Digital Fluoroscopy

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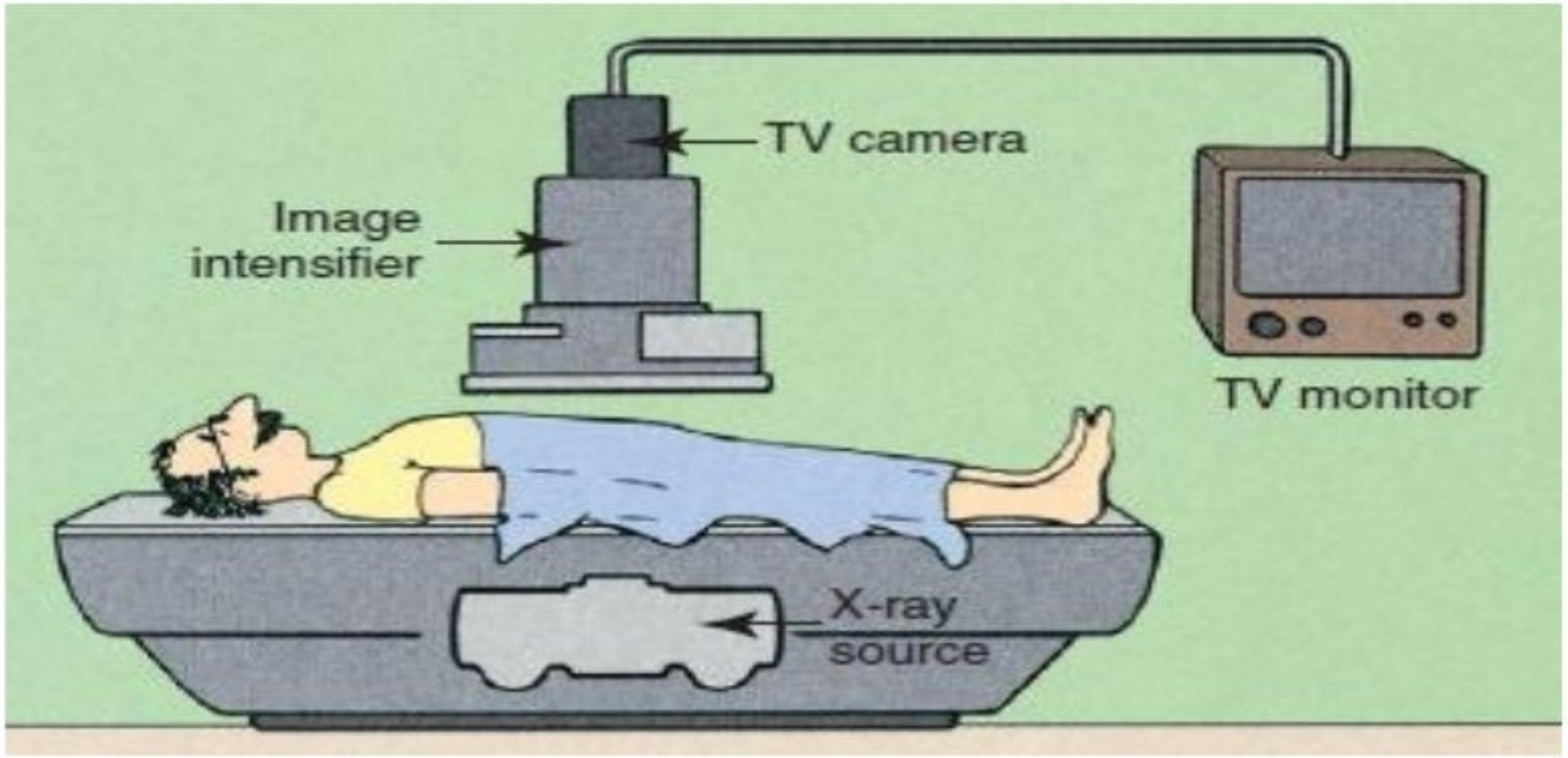
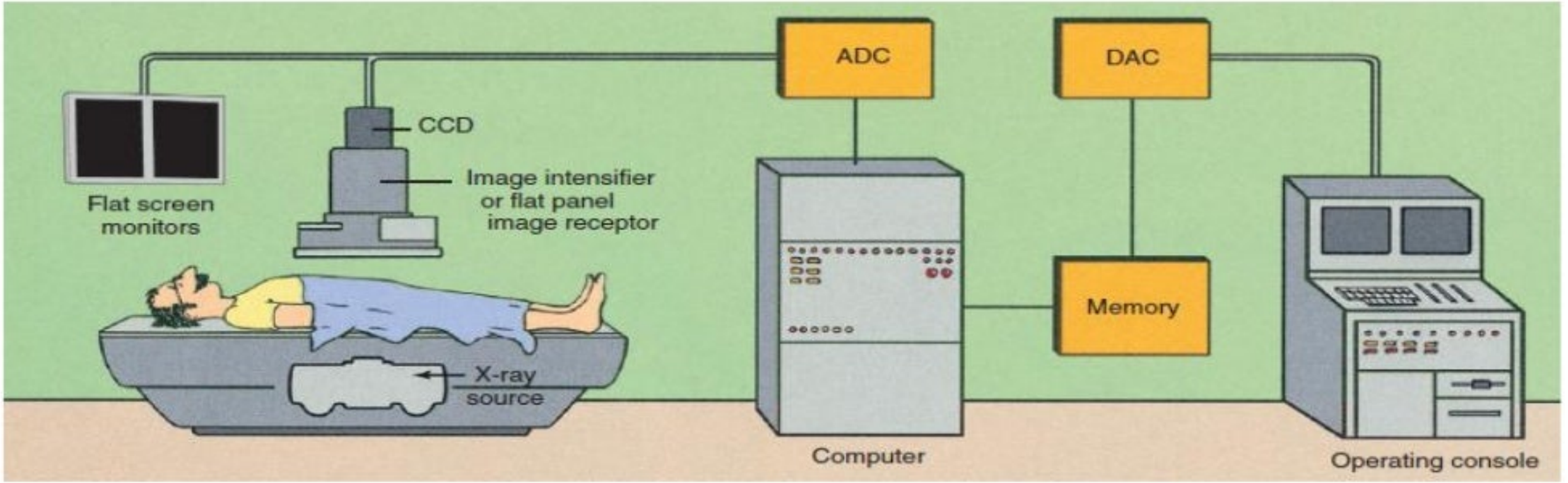
Conventional Fluoroscopy System



