1. Lecture #13

2. Learning Objectives
16. a-c; 17. d-h; 18.a-c

3. 3 Parts

PART #1

Learning Objectives 16.a-c Chapter 25

Assess the purpose and use of digital radiography

a) Describe the fundamentals associated with digital radiography

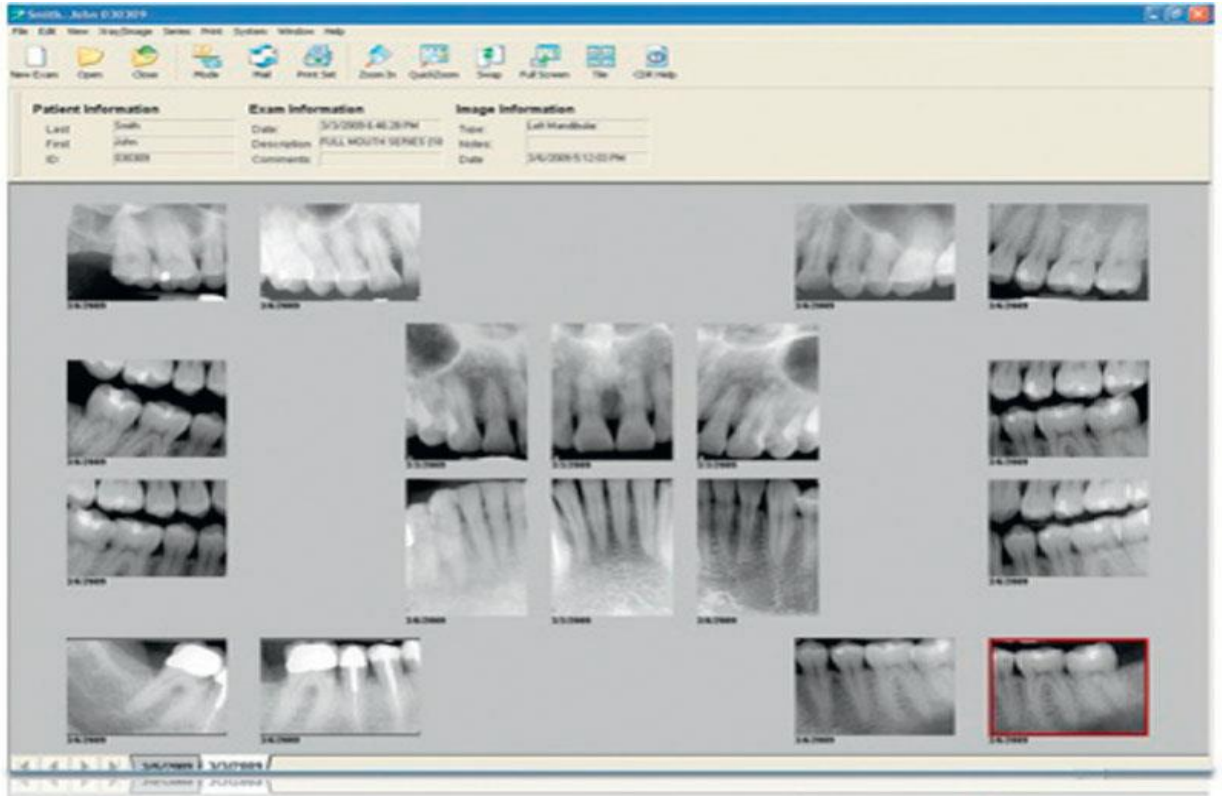
b) Outline the advantages and disadvantages of digital radiography

c) Compare digital radiography to the traditional methods of obtaining radiographs

Digital Imaging

- Basic concepts
- Types of digital imaging
- Step-by-step procedures
- Advantages and disadvantages

Courtesy of Progeny Dental, Lincolnshire: IL.



From Bird DL, Robinson DS: *Modern dental assisting*, ed 10, St. Louis, 2011, Elsevier.

Basic Concepts

- Used to record radiographic images
  - No film or processing chemistry is used
  - Uses an electronic sensor and computerized imaging system that produces x-ray images almost instantly on a computer monitor

Terminology

- Analog image
- Bit-depth image
- Charge-coupled device (CCD)
- Digital imaging
- Digital image
- Digital subtraction
- Digitize

Terminology (Cont.)

- Direct digital imaging
- Indirect digital imaging
- Line pairs/millimeter (lp/mm)
- Pixel
- Sensor
- Storage phosphor imaging

Analog image: radiographic image produced by conventional film

Bit-depth Image: number of gray-scale combinations for each pixel (eg. 8 bit-depth image has gray-scale combination of 2^8, which equals 256 shades of gray

Charge-Coupled Device (CCD): solid-state silicaon chip detector that converts light or x-ray photons into an electrical charge or signal; in digital imaging CCD is found in the sensor

Digital Imaging : filmless imaging system; a method of capturing an image using a sensor, breaking it into electronic pieces, and presenting and storing the image using a computer and related imaging software

Digital Image: an image composed of pixels that can be stored in a computer

Digital Subtraction: a feature (method) of reversing gray-scale image as it is viewed – radiolucent images (normally black) appear white and radiopaque images (normally white) appear black

Digitize: in digital imaging, to convert an image into a digital form that, in turn, can be processed by a computer

Direct Digital Imaging: method of obtaining a digital image, in which an intraoral sensor is exposed to x-radiation to capture a dental image that can be viewed on a computer monitor

Indirect Digital Imaging: method of obtaining a digital image, in which a sensor is scanned following exposure to x-radiation and then converted into a digital form that can be viewed on a computer monitor

Line Pairs/millimeter (lp/mm): measurement used to evaluate the ability of the computer to capture the resolution (or detail) of an image

Pixel: a discrete unit of information, in digital electronic images, digital information is contained in, and presented as, discrete units of information; also termed *picture element*

Sensor: in digital imaging, a receptor that is used to capture an intraoral or extraoral image

Storage Phosphor Imaging: method of obtaining a digital image in which the image is recorded on a phosphor-coated plate and then placed into an electronic processor, where a laser scans the plate and produces an image on a computer monitor

Purpose and Use

- To generate images that can be used in the diagnosis and assessment of dental disease

- For example??

