Medical Imaging

Past, Present... And Coming

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We'll take a look at:

- X-Ray and CT
- Visible light images
- Nuclear imaging
- MRI
- Ultrasound
- Image quackery
- On the way







X-ray



Wilhelm Röntgen (1845–1923) X-ray





Painless and harmless... guaranteed to be permanent

Hair Removed Permanently Patient receiving treatment on the cheek. No pain or sensation of any kind. The INFALLIBLE method successfully used for 16 years by Dr. Albert C. Geyser, late Professor of Electrical Therapeutics at Cornell University and endorsed by many leading physicians. No Needle, No Wax, No Chemical Painless and Harmless-Guaranteed to be Permanent Tricho System



x-ray





X-ray orthopedic



Knee replacement

lumbar spine x-ray









X-ray flouroscopy



X-ray flouroscope receiver



X-ray angiography





Pseudoaneurysm of right branch of hepatic artery

Liver metastasis

X-ray angiography

Normal coronary arteries



Partial occlusion of coronary arteries

Filling of coronary arteries



X-ray flouroscopy



1936 Nazi experiments with whole body flouroscopy



X-ray flourscopy

With suitable contrast medium, x-ray flouroscopy is useful for many organ system studies.





X-Ray Computerized Tomography: CT

Gathering data



Analyzing data



Rotating 2-D fan-beam x-ray sources and image planes

Back projection and summing of all the 1-D image lines





First-gen (1975) commercial CT image



Modern CT resolution

CT brain scan mapping hemorrhagic stroke site and extent







Axial CT study of normal abdomen

Coronal CT study of chest



X-ray diffraction photograph of DNA



Rosalind Franklin



A DNA strand was stretched across a paperclip and mounted on a piece of cork X-rays were sent through the DNA strand and their diffracted paths were captured on sensitised paper – creating Photo 51

The 'X' in the centre of Photo 51 was caused by the helical shape of the DNA molecules in the sample



Watson & Crick's Double Helix Model (1953)





normal strand of hair

hair from breast cancer patient



Ring identified 12/13 cancer patient, wth false positives in 3/20 controls.

Early illustrations

Turning from X-rays to images created in ordinary light...

Galen (129-200AD) Land being the second size of the product of the second se

Early illustrations



191 84 11 ALL ADDRESS CLASSE IN ACCESS & San increased them or word the an angle signs and the want more stall their as seefing 14 Faller agents to 1.88 of a upp foot that find upp one and we are see and fairs and an all is an an and and where stand in the granter 100 500 and the same a Address to A and if a accide and and the set of a town the world have so it and desired any int with some strend at and gated with the sea she the ten and true and There dough an And the act at an attemption that the and and and depicted the out and and declark trees in and Heart in De humani corporis fabrica.

Vesalius (1514-1564)



The next step:

MEDICAL MICROSCOPY.

Crouch, 66 Barbican. Pillischer, 88 New Bond Street. Powell & Lealand, 170 Euston Road. Swift, 81 Tottenham Court Road. Parkes, 5 St. Mary's Row, Birmingham. Ross, 164 New Bond Street.

20

In America very similar instruments, possessing everything that can be desired, and excellent both in manufacture and in the qualities of the lenses, may be obtained from Joseph Zentmayer, 209 South Eleventh Street, Philadelphia, and Bausch & Lamb Optical Company, 48 and 50 Maiden Lane, New York, and at 543 North St. Paul Street, Rochester, N. Y. These firms also supply all microscopical apparatus and accessories.

If a suitable stand be already to hand, the extra apparatus may, of course, be added. This applies more particularly to an oil-immersion lens and Abbé's condenser. The best immersions are perhaps those of Zeiss, but they are very expensive. A very good lens is made by Leitz, and costs about f_{15} , whilst a condenser can be fitted for about f_{3} . Both the lens and condenser may be obtained from any of the makers above mentioned.

Having detailed the form of the microscope and the essentials of a good and practical one, we now pass to the use of the instrument. This may seem somewhat superfluous, but a few hints to the inexperienced may save them not only various petty annoyances, but probably also the loss of valuable lenses.

