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imaging update

2001 - A DIGITAL IMAGING ODYSSEY

Queensland Diagnostic Imaging

COMPUTED RADIOGRAPHY (CR)

Computed radiography (CR), sometimes also referred to as digital radiography, is a new system for obtaining radiographs, and for performing fluoroscopic studies such as barium examinations of the stomach and colon. On the 30th of July, Queensland Diagnostic Imaging will open the first totally digital private radiology practice in Queensland at our new Holy Spirit Hospital Northside rooms. This article will outline what CR is, how it works, and how it will benefit your patients.

CONVENTIONAL RADIOGRAPHY AND FLUOROSCOPY

X-rays are produced in an X-ray tube by focusing a beam of high-energy electrons on to a tungsten target. The X-ray beam thus produced is directed to the area of interest, e.g., the chest or abdomen, and onto an X-ray film. In passing through a patient the X-ray beam is decreased according to the density and atomic number of the various tissues in a process known as attenuation. X-rays turn X-ray film black. Therefore the less dense a material, the more X-rays get through and the blacker the film, i.e., materials of low density appear darker than objects of high density. The X-ray film is then developed in a darkroom or in a free standing daylight processor. Either method requires the use of chemicals, which must be replenished on a regular basis.
A disadvantage of this method is the inability to manipulate the image once the X-ray exposure has been performed. This means that if the exposure is incorrect (i.e., the film is too light or too dark), the examination may need to be repeated.

The major advantages of CR result from the separation of image acquisition, image processing and image display. Each of these factors may be altered and manipulated to obtain the maximum information from the original exposure.

HOW CR WORKS

The key components of a CR system are:
- Photostimulable phosphor plates.
- Laser reader.
- Image processing.
- Image display systems.

Photostimulable phosphor plates

Rather than X-ray film cassettes, CR acquires images using storage phosphor imaging plates. These plates are manufactured in a variety of sizes, depending on the body part to be imaged. As with conventional radiography, the patient is exposed to an X-ray beam. The energy from the X-ray beam is stored on the phosphor plate. This energy is then released by exposure to visible light of an appropriate wavelength, hence the term 'photostimulable'. The amount of energy stored at any point on the phosphor plate is directly proportional to the X-ray energy absorbed. The storage phosphors used for radiography are europium-doped barium fluorohalide crystals.

Laser reader

For readout of the stored image, the exposed phosphor plate is passed through a laser scanner. As the plate moves through the scanner at a constant speed, a laser beam is guided over its surface by a series of optics and a rapidly moving mirror.
The laser moves rapidly back and forward perpendicular to the direction of plate movement. The movement of the plate and excursion of the laser beam are timed such that after one line is scanned, the plate has moved to the position of the next line. As the laser passes over the plate, the stored energy is released in the form of light. This released light is collected in a second series of optics, and its energy amplified in a photomultiplier tube. The analogue signal from the photomultiplier tube is then sampled and

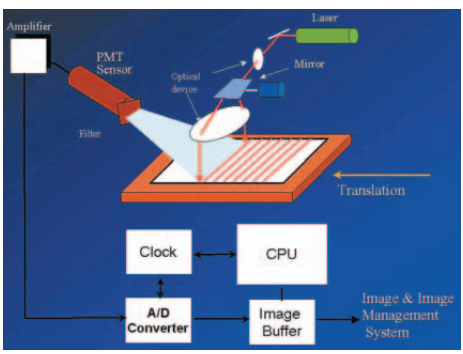

FIG 1. A schematic diagram of the inner workings of a laser scanner system for computed radiography.

digitized by an analogue-to-digital converter (ADC). Following this laser read-out process the plate is 'cleared' by exposure to a strong light, to be re-used.

The design of the laser scanner is crucial to the two most important factors in image quality, i.e., spatial resolution and contrast sensitivity.

