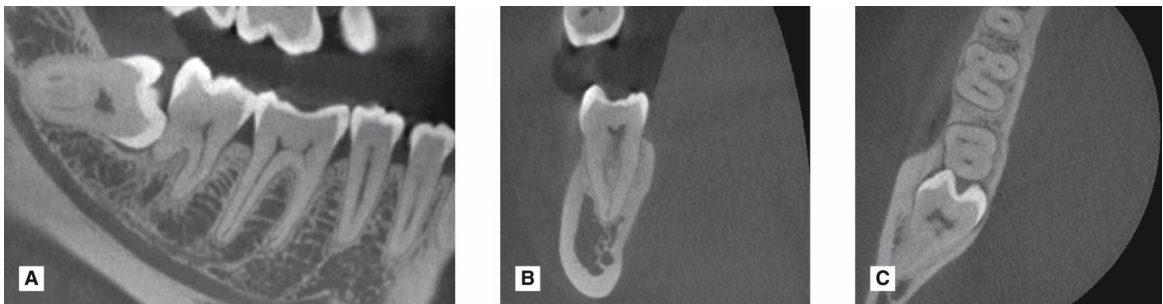


FIG. 1.2 Modern cone beam computed tomography (CBCT) radiographic images in three dimensions of the lower right molar teeth in the (A) sagittal, (B) coronal and (C) axial planes.

The range of knowledge of dental radiography and radiology thus required can be divided conveniently into four main sections:

- *Basic physics, X-ray equipment and image receptors* – how X-rays

are produced, their properties and how their interactions result in the formation of the various two-dimensional and three-dimensional radiographic images

- *Radiation protection* – the protection of patients and dental staff from the harmful effects of X-rays
- *Radiography* – the techniques involved in producing the various radiographic images
- *Radiology* – the interpretation of these various radiographic images, which requires a knowledge of the normal anatomy of the teeth and the jaws as well as the different appearances of underlying disease.

Understanding the different radiographic images is central to the entire subject. This chapter provides an introduction to the nature of the traditional two-dimensional image and to some of the factors that affect its quality and perception. The more complex modern CBCT images are described later in .

Nature of the Traditional Two-Dimensional Radiographic Image

The basic requirements to create a traditional two-dimensional dental radiographic image include an *X-ray generating machine* , a *patient* and an *image receptor* placed either inside the mouth (*intraoral*) or outside the mouth (*extraoral*), as shown in [Fig. 1.3](#) . Originally the image receptor used was *film* coated with photographic emulsion that blackened when hit by X-rays. Nowadays film is being replaced more and more by a variety of *digital sensors* with the image being created in a computer and displayed on a monitor. Those parts of the digital sensor that have been hit by X-rays appear black in the computer-generated image. The extent to which the emulsion or the computer-generated image is blackened depends on the number of X-rays reaching the film or the sensor, which in turn depends on the density of the object.

However the final image is captured, it can be described as a two-dimensional picture made up of a variety of black, white and grey superimposed shadows and is thus sometimes referred to as a *shadowgraph*.

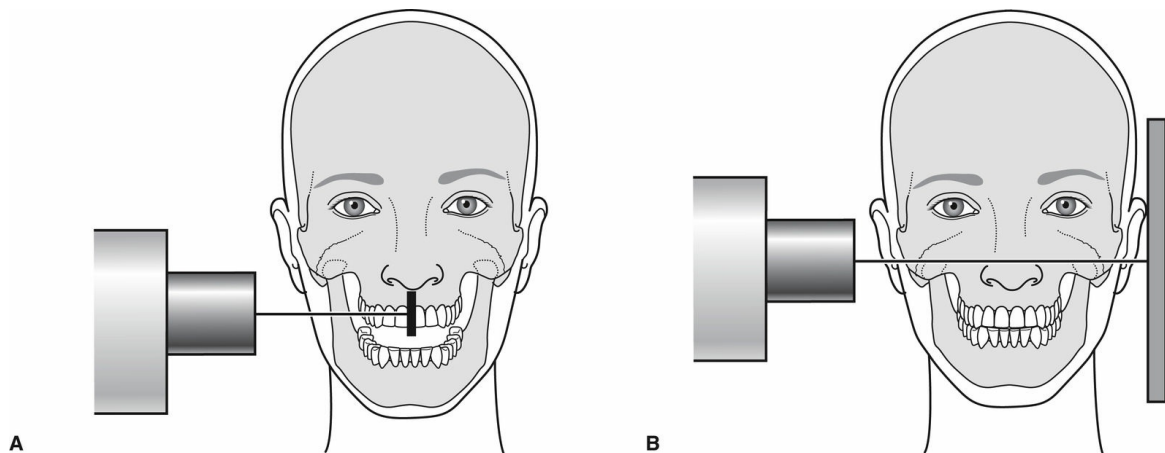


FIG. 1.3 Diagrams showing the basic requirements for two-dimensional radiography – an X-ray generating machine, a patient and an image receptor for **(A)** intraoral imaging and **(B)** extraoral imaging.

Understanding the nature of the *shadowgraph* and interpreting the information contained within it requires a knowledge of:

- The radiographic shadows
- The three-dimensional anatomical tissues
- The limitations imposed by a two-dimensional picture and superimposition.

