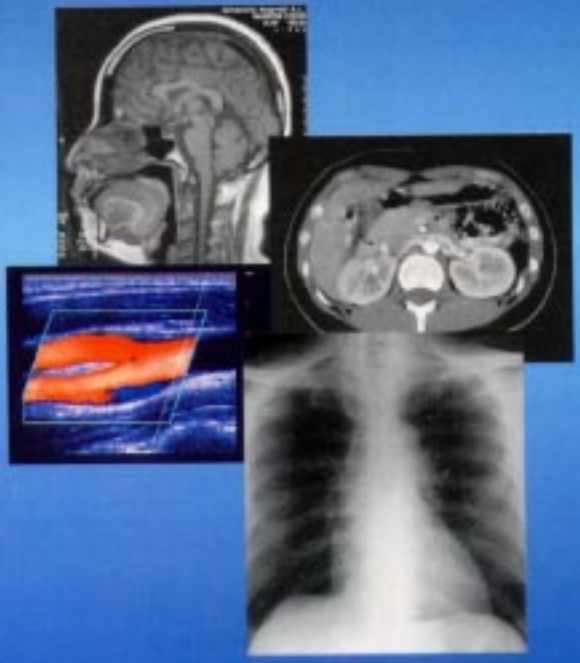
Guidelines for Clinical Practice in Radiology



Malaysian Radiological Society

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"... doing something because it is feasible does not make it practical,

If something is practical it is not necessarily useful,

That which is practical is not always necessary,

And that which is necessary is not always appropriate."

Edward V. Staab
Decisions in Imaging Economics Supplement September/October 1998, p 8-10.

CONTENTS

PREFACE

There has been tremendous developments in imaging technology from radiology, ultrasonography, CT imaging and magnetic resonance imaging in the last two decades. With such rapid progress, some of the imaging techniques may not have been available in the medical curriculum in the earlier days and there is a generation of medical practitioners who may not understand the effectiveness of the newer technologies.

Guidelines For Clinical Practice in Radiology is specially designed for the undergraduates and the practising clinicians to assist them in the best possible way to solve a clinical problem. We hope to stimulate discussions among the radiologists and the clinicians so that more effective use of imaging can be achieved.

The idea of producing this guide was suggested by Tan Sri Dato' (Dr.) Abu Bakar Suleiman, the Director-General of Ministry of Health. Dr. P. Sathyamoorthy, Senior Consultant Radiologist, Department of Diagnostic Imaging, Hospital Kuala Lumpur approached the Malaysian Radiological Society to formulate diagnostic imaging guidelines in clinical practice so that the best use of Departments in Clinical Radiology could be achieved.

We are indebted to the radiologists and the clinicians for their significant contributions in making this guide possible. However, recognizing that radiology is a rapidly developing speciality, we welcome feedbacks and suggestions for considerations in our future edition.

We hope that doctors and hospitals will find this quick reference guide genuinely helpful, taking into consideration the facilities and the types of equipment that are available.

Dr. Joginder Singh
President, 1998/2000
Malaysian Radiological Society

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INTRODUCTION

- Biological Effects of Radiation
- Radiation Doses Received from Various Radiological Examinations
- Radiation Protection in Radiological Practice
- The Imaging Modalities
- Contrast Media Used In Diagnostic Imaging
- Safety of Ultrasonography
- Safety of Magnetic Resonance Imaging

INTRODUCTION

Imaging is playing an increasingly important role in the management of patients for purposes of diagnosis and also for screening and in guiding therapeutic intervention. The ultimate aim of all medical practices is to ensure better patient outcomes. With the increasing complexity and specialization of medical practice, the clinician is often faced with a wide array of different available imaging modalities. For any specific clinical problem, the questions the clinician should consider include:

- Is imaging necessary at all?
- If so, which imaging modality will help the clinician to manage the patient accurately, safely, quickly yet economically?

Clinical history taking and physical examination are the essential initial steps in the assessment of any patients. In those patients who require imaging, the choice of the most effective imaging modality to use is often difficult and frequently controversial. The sequence of imaging to be followed is influenced by many factors including the availability of equipment, skills of the practitioner, budgetary constraints, safety, expected quality of the results and conclusions which can be drawn.

Although the economic situation may be the ultimate factor limiting the choice of imaging modality, the risk of ionizing radiation must also be considered. The principle that no patient should be exposed to unnecessary radiation is a very good reason why the sequence of imaging must be carefully chosen by a radiologist or medical practitioner who has a clear idea of what should be done after the clinical examination, and which subsequent imaging may be needed when the first results are available. Thus, priorities must be established and the sequence of imaging will have many local variations.

Radiography is still the most common method of imaging throughout the world with 80% of all diagnostic images being the chest and skeleton. However, in many clinical situations, ultrasonography is now the imaging modality of choice. It has been estimated that in the near future, one out of every three studies will be an ultrasound. All pregnant women should first have an ultrasonography investigation. For the liver, pancreas, spleen, gynaecological problems, scrotum and prostate, ultrasonography should be used first.

There are, today, so many different choices and such a wealth of information that it is often too much for any individual to master, and consultation with colleagues has become essential for good care of patients. These guidelines were prepared to aid the clinician in the diagnostic work-up of the patients. These guidelines are structured on a system basis, covering head and neck, central nervous system, cardiovascular system, musculoskeletal system, respiratory system, gastrointestinal system, genitourinary system, female reproductive system, breast disease and paediatrics. For each clinical problem the preferred pathway of imaging is discussed. All imaging techniques are considered including MRI which is available in all major hospitals. The guidelines may be modified to suit local needs. While these guidelines may provide useful guidance, they will not displace, wherever available, personal discussions between the physician and the radiologist.

Algorithms are vital for certain clinical/radiological problem or provisional diagnosis. This is by no means a comprehensive collection of all medical and surgical problems. Brevity and precision are sought and the most direct and simple pathways are attempted. These guidelines are aimed at hospital doctors of all levels as well as GPs who have to decide which imaging technique is the best for their patients. They will also help those who are performing the examinations in the hope of limiting the use of imaging to cases where it will really benefit the individual. In addition, the guidelines will help those who deal with patients who want something done.

An orderly and logical approach to the diagnostic imaging of all patients will result in more accurate diagnosis, less harmful radiation and cost-effective. All these three goals are well worth achieving.

Below is a glossary of approximate cost ranges for the different radiological procedures.

$ = low RM 30-80
$$ = intermediate RM 80-250
$$$ = high RM 250-800
$$$$ = very expensive >RM 800

Abbreviation	Definition		Comment
XR	Plain radiography one to four films	$	
CXR	Chest radiograph	$	
AXR	Abdominal radiograph	$	
Ba swallow/ meal/FT	Barium swallow/ meal/follow-through	$$	The use of non-ionic contrast media may increase cost
MCU	Micturating cystourethrogram	$$	
IVU	Intravenous urography	$$-$$$	The cost varies by ionic or non-ionic contrast and the doses given.
HSG	Hysterosal-phingography	$$	
Cervical/ Thoracic/ Lumbar Myelogram	–	$$$-$$$$	Can be expensive due to usage of non-ionic contrast media and also is time consuming.
Angiography DSA	– Digital subtraction angiography	$$$-$$$$	Cost may vary depending on complexities of procedures, usage of catheter or angioplasty and whether admission is needed.
Biopsy and interventional radiology	–	$$$-$$$$	Shorter hospital stay may off set the cost of these expensive techniques.
CT CTA HRCT	Computed Tomography CT Angiography High resolution CT	$$$-$$$$	The cost increases with the use of contrast media and amount of area covered.
US US Dop	Ultrasound US Doppler	$$-$$$	The more complex investigation (doppler) may be time consuming thus becoming more expensive.
MRI MRA	Magnetic Resonance Imaging MRI Angiography	$$$-$$$$	MRI, when used judiciously may cost less than other alternatives, i.e. myelogram or angiography.
NM	Nuclear Medicine	$$-$$$	The cost varies with the radionucleide use.
PET	Positron Emission Tomography	$$$$	Use short-lived radionuclides. Thus PET depends on close proximity to a cyclotron source,

BIOLOGICAL EFFECTS OF RADIATION

Radiation may result in damage to cells. Actively dividing cells are more radio-sensitive (i.e. bone marrow, gonads, lymph glands, breasts). This damage could be in several forms:

- Cell death
- Mitotic inhibition (temporary/permanent)
- Chromosome aberration/genetic damage leading to mutations

The nature and extent of cell damage vary according to:

- Radiation dose
- Dose rate
- Type of radiation
- Tissue/ organ irradiated
- Irradiated volume

In general, two types of biological effects are evident as a result of radiation damage: Stochastic or non-stochastic (deterministic).

Stochastic effects are those that have a certain probability of occurrence, and the probability increases with radiation dose – there is no threshold below which the effect will not occur at all. Stochastic effects can be divided into somatic and genetic effects. The most important stochastic effect in the individual who is exposed to radiation is the induction of cancer. Other examples are hereditary defects, development changes and mental retardation.

Non-stochastic effects are those where the severity of effects increases with dose. Dose threshold may exist below which the effect will not occur. Some examples of non-stochastic effects are erythema, cataract, and sterility.

RADIATION DOSES RECEIVED FROM VARIOUS RADIOLOGICAL EXAMINATIONS

Typical levels of patient doses from common radiological examinations, expressed in terms of the equivalent number of chest radiographs and also the background equivalent radiation time (BERT) are summarized below. This table should be used as a guideline only since they vary considerably from one radiology department to another. Of course, large patients will need more radiation than small patients.

Examination	Equivalent Number of Chest Radiographs	Background Equivalent Radiation Time (BERT)
Extremities	0.5	< 1.5 days
Dental (Bite-wing)	1	3 days
Chest	1	3 days
Skull, Mammography, Cervical Spine	5	2 weeks
Hip	15	2 months
Thoracic spine, Pelvis	55	6 months
Cholecystography	65	7 months
Abdomen	70	8 months
CT Head	90	10 months
Lumbar Spine	110	1 year
Intravenous Urography, Barium Meal	230	2 year
CT Abdomen, CT Pelvis	365	3.5 years
CT Chest	415	4 years
Barium Enema	435	4 years

RADIATION PROTECTION IN RADIOLOGICAL PRACTICE

The International Commission on Radiological Protection (ICRP) recommends that radiological examinations should be carried out only if it is likely that the information obtained will be useful for the management of the patient. If this recommendation is to be followed, any potential risks (if any) of performing a radiological examination should be less than the risk of missing a treatable disease.

The three central principles of the ICRP recommendations are as follows:

- **Justification** – No practice involving radiation shall be adopted unless its introduction produces a positive net benefit.
- **ALARA** – All radiation exposures shall be kept **a**s **l**ow **a**s **r**easonably **a**chievable, economic and social factors being taken into account.
- **Dose Limits** – The radiation dose to individuals shall not exceed the limits recommended for the appropriate circumstances by the Commission.

Radiological protection should play an important role in the quality assurance program of any department, clinic or hospital. With the above principles in mind, the following guidelines are recommended for radiological procedures.

Protection of Patients

(Note: this applies to all categories of patients)

- Each radiological examination should be clinically justified.
- Avoid repeating radiological examinations is one important way of reducing the radiation dose.
- Minimize the number of radiographs taken.
- Use non-ionizing modalities such as ultrasonography and MRI wherever possible.

Protection of Children (Paediatrics)

- Special attention should be paid to mimimizing the amount of radiation received.
- If parents are required to be in the room, they should wear lead gowns and should not be directly exposed to radiation.

Protection of Women of Reproductive Age and Pregnant Women

- Radiation exposure to lower abdomen and pelvis for women of child-bearing age should be kept to a minimum. During pregnancy radiation to these regions should only be done if the examination cannot be postponed.
- Ask all women of reproductive age if they could be pregnant.
- Consider any woman of reproductive age whose period is overdue to be pregnant.
- The prime responsibility for declaring that a patient is pregnant lies with the referring clinician.
- The first 4 weeks following the last menstrual period (LMP) is not considered as critical period for radiation exposure as organogenesis is unlikely to be occurring in the embryo.
- Majority of routine examinations, except those falling into the 'high dose to the pelvis' category, the '28-Day Rule' should be applied.
- For non-urgent examinations involving high doses to the uterus in patients who are at risk of pregnancy but not yet overdue, delay the examination until the first 10 days of their next menstrual cycle. High dose examinations include computed tomography of the abdomen and pelvis and barium enema.
- Organogenesis begins soon after the time of the first missed period and continues for the next 3-4 months. During this time the foetus is considered to be radio-sensitive.

- Examination of the abdomen or pelvis should be delayed if possible to a time when foetal sensitivity is reduced, i.e. post-24 weeks' gestation (in the third trimester).
- Use non-ionising modalities such as ultrasonography and MRI wherever possible.
- Examination of other areas (e.g. chest, skull, extremities) could be carried out with minimal foetal exposure at any time during pregnancy.
- The use of lead apron draped over the abdomen is more reassuring than of any practical value.
- The risk of radiation damage to a foetus, even at the relatively high doses resulting from abdominal or pelvic computed tomography or barium enema, is small. Inadvertent exposure in early pregnancy will not in itself be an indication for termination or for the use of invasive diagnostic procedures such as amniocentesis.
- Nuclear medicine studies should be avoided if possible during pregnancy.

THE IMAGING MODALITIES

Ultrasonography

US is a method of imaging that uses high-frequency sound waves beyond the range of human hearing to image structures inside the body. The capabilities and scope of ultrasound equipment have advanced remarkably in the ensuing years (colour Doppler, Power Doppler, transvaginal, transoesophageal, etc). The obvious advantage of US is that it has no radiation involvement, mainly non-invasive, readily available, portable and is relatively an inexpensive examination. The only limiting factors are the patient physical habitues and bowel gas. US is a problem orientated modality. It should not however be used as a total body survey.

Computed Tomography (CT)

CT is now widely available in most imaging departments in Malaysia. CT provides excellent anatomical image in the axial plane and in some coronal plane. The newer advancement in CT (Helical CT) allows breath-hold volume data acquisition. A three-dimensional data set is acquired and than reconstructed into images representing transverse section, of the body. Such advances have opened up new diagnostic opportunities in CT pulmonary angiogram, three-dimensional reconstruction of fractures and CT pulmonary bronchogram. It is worth remembering the CT is an expensive examination and imparts a high radiation dose. Examinations on children require a higher level of justification since such patients are at greater risk from radiation.

The limiting factors for CT would be the presence of metal prosthesis, residual barium (CT examination is deferred for a week), uncooperative patient who is unable to remain stationary and pregnancy.

CT remains the optimal investigation for acute trauma. It is widely use for intracranial problems like CVA, remains a simple method of staging for many malignant diseases, allows accurate guidance for drainage procedures and biopsy and provides better anatomical detail in obese patients than US.

However, it must be stressed than a single CT abdomen imparts a radiation dose equivalent to approximately 360 chest radiographs.

Interventional Radiology (Including Angiography and Minimal Access Therapy)

This branch of radiology is currently making significant advancement with several new techniques emerging lately. Abdominal abscesses and empyema drainage's, liver and tumor biopsy and angioplasty are routinely performed in most radiology departments. Embolization of head and neck tumours, vascular malformation and other vascular tumours provides a definitive mode of treatment as well as an adjunct to surgery or radiotherapy.

The aim of the treatments, relative contraindication and after-care of this procedure should be addressed by consultation between the referring clinicians and the appropriate radiologist. The relative contraindications for an elective angiography are recent myocardial infarction, history of severe contrast reaction, renal failure, coagulopathy, pregnancy and impaired ability of patient to lie down flat or cooperate.

Magnetic Resonance Imaging (MRI)

MRI has been the newest addition to the diagnostic tool in an Imaging Centre. The usage and capabilities of MRI is still expanding with newer techniques and improvement in software. MRI is the modality of choice for neurological imaging (temporal lobe epilepsy, demyelinating, TIA screen with MRA, sella contents and developmental anomalies), spinal and musculoskeletal disorder due to the high contrast sensitivity and multiplanar capabilities.

There are some definite contraindications to the use of MRI: claustrophobia, patient with aneurysm clip of unknown type, cardiac pacemakers, foreign bodies in orbits and cochlear implant. Any uncertainty about the contraindications should be discussed with the imaging department well in advance.

Nuclear Medicine (NM)

Local arrangements for radionuclide studies may vary. In some centres it is under the department of radiology under a consultant radiologist with a special interest in radionuclide studies. In other hospitals, the consultant usually runs specialized NM departments specifically trained in NM technique.

Whatever the local arrangements, an experienced consultant should be available to discuss the various NM techniques for the appropriate clinical situation. NM gives anatomical information based on function of a target organ. Circulatory dynamics of the heart and blood vessel can be visualized.

The contraindications are pregnancy and residual barium from previous barium examinations that can lead to artifacts.

Mammography

Mammography is now playing an increasing pivotal role in breast screening and management of patients with breast complaints. Mammography is rarely necessary in patients below 25 years and occasionally necessary in those above 35 years. Cinical assessment and US should be considered in these young patient.

The advantages of mammogram is in its ability to perform and interpret quickly, inexpensive, able to image whole of both breasts. Mammography has a high sensitivity for detection of DCIS (ductal carcinoma *in situ*) and invasive breast cancer, high specificity if followed by triple assessment (clinical, cytological and radiological) and is the only screening modality known to reduce population mortality.

The risk of developing breast cancer as a result of undergoing mammography has been calculated as one chance in a million. To put it in perspective, the chance of a woman developing breast cancer at some time in her life is 1 : 12.

Barium Studies

Barium studies were traditionally the mainstay of radiology department. It is still recommended before possible endoscopy for patients with swallowing difficulty. Detailed fluoroscopy is needed for motility disorder. Video swallows for suspected pharyngeal dysfunction in conjunction with speech therapist is now practised in some centres. Double contrast barium enemas, small bowel follow-throughs, enterocolysis and fistulograms are commonly practiced in most centres.

A barium study is contraindicated in bowel perforation. Good practice requires sigmoidoscopy before barium enema, therefore barium enema is deferred for 7 days after a full thickness biopsy.

Intravenous Urography (IVU)

There has been a fall in demands for IVU with increasing use of US. There is a wide variation in local policy with regards to imaging strategies for many of the urological complaints. It remains the investigation of choice for renal colic.

The contraindication to the study would be similar to giving intravenous iodinated contrast media.

CONTRAST MEDIA USED IN DIAGNOSTIC IMAGING

Oral Contrast Media

Barium Sulphate

This substance is used for studies of the gastrointestinal tract. It is an inert compound which forms a suspension with water and is not absorbed from the gastrointestinal tract. It is contraindicated in the presence of intestinal perforation. If it leaks into the peritoneal cavity, it will lead to peritonitis, which can be fatal. Aspiration of barium into the lungs does not usually cause problems. Chest physiotherapy is advised.

Gastrografin®

This is an ionic iodinated contrast media which is used to outline the bowel in suspected cases of perforation. It should be noted that this compound is hyperosmolar and can result in inflow of fluids into the intestine, which especially in infants can result in hypovolemia. Diluted Gastrografin® has been used to opacify the bowel for patients undergoing CT. There is some absorption of gastrografin from the GIT and therefore it would carry similar risks as intravascular contrast media.