A digital image is composed of a two dimensional array of picture elements or pixels. The smaller the pixels, the greater the resolution of the image. The spatial resolution of a CR system is determined by two separate factors, operating at right angles to each other. The first of these is in the direction of the scanning laser beam, and is determined by the number of samples registered by the ADC. In the other direction, the spatial resolution is determined by how far the phosphor plate moves from the start of one sample line to the next. These two factors are usually coordinated to produce square pixels. For example, the Kodak CR900 system to be installed by QDI has the ADC sampling 2048 times as the laser beam scans 350mm. This means that the laser beam moves 0.17mm between samples. In this example the plate would move 0.17mm between scan lines.

Contrast sensitivity refers to the ability of the system to distinguish objects of similar density. This is a function of the sensitivity of the ADC, which in turn is a function of the number of bits used. The Kodak CR900 uses a 12 bit ADC. This means that 2^{12}, or 4096 discrete density values may be assigned to each pixel.

Image processing.

Once the image is obtained it may be further refined by using a number of computer based processing methods. Image processing may be used to alter the overall 'blackness' or 'whiteness' of a film, to give more or less contrast as required, to sharpen or enhance edges, and to reduce background noise.

Fig 2a

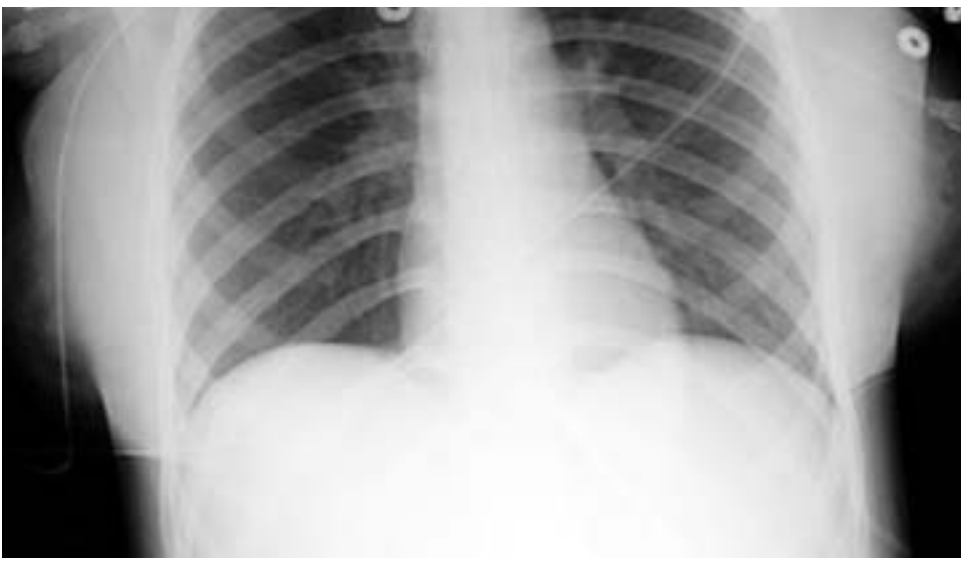

Fig 2b

FIG 2. Chest radiograph in a paediatric patient to assess position of nasogastric tube (NGT). The initial film was slightly underexposed (Fig 2.A). With post-processing of the image, a much better chest radiograph is produced (Fig. 2.B). Note that the nasogastric tube can now be seen

With conventional radiography, these factors are set once the X-ray exposure is performed. This means that if the film is too light or too dark, it needs to be repeated, thus exposing the patient to further radiation. Even the most experienced radiographers need to repeat 10 to 15% of exposures. This extra radiation dose is virtually eliminated by the use of CR.

Image display systems.

It is in the areas of image display and image transfer that CR really excels. The digital images may be displayed on a monitor for instant reporting. Further manipulation of the images is possible at this stage, including alteration of density and magnification of areas of interest. Images may be transferred to monitors at other sites within the hospital via an Intranet. This is particularly useful for images acquired in the Accident and Emergency Department. These images can be instantly reported, even if A & E is some distance from the radiology department. Furthermore, images may be instantly transferred to ICU, and to other wards. In the future, following conversion to a suitable format such as JPEG, images may even be sent over the Internet.