Fundamentals

- Digital imaging
  - A method of capturing a radiographic image using a sensor, breaking it into electronic pieces, and presenting and storing the image using a computer
  - Image: used to describe the pictures that are produced
  - A sensor placed inside the mouth
  - The electronic signal is digitized

Radiation Exposure

- The typical sensor is more sensitive to x-rays than conventional film.
  - Exposure times are 50% to 80% less than that required for conventional radiography using E-speed film.
- **digital imaging: 3 impulses-3/60 or 0.05 second**
- **conventional: 12 impulses-12/60 or 0.2 second**

Equipment

- X-radiation source (x-ray unit)
- Intraoral sensor
  - Charge-coupled device
  - Complementary metal oxide semiconductor/active pixel sensor
  - Charge injection device
- Computer

X-Radiation Source

- Most digital imaging systems use a conventional dental x-ray unit as the x-radiation source.
  - The x-ray unit timer must be adapted to allow exposures in a time frame of 1/100 of a second.

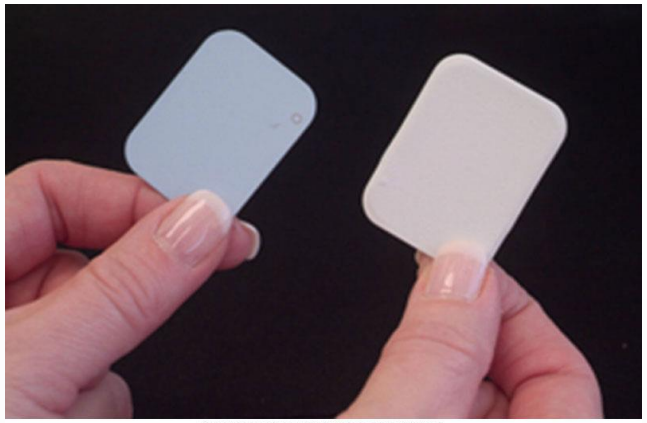
Courtesy of Instrumentarium Dental Inc., Milwaukee, WI.

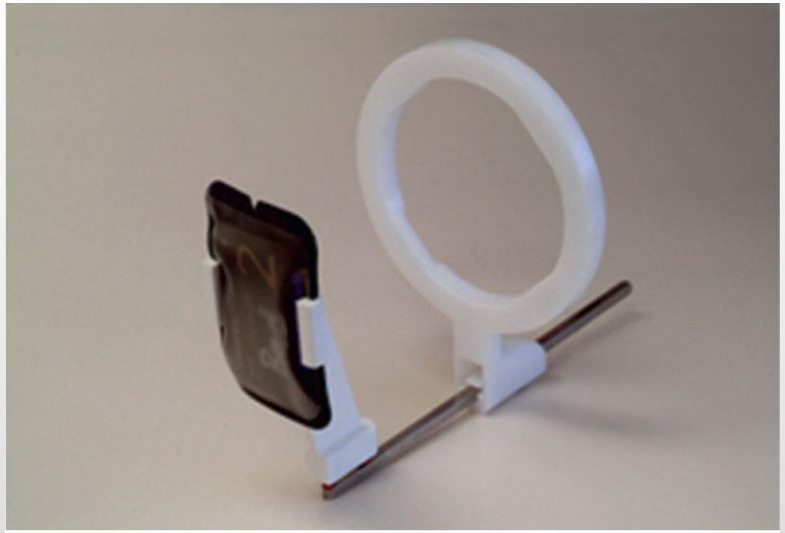
Intraoral Sensor

- A small detector that is placed in the mouth of the patient and used to capture the radiographic image
  - **Wired**
    - The imaging sensor is linked by a fiber optic cable to a computer.
  - **Wireless**
    - The imaging sensor is not linked by a cable.

Courtesy of DEXIS, Des Plaines, IL

Courtesy of Gendex Imaging, Des Plaines, IL





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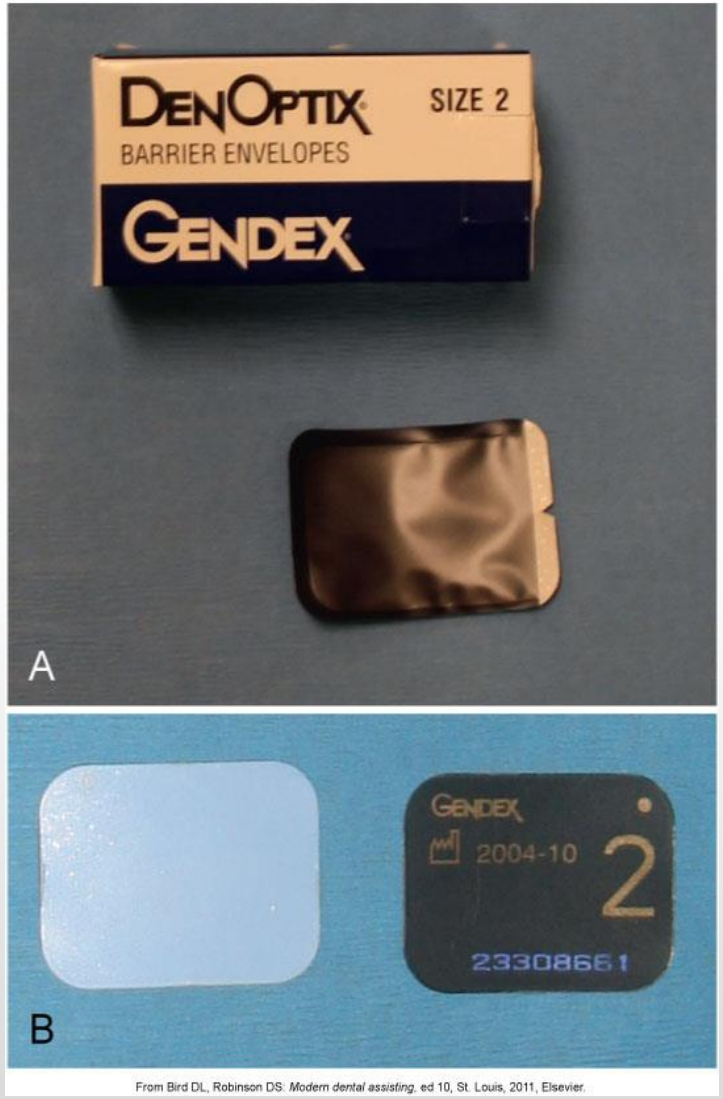