Intravascular Contrast Media

These are essentially iodine containing compounds. There are two types:

- High osmolality contrast media
- Low osmolality contrast media

Safety Issues

Contrast Reactions

- *Non-idiosyncratic* – vasodilatation, flushing, hypotension and direct organ toxicity such as cardiac arrhthymia, pulmonary oedema and acute renal failure
- *Idiosyncratic* – hives urticaria, bronchospasm, laryngeal spasm and cardiovascular collapse

Severity of Contrast Media Reactions

These can be classified as:

- Mild – usually require no treatment
- Moderate – mild bronchospasm, laryngospasm, hypotension
- Severe – those reactions which can be fatal

Incidence of all Adverse Reactions with Intravenous Contrast Media

- High Osmolality – 12%
- Low Osmolality – 3%

Mortality rates with High Osmolality – approximately 1/40,000
Low Osmolality – approximately 1/200,000

Risk Factors

- Previous severe reactions to intravenous contrast media– two to five-fold risk of another reaction.
- Asthma – two-fold
- Children below 1 year
- Adults above 50 years
- Pheocromocytomas - hypertensive crisis
- Sickle cell disease
- Diabetic patients on Metformin
- Seafood allergy
- Renal failure
- Multiple myeloma

Premedication

Steroid premedication has been suggested especially in those high-risk patients at least 12 hours prior to the examination.

SAFETY OF ULTRASONOGRAPHY

Diagnostic ultrasonography has been in use for more than 35 years. No definite deleterious effect has been reported until now. The intensity of the ultrasound beam should be kept to a minimum.

Biological effects of ultrasound that have been demonstrated include

- cavitation
- thermal heating
- micro-bubbles

Thermal heating occurs progressively from M mode, to colour Doppler to pulsed Doppler (highest in 'power angio mode').

SAFETY OF MAGNETIC RESONANCE IMAGING

MRI is relatively new in its application to imaging of the human body.

The safety aspects of MRI can be divided into:

- The main magnetic field of a 1.5 Tesla magnet is about 20,000 - 30,000 times the strength of the earth's magnetic field. Within the region of the magnet it is possible for ferromagnetic objects to be dangerous, e.g. flying needles, pins, buckets, etc.

  Pacemakers will malfunction and can result in the death of patients.

  Ferromagnetic aneurysmal clips will undergo twisting in a magnetic field and can result in fatal haemorrhage.

  Implanted prosthesis, e.g. hip prosthesis can be safely scanned – provided there is no evidence of loosening.

  Other implanted metallic devices such as penile prosthesis and cochlear implants, metallic foreign body in the eye are contraindicated.

  It is best to discuss with the radiologist regarding other objects.

- The varying magnetic field can induce heating in metallic foreign bodies or some surgical implants. The heating usually does not cause a problem.

- Radio frequency waves can cause some heating effect. This is, however, not significant.

  Cables from the RF coils should be properly shielded from the patient - otherwise burns can result.

MRI in Pregnancy

There is no conclusive data on this. It would be prudent to limit MRI in patients during the first trimester. It is important to always assess the risks and benefits to the patients in making this decision.

Contraindication to MRI

- Ferromagnetic aneurysm clips
- Poppen-Blayloch carotid artery vascular clamp
- Improperly placed or not firmly placed intravascular coil, filter or stent
- Most otologic implants
- Penile implants
- Cardiac pacemakers and implantable cardiac defibrillators
- Other ferromagnetic devices
  (Reference: *Pocket Guide to MR Procedures and Metallic Objects*, updated 1998, Frank G. Shellock, Lippincott-Raven, Philadelphia, New York.)

Contrast Media Used in MRI

Gadolinium DTPA is a rare earth compound. The incidence of adverse reactions with this is even less than that of the iodinated intravascular contrast agents.

Side-effects include headache and vomiting. Very rarely anaphylactic reaction leading to death can occur.

HEAD AND NECK

- Thyroid Mass
- Solitary Thyroid Mass
- Diffusely Enlarged Hyperfunctioning Thyroid
- Sinusitis
- Non-Traumatic Epistaxis
- Facial Trauma

Thyroid Mass

History and clinical examination is required prior to any imaging procedure. The status of thyroid function should be evaluated first by the referring physician.

Either there is a focal enlargement/nodule or the whole gland may be enlarged. Usually, with solitary nodules, patients are sent for fine-needle aspiration biopsy without any imaging.

Solitary Thyroid Mass (in Euthyroid Patients)

PLAIN RADIOGRAPHY

Has a limited role to play. It may be helpful in the assessment of tracheal compression or retrosternal extension.

Presence of calcification does not differentiate malignant lesions from benign ones.

ULTRASONOGRAPHY (US)

Able to characterize lesions, i.e. determine if lesion is cystic or solid. Able to assess for enlarged lymph nodes of the neck.

Useful in guiding needle placement for aspiration biopsy.

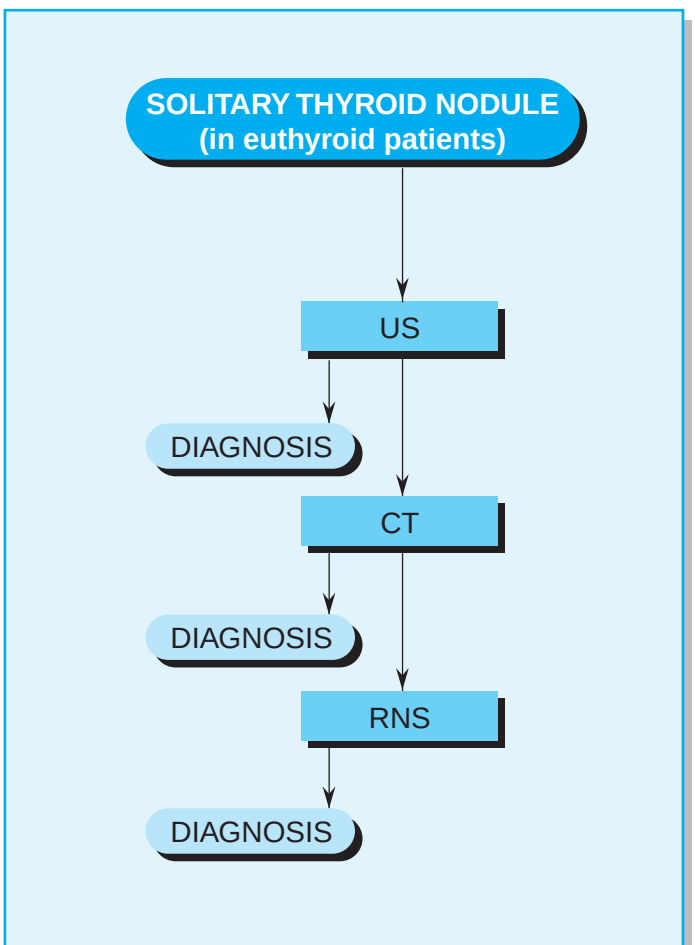
COMPUTED TOMOGRAPHY (CT)

Useful in assessment of tumour extension into the surrounding structures and regional lymph nodes.

RADIONUCLIDE SCINTIGRAPHY (RNS)

Should not be used singly to decide the management of solitary lesions.

Useful in the assessment of metastases if malignancy is confirmed.



DIFFUSELY ENLARGED HYPERFUNCTIONING THYROID

PLAIN RADIOGRAPHY

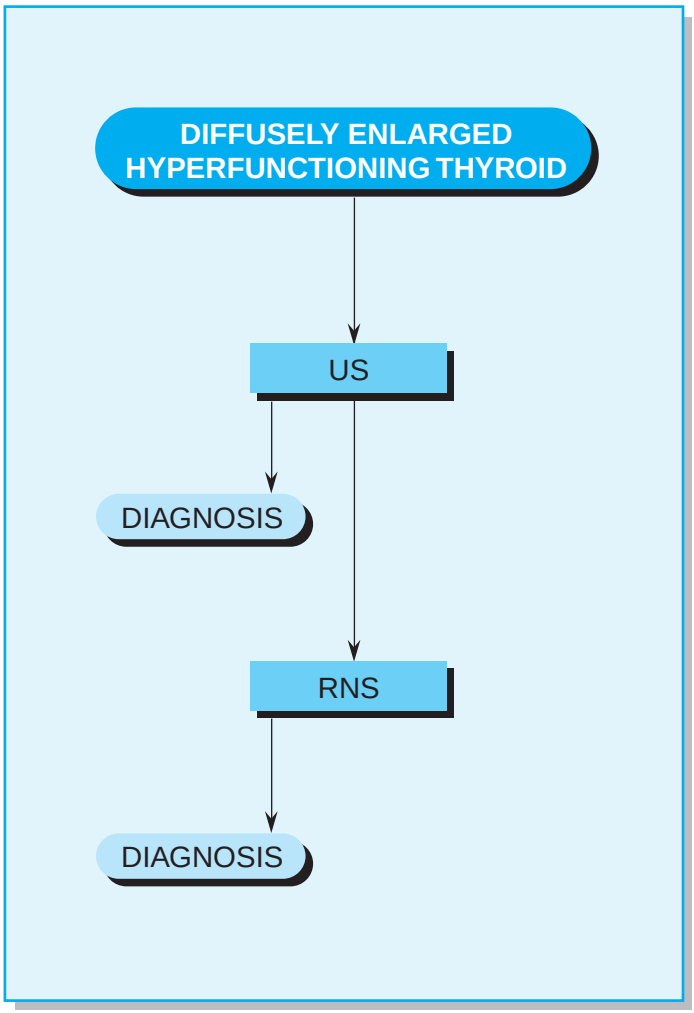
May be useful in the assessment of tracheal compression and displacement.

ULTRASONOGRAPHY (US)

Used to differentiate if the gland is truly diffusely enlarged or nodular.

RADIONUCLIDE SCINTIGRAPHY (RNS)

Able to reveal either single or multiple hyperfunctioning nodules.


DIFFUSELY ENLARGED HYPERFUNCTIONING THYROID
US
DIAGNOSIS
RNS
DIAGNOSIS

SINUSITIS

A common health problem. Imaging has a role in protracted or recurrent disease and when surgery is contemplated.

PLAIN RADIOGRAPHY

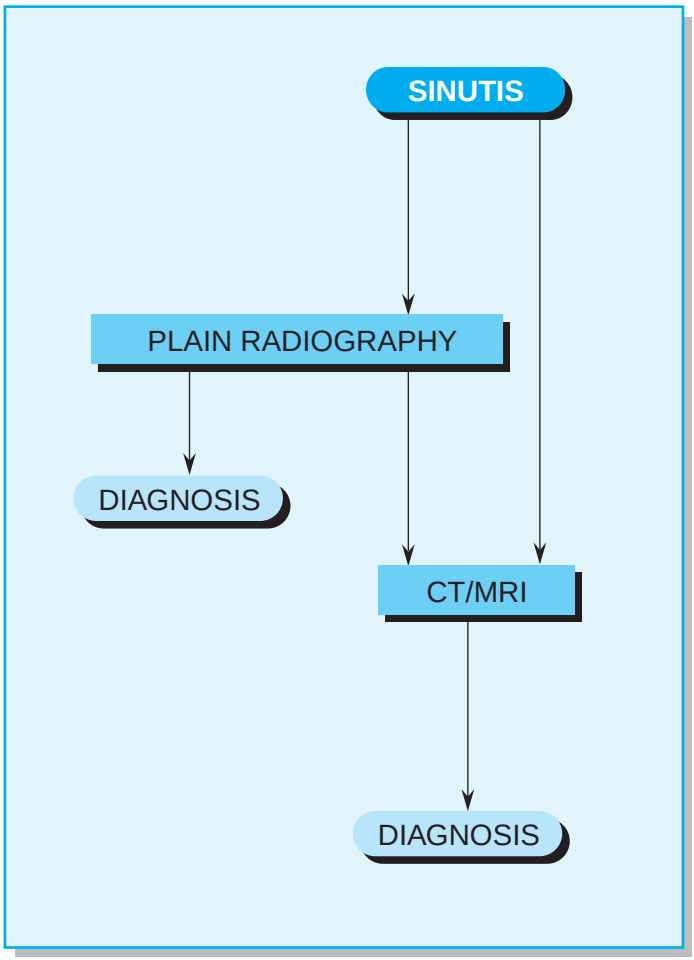
Accurate in demonstrating air-fluid levels. However, the degree of chronic inflammatory disease is often under-estimated.

COMPUTED TOMOGRAPHY (CT)

Able to accurately define sinus diseases and is used prior to functional endoscopic sinus surgery (FESS). CT is able to optimally display bone, soft tissue and air within the sinuses.

MAGNETIC RESONANCE IMAGING (MRI)

Provides better visualization of soft tissue than CT. Its disadvantage is its inability to display cortical bone, thus cannot reliably be used as an operative 'road map'. However, it is useful in diagnosing fungal concretions.


SINUTIS
PLAIN RADIOGRAPHY
DIAGNOSIS
CT/MRI
DIAGNOSIS

NON-TRAUMATIC EPISTAXIS

There are numerous causes of epistaxis. The age of the patient helps in the diagnosis. Physical examination is important to exclude medical causes of epistaxis. If a surgical cause is suspected, imaging plays an important role in determining the cause, extent and management of the patient.

PLAIN RADIOGRAPHY

Has a limited role. A mass may be demonstrable if it is large enough.

COMPUTED TOMOGRAPHY (CT)

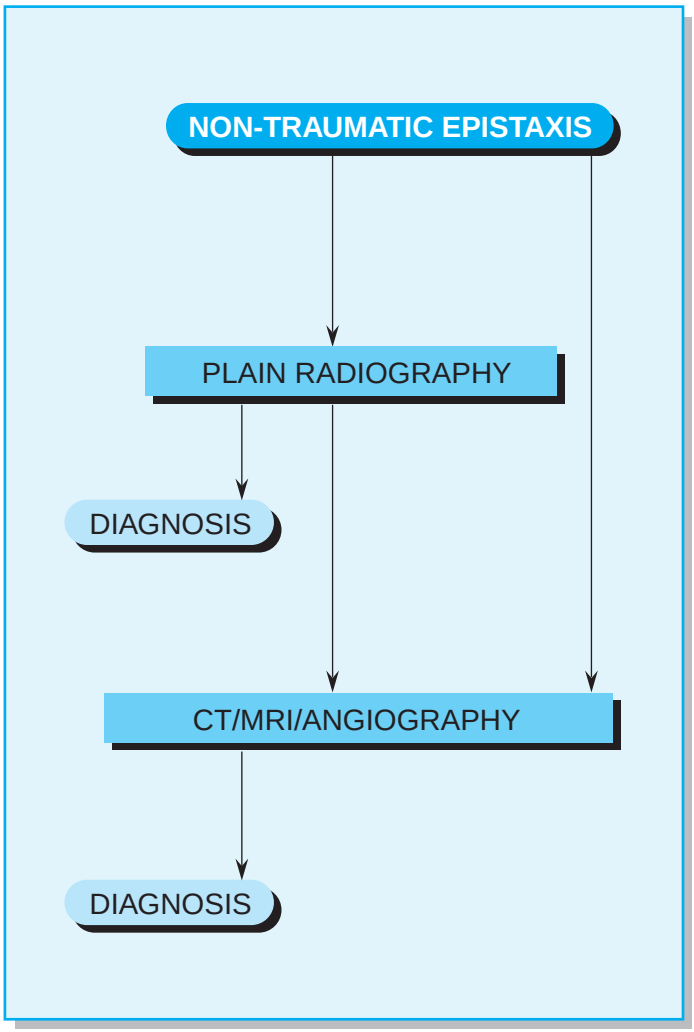
Able to demonstrate the tumour, local and distant extension. Bony involvement is well-demonstrated.

MAGNETIC RESONANCE IMAGING (MRI)

Able to demonstrate extension of the tumour.

ANGIOGRAPHY

Has a limited role to play in diagnosis. Its use is mainly to demonstrate blood supply to the tumour and prior to an interventional procedure, i.e. embolization.


NON-TRAUMATIC EPISTAXIS
PLAIN RADIOGRAPHY
DIAGNOSIS
CT/MRI/ANGIOGRAPHY
DIAGNOSIS

FACIAL TRAUMA

The role of imaging is to define the extent of the injury.

PLAIN RADIOGRAPHY

Usually the initial imaging used in the assessment of facial trauma.

Views of the cervical spine may help to exclude concomitant cervical spinal injury.

COMPUTED TOMOGRAPHY (CT)

Used for more complete evaluation of facial skeleton, facial soft tissues, brain and dural spaces. Images should be taken in both axial and coronal planes.

3-D reconstruction is valuable for the craniofacial surgeons to visualize the fracture segments and their relationship to one another in any one plane.

In cases of rhinorrhoea and otorrhoea, CT of the skull base after intrathecal contrast administration may help to locate the site of perforation.

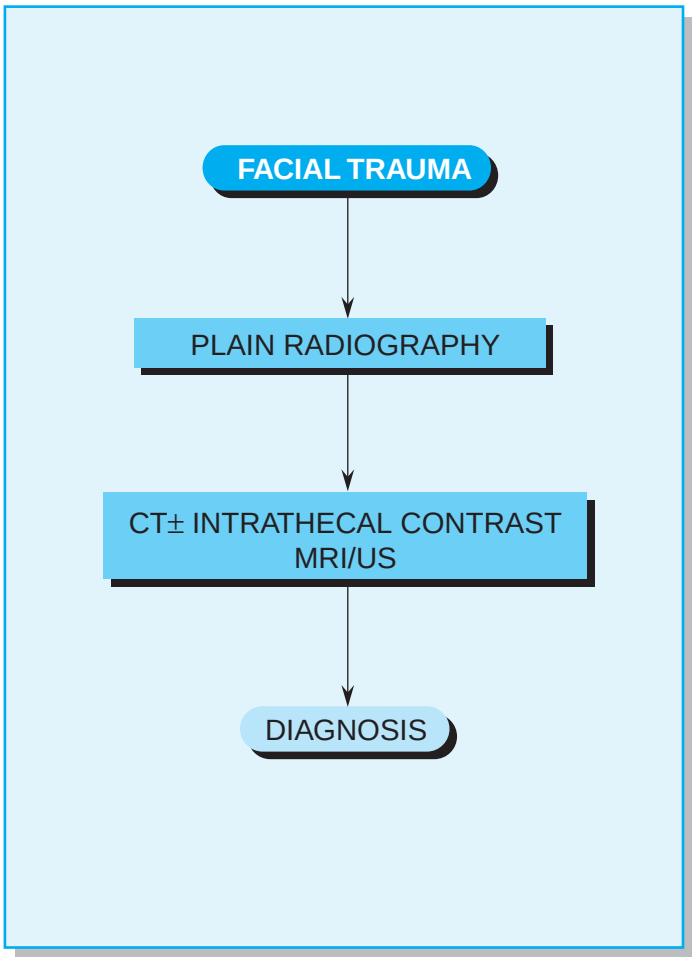
MAGNETIC RESONANCE IMAGING (MRI)

Not indicated in acute trauma.

Useful in locating the site of dural perforation, demonstration of blow-out fracture and differentiating blood from inflammatory reactions and oedema fluid (if performed within 48 hours of injury).