Digital Fluoroscopy System

Advantages of DF over conventional fluoroscopy include the speed of image acquisition and post processing to enhance image contrast.



Digital fluoroscopy is currently most commonly configured as a conventional fluoroscopy system.

The analog video signal is converted to a digital format with an analog-to-digital converter (ADC).

A computer has been added, as have multiple monitors and a more complex operating console

Charge-Coupled Device

A major change from conventional fluoroscopy to DF is the use of a charge-coupled device (CCD) instead of a TV camera tube.

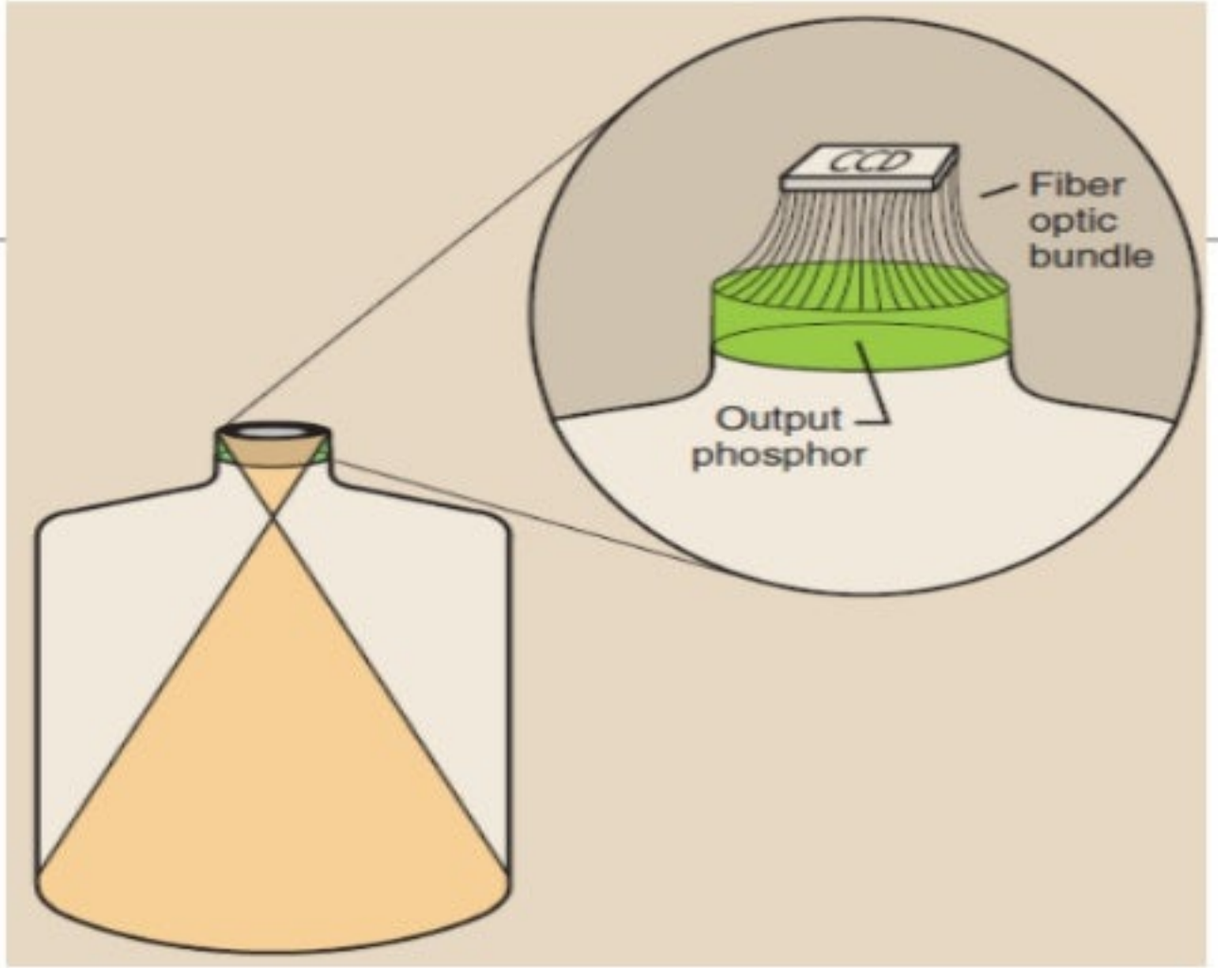
The sensitive component of a CCD is a layer of crystalline silicon.