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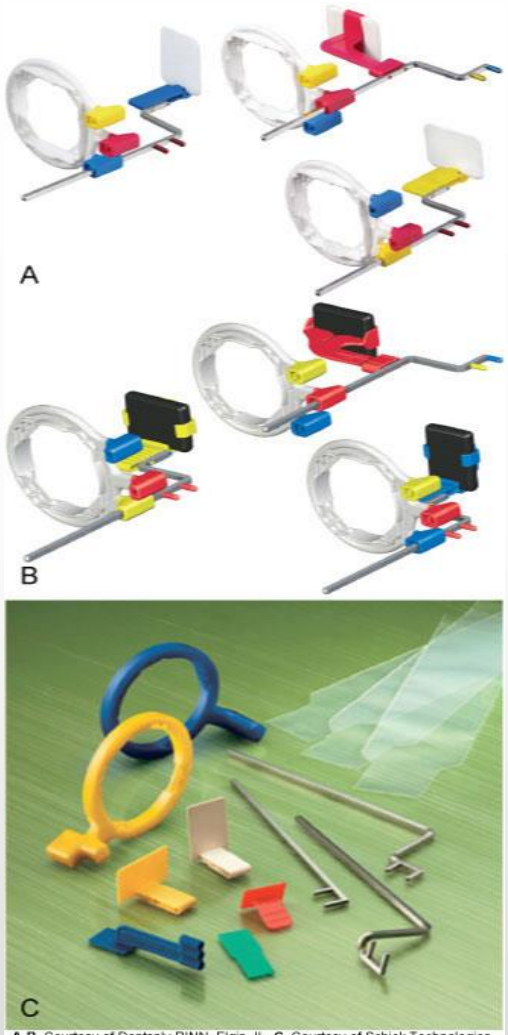
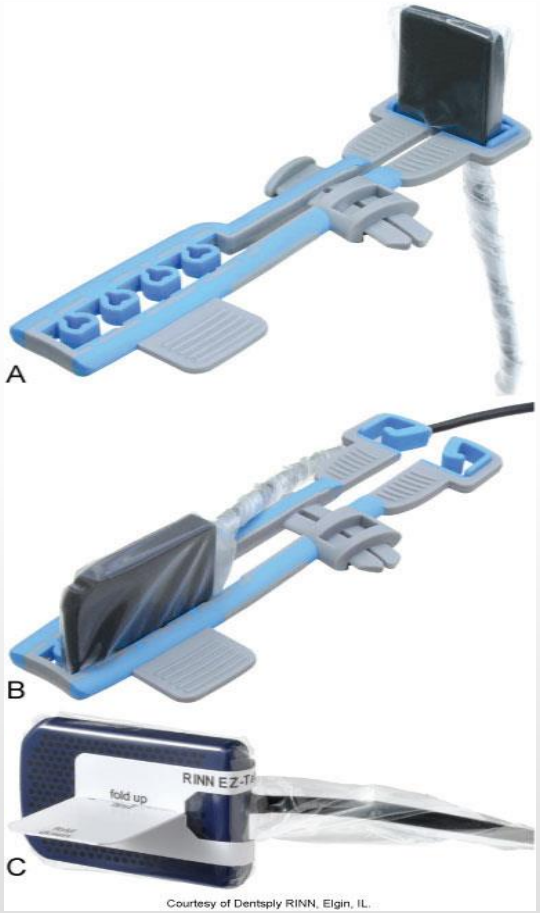


A-B, Courtesy of Dentsply RINN, Elgin, IL. **C,** Courtesy of Schick Technologies, Long Island City, NY.



Courtesy of Dentsply RINN, Elgin, IL.

Intraoral Sensor

- Most popular types of direct sensor technologies
  - Charge-coupled device
  - Complementary metal oxide semiconductor/active pixel sensor

Charge-Coupled Device (CCD)

- The most common image receptor used in dental digital imaging
  - A solid-state detector that contains a silicon chip with an electronic circuit embedded in it
  - The electrons that make up the silicon CCD can be visualized as being divided into an arrangement of blocks or picture elements known as pixels

Pixel: a small box or “well” into which the electrons produced by the x-ray exposure are deposited

The x-ray photons that come into contact with the CCD cause electrons to be released from the silicon and produce a corresponding electronic charge.

Each pixel arrangement, or electron potential well, contains an electronic charge proportional to the number of electrons that reacted within the well. Each electronic well corresponds to a specific area on the linked computer screen.

Complementary Metal Oxide Semiconductor/Active Pixel Sensor (CMOS/APS)

- One manufacturer uses a CMOS/APS sensor instead of a CCD.
  - The chip is less expensive to produce and offers greater durability than the CCD.