ULTRASONOGRAPHY (US)

Useful in the assessment of trauma to the globe, i.e. lens displacement, retinal detachment, bleeding into the chambers and location of foreign bodies.


FACIAL TRAUMA
PLAIN RADIOGRAPHY
CT± INTRATHECAL CONTRAST
MRI/US
DIAGNOSIS

CENTRAL NERVOUS SYSTEM

- Suspected Intracranial Lesion
- Head Injury
- Cerebrovascular Disease
- Headache
- Epilepsy / Seizure
- Vertigo and Hearing Loss

SUSPECTED INTRACRANIAL LESION

COMPUTED TOMOGRAPHY (CT)

CT is the most practical initial study in the diagnosis of intracranial haemorrhage. It is also used in the diagnosis of infarctions, tumours, infiltrative diseases and hydrocephalus.

Sensitivity is lower in white matter disease.

MAGNETIC RESONANCE IMAGING/ANGIOGRAPHY (MRI/MRA)

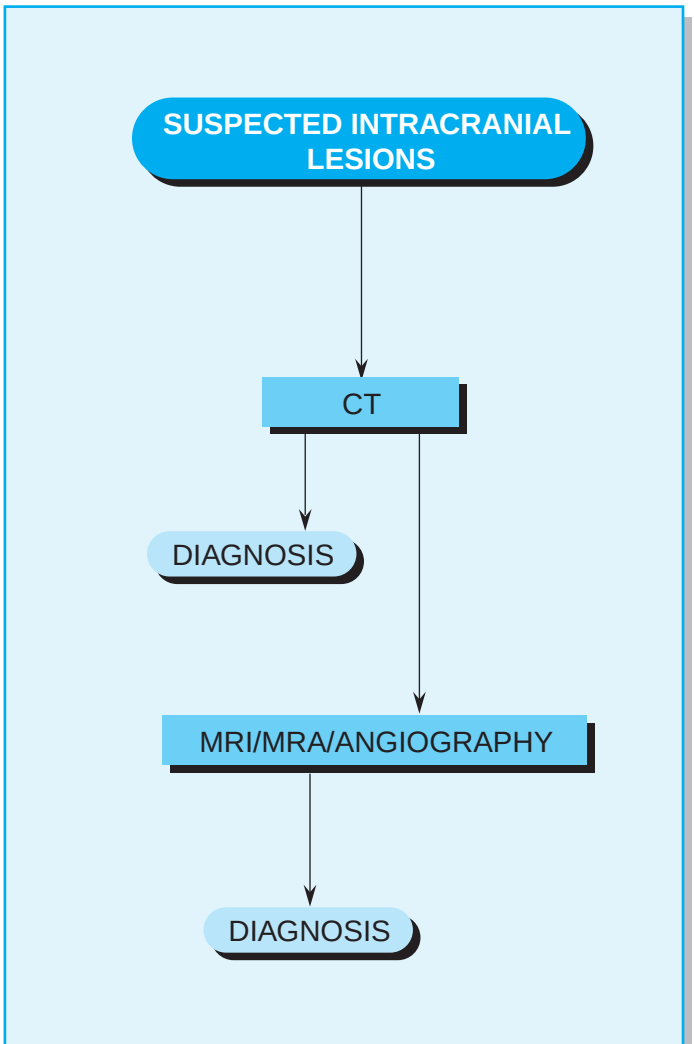
It is superior to CT in soft tissue resolution and has multiplanar capabilities.

Useful in the evaluation of white matter disease or evaluation of structures where CT would give poor results such as the brain stem, the internal auditory canal, etc.

Magnetic Resonance Angiography (MRA) may be used to demonstrate AVMs non-invasively and evaluate their vasculature.

ANGIOGRAPHY

Essentially the imaging modality of choice in the detection and precise anatomical localization of AVM and aneurysm.


SUSPECTED INTRACRANIAL LESIONS
CT
DIAGNOSIS
MRI/MRA/ANGIOGRAPHY
DIAGNOSIS

HEAD INJURY

In the adolescent and young adult population, head injury following trauma is a major cause of hospital admission and morbidity. Imaging is used to identify and characterize the injury as well as to influence the management.

PLAIN RADIOGRAPHY

Skull radiography is useful for imaging fracture and for the localization of foreign bodies.

A normal skull radiograph does not exclude an intracranial injury.

Cervical radiographs are also indicated in patients who have a history, symptoms and signs of concommitant cervical injury.

COMPUTED TOMOGRAPHY (CT)

Recommended for patients with neurological impairment and those with a history of high velocity or high impact trauma such as road traffic accidents, fall from height, etc.

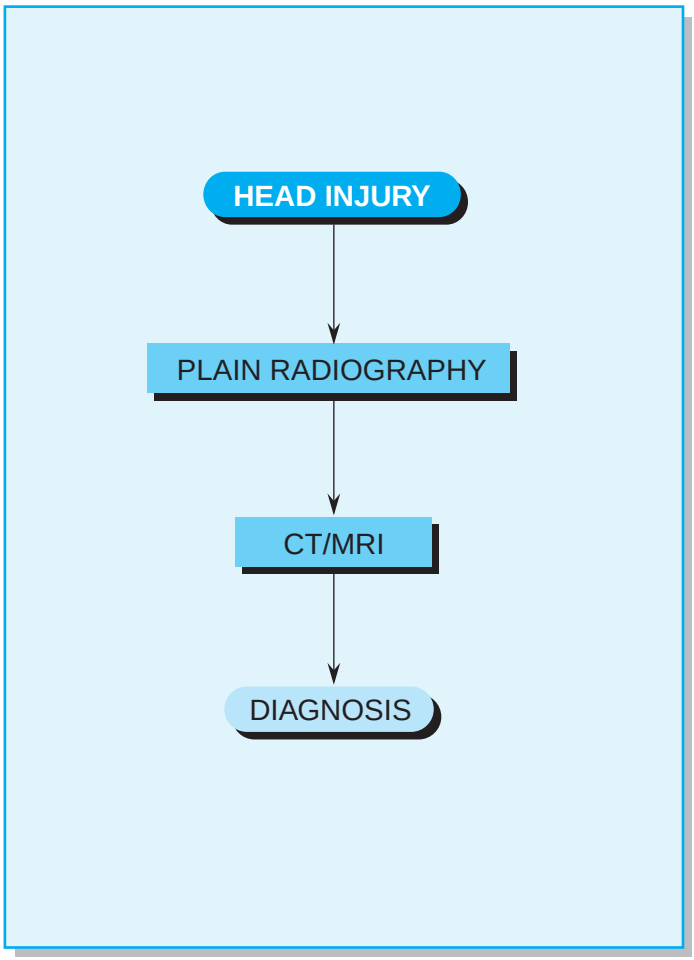
Sensitive to detect acute haemorrhage and its complications, thus allows rapid identification of those who require hospital admission and surgical intervention.

MAGNETIC RESONANCE IMAGING (MRI)

Has little role in the acutely injured patients.

Insensitive in the detection of subarachnoid haemorrhage and even in parenchymal haemorrhage where interpretation can be difficult in the acute and immediate stage.

Superior to CT in the detection of non-haemorrhagic lesions such as contusions, oedema, hypoxic-ischaemic encephalopathy and diffuse axonal injury. Best utilized in the detection and characterization of subacute /chronic brain injuries.


HEAD INJURY
PLAIN RADIOGRAPHY
CT/MRI
DIAGNOSIS

CEREBROVASCULAR DISEASE

Diseases of the cerebral vasculature often manifest as stroke in which the vast majority occur in the distribution of the carotid arteries. In symptomatic patients, if focal neurological symptoms continue for more than 24 hours, stroke is diagnosed. A focal neurological deficit lasting less than 24 hours is defined as a Transient Ischaemic Attack (TIA).

COMPUTED TOMOGRAPHY (CT)/CT ANGIOGRAPHY

Owing to the relative insensitivity of the clinical history and examination in differentiating ischaemic from haemorrhagic stroke, all patients must have an urgent brain CT examination. Patients with TIA should also be evaluated by CT.

CT angiography may be used for evaluation of carotid artery disease.

DOPPLER ULTRASONOGRAPHY (US)

Doppler US is a sensitive non-invasive technique in the evaluation of carotid stenosis. Patients who have more than 70% stenosis should be referred for further imaging.

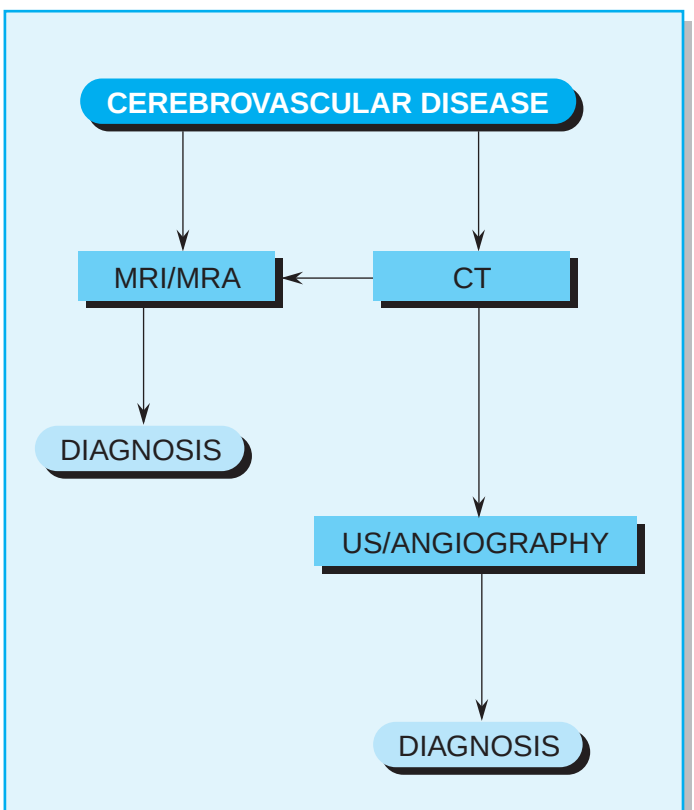
ANGIOGRAPHY

The cranial vessels are demonstrated with great precision. Atheromatous plaques at the carotid bifurcation causing stenosis are accurately delineated. This is an invasive technique and should only be performed in patients considered suitable for surgery or if medical management depends on it.

MAGNETIC RESONANCE IMAGING (MRI)/MR ANGIOGRAPHY (MRA)

Superior to CT in the detection of brain stem ischaemic strokes, and should be performed only if the diagnosis of stroke is equivocal and long term management depends on it.

Suitable in the demonstration of the extra and intra-cranial vessels. The images may be displayed and reviewed in any plane including real time rotation.



HEADACHE

Headache is one of the most common clinical complaints. However, most headaches are not due to intracranial pathology. The need for and the sequence of imaging will depend on the results of the clinical examination and the presence or absence of localizing symptoms and signs. In acute severe headache, imaging is indicated even in the absence of neurological signs.

PLAIN RADIOGRAPHY

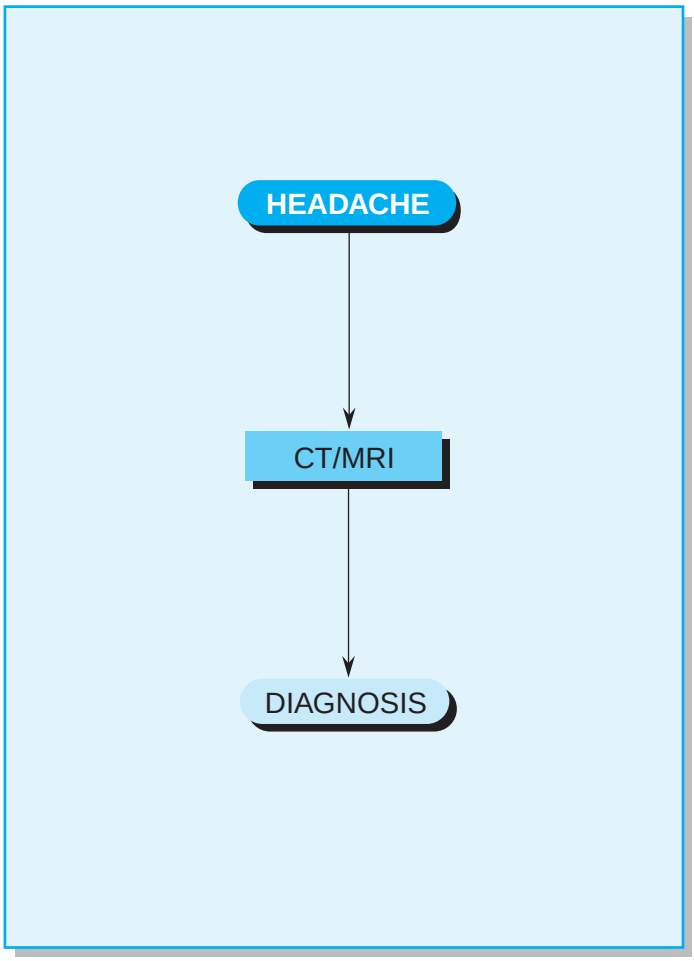
Paranasal sinus and mastoid radiography are useful in headaches associated with sinusitis or mastoiditis.

COMPUTED TOMOGRAPHY (CT)

Will exclude most mass lesions, haemorrhage or hydrocephalus and sinus disease. (*Refer to **Sinusitis**, p. 24 and **Suspected Intracranial Lesion** p. 32*).

MAGNETIC RESONANCE IMAGING (MRI)

More sensitive in the detection of intracranial lesions and is indicated if symptoms persist following adequate treatment and a negative CT examination.


HEADACHE
CT/MRI
DIAGNOSIS

EPILEPSY / SEIZURE

Epilepsy is a common disorder.

The classification of seizure disorders is important because it influences the etiologic diagnosis and appropriate treatment.

There are two main types of seizure: partial seizure and generalized seizure.

Partial seizure shows either clinical or EEG evidence of onset from a localized area within the cerebral hemisphere. The area involved will characterize the symptoms and signs that appear during the seizure.

Primary generalized seizure originates from deep within the brain and involve both cerebral hemispheres simultaneously.

Certain types are likely to be associated with structural brain lesions including tumours, infection, infarction, traumatic brain injury, vascular malformations and developmental abnormalities.

COMPUTED TOMOGRAPHY (CT)

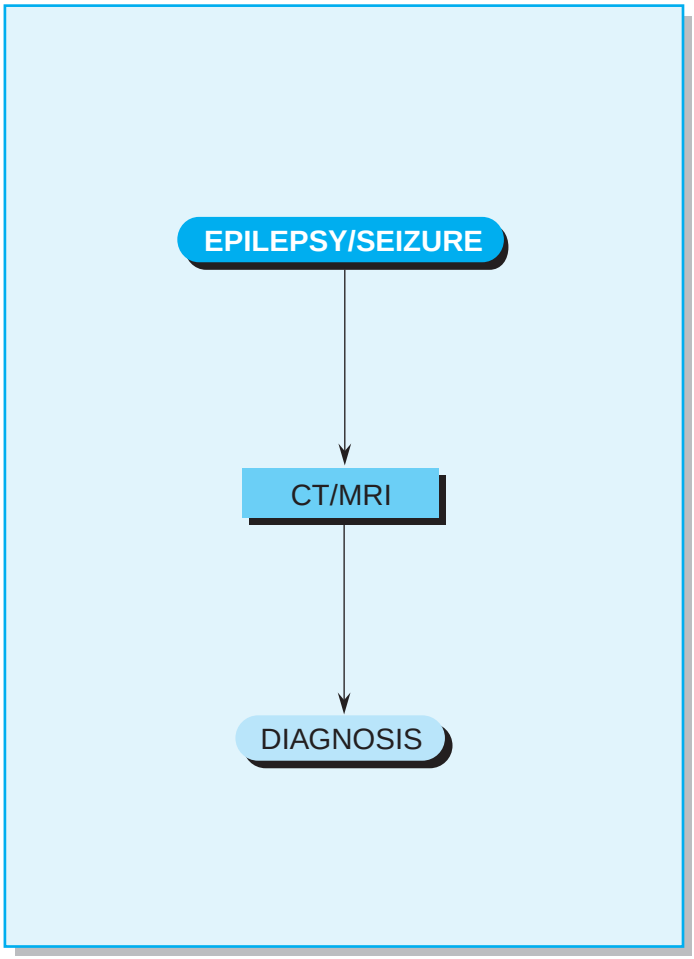
Sensitive but not specific in intracranial lesions. CT, however, is mandatory if seizure onset is above the age of 20 years, if the EEG shows lateralizing or localizing feature, or if the seizure suggest a focal onset.

MAGNETIC RESONANCE IMAGING (MRI)

Sensitive and specific for excluding intracranial lesions. It may provide evidence of focal cerebral abnormalities not seen on CT.

Hippocampal sclerosis, the most common cause of chronic partial epilepsy can only be visualized on MRI.

Cranial MRI is indicated in patients with partial epilepsy in whom the seizures are intractable to medical treatment and is mandatory prior to epilepsy surgery.


EPILEPSY/SEIZURE
CT/MRI
DIAGNOSIS

VERTIGO AND HEARING LOSS

Dizziness is a common complaint. Vertigo is a form of dizziness in which there is an illusion of movement.

Vertigo is subdivided into peripheral vertigo (due to failure of the end organs) or central vertigo (failure of the vestibular nerves or central connections to the brainstem and cerebellum).

Vertigo and dizziness are not infrequently associated with hearing loss.

PLAIN RADIOGRAPHY

Skull radiography should include the submentovertex and fronto-occipital views to show the auditory meati and auditory structures of the temporal bone.

A normal radiograph does not exclude abnormality.

COMPUTED TOMOGRAPHY (CT)

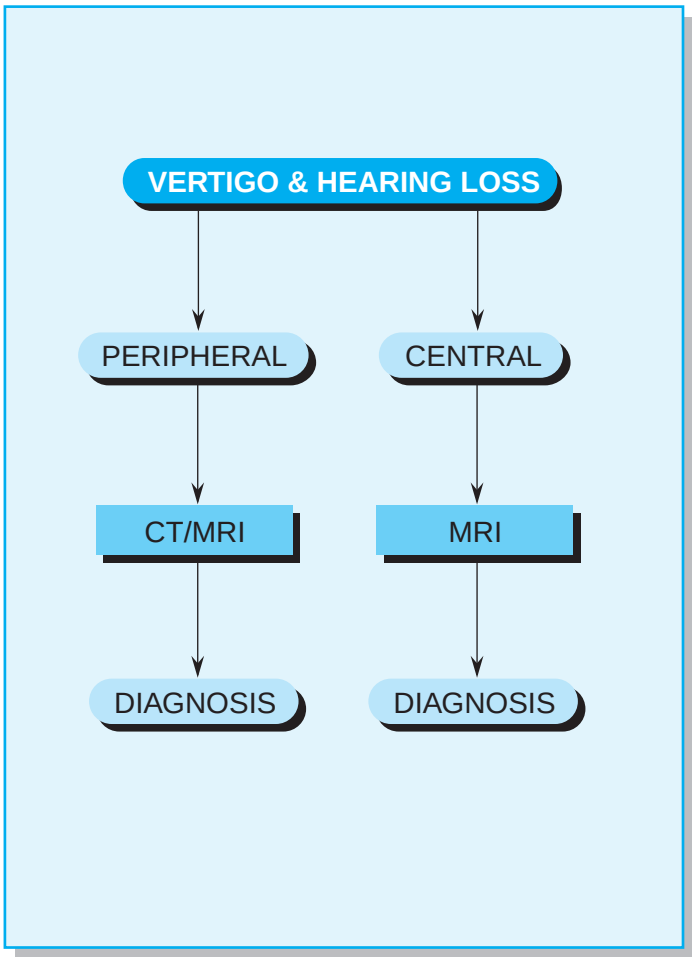
CT will show the auditory structures accurately.