In removing the instrument from its box it should be grasped by the column, not by its foot, as thereby much strain on its bearings is prevented. Any jarring of the adjustments soon puts them out of order. For this reason when in constant use it is preferable to keep it under a belljar rather than to be constantly lifting it out of and into

THE MICROSCOPE AND ACCESSORIES. 21 its case. Scrupulous cleanliness cannot be too strongly



1898 optics textbook



Modern monocular microscope with multiple objectives

Microscopy

Biopsy



Patch of tissue imaged: 0.003" x 0.004"

Fig. 3 Glomerulations demonstrating significant morphologic overlap with and transition to cribriform Gleason pattern 4 carcinoma.







6 2013 🤀 Wolters Kluwer Lippincett Williams & Wilkins



Endoscopy



camera location

pass 1

pass 2

Endoscopic exam of normal trachea

Other places to look



Microscopy

E Coli about one ten-thousandths of an inch long T4 one-tenth as large as E Coli host



Giant Microbes T4 (T4-Bacteriophage) Plush Toy

by Giant Microbes

List Price: \$27.22 Price: \$12.95 *Prime* You Save: \$14.27 (52%)





TEM image of E Coli bacteria

Nuclear Imaging



SPECT (Single Photon Emission Computerized Tomography)



Gamma camera

Otgan with tadioactive emissions

Collimator

Detector Crystal

Photomultipliet Tube Attay

Position Logistic Citcuits

Detector Cover

Nuclear imaging - SPECT

Thallium myocardial perfusion stress test



Dark areas of the heart muscle have low perfusion





Nuclear imaging - SPECT

Lung scan: tumor cells are more active



Nuclear imaging - PET

PET: Positron Emission Tomography



Radionuclide tracer: FDG, a form of glucose. The more metabolically active the tissue, the more FDG will flow there.





@2000 How Stuff Works

Nuclear imaging - PET

X-ray CT codes for structure, PET for activity



There's hope for us people of a certain age!



Brain scan: Test of an Alzheimer's regimen Treatment with Nerve Growth Factor NGF.



Activity coding (radio-isotope tagged glucoselike 18F FDG) data overlaid on standardized MRI templates.

Nuclear imaging

Comparing the two nuclear imaging modalities:



SPECT

- Emits gamma radiations
- Lower resolution
- Less capital intensive scanner
- Longer lived radioisotopes



Combined PET/CT scan



Comparison: CT alone vs PET/CT



Axial CT image of lungs showing large mass in left lung

Combined CT/PET image showing tumor





And now for something completely different...

Medical Imaging Quackery





The Psychograph: A phrenology imager

Pseudoscience imaging

Proper application of psychograph helmet







Our Products
<u>Nervo-Scope®</u>
<u>Accessories</u>
<u>Supplies</u>

Our Products >> Nervo-Scope® ETS-9A

Nervo-Scope® ETS-9A



Item #: CHR-ETS-9A

Nervo-Scope® reliably detects and measures minute heat differences in the tissues along the spine. The instrument can be used comfortably for both pre and post adjustment assessment.

In today's world, cell phones, tablets, laptops, Blue Tooth systems, wireless networks, radio transmitters, fluorescent lights, etc. are everywhere. In essence, RFI is at an all time high.

As a result of feedback from the Chiropractic community, EDL's newest Nervo-Scopes® (ETS-9 and ETS-9A) are engineered to reject the influence of these sources and give stable, accurate readings every time the instrument is used.

EDL's newest Nervo-Scopes® have the same sensitivity as our previous models. The ETS-9A is compatible with the Analagraph® Graph Recorder and both models are designed to automatically power down after ten minutes.

'Nervo-Scope" delivers thermographic data at the level of hundredths of a degree along the spine.

No published replicated experiments to show any diagnostic value.



Each Nervo-Scope® includes a foam-padded carrying case and cleaning brush. All of the ETS series Nervo-Scopes are protected by a full two-year warranty against workmanship and defective components.

Pseudoscience: system of thought claiming scientific validity but lacking a scientific evidentiary base

Pseudoscience imaging

Note: EMI is not acupuncture, which has proven therapeutic, if not diagnostic, value.