Computer

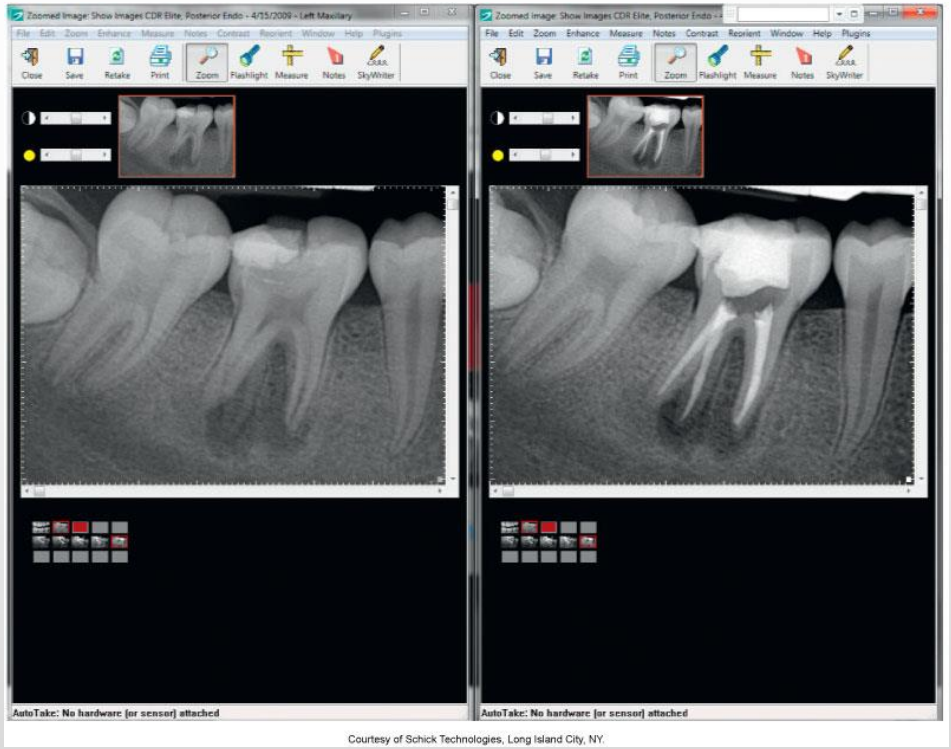
- Used to store the incoming electronic signal
  - Converts the electronic signal from the sensor into a shade of gray that is viewed on the computer monitor
- The computer digitizes, processes, and stores information received from the sensor

An image is recorded on a computer monitor in 0.5 to 120 seconds

Has split screen and magnification capability.

Capabilities

Split Screen



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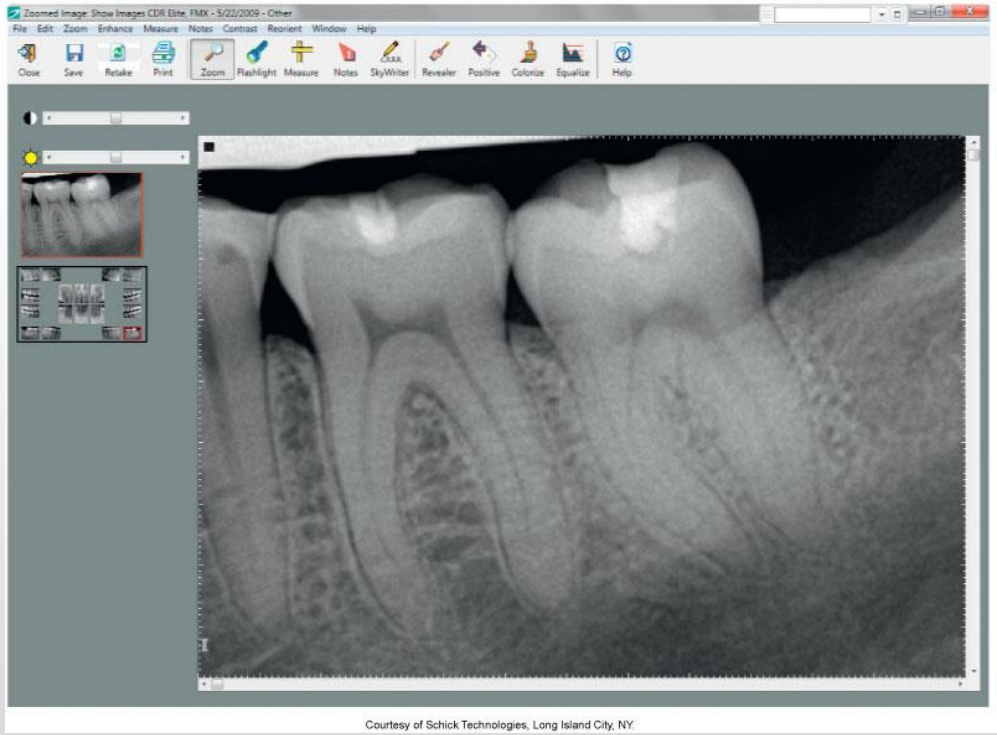
Magnification



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Types of Digital Imaging

- Direct Digital Imaging
- Indirect Digital Imaging
  - Scanning traditional radiographs
  - Storage phosphor imaging

Direct Digital Imaging

- Components include an x-ray machine, an intraoral sensor, and computer monitor
  - A sensor is placed into the mouth of the client and exposed
  - The sensor captures the radiographic image and transmits it to the computer monitor
  - Software is used to enhance and store the image

Indirect Digital Imaging

- Components include a CCD camera and a computer.
  - An existing x-ray film is digitized using a CCD camera.
  - The image is displayed on a computer monitor.

Storage Phosphor Imaging

- A wireless digital imaging system
  - This is a reusable imaging plate coated with phosphors is used instead of a sensor with a fiber optic cable.
  - The phosphor-coated plates are flexible and fit into the mouth.

A high-speed scanner is used to convert the information into electronic files. This type of digital imaging is less rapid than direct digital imaging.