Enhanced axial scans are indicated in suspected cases of acoustic neuroma where MRI is not available or contra-indicated.

MAGNETIC RESONANCE IMAGING (MRI)

Lesions of the brainstem or cerebellum which result in centeral vertigo can be readily diagnosed by MRI.

Highly sensitive and specific for acoustic neuroma.


VERTIGO & HEARING LOSS
PERIPHERAL
CENTRAL
CT/MRI
MRI
DIAGNOSIS
DIAGNOSIS

CARDIOVASCULAR SYSTEM

- Acute Chest Pain – Myocardial Ischaemia or Infarction
- Acute Chest Pain – Aortic Dissection (Aneurysm)
- Acute Chest Pain – Pulmonary Embolism
- Pulsatile Abdominal Mass – Abdominal Aortic Aneurysm
- Vascular Claudication of Lower Limb
- Deep Vein Thrombosis
- Secondary Hypertension
- Investigation of Claudication – Spinal Canal in Origin

ACUTE CHEST PAIN – MYOCARDIAL ISCHAEMIA OR INFARCTION

CHEST RADIOGRAPHY

Excludes other causes of chest pain, e.g. pneumothorax, rib fractures and pneumonia. However, leaking aortic aneurysm, pulmonary embolism and aortic dissections may also be diagnosed on the chest radiograph but the sensitivity is lower.

May be used for detecting complications.

CORONARY ANGIOGRAPHY

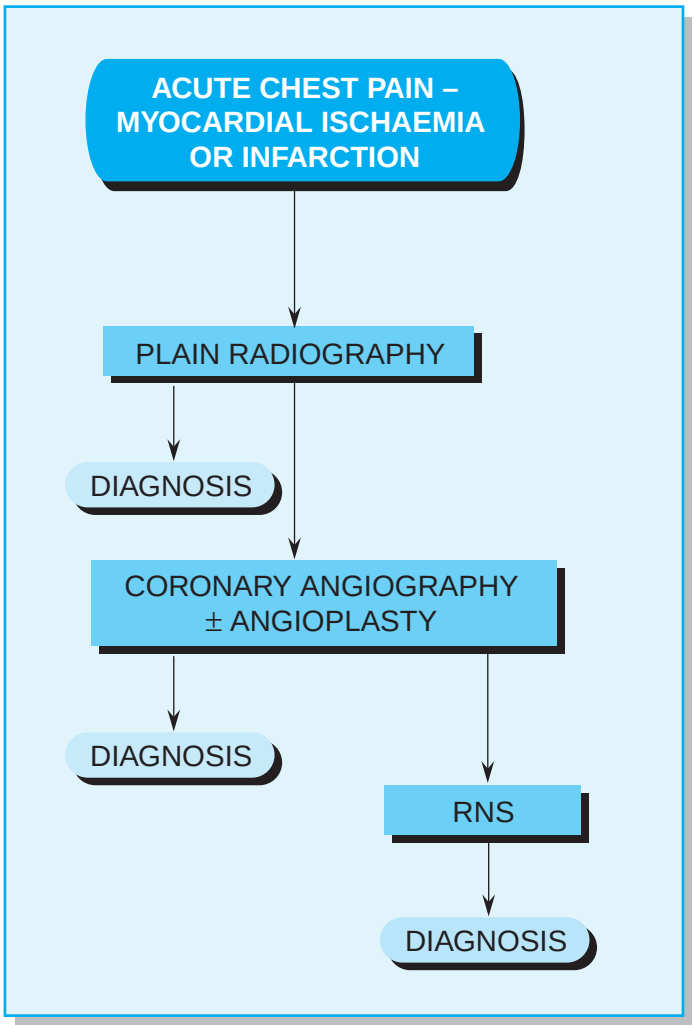
It is the 'gold standard' in making a definitive diagnosis of coronary artery disease to show localization of stenosis and the extent of coronary disease.

LEFT VENTRICULAR ECHOCARDIOGRAPHY

This is done to assess ventricular function and any valvular involvement.

RADIONUCLIDE SCINTIGRAPHY (RNS)

In some cases, RNS is done to indicate extent of myocardial injury.


ACUTE CHEST PAIN – MYOCARDIAL ISCHAEMIA OR INFARCTION
PLAIN RADIOGRAPHY
DIAGNOSIS
CORONARY ANGIOGRAPHY ± ANGIOPLASTY
DIAGNOSIS
RNS
DIAGNOSIS

Acute Chest Pain – Aortic Dissection (aneurysm)

The chest pain is excruciating, tearing, anterior or interscapular. Mortality is high.

The imaging guidelines will differ with the facilities available in an emergency situation.

PLAIN RADIOGRAPHY

Diagnosis can be difficult on a chest radiograph. Unfolding of the aorta or mediastinal widening should be looked for.

ECHOCARDIOGRAPHY

This can be performed and has a sensitivity of about 60% but is operator dependent.

In some centres, trans-oesophageal echocardiography is done with fairly good accuracy.

COMPUTED TOMOGRAPHY (CT)

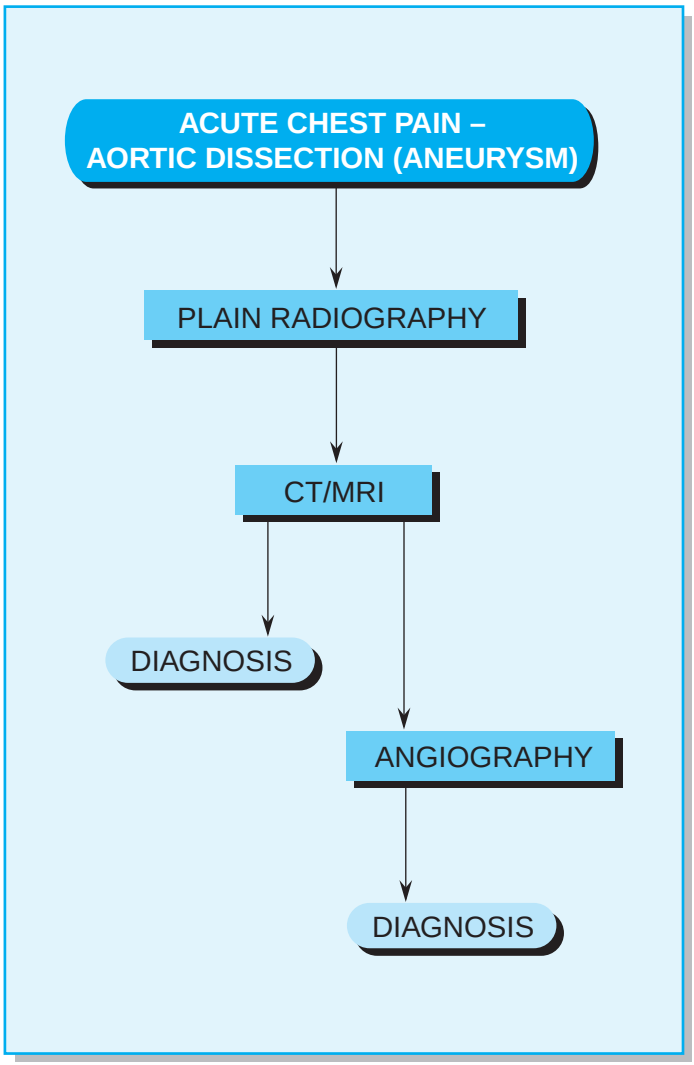
High sensitivity for dissection/aneurysm.

MAGNETIC RESONANCE IMAGING (MRI)

Same sensitivity as CT.

ANGIOGRAPHY

Remains the 'gold standard' which shows the extent of the involvement.


ACUTE CHEST PAIN –
AORTIC DISSECTION (ANEURYSM)
PLAIN RADIOGRAPHY
CT/MRI
DIAGNOSIS
ANGIOGRAPHY
DIAGNOSIS

ACUTE CHEST PAIN – PULMONARY EMBOLISM

PLAIN RADIOGRAPHY

A chest radiograph (PA and Lateral views) forms an important initial examination. The chest radiograph can clarify some confusing radioisotope perfusion scans.

RADIONUCLIDE SCINTIGRAPHY (RNS)

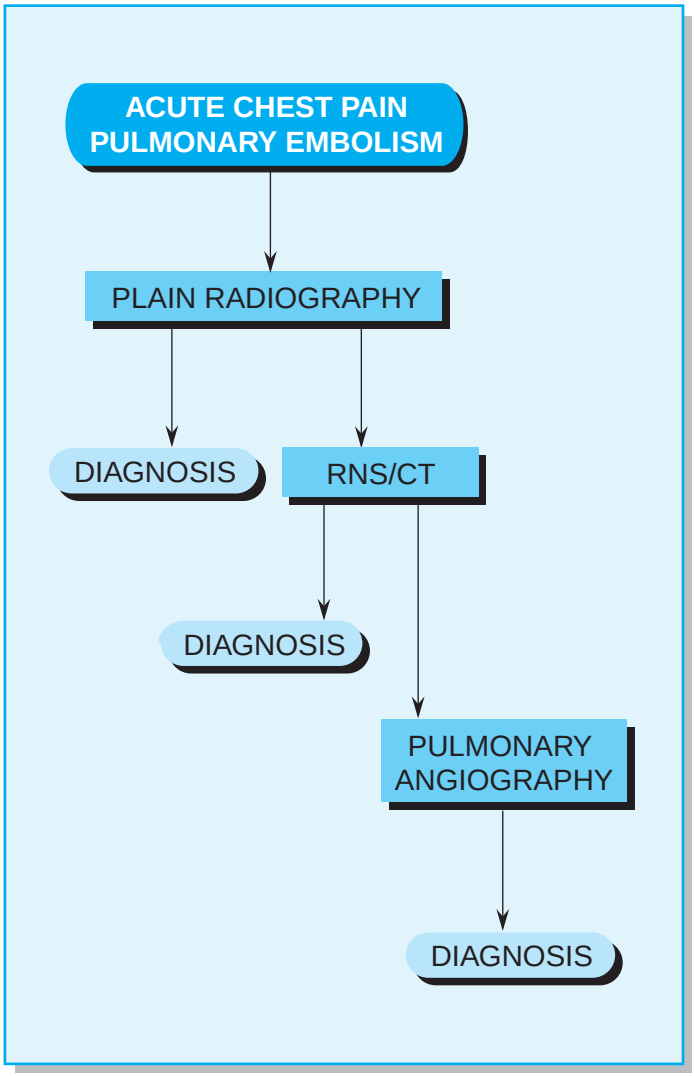
Normal and high probability scans are reliable. Patients with indeterminate or intermediate and low probability scans require further imaging.

COMPUTED TOMOGRAPHY (CT)

Able to diagnose thrombus within the third or fourth division of the pulmonary arteries and is currently the modality of choice.

PULMONARY ANGIOGRAPHY

This is the 'gold standard' for the diagnosis of pulmonary embolism. However due to its invasive nature it is not requested often.


ACUTE CHEST PAIN
PULMONARY EMBOLISM
PLAIN RADIOGRAPHY
DIAGNOSIS
RNS/CT
DIAGNOSIS
PULMONARY
ANGIOGRAPHY
DIAGNOSIS

Pulsatile Abdominal Mass – Abdominal aortic Aneurysm

The finding of a pulsatile abdominal mass can be due to an aneurysm of the abdominal aorta or a tortuous abdominal aorta from transmitted pulsations. An aneurysm is diagnosed when the aorta is more than 3 cm in diameter.

PLAIN RADIOGRAPHY

Easily performed and shows calcification, if present. It does not accurately define an aneurysm.

ULTRASONOGRAPHY (US)

Definite screening modality and enables measurement of the aortic length and diameter.

COMPUTED TOMOGRAPHY (CT)

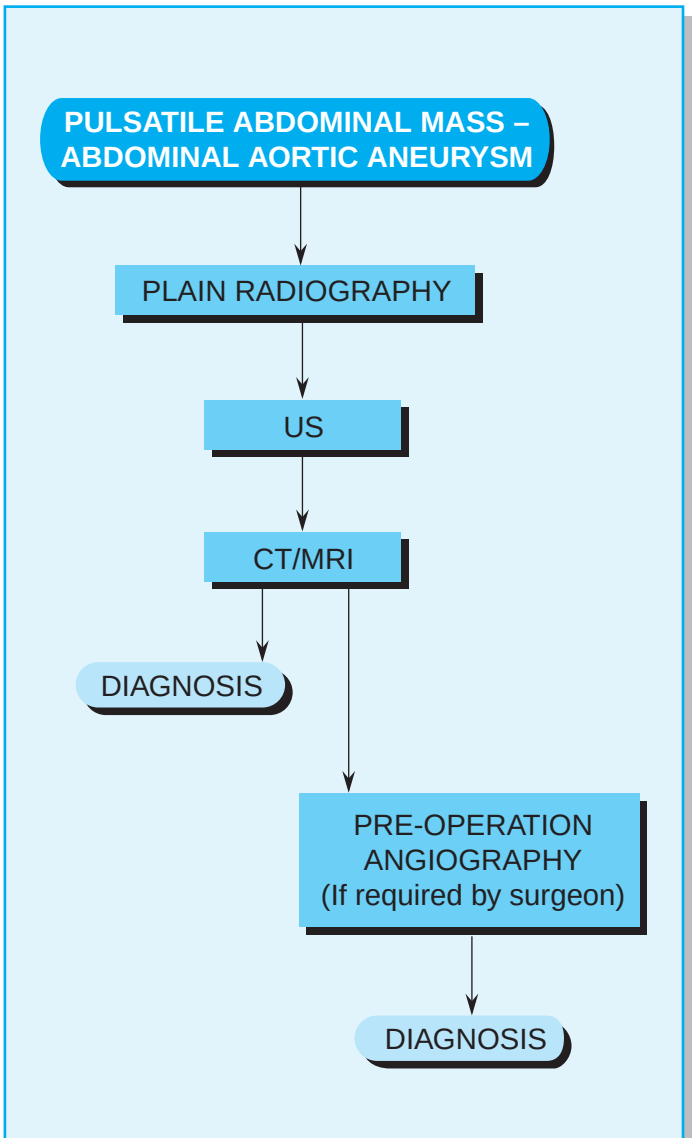
A contrast enhanced examination defines the aneurym and its extent accurately. With helical CT, the branches of the abdominal aorta are clearly visualized.

MAGNETIC RESONANCE IMAGING (MRI)

A contrast enhanced examination will accurately define the extent of disease if CT or US is indeterminate.

ANGIOGRAPHY

This is used infrequently when CT or US is available. May have a role if renal or iliac artery involvement needs to be assessed prior to definitive surgery.


PULSATILE ABDOMINAL MASS – ABDOMINAL AORTIC ANEURYSM
PLAIN RADIOGRAPHY
US
CT/MRI
DIAGNOSIS
PRE-OPERATION ANGIOGRAPHY (If required by surgeon)
DIAGNOSIS

VASCULAR CLAUDICATION OF LOWER LIMB

Vascular claudication can be confused with pain due to central spinal canal stenosis. History and clinical examination is important to differentiate the two.

ANGIOGRAPHY

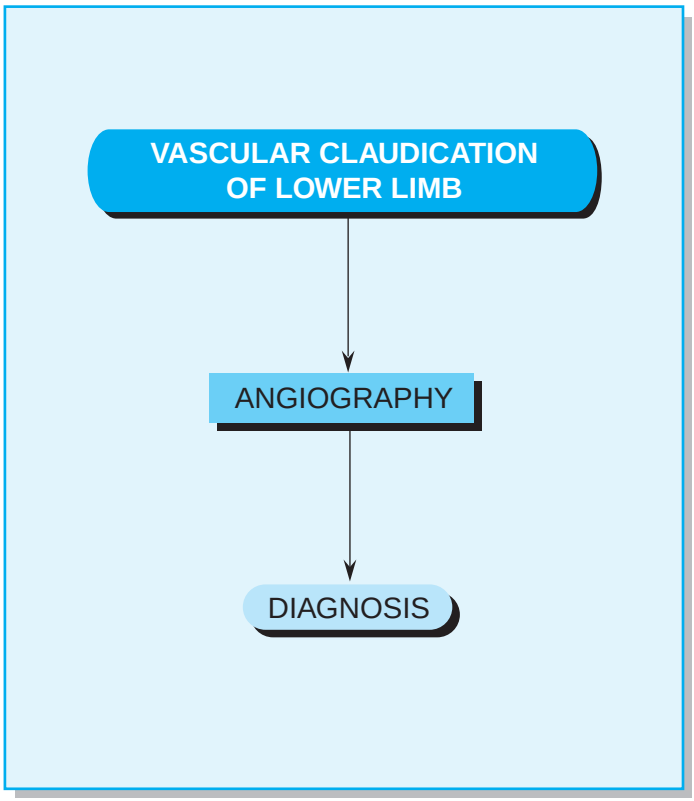
Examination of choice for demonstrating the iliac, femoral and tibial vessels. Arterial occlusions and stenosis are now quite satisfactorily treated by balloon angioplasty. Arterial angioplasty stenting and artherectomy can also be performed by interventional radiologists.

ULTRASONOGRAPHY (US)

Doppler US has a role in the diagnosis but more so in the follow-up of localized disease.

MAGNETIC RESONANCE ANGIOGRAPHY (MRA)

May be used to non-invasively image the vessels of the lower limbs though not widely available.


VASCULAR CLAUDICATION
OF LOWER LIMB
ANGIOGRAPHY
DIAGNOSIS

DEEP VEIN THROMBOSIS

Some of the pathological conditions that mimic signs and symptoms of deep vein thrombosis are Baker's cyst, cellulitis, lymphadenoma, chronic venous disease and musculoskeletal disorders.

The site of deep vein thrombosis is important since involvement of the popliteal and above knee veins are associated with pulmonary embolism. Thrombi demonstrated in these veins require treatment.

