The Components of the Fluoroscope

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Overview

- Historical background
- The modern fluoroscope and its components
- Future trends
1895:
Roentgen discovers x-rays
Roentgen’s experiment

- Studying a cathode ray tube enclosed in a box
- Applied current from cathode to metal anode
- Noticed mysterious light emanating from a barium platinocyanide fluorescent screen several feet away
- Called the rays that produced the light ‘x-rays’
The cathode ray tube

An evacuated glass tube in which a stream of charged particles is created in the cathode and flows toward the anode.
Roentgen’s device
Rontgen’s big idea

- Interpose human tissue between x-ray source and x-ray viewing medium
1895
Roentgen produces the first x-ray picture
The effects of x-rays can be visualized

- X-rays are a form of ionizing radiation
  - They will impact various media
- X-rays will cause a phosphor to emit light
  - Principle underlying fluoroscopy monitor
- X-rays will expose a photographic plate
  - Basic principle underlying x-ray film
Tissue placed between x-ray source and viewing medium:

X-rays will penetrate low density and be absorbed or scattered by high density tissue

The tissues will cast “shadows” onto the medium based on their relative densities
5 radiologic densities

- Air
- Fat
- Water (soft tissue)
- Bone
- Metal
X-ray radiograph

- X-rays travel through the target and are projected onto a photographic plate
- The x-rays that pass through to the plate, expose the film causing it to turn dark
- Thus high density tissue appears white on the film because it blocks the x-rays from reaching the medium

- Static image
Fluoroscopy

- Interpose tissue between x-ray source and phosphor
- The x-rays will stimulate the phosphor to glow brightly white
- High density tissue appears dark on fluoroscopy
- Real time imaging possible
1896: Edison elaborates on Roentgen’s discovery and invents the fluoroscope

- Found that calcium tungstate produced brighter images on the fluorescent screen
- Produced the first commercially available fluoroscope
- Did not patent the fluoroscope because of altruistic concerns
Making Use of the X-ray
WONDERFUL NEW RAY SEES THROUGH HAND!

X-Ray Studio...

110 East Twenty-Sixty Street,

...New York C...
Mihran Kassabian (1870-1910)
Functions of the modern fluoroscope

- Provide a stream of high velocity electrons
- Focus these electrons on a metal target
- Direct the resulting x-rays through tissue
- Capture x-rays after leaving tissue
- Process the resultant image for viewing
How does the fluoroscope control the x-ray radiation?
The fluoroscope can control the number of x-rays produced

- The x-ray generator controls the amount of electrical current delivered to the x-ray tube
- Amount of current is measured in amps (mA)
- mA determines the number of x-rays released by the x-ray tube
- mA determines density and intensity of the x-ray beam
The fluoroscope can control the **energy** of x-rays produced

- The x-ray generator also controls the voltage of the current in the x-ray tube which determines the **energy** and **penetrating** ability of the x-rays

- Voltage is measured in volts
  - Kilovolt peak (kVp)
The fluoroscope can direct the x-ray beam
The computers within the fluoroscope can process the images for optimal viewing

- The OEC 9900
The Fluoroscope and its Components
X-ray generator

- Converts AC current from the wall outlet to high voltage DC current within the fluoroscope

- Allows for adjustment of mA and kVp
  - Automatic
  - Manual
X-ray tube

- Vacuum tube that contains the cathode and anode
- DC current flows from the cathode to the positively-charged tungsten anode
- X-rays are given off as the electrons interact with the metal atoms
- Inefficient process
  - 99% heat
  - 1% x-rays
Image intensifier

- Native fluoroscopy images are dim
- Image intensifier converts X-rays into light photons
- Image intensifier amplifies brightness from 5,000 to 20,000 fold
Image intensifier

- x-rays from x-ray tube
- input phosphor
- cathode
- anode
- output phosphor
- monitor
Collimation

- Radiopaque blades that move into the path of the x-ray beam
- Modifies the size and shape of the x-ray beam to better conform to the FOV
- Reduces scatter by reducing the volume of tissue exposed to x-rays
- Improves image quality by reducing image degradation
Optical coupling

- The native x-rays are converted to voltage signals that are viewable on closed circuit television

- Typical C-arm system has a second TV monitor to display static image
Image processing

- Analogue image signal is digitized and stored in computer memory for processing

- Computer processing facilitates
  - Image enhancement
  - Image storage
  - Image distribution
Future trends

- More intense digital processing of images
- Axial imaging with the C-arm fluoroscope
- Flat panel displays to replace the image intensifier
Summary

- Fluoroscopy is a powerful tool that forms the basis of our new medical specialty
- Interventional pain specialists need to be familiar with the basic components and operation of the fluoroscope