Courtesy of Gendex Imaging, Des Plaines, IL

Step-by-Step Procedures

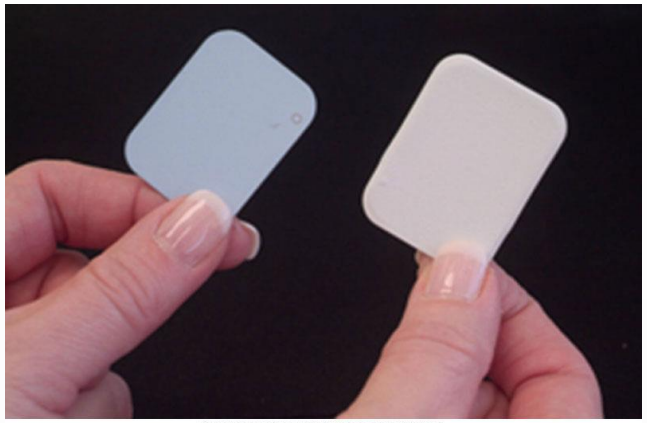
- Sensor Preparation
- Sensor Placement

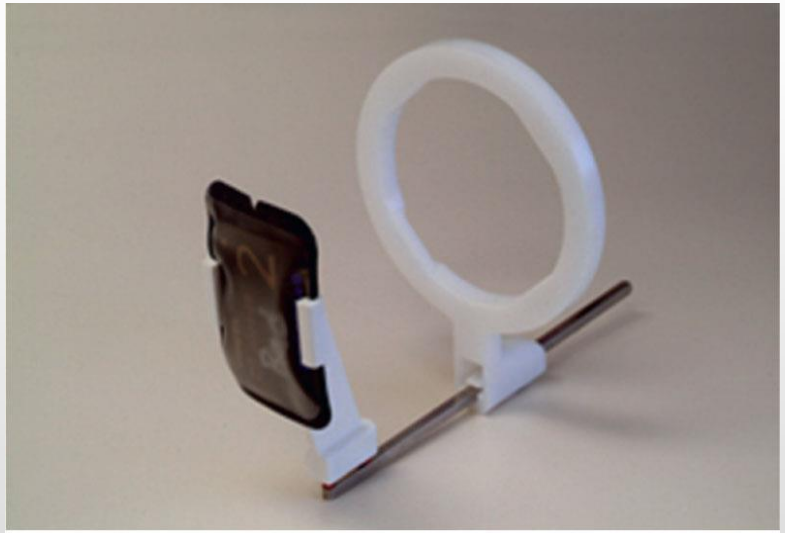
Step-by-Step Procedures

- It is critical to refer to the manufacturer-provided instruction booklet for information concerning the operation of the system, equipment preparation, client preparation, and exposure.

Sensor Preparation

- Each sensor is sealed and waterproofed.
  - The sensor must be covered with a disposable barrier because it cannot be sterilized.





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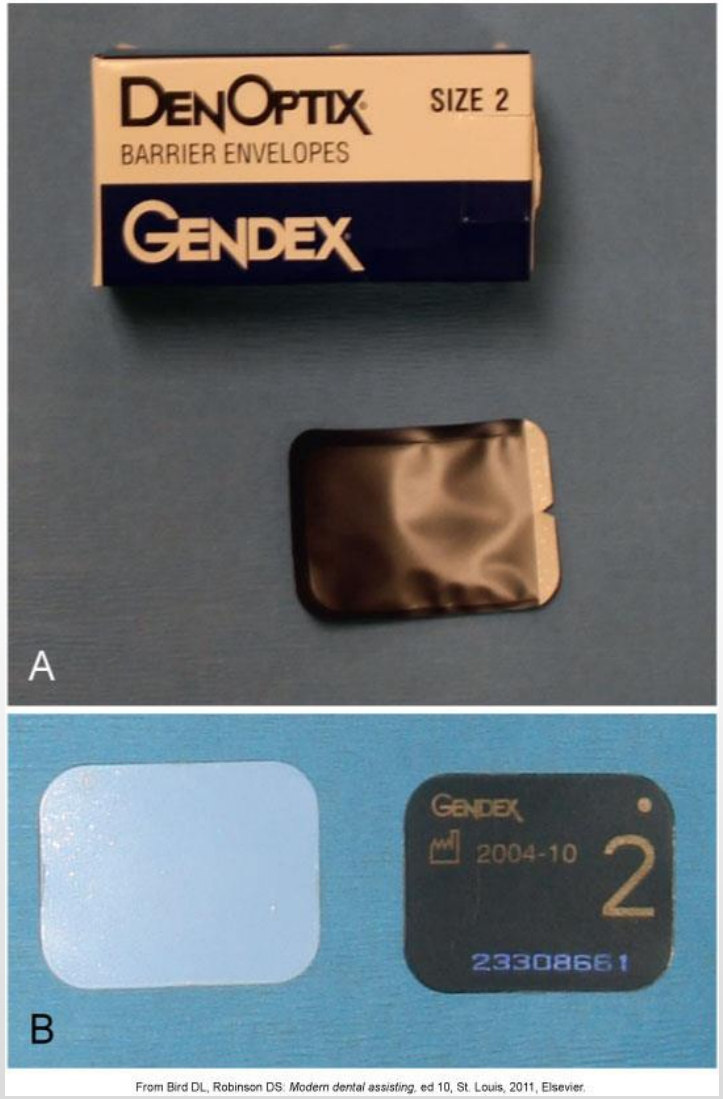