ULTRASONOGRAPHY (US)/DOPPLER ULTRASONOGRAPHY

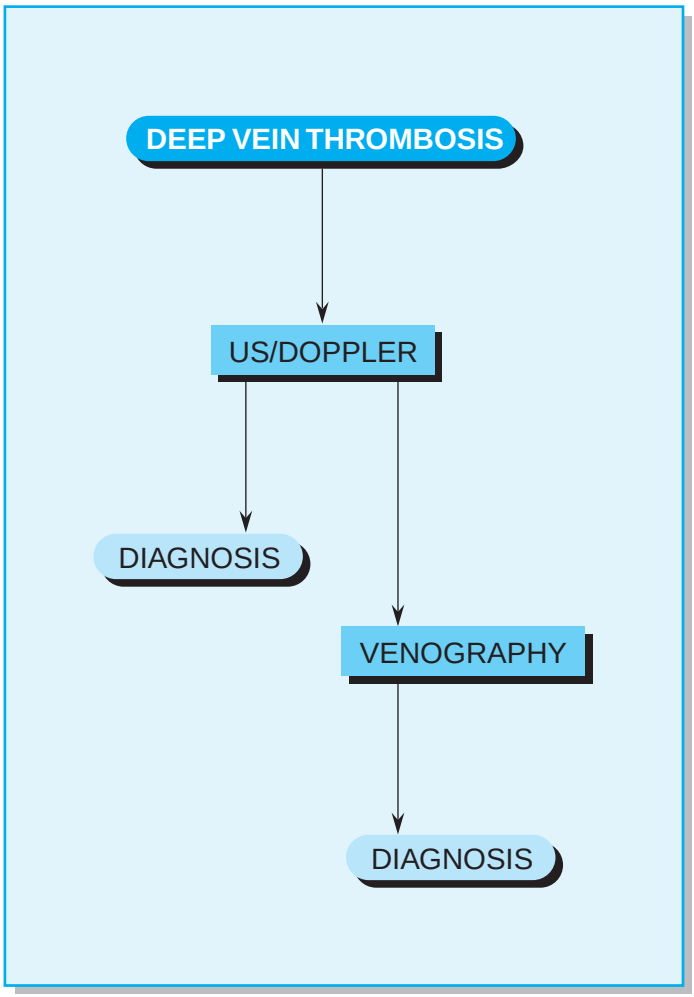
Compression US is now regarded as the most efficient technique and is easy to perform. Currently available in many centres. For calf and iliac veins, colour doppler US is necessary for detecting the presence of thrombi.

VENOGRAPHY

A simple and cost-effective method. It is the most reliable test for demonstrating venous thrombosis.

MAGNETIC RESONANCE IMAGING (MRI)

May have a role in the diagnosis of deep vein thrombosis of the iliac veins.


DEEP VEIN THROMBOSIS
US/DOPPLER
DIAGNOSIS
VENOGRAPHY
DIAGNOSIS

SECONDARY HYPERTENSION

Essential secondary hypertension is common and require very minimal imaging. The role of imaging is to detect treatable causes of secondary hypertension as well as to assess the effect of hypertension on other organs. The imaging protocol will depend on the underlying cause, i.e. vascular, renal or adrenal disease.

PLAIN RADIOGRAPHY

Usually the initial imaging as a baseline. It may demonstrate rib notching, cardiomyopathy or cardiac failure.

INTRAVENOUS UROGRAPHY (IVU)

Able to demonstrate renal size, scarring or presence of obstruction. However, it is not reliable in detecting renal artery stenosis.

ULTRASONOGRAPHY (US)

Able to provide the same information as IVU. May also detect adrenal masses.

COMPUTED TOMOGRAPHY (CT)

May be better able to characterize abnormalities of the kidneys or adrenal masses. May also be used for intervention.

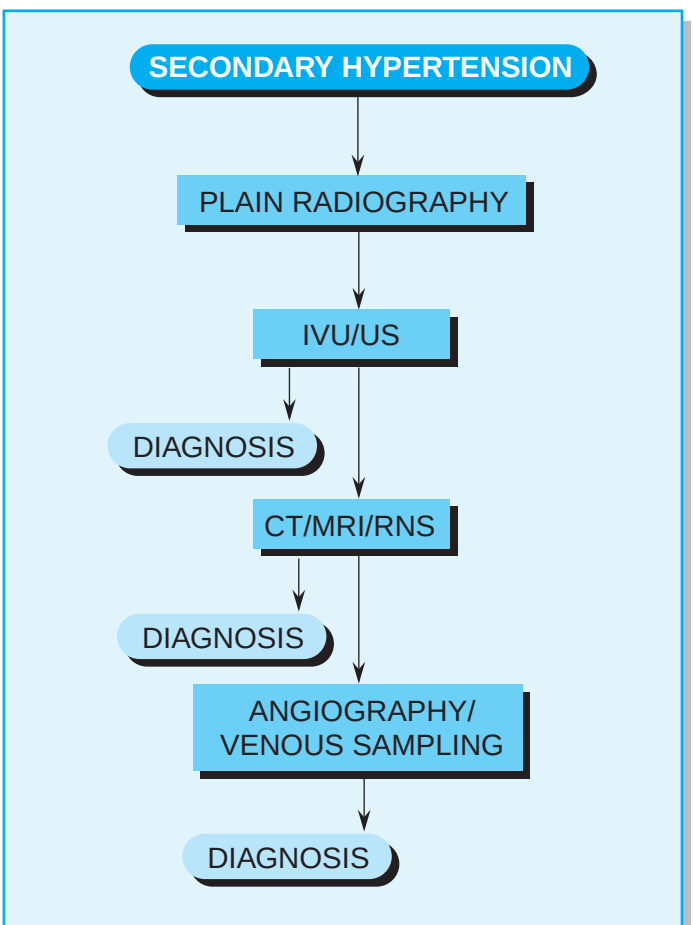
MAGNETIC RESONANCE IMAGING (MRI)

Suitable for non-invasive evaluation of the aorta and other vascular abnormalities. It also has a role in the characterization of adrenal lesions.

ANGIOGRAPHY

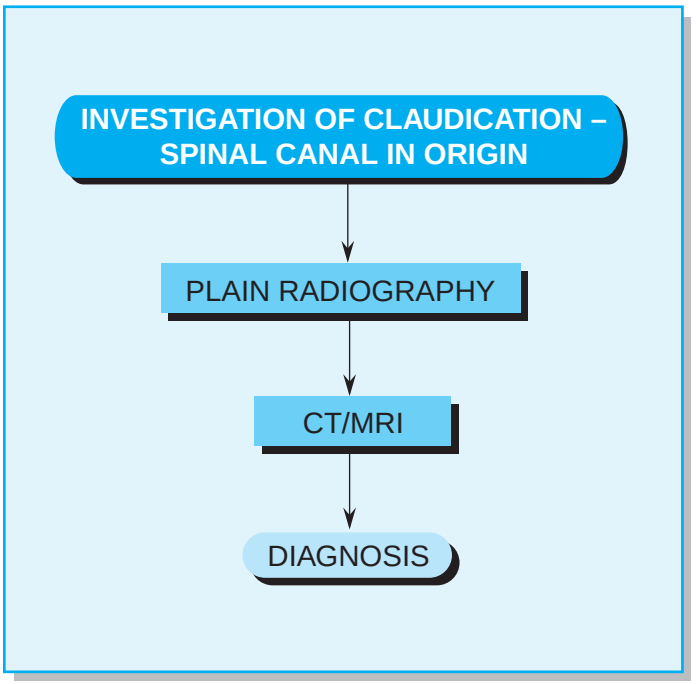
Venous sampling may be necessary for the detection of small cortical adenomas as well as for sampling renal vein renin levels.

Arch and abdominal aortography and renal angiography (DSA) are the 'gold standard' for characterization of vascular anomalies.



INVESTIGATION OF CLAUDICATION – SPINAL CANAL IN ORIGIN

Refer to ***Low Back Pain***, p. 78.



MUSCULOSKELETAL SYSTEM

- Avascular Necrosis (AVN)
- Stress Fracture
- Skeletal Infection (Bone or Joint)
- Primary Bone Tumour
- Soft Tissue Mass
- Shoulder Pain
- Cervical Spine Trauma
- Osteoporosis
- Low Back Pain
- Neck Pain
- Metastatic Bone Disease

AVASCULAR NECROSIS (AVN)

Avascular necrosis is frequently insidious in onset, the hip being the most common site.

PLAIN RADIOGRAPHY

Radiographic changes are not evident until marked bone destruction has occurred. If the plain radiograph findings are not diagnostic, further imaging is required.

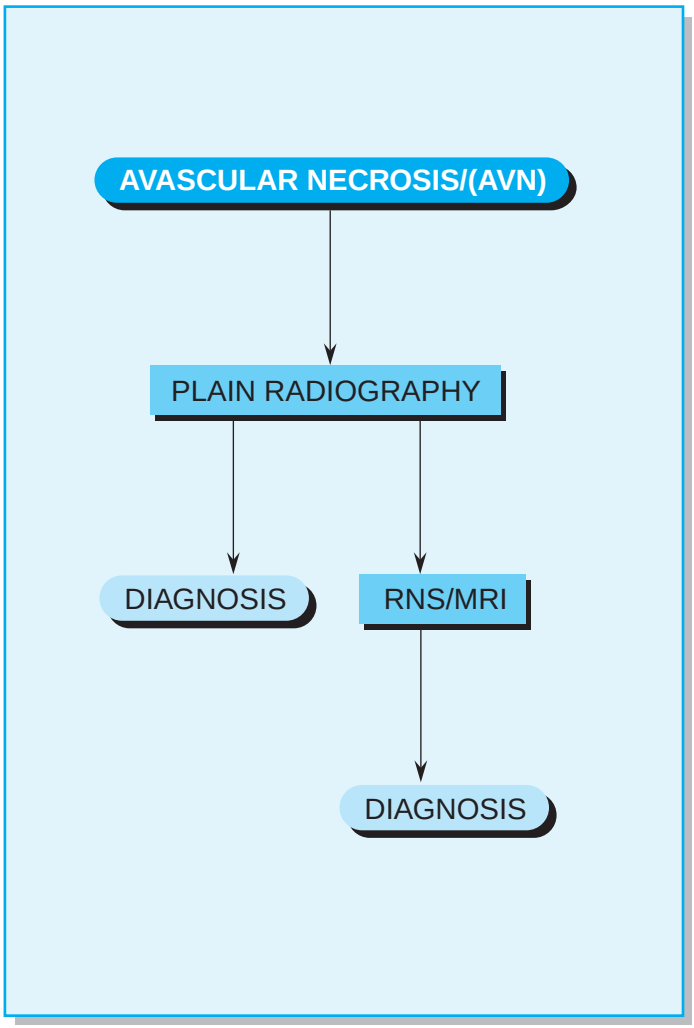
RADIONUCLIDE SCINTIGRAPHY (RNS)

Radionuclide bone scan will show changes at an earlier stage of the disease but even then considerable damage may have occurred.

RNS has a sensitivity of 81% compared with 100% for MRI.

MAGNETIC RESONANCE IMAGING (MRI)

Is ideally the imaging modality of choice for early evaluation of bone marrow changes, indicating AVN in early and intermediate stage (those with the disease yet to be detected with radiography or RNS).


AVASCULAR NECROSIS/(AVN)
PLAIN RADIOGRAPHY
DIAGNOSIS
RNS/MRI
DIAGNOSIS

STRESS FRACTURE

The clinical setting is often highly suggestive of stress fracture (repetitive or new athletic activity). Specific athletic activities result in specific areas of stress fracture. The common sites are metatarsals, calcaneus, tibial shaft, femoral neck and ribs.

PLAIN RADIOGRAPHY

Early plain radiograph findings may be less specific (subtle periosteal reaction) or even normal. Late radiographs may be specific but not sensitive. However plain radiographs are recommended as the initial imaging technique and if findings are conclusive, no further imaging is needed.

RADIONUCLIDE SCINTIGRAPHY (RNS)

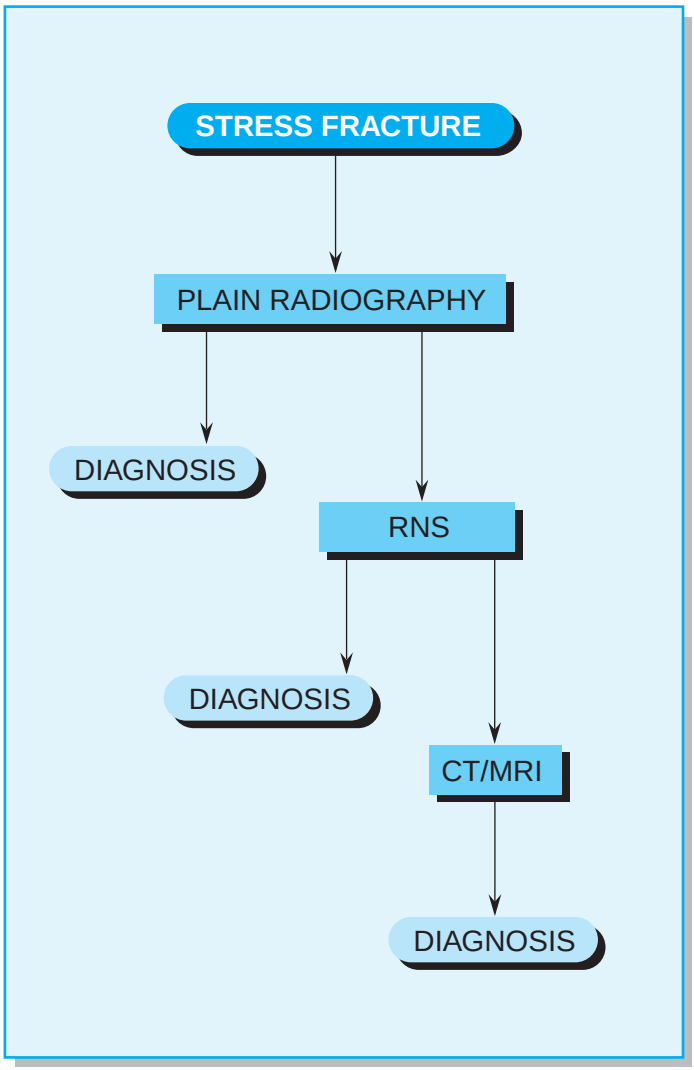
A more sensitive test to show early stress fracture. May differentiate between osseous and soft tissue injury and show stress related bony changes at sites of ligamentous attachments. RNS can differentiate a recent lesion from an older lesion.

COMPUTED TOMOGRAPHY (CT)

May be done when clinical features are unusual or the abnormalities seen on RNS or plain radiograph requires further definition.

MAGNETIC RESONANCE IMAGING (MRI)

Shows the changes earlier than RNS. It may show the fracture line itself; in such cases MR becomes sensitive and quite specific.


STRESS FRACTURE
PLAIN RADIOGRAPHY
DIAGNOSIS
RNS
DIAGNOSIS
CT/MRI
DIAGNOSIS

SKELETAL INFECTION (BONE OR JOINT)

A diagnostic aspiration is done if the clinical findings are classical of septic arthritis.

PLAIN RADIOGRAPHY

May be normal for the first two weeks after clinical presentation.

ULTRASONOGRAPHY (US)

Useful in the detection of osteomyelitis and septic arthritis.

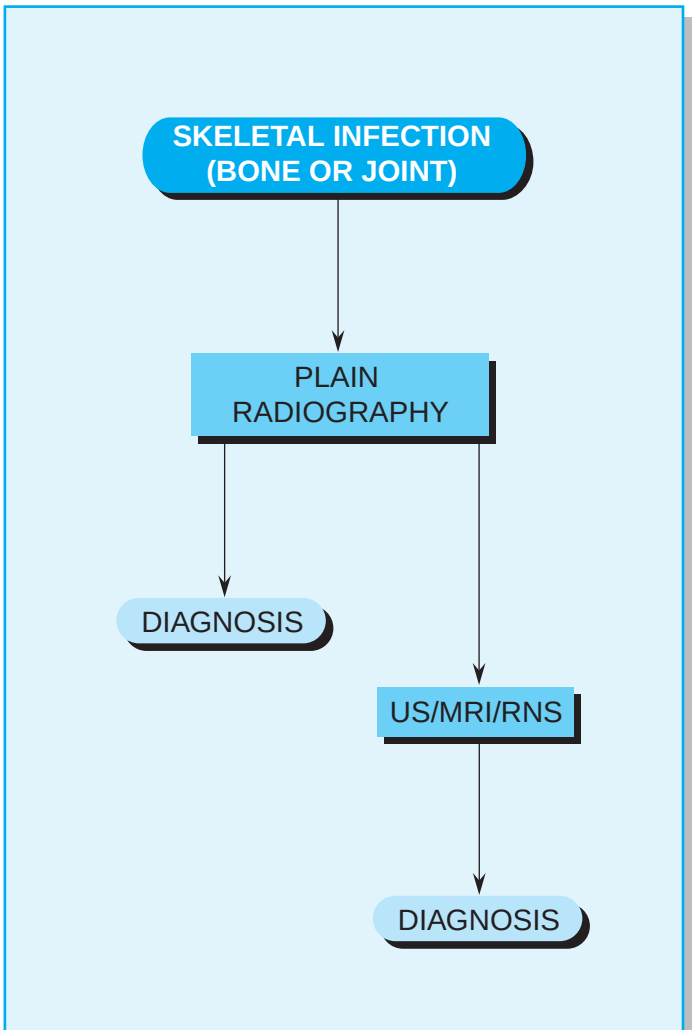
MAGNETIC RESONANCE IMAGING (MRI)

A sensitive technique in the evaluation of early stages of osteomyelitis. Contrast enhanced examination is useful to produce enhancement of involved areas.

RADIONUCLIDE SCINTIGRAPHY (RNS)

In acute osteomyelitis, RNS is more sensitive than plain radiographs in the first two weeks after presentation and is usually abnormal two–three days following the onset of symptoms.

RNS with ^{67}Ga or ^{111}In-oxine labelled leucocytes may be more useful in difficult or problematic cases.


SKELETAL INFECTION
(BONE OR JOINT)
PLAIN
RADIOGRAPHY
DIAGNOSIS
US/MRI/RNS
DIAGNOSIS

PRIMARY BONE TUMOUR

PLAIN RADIOGRAPHY

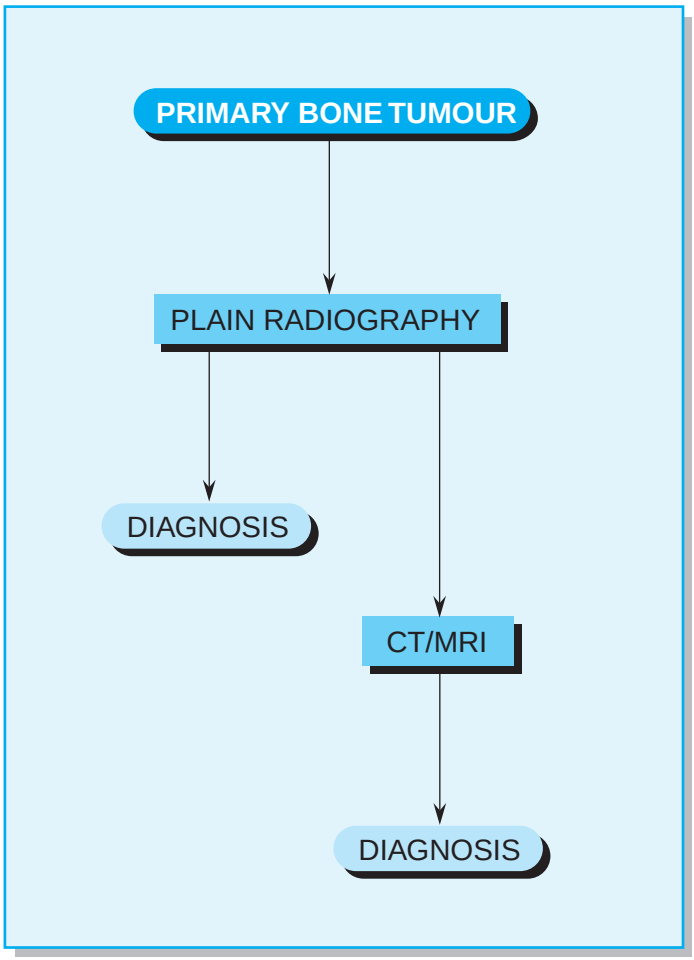
Routine radiography remains the primary screening technique.