Images are stored in one of three ways. First, the image may be recorded on an X-ray film with a dry laser printer, producing a permanent record that the patient can keep. It is important to realise that this will be done for all patients referred to QDI at Holy Spirit Northside. These films have a rather 'crisp' look compared to conventional films. For example, with images of bones, the trabecular pattern is particularly well seen. Furthermore, soft tissue planes in the chest and abdomen are generally better seen than with conventional radiographs.

Second, a permanent digital storage method such as CD-ROM may be used. The price of a recordable CD is about the same as a single sheet of X-ray film. Given the number of images able to be recorded on a standard 650 megabyte CD, the cost savings are obvious, let alone the convenience when compared to juggling multiple films.

Third, images may be placed in a picture archiving and communications system (PACS). This refers to a computer-based system with enormous storage capacity, able to store and retrieve a vast number of images. Such PACS systems have been introduced by several large public hospitals in Australia.

BENEFITS OF CR

In summary, CR represents a major step forward in the practice of radiology. The main advantages of CR are:

- No need for chemicals for developing X-ray films. The films used to record digital images are produced by dry laser printing.

- No need to repeat films to correct exposure factors, therefore reduced overall radiation dose. This is particularly so with 'difficult' patients including children, and in fact the children's hospitals in Sydney and Brisbane have led the way in Australia with the implementation of this technology.

- Instant transfer of images via Intranet to and from A & E, ICU, hospital wards and clinics.

- Convenient storage on computer based systems such as CD-ROM.

Dr David Lisle. MB,BS., FRANZCR.
Queensland Diagnostic Imaging

Dr Lisle is a radiologist with QDI.
He will be working at the Holy Spirit Northside rooms and has special interests in Musculoskeletal Imaging and Ultrasound, MRI and Paediatric Imaging.

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www.qdixray.com.au

QDI News

QDI remains privately owned and committed to providing a clinically independent choice for radiology services. QDI continues to invest in improving the service provided to our referring doctors and patients. Our commitment to bringing you the best technology, better levels of service in terms of faster reporting times, delivery of results and providing services sensitive to the needs of our patients and doctors is further demonstrated in this edition of QDI News.

CARDIC SCORING SERVICE EXPANDS

Holy Spirit Northside has installed a multislice CT scanner which is identical to the machine at HSH Wickham Terrace. With the Scimage cardiac scoring package, QDI is using state of the art technology to image calcium deposits in the coronary arteries. As a screening procedure, the examination is not rebatable by Medicare and a fee of $250 applies. Any questions regarding this service may be directed to the Holy Spirit Hospital, Wickham Terrace, on 38396161 or for bookings call 3832 8838.

QDI NORTH WEST EXPANDS SERVICE

In addition to providing a comprehensive medical imaging department at North West Private Hospital, QDI has built a dedicated Women's Imaging Centre. The installation of a Norland Excell Bone Densitometry Machine completes the service, which includes advanced breast imaging examinations. The results from the BMD machine can be correlated with QDI Strathpine, offering your patients a convenient alternative for women's imaging in the inner-west region.

HOLY SPIRIT NORTHSIDE

QDI Holy Spirit Northside (HSN) is located on the Ground Floor of the Holy Spirit Northside Private Hospital, co-located with The Prince Charles Hospital in Chermside. Opening on the 30th of July 2001, QDI will be providing medical imaging services for hospital inpatients and outpatients from the wider community.

The main department will be open Monday-Friday from 8.30am to 5.30pm. A&E Department coverage will be 24 hours a day, 7days a week with an on-call service.

A patient drop off area is located at the foyer of the hospital and ample parking is available in the multi-level carpark near the public hospital. Access to the hospital and radiology may be gained through the secondary entrance located next to the A&E.

Services at the site will include:

- Multi Slice CT including Cardiac Scoring
- Digital X-ray and Fluoroscopy
- General Ultrasound
- Musculoskeletal Ultrasound
- Vascular Ultrasound
- Echocardiography
- Nuclear Medicine including cardiac Nuc. Med.