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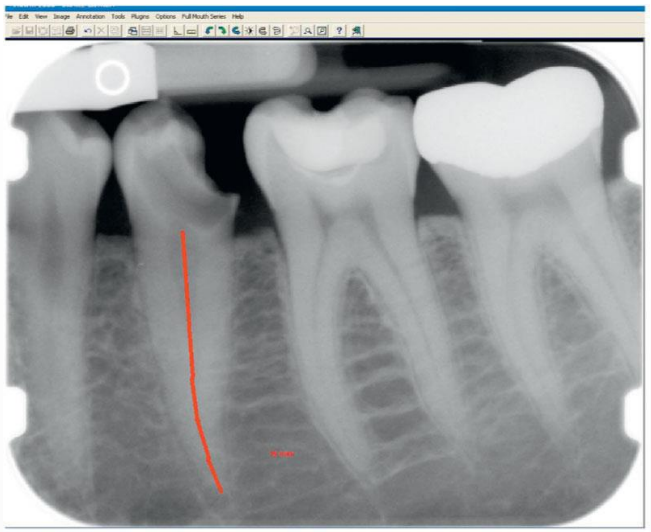
Sensor Placement

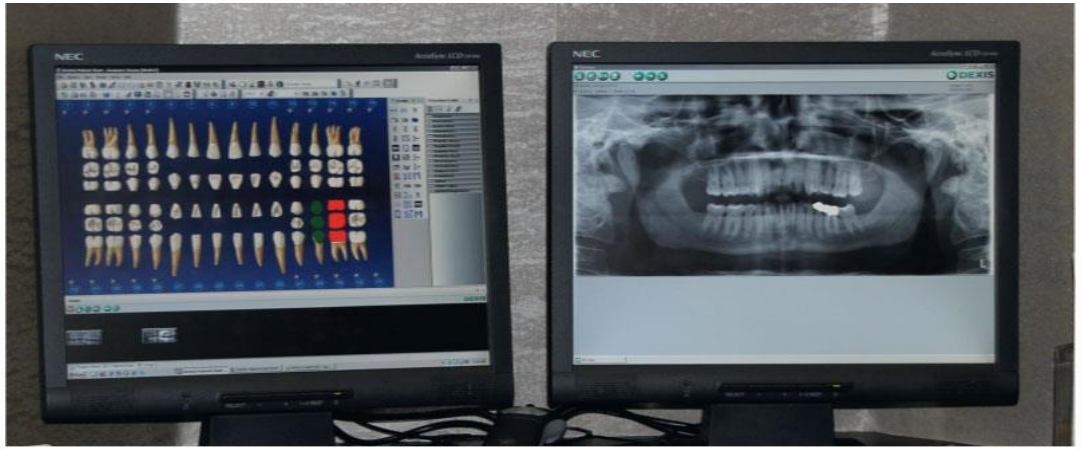
- The sensor is held in the mouth by bite-block attachments or devices that aim the beam and sensor accurately.
  - The **paralleling technique** is the preferred exposure method.

Advantages of Digital Imaging

- Superior gray-scale resolution
- Reduced exposure to x-radiation
- Increased speed of image viewing
- Lower equipment and film cost
- Increased efficiency
- Enhancement of diagnostic image
- Effective client education tool (digital subtraction)



Courtesy of Dr. Donald Tyndall, The University of North Carolina School of Dentistry, Chapel Hill, NC.



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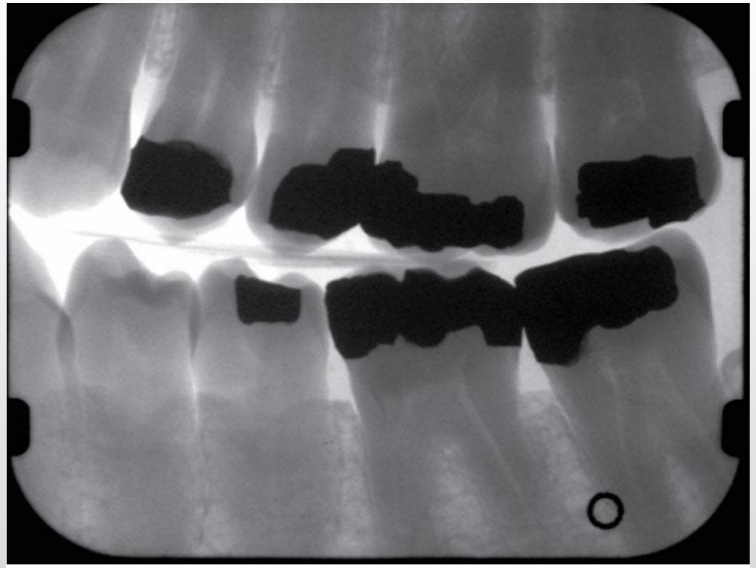

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Digital Subtraction

Disadvantages of Digital Imaging

- Initial set-up costs
- Image quality
- Sensor size
- Infection control
- Legal issues

PART #2

Learning Objectives 17.d-h Chapter 10, Chapter 14 (review)

Describe the quality assurance methods for all radiographic related procedures

d) Analyze the importance of operator competence in dental radiographic procedures

e) Recognize the need for the DDS prescription of client specific radiographs

f) Explore the issues surrounding informed consent and informed refusal and how to communicate and be an effective advocate for your client

g) Outline the varying methods for documentation of the radiographic procedure in a clients file

h) Create a job description identifying the person responsible for the quality assurance in a clinical setting

Operator Competence

- A nondiagnostic film must be retaken.
  - Retakes expose the patient to additional radiation.
  - Repeated operator errors and errors requiring retakes should be recorded.

Knowledge and Skill Requirements

- Background knowledge essential
  - covered through chapters 1-9, 10, 14-16

Chapter 10	quality assurance in the dental office
Chapter 14	legal issues
Chapter 15	infection control
Chapter 16	radiographic examinations
Chapter 17	paralleling technique
Chapter 18	bisecting technique
Chapter 19	bitewing technique
Chapter 20	exposure/technique errors
Chapter 21	occlusal/localization techniques

Chapter 22	panoramic imaging
Chapter 23	extraoral imaging
Chapter 24	imaging of clients with special needs (to be read on your own)
Chapter 25	digital imaging
Chapter 26	three dimensional digital imaging

Radiographs can only be prescribed by the DDS and must be client specific

True or False

TRUE: the DDS is the RPO (?) and is the only person qualified to prescribe radiographs on a client specific nature

Is this changing?