COMPUTED TOMOGRAPHY (CT)

It is the imaging modality of choice for tumours located within the cortical regions, flat bones, thin cortex and little marrow. Better to demonstrate calcification which may be suspected from radiographs. CT is also preferred for evaluating patients with osteoid osteoma.

MAGNETIC RESONANCE IMAGING (MRI)

Superior to CT in defining the extent of bone marrow and soft tissue involvement as well as involvement of adjacent joints. It is the technique of choice for evaluating and staging primary bone sarcomas.


PRIMARY BONE TUMOUR
PLAIN RADIOGRAPHY
DIAGNOSIS
CT/MRI
DIAGNOSIS

SOFT TISSUE MASS

PLAIN RADIOGRAPHY

Usually the first technique for evaluation of patients with suspected soft tissue mass. Plain radiographs may identify certain features which may either allow the diagnosis to be made or indicate which procedure might be the most appropriate for further evaluation.

ULTRASONOGRAPHY (US)

Able to differentiate cystic from solid lesions. Aspiration biopsy may be performed under ultrasound guidance.

COMPUTED TOMOGRAPHY (CT)

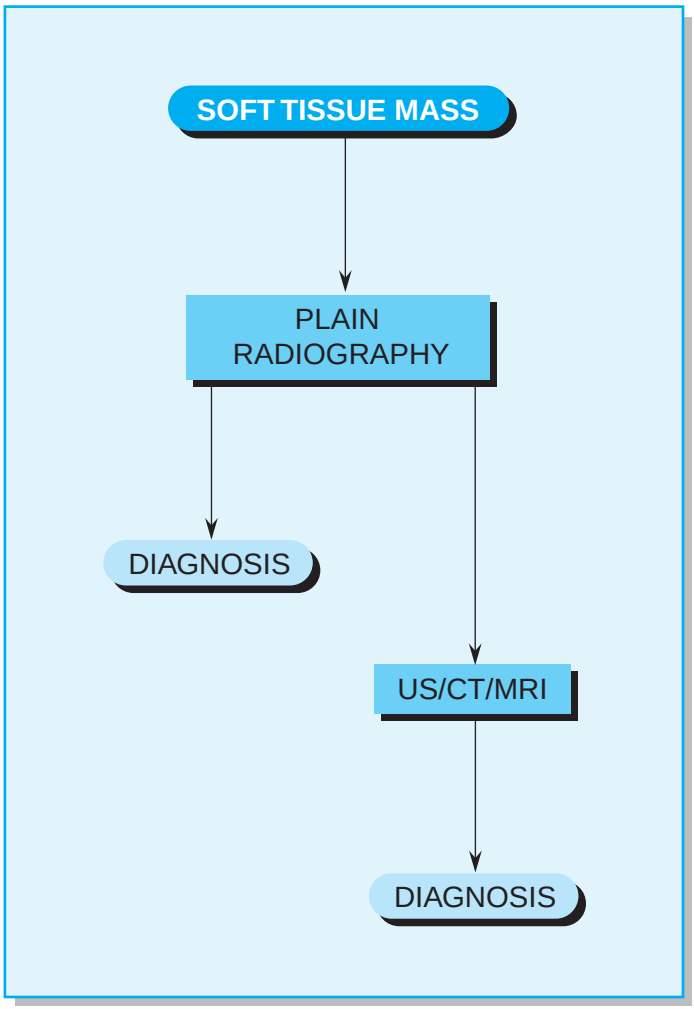
Useful in patients with subtle bone changes or soft tissue calcification.

MAGNETIC RESONANCE IMAGING (MRI)

Becomes the technique of choice for detection and characterization of soft tissue masses because of its improved soft tissue contrast resolution and multiplanar imaging capabilities.

ANGIOGRAPHY

In selected cases, angiography will provide useful information prior to surgery.


SOFT TISSUE MASS
PLAIN RADIOGRAPHY
DIAGNOSIS
US/CT/MRI
DIAGNOSIS

SHOULDER PAIN

Often difficult to differentiate the various causes of shoulder pain based on the clinical history and physical examination alone.

PLAIN RADIOGRAPHY / ARTHROGRAPHY

A useful initial tool for the diagnostic work-up of a patient with shoulder pain to exclude skeletal abnormalities and calcific tendinitis. They may also suggest the presence of unsuspected or additional soft tissue injuries (e.g. Hill-Sachs defect, Bankart lesion or rotator cuff arthropathy).

Plain radiographs of the cervical spine may be helpful in excluding referred shoulder pain due to pathology in the cervical spine.

ULTRASONOGRAPHY (US)

Very sensitive, specific and cost-effective examination of the shoulder. Its major role is in the assessment of the tendons and bursae. Ultrasonography is a dynamic study and is the only modality capable of real time demonstration of impingement.

COMPUTED TOMOGRAPHY (CT) AND CT ARTHROGRAPHY

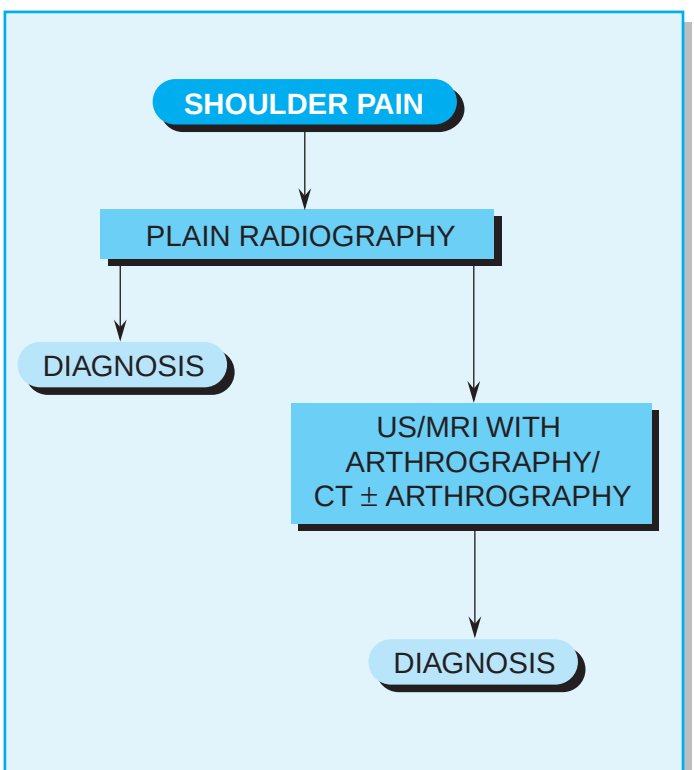
Allows a detailed evaluation of bony structures and depicts the differences between soft tissues better in comparison with plain radiographs. It is a useful adjunct for further imaging of bony abnormalities noted on radiographs.

CT arthrography enables the evaluation of structures in the shoulder joint and is a valuable tool in the assessment of glenohumeral instability.

MAGNETIC RESONANCE IMAGING (MRI)/MR ARTHROGRAPHY

The most comprehensive imaging method in the evaluation of shoulder pain. It provides multiplanar imaging and exceptional soft tissue contrast allowing evaluation of rotator cuff abnormalities and other structural abnormalities frequently associated with impingement syndrome.

MR arthrography improves the diagnostic accuracy of shoulder joint instability and is superior to CT arthrography.



CERVICAL SPINE TRAUMA

PLAIN RADIOGRAPHY

Remains the most useful screening modality.

If the lateral view shows a fracture or dislocation, further views should be done after application of a cervical collar.

Patients with normal radiographs but who have persistent pain or suspected ligament injuries, should have flexion and extension views in the erect position. This should be done under direct medical supervision.

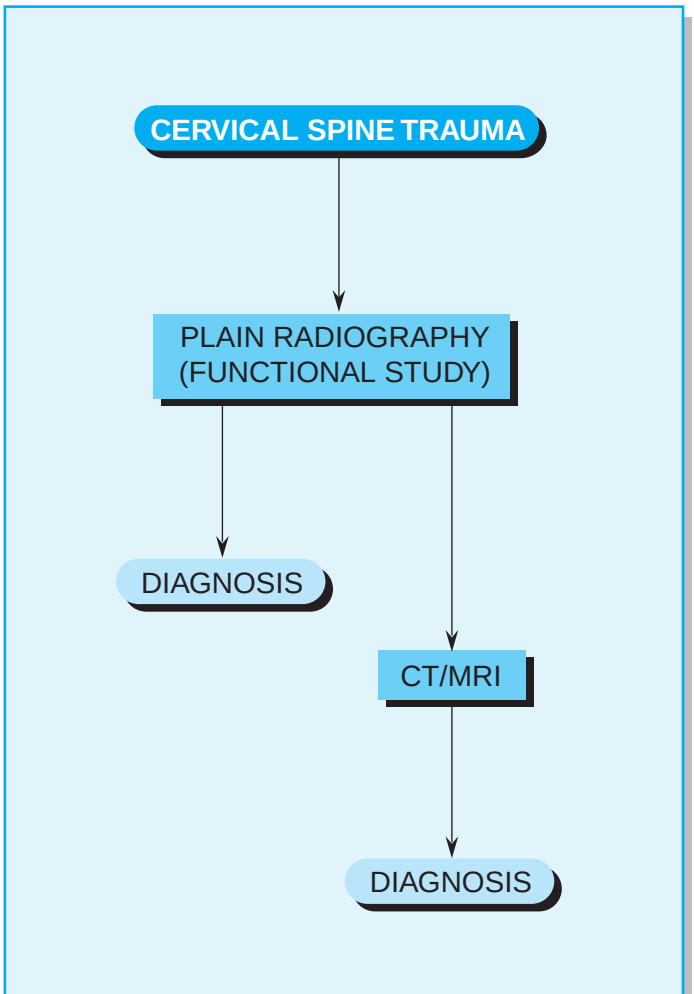
COMPUTED TOMOGRAPHY (CT)

Superior in demonstrating the display of complex fractures with associated bony fragments and soft tissue injury. Bony fragments within the spinal canal are directly visualized.

Multiple projection reconstruction is helpful in further characterizing the extent of injury.

MAGNETIC RESONANCE IMAGING (MRI)

Indicated in patients with neurological deficits or in patients suspected of cord injury without neurological deficit (disc prolapse and cord injury) and to detect a surgically treatable lesion such as an epidural haematoma.


CERVICAL SPINE TRAUMA
PLAIN RADIOGRAPHY
(FUNCTIONAL STUDY)
DIAGNOSIS
CT/MRI
DIAGNOSIS

OSTEOPOROSIS

Osteoporosis is the reduction in the quantity of bone per unit volume. This may be suspected clinically in high risk patients or suggested by plain radiographs. Radiological estimation of bone mineral density (BMD) is indicated if patient management is dependent on the degree of bone loss.

DUAL ENERGY X-RAY ABSORPTIOMETRY (DXA/DEXA)

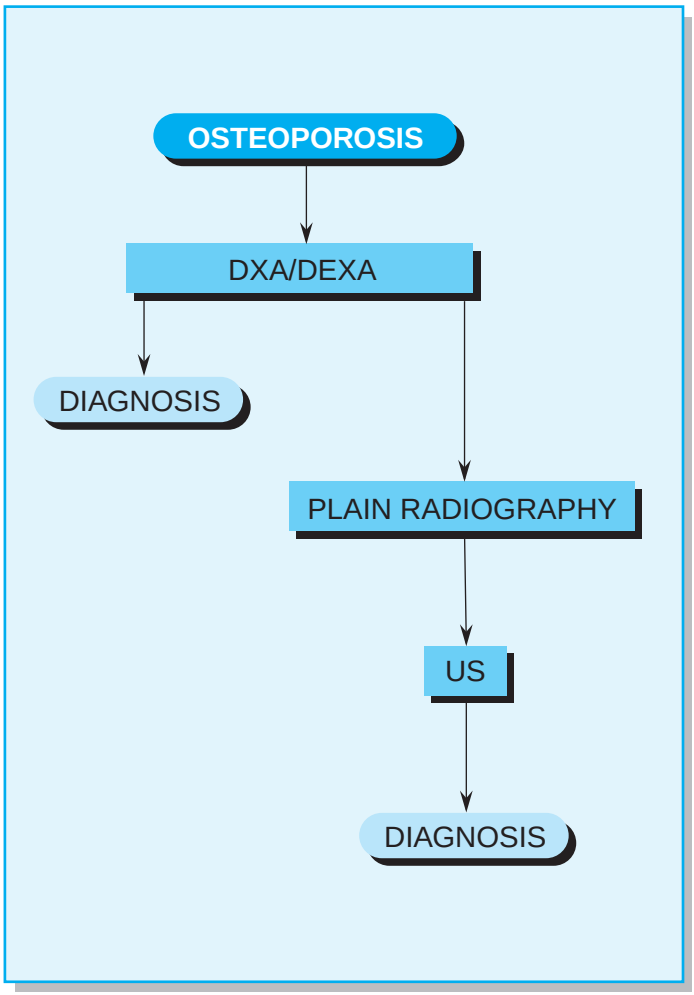
Offers a rapid, accurate and precise estimation of bone mass with reduced radiation dose.

PLAIN RADIOGRAPHY

Not sensitive and non-quantitative. However, radiographs of the thoracic and lumbar spine may demonstrate the presence of collapsed vertebral bodies.

ULTRASONOGRAPHY (US)

Quantitative US appears to offer a inexpensive alternative method to assess bone mass and fracture risk.


OSTEOPOROSIS
DXA/DEXA
DIAGNOSIS
PLAIN RADIOGRAPHY
US
DIAGNOSIS

LOW BACK PAIN

The many causes of low back pain include degenerative disease and congenital spinal stenosis, neoplasm, infection, trauma and inflammatory or arthritic process. Acquired spinal stenosis due to degenerative joint and disc disease accounts for the majority of cases.

PLAIN RADIOGRAPHY

Patients with low back pain do not require imaging at the initial presentation. Plain radiographs are done after initial treatment fails. Spinal infection, tumour and ankylosis are readily demonstrated. Good at demonstrating skeletal detail but inadequate for assessment of soft tissue abnormalities.

LUMBAR MYELOGRAPHY

An invasive procedure. Able to detect cord and nerve root compression when MRI and CT are not available. May be followed by CT.

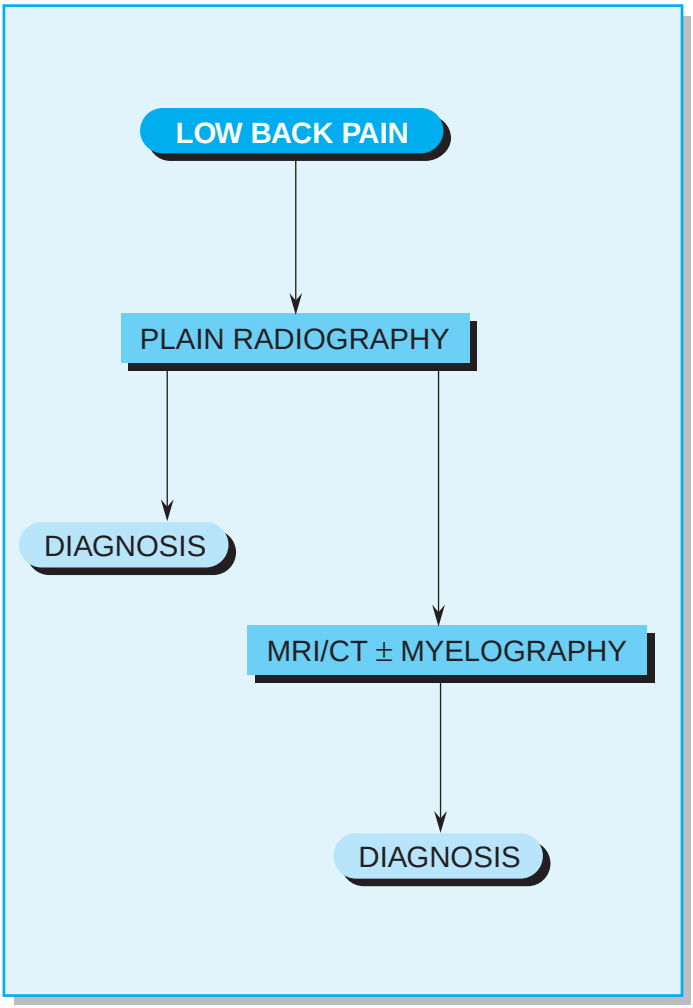
COMPUTED TOMOGRAPHY (CT)

Useful modality for diagnosis of disc prolapse, spinal stenosis and facet joint diseases.

CT and myelography will remain important in those patients who for technical reasons may not be able to enter the MRI scanner (e.g. pacemaker patients, claustrophobics) or in patients whose MRI findings do not correlate with clinical symptoms.

MAGNETIC RESONANCE IMAGING (MRI)

Useful in the evaluation of spinal disorders. The vertebrae, intervertebral discs, ligaments, spinal canal and neural foramina can be evaluated.


LOW BACK PAIN
PLAIN RADIOGRAPHY
DIAGNOSIS
MRI/CT ± MYELOGRAPHY
DIAGNOSIS

NECK PAIN

Neck pain is commonly due to muscle spasm resulting from an acute ligamentous sprain with no corresponding radiological changes.

PLAIN RADIOGRAPHY

Plain radiographs may be all that are required. Bony alignment and the degree of degenerative change can be determined. Plain radiograph abnormalities do not correlate well with neurological signs.

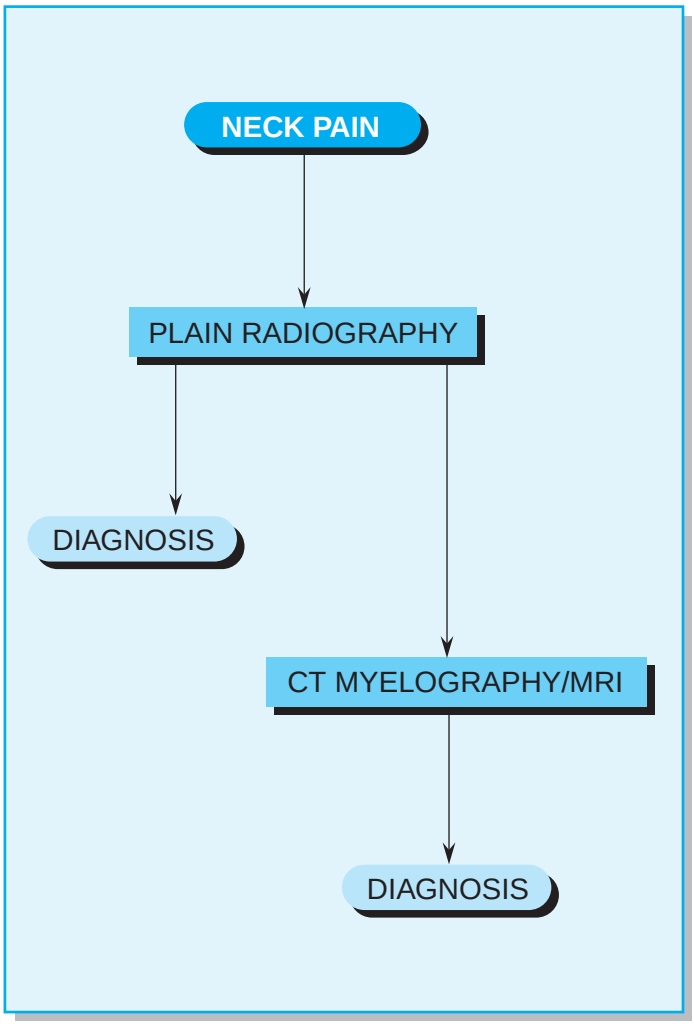
MYELOGRAPHY/CT MYELOGRAPHY

Usually followed by CT (CT myelography). These two examinations are complementary for assessing cervical radiculopathy.