The Radiographic Shadows

The amount the X-ray beam is stopped (attenuated) by an object determines the *radiodensity* of the shadows:

- The white or *radiopaque* shadows on an image represent the various dense structures within the object which have totally stopped the X-ray beam.

- The black or *radiolucent* shadows represent areas where the X-ray beam has passed through the object and has not been stopped at all.

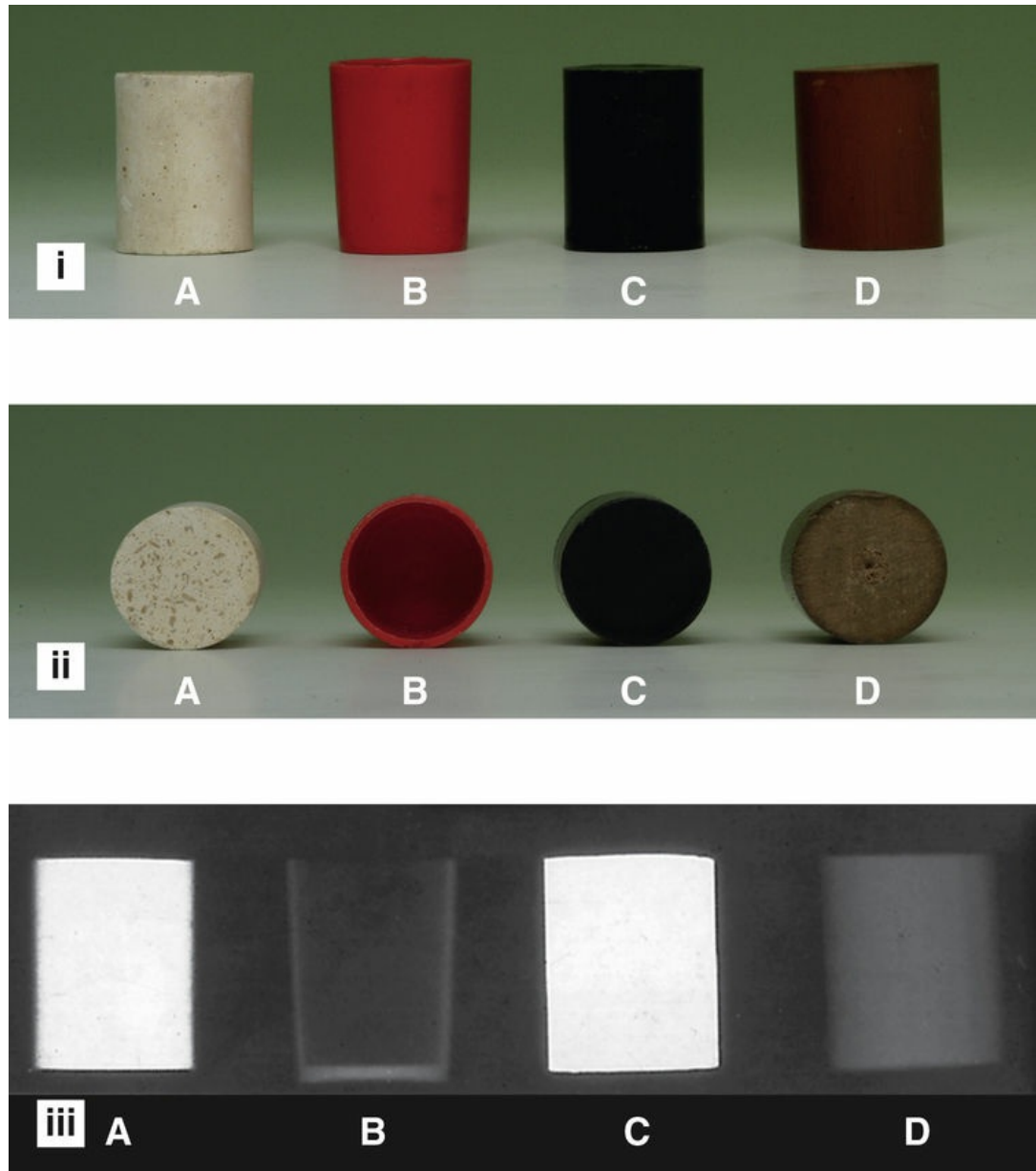


FIG. 1.4 (i) Front view and (ii) plan view of various cylinders of similar shape but made of different materials: (A) plaster of Paris, (B) hollow plastic, (C) metal, and (D) wood. (iii) Radiographs of the cylinders show how objects of the same shape, but of different materials, produce different radiographic images.

- The grey shadows represent areas where the X-ray beam has been stopped to a varying degree.

The final *shadow density* of any object is thus affected by:

- The specific type of material of which the object is made
- The thickness or density of the material
- The shape of the object
- The intensity of the X-ray beam used
- The position of the object in relation to the X-ray beam and image receptor
- The sensitivity and type of image receptor.

The effect of different materials, different thicknesses/densities, different shapes and different X-ray beam intensities on the radiographic image shadows are shown in Figs. [1.4](#) - [1.7](#) .