The CCD is mounted on the output phosphor of the image-intensifier tube and is coupled through fiber optics.

The CCD has greater sensitivity to light a lower level of electronic noise than a television camera tube.

The response of the CCD to light is very stable. Warm up of the CCD is not required.

"DF with CCD results in wider dynamic range and better contrast resolution than conventional fluoroscopy."



Manner in which a charge-coupled device can be coupled to the image-intensifier tube.

Flat Panel Image Receptor

The further improvement of DF imaging is developing the flat panel image receptor (FPIR).

Such an image receptor is composed of cesium iodide (CsI)/amorphous silicon (a-Si) pixels.

The FPIR is much smaller and lighter and is manipulated more easily than an image intensifier.

Flat-panel detectors are more sensitive and faster than film.

Their sensitivity allows a lower dose of radiation for a given picture quality than film.

As tubes were replaced by CCD, now, CCD will be by FPIRs

FPIR is smaller, lighter and manipulated more easily

It provides easy manipulation of patient, radiologist/radiographer

No cassette is required

IMAGE DISPLAY

Flat Panel Image Display

Flat panel display technology is rapidly replacing the cathode ray tube (CRT) in all applications.

Flat panel monitors are easier to view and easier to manipulate, and they provide better images.

Digital Subtraction Angiography

Introduction

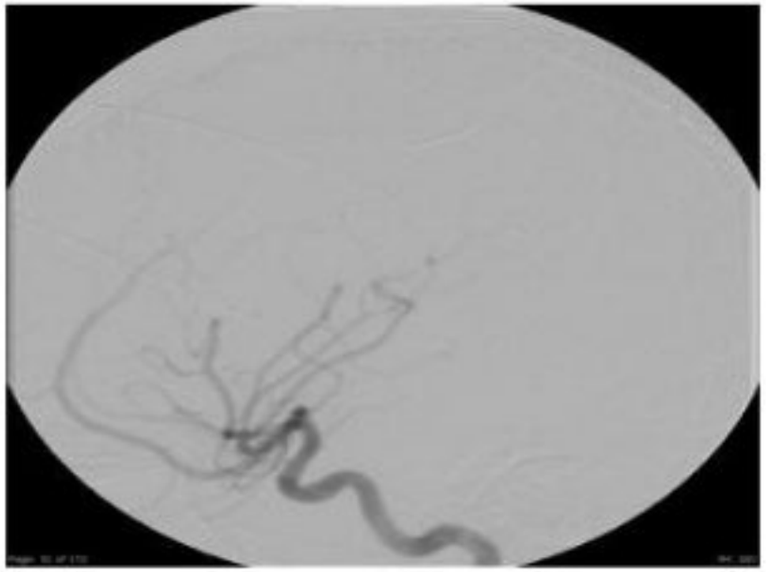
- In DF, microcomputers and microprocessors are used
- Computers are vital for image quality and speed of image formation
- It also determine image matrix size, system dynamic range and image acquisition range, also image acquisition rate
- The output signal from image-intensified digital image receptor is transmitted to an analog-to-digital converter (ADC)
- ADC converts analog signal into digital signal
- 8-bit ADC convert the analog signal into values (0-255)
- 10-bit ADC is more precise (0-1023)
- The output of the ADC is transferred to main memory and is manipulated so that a digital image in matrix form is stored
- In primary memory, data acquisition and transfer is rapid 30 images per second