CT myelography still compares favourably in the assessment of lateral disc herniation and osteophytic foraminal narrowing in patients with cervical radiculopathy.

MAGNETIC RESONANCE IMAGING (MRI)

Advantage of being a non-invasive outpatient procedure. It is the best imaging modality for evaluating abnormalities of the spine, spinal canal and its contents.


NECK PAIN
PLAIN RADIOGRAPHY
DIAGNOSIS
CT MYELOGRAPHY/MRI
DIAGNOSIS

METASTATIC BONE DISEASE

RADIONUCLIDE SCINTIGRAPHY (RNS)

The imaging modality of choice. It is more sensitive than plain radiography. However, it is non-specific. The greatest advantage of this examination is that it allows for total body survey.

PLAIN RADIOGRAPHY

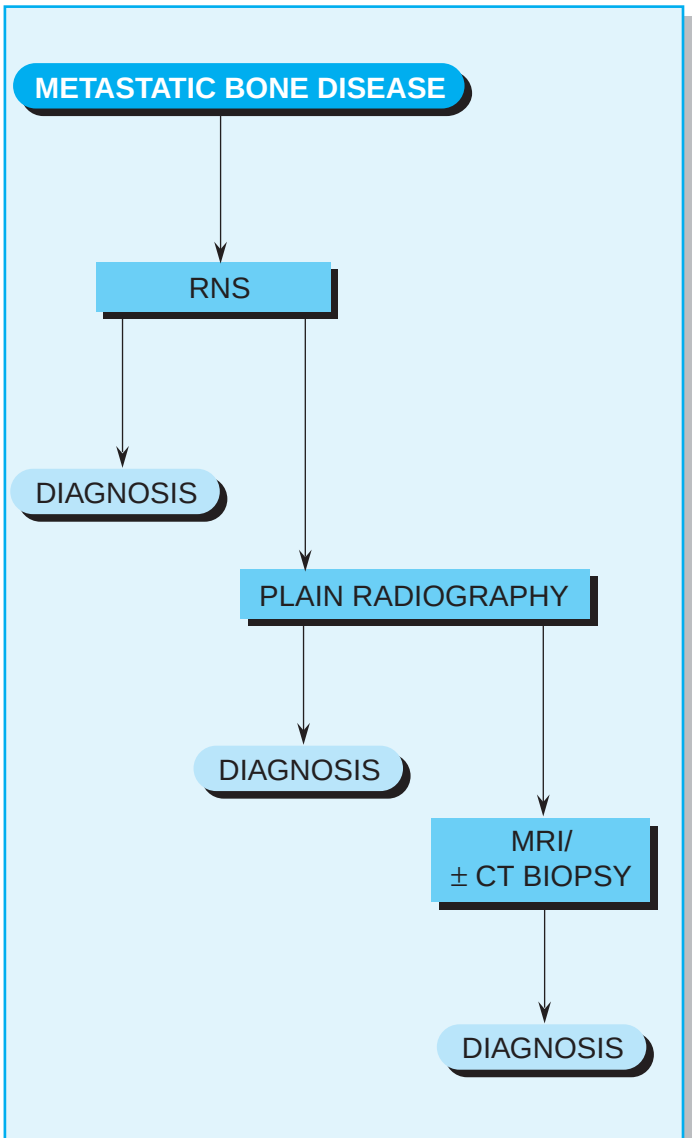
In a known case of primary malignancy, if the RNS shows a solitary lesion, it should be further evaluated with plain radiography and, if not diagnostic, to proceed to further imaging (CT/MRI).

MAGNETIC RESONANCE IMAGING (MRI)

Recommended if radiographic examination of RNS detected lesion is negative. Particularly useful in the evaluation of the spine.

COMPUTED TOMOGRAPHY (CT)

Useful for needle guidance if a biopsy is to be performed.


METASTATIC BONE DISEASE
RNS
DIAGNOSIS
PLAIN RADIOGRAPHY
DIAGNOSIS
MRI/
± CT BIOPSY
DIAGNOSIS

RESPIRATORY SYSTEM

- Chest Trauma
- Bronchiectasis
- Haemoptysis
- Solitary Pulmonary Nodule
- Mediastinal or Hilar Mass
- Multiple Pulmonary Nodules
- Diaphragmatic Mass
- Chronic Cough

CHEST TRAUMA

The extent of imaging as well as imaging modality of choice will depend on the clinical assessment and severity of injury. Chest injury usually presents as part of multi-organ trauma.

PLAIN RADIOGRAPHY

Usually the initial imaging examination in the assessment of trauma. In unstable patients, this may be the only examination necessary prior to surgery. The presence of rib fractures may not alter management.

In severely injured patients, the presence of serious injury may not be detected by plain radiography. Further imaging is required if clinically indicated.

COMPUTED TOMOGRAPHY (CT)

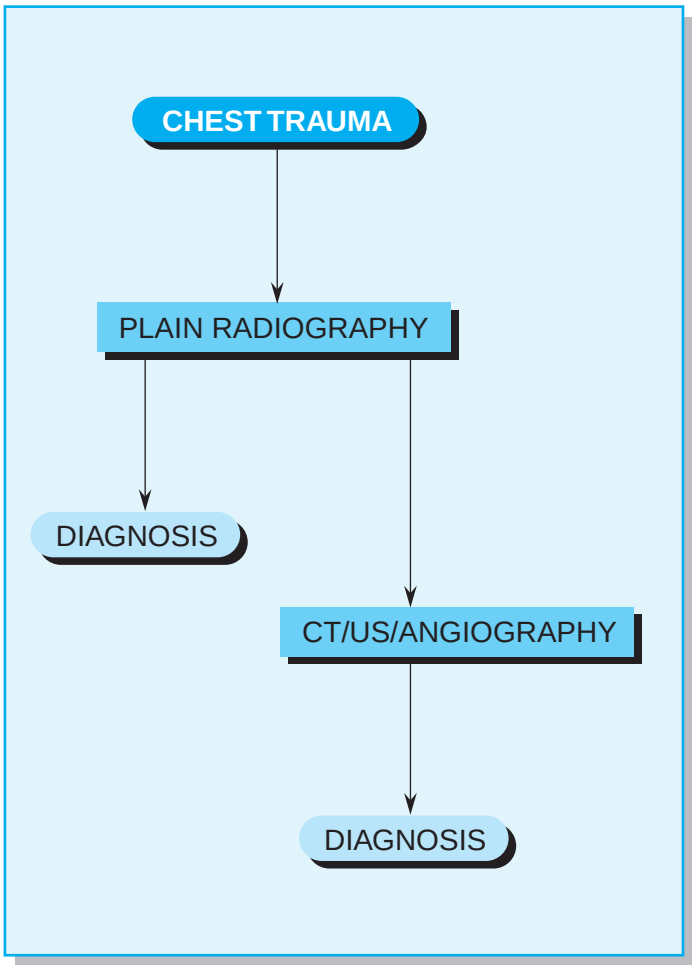
Should only be done in the haemodynamically stable patient. CT can better detect and define the extent of lung and mediastinal injury. CT can also be performed at the same time to detect and assess the extent of intra-abdominal injury.

ULTRASONOGRAPHY (US)

May allow quick demonstration of pleural or pericardial effusion and even the presence of subdiaphragmatic fluid especially if CT is not available.

ANGIOGRAPHY

This is the 'gold standard' in the diagnosis of aortic tears.


CHEST TRAUMA
PLAIN RADIOGRAPHY
DIAGNOSIS
CT/US/ANGIOGRAPHY
DIAGNOSIS

BRONCHIECTASIS

The role of imaging is to confirm the presence and determine the extent of disease as well as to exclude other causes.

PLAIN RADIOGRAPHY

The sensitivity of CXR in the diagnosis and staging of bronchiectasis is only moderate. However, it is useful to exclude other causes or show the presence of complications, e.g. superimposed infection.

COMPUTED TOMOGRAPHY - HIGH RESOLUTION (HRCT)

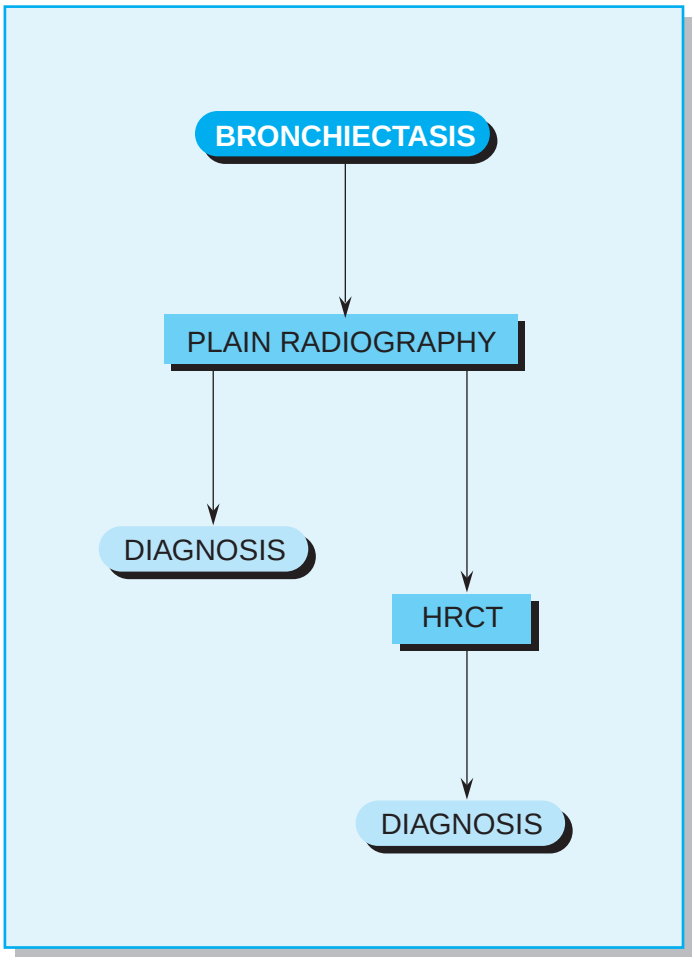
Now considered the modality of choice for diagnosis and staging of bronchiectasis. It is non-invasive and can be used for screening as well as in the assessment of resectability.

BRONCHOGRAPHY

Once considered to be the 'gold standard' but is no longer widely practised. It is invasive and only done when CT is inconclusive.

ANGIOGRAPHY

Most often used in patients with persistent haemoptysis prior to embolisation.


BRONCHIECTASIS
PLAIN RADIOGRAPHY
DIAGNOSIS
HRCT
DIAGNOSIS

HAEMOPTYSIS

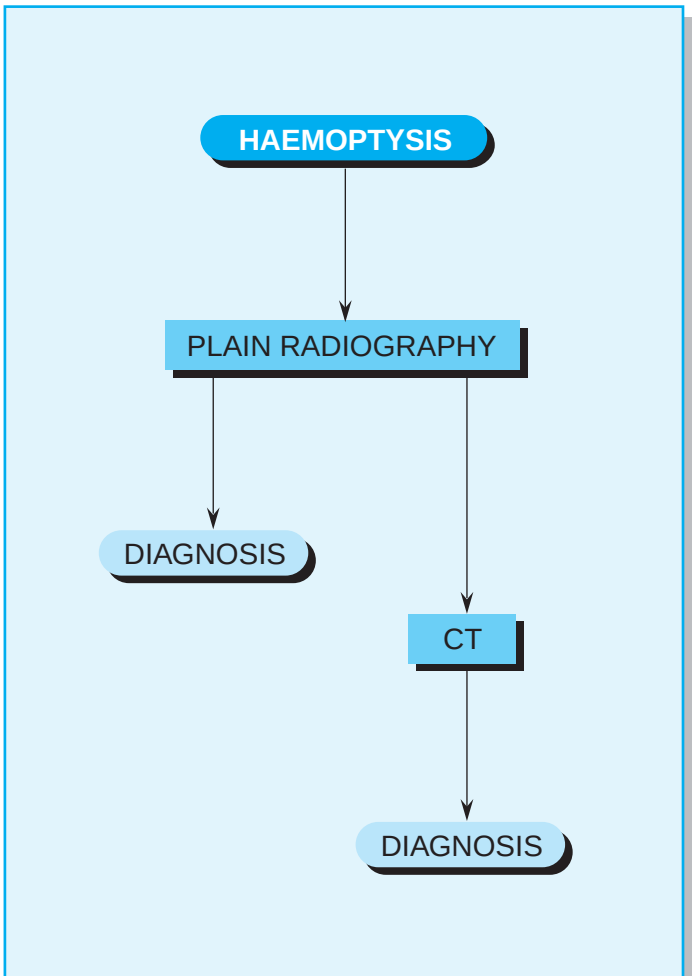
Imaging is part of the assessment in addition to sputum bacteriology and cytology. Bronchoscopy plays a vital role in the management of these patients especially if they are smokers and or older than 40 years even if imaging is normal.

PLAIN RADIOGRAPHY

Chest radiography is usually the initial imaging examination. It may be diagnostic but is however often normal. Tuberculosis is among one of the most common causes followed by bronchogenic carcinoma and bronchiectasis.

COMPUTED TOMOGRAPHY (CT)

Used to either characterize lesions seen on chest radiography or to look for lesions which may be missed. Contrast enhanced CT may also be useful for the detection of pulmonary emboli. HRCT as discussed for bronchiectasis is also useful. This may also be used to detect pulmonary emboli.


HAEMOPTYSIS
PLAIN RADIOGRAPHY
DIAGNOSIS
CT
DIAGNOSIS

SOLITARY PULMONARY NODULE

These are usually detected on chest radiography. Granulomas are common in view of the presence of TB in the community. However malignancy needs to be excluded especially those with risk factors, e.g. smoking. Metastases may also present as a solitary nodule.

PLAIN RADIOGRAPHY

Review of any previous radiographs is the most useful step to determine if there has been an increase in size. Otherwise these can be followed-up by chest radiographs. However, the nodule can be considered to be benign if there has been no change in the size of the nodule for over two years.

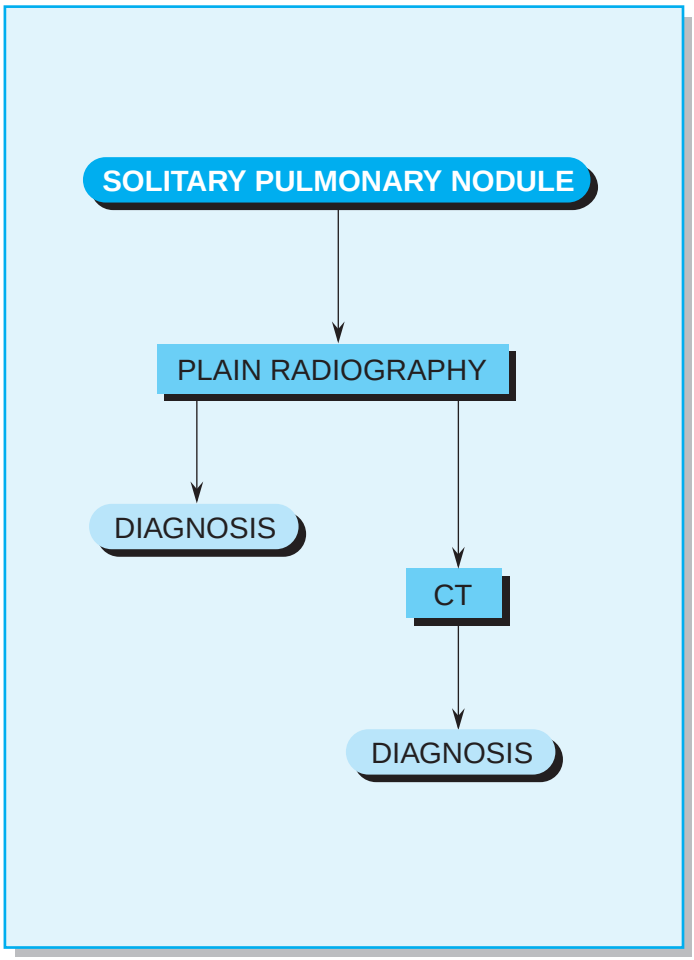
COMPUTED TOMOGRAPHY (CT)

To assess the nodule (for the presence of central calcification), determine the presence of other nodules and lymphadenopathy. Metastases to the liver and adrenals will also be demonstrated. CT may also be used for the diagnosis of a pulmonary arterio-venous malformation.

Usually used to guide interventions, e.g. FNAC of the lesions.

ANGIOGRAPHY

May be necessary if the confirmation of a pulmonary arterio-venous malformation is required. This will require cannulation of the pulmonary artery.


SOLITARY PULMONARY NODULE
PLAIN RADIOGRAPHY
DIAGNOSIS
CT
DIAGNOSIS

MEDIASTINAL OR HILAR MASS

This is usually detected on chest radiography. The aim of imaging is to determine the nature of the mass and staging for malignancy.

PLAIN RADIOGRAPHY

The lateral view has a limited role in the assessment of the hilar or mediastinal mass. It may help determine the location of the mass but cannot characterize the nature of the mass. Follow-up radiographs may be useful if the cause is considered to be infective.

The plain radiographic findings help the bronchoscopist to decide which lobe or lobes are affected.

Conventional tomography is not used these days.