Legal Issues and the Dental Patient

- Risk Management
- Malpractice Issues
- Client Records
- Clients Who Refuse Radiographs

Risk Management

- The policies and procedures that should be followed by the dental radiographer to reduce the chances that a client will file legal action against the dental radiographer or the supervising dentist

Informed Consent/Informed Refusal

- Client has the right to agree or refuse treatment (prescribed radiographs by the DDS)
- They must have all information explained to them in order for them to make an **INFORMED** decision

Risk Management

- Informed consent
  - Self-determination
    - Persons seeking health care services have the legal right to make choices about the care they receive, including the opportunity to consent to or to refuse treatment.

Informed Consent

- Information presented to the client should include:
  - The purpose and potential benefits of the radiographs
  - The person responsible for exposing the radiographs

- The number and type of radiographs
- The possible harm that may result if the radiographs are not exposed (only if client refuses)

- The risks associated with x-ray exposure
- The alternative diagnostic aids that may serve the same purpose as the radiographs

Informed Consent

- Disclosure
  - The process of informing the client about the particulars of exposing dental radiographs
- Informed consent
  - Defined as consent given by the client following complete disclosure

Liability

- Dentists are legally accountable or liable to supervise the performance of dental auxiliaries.

Malpractice Issues

- Malpractice
  - Results when the dental practitioner is negligent in the delivery of dental care
- Negligence
  - When the diagnosis made or the dental treatment delivered falls below the standard of care

Malpractice Issues

- Standard of care
  - The quality of care that is provided by dental practitioners in a similar locality under the same or similar conditions
- Statute of limitations
  - The time period during which a client may bring a malpractice action against the dentist or auxiliary

Client Records

- Documentation
  - Informed consent
  - Number and type of radiographs exposed
  - Rationale for exposing such radiographs
  - Diagnostic information obtained from the interpretation of the radiographs
- Confidentiality

Clients Who Refuse Dental Radiographs

- The situation must be carefully considered by the dentist.
  - The dentist must decide whether an accurate diagnosis can be made and whether treatment can be provided.

- Record-keeping log
- Plan for evaluation and revision
- In-service training

- The RPO is ultimately responsible for all things related to radiography in the clinical setting

PART #3

LEARNING Objective 18.a-c Chapter 15

describe the rationale for infection control for all radiographic related procedures, apply current infection control guidelines

- Review infection control terminology and basics – microbiology and infection control

a) Describe the procedures related to infection control for: x-ray machines, x-ray film, screens and cassettes, viewing equipment, darkroom and processing equipment (already done)
b) Describe the infection control procedures used prior to, during and following radiographic exposure
c) Describe the infection control procedures used for processing x-ray film

Rationale for Infection Control

◊ primary purpose of infection control procedures is to prevent the transmission of infectious diseases

◊ infectious diseases may be transmitted from a client to the dental professional, from dental professional to client and from one client to another client

◊ dental professionals and their client may be exposed to a variety of pathogens

General Routes of Disease Transmission

◊ direct contact with pathogens present in saliva, blood, respiratory secretions or lesions

◊ indirect contact with contaminated objects or instruments

◊ direct contact with airborne contaminants present in spatter or aerosols or oral and respiratory fluids

Other Conditions that need to be Present

3 conditions must be present:

1. A susceptible host
2. A pathogen with sufficient infectivity and numbers to cause infection
3. A portal of entry through which a pathogen may enter the host

◊ effective infection control practices are intended to alter one of these three conditions, thereby preventing disease transmission

Terminology

Antiseptic: A substance that inhibits the growth of bacteria. This term is often used to describe hand washing and wound cleansing procedures

Asepsis: The absence of pathogens or disease causing microorganisms. This term is often used to describe procedures used that prevent infection

Bloodborne pathogens: Pathogens present in blood that cause disease in humans.

Disinfect: the use of a chemical or physical procedure to inhibit or destroy pathogens. Highly resistant bacterial and mycotic (fungal) spores are NOT killed during disinfection procedures.

Disinfection: The act of disinfecting.

Exposure incident: A specific incident that involves contact with blood or other potentially infectious materials and that result from procedures performed by the dental professional

Infectious waste: Waste that consists of blood, blood products, contaminated sharps or other microbiologic products

Occupational exposure: Contact with blood or other infectious materials that involves the skin, eye or mucous membranes and that results from procedures performed by the dental professional

Parenteral exposure: Exposure to blood or other infectious material that results from piercing or puncturing the skin barrier (e.g. needle-stick injury results in parenteral exposure)

Sharp: any object that can penetrate the skin, including, but not limited to, needles and scalpels

Sterilize: The use of physical or chemical procedures to destroy all pathogens, including the highly resistant bacterial and mycotic spores

Sterilization: The act of sterilizing

Universal precautions: A method of infection control in which all human blood and certain body fluids are treated as if known to be infectious for HIV, HBV and other bloodborne pathogens

Guidelines for Infection Control Practices

- Review Chapter 15 for diagrammatical outlines of procedures and guidelines

- Protective Attire and Barrier Techniques
- Hand Hygiene and Care of Hands
- Sterilization and Disinfection of Instruments
- Cleaning and Disinfection of Dental Unit and Environmental Surfaces

Intraoral Radiography

Infection Control Procedures *Prior* to Exposure

◊ the dental professional must prepare the surfaces that are likely to be touched during the x-ray exposure (surfaces that may be touched should be covered with disposable materials such as plastic or aluminum foil etc.)

◊ if disposable barriers cannot be used all contaminated areas must be disinfected when radiographic procedures are completed

◊ this would include x-ray machine, dental chair, work area and lead apron

◊ the radiographer must also prepare supplies and equipment to be used (e.g. film, sterilized receptor holders etc.)