Image formation in DSA

Principal advantage of DF is image subtraction technique

An enhanced visualisation of vasculature as a results from venous injection of contrast material

Image contrast is improved by subtraction techniques allowing to view subtracted image during passage of a bolus of contrast medium



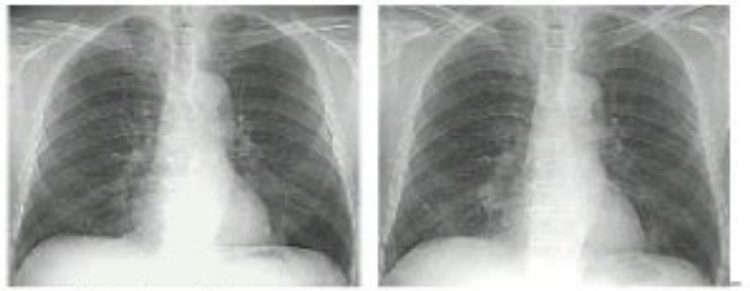
Temporal Subtraction

Temporal subtraction is an image processing technique that facilitates the visualization of pathologic change across serial chest radiographic images acquired from the same patient

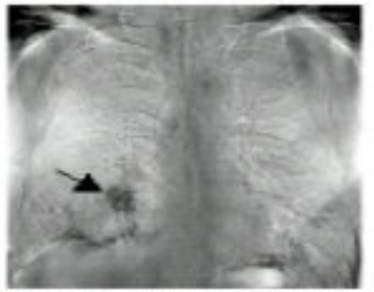
Methods of Subtraction

Temporal Subtraction

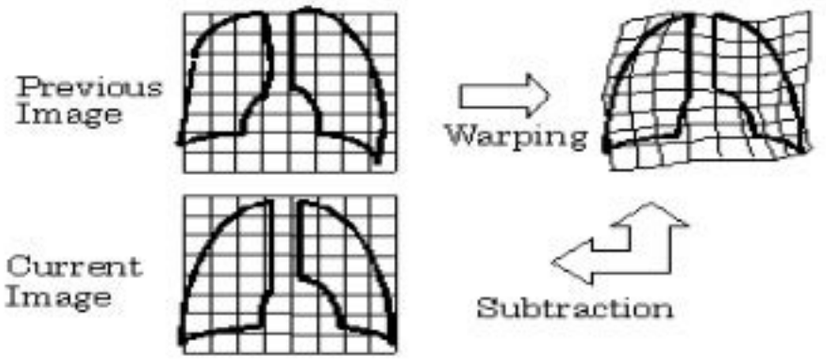
- Mostly used technique
- Referred to a number of computer assisted techniques
- It is image taken at one time is subtracted from an image obtained at a later time
- When contrast media is introduced, subtracted image will contain vessels filled with contrast
- Two methods;
  - Mask mode and the time-interval difference mode (TID)