- Alarm LU 1 Associated - BL 13 5 - Water-Sedation-Sea LU LU 6 - Hai 7 - Luo LU 8 - Metal-Horary-River LU 9 - Earth-Tonify-Source-Stream LU
- LU 10 Fire Spring
- LU 11 Wood Tsing-Well

EMI: Electro-Meridian Imaging

O Five Elements **O**Alam OAssociated O Source, Tsing **O**Tonification O Sedation OLuo OXi-Hsi-Cleft Points O Horary Points OLung O Large Intestine OStomach **O**Spleen OHeart O Small Intestine O 8ladder **O**Kidney **O**Pericardium O Tri-Heater O Galbladder OLiver OVessel (GV,CV) O 30 Primary Points O Auriculotherapy 1 O Auriculotherapy 2 O Auticulotherapy 3 OHerbs 1 O'Herbs 2 O Herbs 3

Pseudoscience imaging





Kirlian photograph: high frequency pulsed contact film image claimed to visualize "life force"

Aura image: claimed to visualize "chakra spiritual energy."



Ultrasound



Sonar works by echolocation



mitral valve defect

normal mitral valve image



The Difference VIDEO Between **3D** 2D











Same baby pre- and post-partum

Raymond Damadian showed in 1968 that Nuclear Magnetic Resonance (NMR) could be used to distinguish cancer from normal tissue (SUNY Downstate).

First MRI (NMR) medical image: Paul Lauterbur 1973 (SUNY Stonybrook)









Horizontal Plane MRI sequence: normal adult head





Magnet Chamber

How MRI works



MRI

Inflammation invisible on x-ray and CT can be identified in MRI





Functional MRI (fMRI): blood flow to a region of the brain increases the density of water molecules, thus increases contrast in MRI.



Fetal MRI revealing spina bifida

Comparisons



MRI

Imaging Risks and Concerns

Average increase in lifetime cancer risk due to CT scans is from 42.0% to 42.7% (Brig & Women's Hopa 2009 study)

Radiation Dosages

Everyday Activities	Radiation Dose	Medical Imaging	Radiation Dose
Watching television	0.01 mSv/year	Chest X-ray (1 film)	0.1 mSv
		Nuclear med. thyroid scan	0.14 mSv
Air travel (roundtrip from D.C. to L.A.	0.05 mSv	Mammogram (4 views)	0.4 mSv
Average annual exposure from breathing radon gas	2 mSv	Nuclear med. lung scan	2 mSv
		Nuclear med. bone scan	4.2 mSv
Average annual exposure living in the United States	3 mSv/year	Tc-99m cardiac diagnostic	11 mSv
		Abdominal CT scan	8 mSv
Annual dose limit for radiation workers in U.S.	50 mSv/year	F-18 FDG PET/CT study	14 mSv
		Cancer treatment	50,000 mSv

0.01 X-ray limb X-ray bone density DEXA 0.01 X-ray chest CT sinuses 6 X-ray spine X-ray mammogram X-ray abdomen Flouroscopy barium swallow CT head Nuc med lung perfusion Nnuc med bone scan CT chest CT pulmonary embolism Flouroscopy cor angio Nuc med cardiac perfus PET/CT whole body scan

12

15

20

20

42

Radiation dosage of various medical imaging procedures measured in equivalent number of chest x-rays

125

100

100

Permissible annual radiation dosage for heath care workers: 500 chest x-rays (50 mSv) Dosage at which clear increased cancer risk can be proved: 1000 chest x-rays (100 mSv)

70





EIT: Electrical Impedance Tomography





SPECT images

EIT images

Microwave thermography

Other imaging modalities

OCT: Retinal Optical Coherence Tomography

tal raster scan) through the macula accumulated on the undersurface of can be seen both within this and Imaging in therapy

Imaging in Therapy: Robotic Surgery

Future: Holography

Com

Virtual autopsy

Future: Holography

Future: Automated detection of brain aneurysms

Image to vessel shape classification by machine learning methods

Future: automated aneurysm classification

3-D reconstruction from MRI

Discovery of aneurysm within otherwise normal vasculature

Geometric patch analysis

Future: Wireless capsule endoscopy

rithm. The left two images are normal regions and the right two images are Crohn's disease inflammation regions.

Future: Holography

Interactive 4-D holographic manipulation

For a list of sources for these images and videos (url's, bibliographic references) please send an email to my address:

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