◊ once radiography area is prepared, the client may be seated***

◊ ensure that chair is in an upright position and at a comfortable height for you, ensure that the headrest supports the client's head (upper arch should be parallel with the floor)

◊ place lead apron on the client, (with thyroid collar) and have client remove glasses, gum, dentures****, retainers etc.)

◊ after this the radiographer should wash their hands and immediately put on gloves, mask and protective eyewear** (in the text the mask and eyewear are optional, at Oxford College these are MANDATORY as you are in close contact with the client when placing the receptor)

◊ if receptor holding devices are to be used, remove from the sterilized packages with ungloved hands in front of the client and then assemble with gloves on**

Infection Control Procedures *During* Exposure

◊ once gloves have been placed, exposure of the x-ray receptors begins (after this point the operator should avoid any contact with uncovered surfaces)

◊ after each receptor is exposed, it should be placed in a disposable container, like a Dixie cup

◊ the disposable container should not be touched by ungloved hands**

◊ used receptor holders should not be placed on an uncovered surface following use

Infection Control Procedures *Following* Exposure

◊ immediately following the completion of receptor exposure, all contaminated items must be discarded and any uncovered areas disinfected
(while operator is still wearing gloves); the protective wrapping can also be removed but ensure you do not touch clean surface with gloves

◊ while the operator is wearing gloves, the contaminated receptor holders must be removed from the treatment area and placed in an area for contaminated instruments

◊ following the removal and disposal of all contaminated items, the gloves must be removed and discarded and the hands should be washed, after hands are washed the lead apron can be removed and the client dismissed from the x-ray area*****

◊ any uncovered areas that were contaminated during exposure, can be disinfected at this time

◊ variations will be discussed further with continuing Radiography Lab

Hand Hygiene and Care of Hands

- Hand hygiene
- Care of hands

Sterilization and Disinfection of Instruments

- Critical instruments
- Semicritical instruments
- Noncritical instruments

Critical instruments

- Penetrate soft tissue and bone
- Require high level of sterilization, sterilized after each use
- None used in dental radiography

Semi-critical instruments

- Contact **BUT** do not penetrate soft tissue or bone
- Beam alignment devices
- Require high level of sterilization, sterilized after each use

Non-critical instruments

- Devices that do not come in contact with mucous membranes
- Pid, tubehead, exposure button, control panel, lead apron
- Intermediate, low level of disinfection

Infection Control Procedures for Processing

◊ after the exposure of x-ray receptors, follow specific infection control guidelines during transport of the receptors to the darkroom, during receptor handling and during receptor processing

Infection Control Procedures Used for Processing

- Receptor transport
- Darkroom supplies
- Receptor handling with and without barrier envelopes
- Disinfection of darkroom
- Daylight loader procedures

Daylight Loader Procedures (receptors without barriers)

- Wipe down exposed receptors as per previous instructions
- Place disinfected receptors in daylight loader
- Unwrap exposed receptors (ungloved) into receptor feed slots on front of automatic processor
- Dispose of receptor wrappers and any other items that you have used
- Proceed to mount radiographs and interpret

Clinisept Barrier

Courtesy Carestream Health, Inc., Rochester, NY.

Courtesy Carestream Health, Inc. Rochester, NY.

Daylight Loader Procedures (receptors with barriers)

- Remove Clinisept barriers and dispose of barriers (blue gloves must be worn) place receptors in non-infected container
- Place receptors in daylight loader
- Unwrap exposed receptors (ungloved) into receptor feed slots on front of automatic processor
- Dispose of receptor wrappers and any other items that you have used
- Proceed to mount radiographs and interpret

Plastic barrier surrounds and protects sensor digital radiography (wireless)

Courtesy Gendex Dental Systems, Des Plaines, IL.

Disposable sleeve digital radiography (wired)

Courtesy Gendex Dental Systems, Des Plaines, IL.

Viewing Equipment

- Ensure surface is clean and void of any debris
- Simply wipe with a damp paper towel
- No contact is made with client only holder (mount) touches the viewbox
- Ensure light bulb is working properly
- In digital radiography ensure monitor screen is clear

Extraoral Radiography

Screens and cassettes

- Be sure screens are wiped and free of debris with a manufacturer recommended cleaner
- If screen is scratched **replace**
- Cassettes do not require any form of disinfection/sterilization as they do not contact client in any way

Waste Management

- Developer
- Fixer
- Film

Developer

- **Used:** not typically hazardous
  - Discharged into sanitary sewer system
  - Never discharge into septic sewer system
  - Considered caustic, must be handled with care
  - Local sewer authority should be contacted prior to discharge

Developer

- **Unused:** hazardous due to high pH (check MSDS sheet for pH level of solution)
  - Should not be discharged into sanitary sewer system
  - Never discharge into septic sewer system
  - Considered caustic, must be handled with care
  - Local sewer authority should be contacted prior to discharge

Fixer and Rinse Waters

- Considered **hazardous** due to silver concentrations
  - Discharged into sanitary sewer system **only** after run through silver recovery unit to remove silver
  - Silver disposed of by approved waste carrier
  - If waste carrier not available then company contacted must come to pick up untreated fixer solutions (containers MUST be labeled)
  - Never discharge into septic sewer system

- Considered caustic, must be handled with care
- Local sewer authority should be contacted prior to discharge

Film Disposal

- Developed receptors may be disposed of in normal trash
- Undeveloped receptors contain silver and lead, collected in appropriate waste container (labeled)
- When full approved carrier must be contacted for removal

- Lead foil in film packets must be collected separately in recycling containers that are located in the darkroom

- When full the container should be sent for recycling

Oxford College Procedures

Please note that the previously stated procedures may vary dependent on office and operatory set- up

Following standard practices ensure safety to the radiographer and the client