Previous Image | Current Image

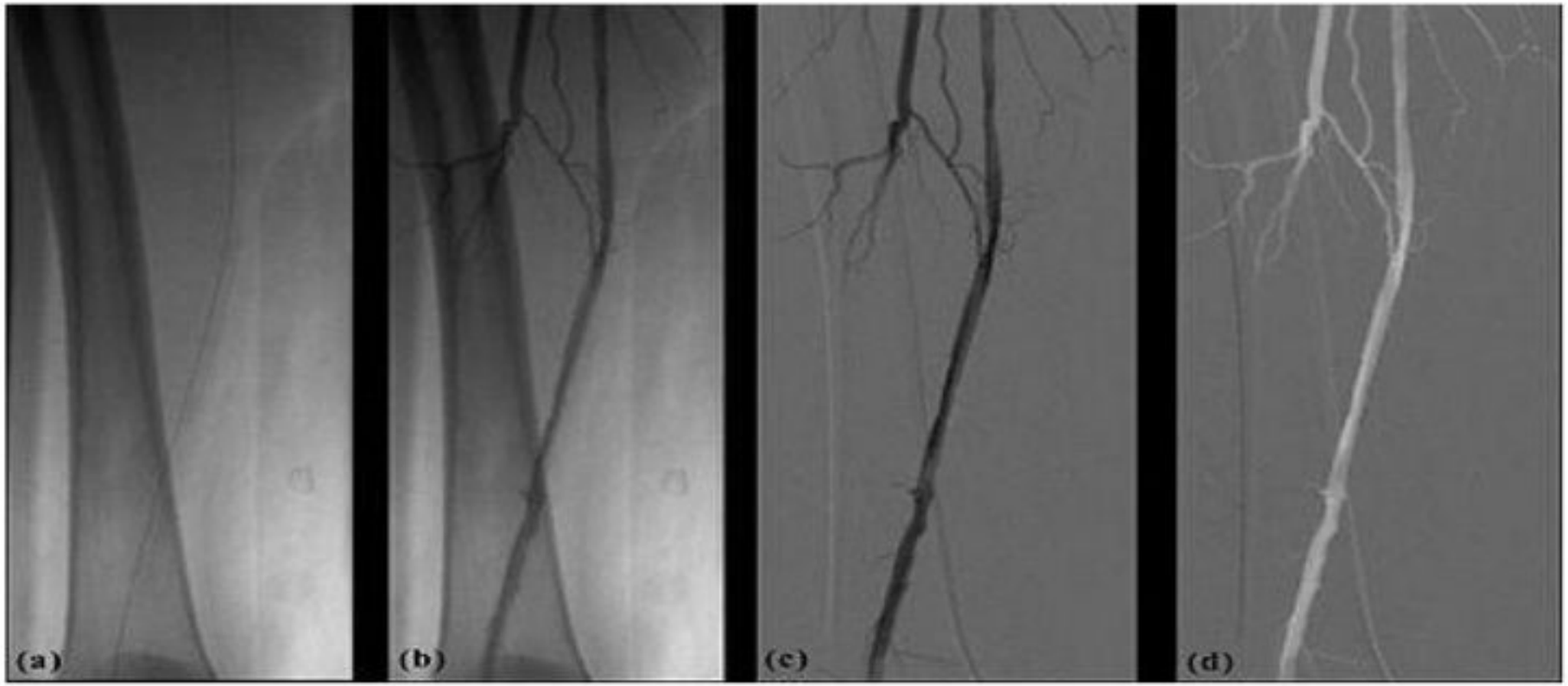


Temporal Subtraction Image



Automated image registration based on nonlinear

Mask mode



Images from a DSA study: (a) Mask Image; (b) Live Image; (c) Mask-Live Image; (d) Live-Mask Image.

Mask mode

- Patient is positioned under normal fluoroscopic control to ensure region of anatomy is in FOV
- Power injector is armed and readied to deliver 30 -50 ml of contrast at rate of 15-20ml/s through venous entry
- On arterial, 10-25ml of diluted contrast material at 10-12 ml/s
- Imaging system is changed from fluoroscopic mode to DF mode
- This requires increase in x-ray tube current 20-100 times
- Activation of a programme for pulse image acquisition as well
- Injector is fired, after a delay of 4-10 s before bolus of contrast medium reaches anatomical site
- An initial x-ray pulsed exposure is made
- Image obtained is stored in primary memory
- Image is displayed on video monitor, this is the mask image

Mask image is followed by series of additional images

The masked image is subtracted from each other and result is stored in primary memory

At same time, subtracted image is displayed on video monitor

Subtracted images are displayed in real time

Image integration is summing up four to eight images to form single image for improving contrast resolution

Remasking is possible if patient moved or improper technique

A typical examination requires total of 30 images in additional to mask image

Unacceptable mask images can be caused by noise, motion and technical factors

Time-Interval Difference mode

- Images are made from different mask and follow-up frame
- In cardiac study, image acquisition begins 5s after injection at the rate of 15 images per second for 4s
- Total of 60 images are obtained
- These images are identified as image no.1 to no.60
- If a TID of four images is selected
- First image produced by subtracting frame 1 from frame 5
- Second image produced subtracting frame 2 from frame 6
- Third image produced subtracting frame 3 from frame 7
- And so on……. This is called progressive masking
- Such images are free of motion artifacts

Conventional & Digital Fluoroscopy Differ

primarily in the imaging system, i.e., an image intensifier-video camera system versus a digital imaging chain which may have neither an image intensifier nor video camera. In general, all other portions of the equipment are similar.

Thank you!