QDI partners, Dr. David Lisle and Dr John McGuire are the doctors in charge and David Kinnane will be radiographer in charge for the department. Bookings will be taken from Wednesday 25th July 2001. Any queries may be directed to them on the following numbers:

Bookings: 3256 3322
Telephone:3256 4011
Fax:3256 4022

QDI Chermside will continue to operate business as usual, offering a great alternative for most outpatient imaging requirements, including OPG, general X-ray, Spiral CT, General Ultrasound

HAPPY ANNIVERSARY - ELECTRONIC DELIVERY OF REPORTS

QDI has been delivering reports electronically for more than one year now. In fact, this mode of delivery accounts for almost 25% of all reports sent by the Group. Using military grade encryption your reports are safe and easy to access. If you have any questions, please call Michelle on 3222 1910.

Enquiries should be directed in the first instance to **QDI Information Officer**
p. 3839 4244 f. 3831 0276 e. qdi@qdixray.com.au

GPO box 2762, Brisbane 4001

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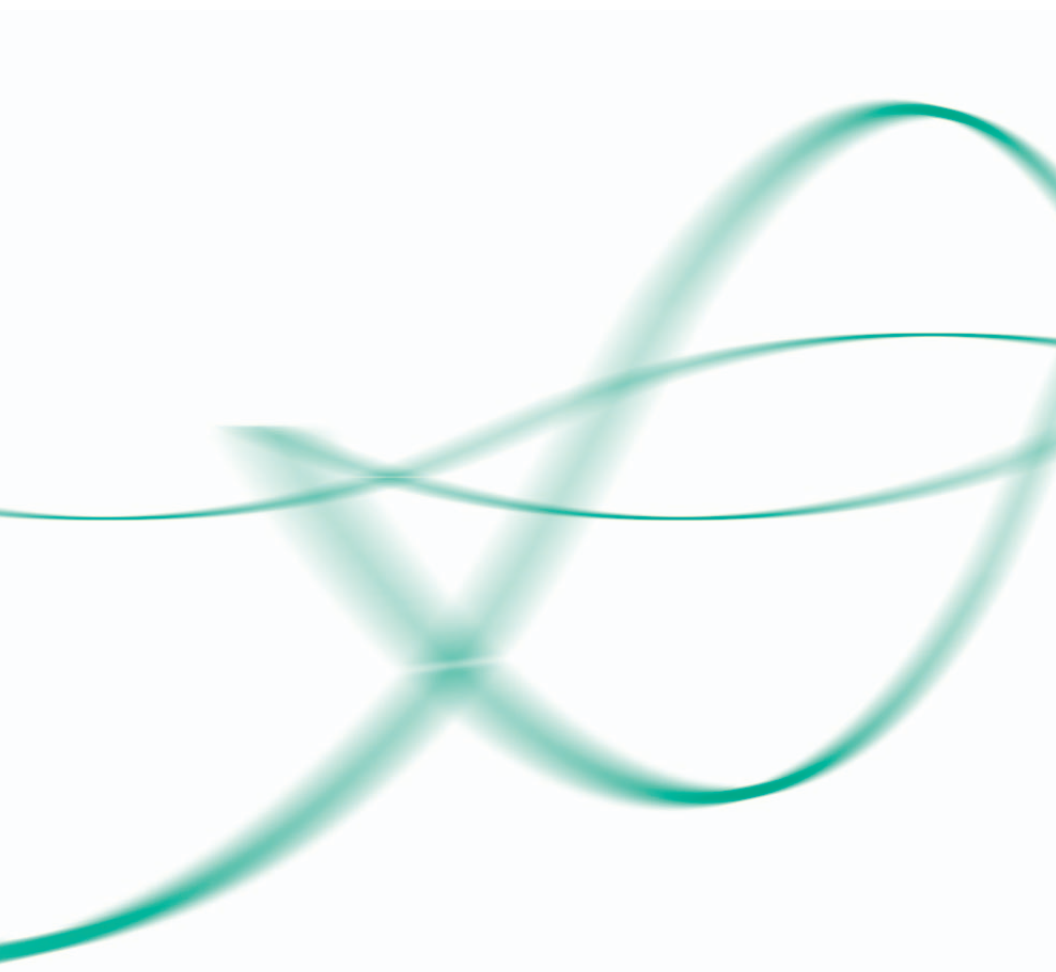

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