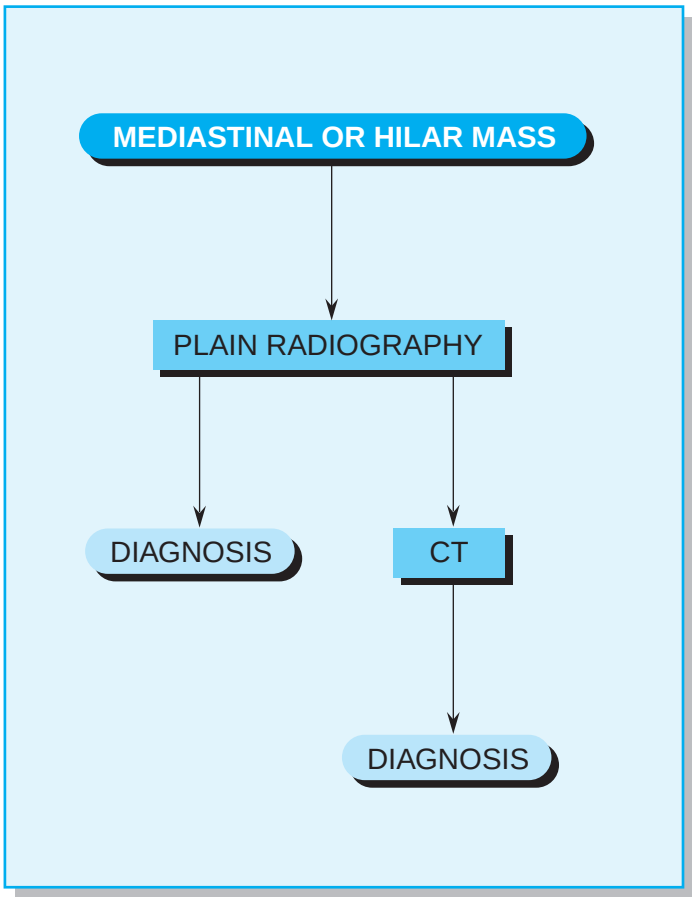
COMPUTED TOMOGRAPHY (CT)

Performed to detect the presence and location of the mass. It will also help characterize the mass and staging for malignancy, i.e. presence of lung nodules and lymphadenopathy. Lesions in the abdomen may also be demonstrated.

FNAC of the mediastinal mass lesions may be performed especially if it is in the anterior mediastinum.

ANGIOGRAPHY

Rarely necessary with the availability of CT except in determining the extent of aortic dissection.


MEDIASTINAL OR HILAR MASS
PLAIN RADIOGRAPHY
DIAGNOSIS
CT
DIAGNOSIS

MULTIPLE PULMONARY NODULES

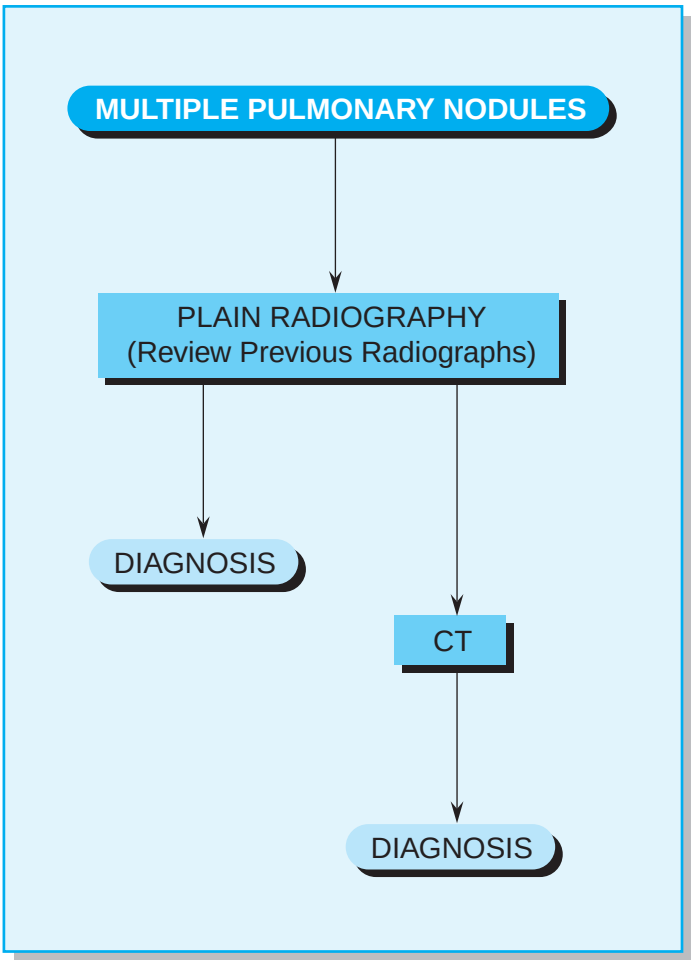
PLAIN RADIOGRAPHY

Usually detected on chest radiography. In patients with history of a primary malignancy, they are most likely to be metastases. Comparison with previous radiographs may be helpful.

COMPUTED TOMOGRAPHY (CT)

Multiple lung nodules are occasionally seen on CT for staging in which case they are metastases. Presence of cavitation or calcification or presence of lymphadenopathy can also be demonstrated.

May be used for guiding interventional procedures, e.g. FNAC.


MULTIPLE PULMONARY NODULES
PLAIN RADIOGRAPHY
(Review Previous Radiographs)
DIAGNOSIS
CT
DIAGNOSIS

DIAPHRAGMATIC MASS

This is usually detected on chest radiography. The aim of imaging is to determine the nature of the mass. Causes below the diaphragm must always be considered.

PLAIN RADIOGRAPHY

A PA chest radiograph is usually done. The lateral view has a limited role in the assessment of a diaphragmatic mass. In elderly patients this may be due to a focal eventration. Chest radiographs in inspiration and expiration may determine if there is paralysis of the diaphragm. The mediastinum should be carefully assessed. Comparison with previous chest radiographs may also be helpful.

FLUOROSCOPY

Allows real time assessment of the movements of the diaphragm.

BARIUM STUDIES

When the mass is likely to be related to bowel, then either a barium meal or enema may be necessary to confirm the mass.

ULTRASONOGRAPHY (US)

Allows the assessment of the sub-diaphragmatic areas, e.g. liver masses, pleural collections, etc. It can also be used to assess movement of the diaphragm.

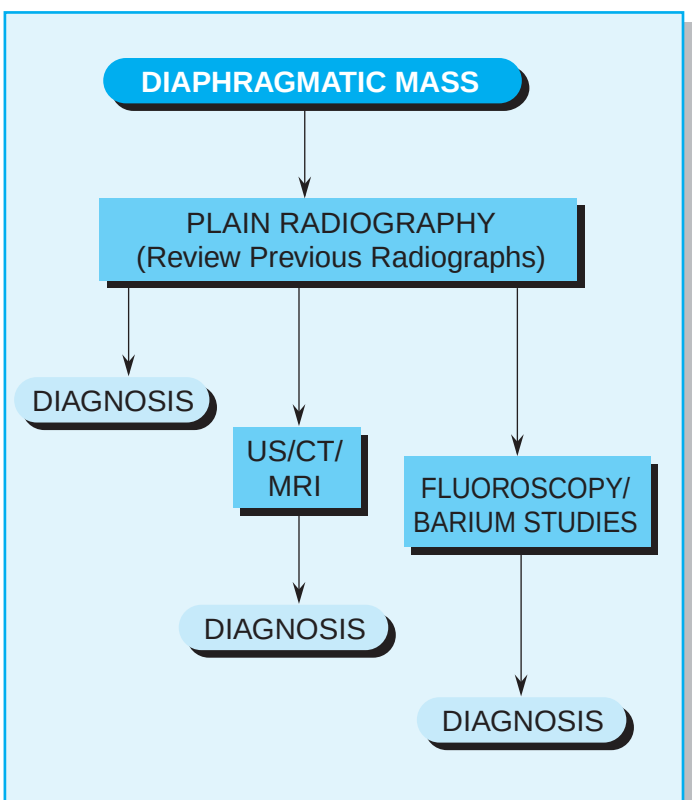
May be used to guide interventions.

COMPUTED TOMOGRAPHY (CT)

To detect the presence and location of the mass. It will also help characterize the mass and staging for malignancy, i.e. presence of lung nodules and lymphadenopathy. It can demonstrate bowel within the thoracic cavity.

MAGNETIC RESONANCE IMAGING (MRI)

May provide additional information since it allows imaging in the coronal and sagittal plane.



CHRONIC COUGH

This is a common problem. It is important that heart failure be excluded in the appropriate setting. In addition, the post-nasal drip syndrome is the most common reason for chronic cough in a non-smoking individual with a normal chest radiograph.

PLAIN RADIOGRAPHY

In most instances, a PA radiograph would suffice. Lateral views are not mandatory. If this is an abnormality then subsequent imaging will depend on the findings. Activity of tuberculous lesions cannot be based on radiography alone. Sputum AFB may be examined.

In the appropriate setting, radiographs of the sinuses should be performed.

COMPUTED TOMOGRAPHY (CT)

Usually done to better define any pathology seen on the chest radiograph, e.g. aortic aneurysm, lymphadenopathy, lung mass, etc. It may however be also done when there is a high index of clinical suspicion e.g. in patient with known primary, evaluation of bronchiectasis, etc.

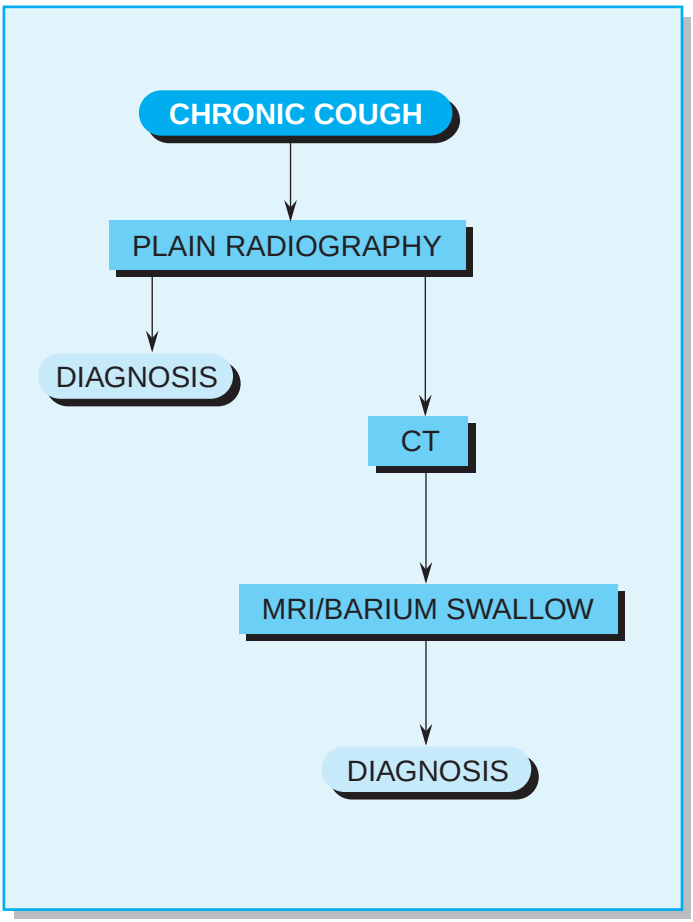
CT of the sinuses may also be indicated to exclude the post-nasal drip syndrome.

MAGNETIC RESONANCE IMAGING (MRI)

This is rarely indicated unless further assessment of vascular disease of the great vessels or of bronchogenic carcinoma to determine chest wall involvement is necessary.

BARIUM SWALLOW

Used to detect symptomatic or asymptomatic reflux which is also a common cause of chronic cough.



GASTROINTESTINAL SYSTEM

- Dysphagia
- Dyspepsia
- Abdominal Pain
- Abdominal Mass
- Suspected Abdominal Abscess or Collection
- Intestinal Obstruction
- Gastrointestinal Haemorrhage
- Blunt Abdominal Trauma
- Jaundice

DYSPHAGIA

The underlying cause of dysphagia may be neurological or mechanical .

PLAIN RADIOGRAPHY

A chest radiograph has a role in detecting some mediastinal causes of dysphagia.

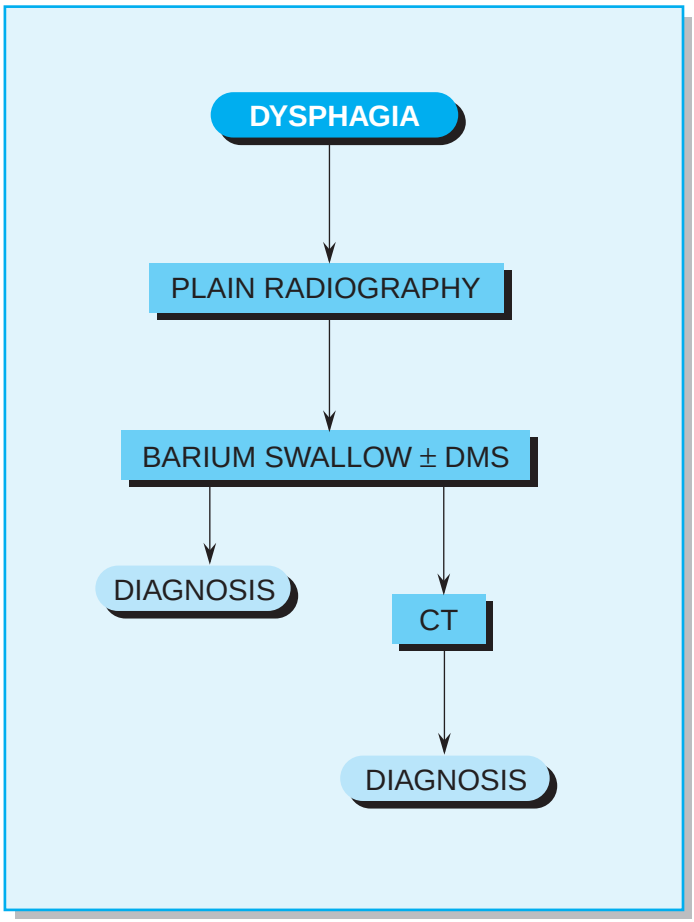
BARIUM SWALLOW

Able to demonstrate if there is a mechanical cause. The length and severity of a stenotic segment is well-displayed on a barium swallow examination.

Neurological causes of dysphagia may be assessed with a dysphagia motility study (DMS) which is a fluoroscopic recording and evaluation of deglutition.

COMPUTED TOMOGRAPHY (CT)

Required to further assess extrinsic lesions and to stage tumours prior to surgery.


DYSPHAGIA
PLAIN RADIOGRAPHY
BARIUM SWALLOW ± DMS
DIAGNOSIS
CT
DIAGNOSIS

DYSPEPSIA

Dyspepsia may either be due to causes in the stomach, duodenum or gall-bladder.

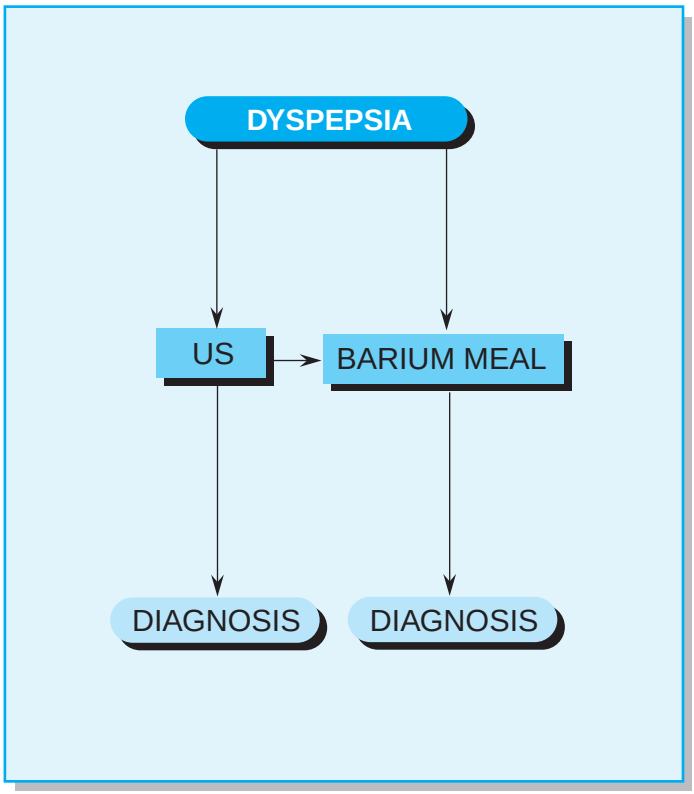
The choice of initial examination depends on the provisional diagnosis.

ULTRASONOGRAPHY (US)

Initial imaging modality of choice and is excellent for the detection of gall-bladder disease.

BARIUM MEAL

A barium meal examination is useful for assessing the oesophagus, stomach and duodenum. This is relatively non-invasive with comparable results to endoscopy.


DYSPEPSIA
US
BARIUM MEAL
DIAGNOSIS
DIAGNOSIS

ABDOMINAL PAIN

When imaging is indicated, the choice of the initial examination depends on the symptoms and signs.

PLAIN RADIOGRAPHY

An abdominal radiograph is a useful initial examination in diagnosing many causes.

ULTRASONOGRAPHY (US)

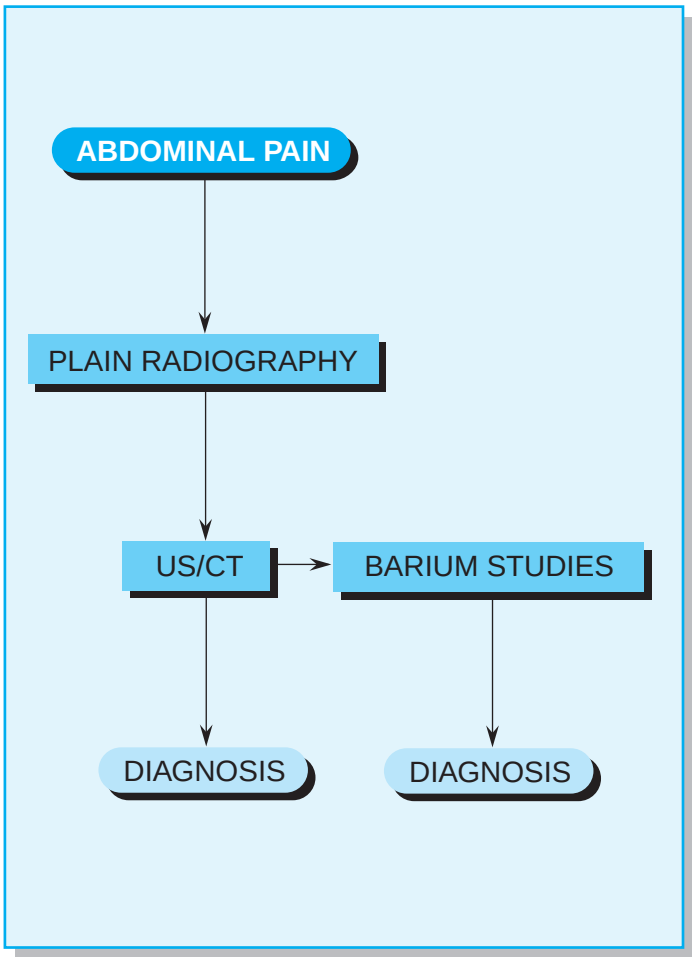
Useful for rapid evaluation of the abdomen and pelvis.

COMPUTED TOMOGRAPHY (CT)

Provides an excellent survey of the abdomen and pelvis and also useful to detect and assess fluid collections. Occasionally, CT may detect unsuspected pathology, e.g. tumours, inflammatory bowel disease, extraluminal air and bowel infarction.

BARIUM STUDIES

If GIT pathology is suspected as the cause of abdominal pain, then a barium meal follow-through/small bowel enema is indicated.


ABDOMINAL PAIN
PLAIN RADIOGRAPHY
US/CT
BARIUM STUDIES
DIAGNOSIS
DIAGNOSIS

ABDOMINAL MASS

PLAIN RADIOGRAPHY

An abdominal radiograph is a useful initial examination.

ULTRASONOGRAPHY (US)

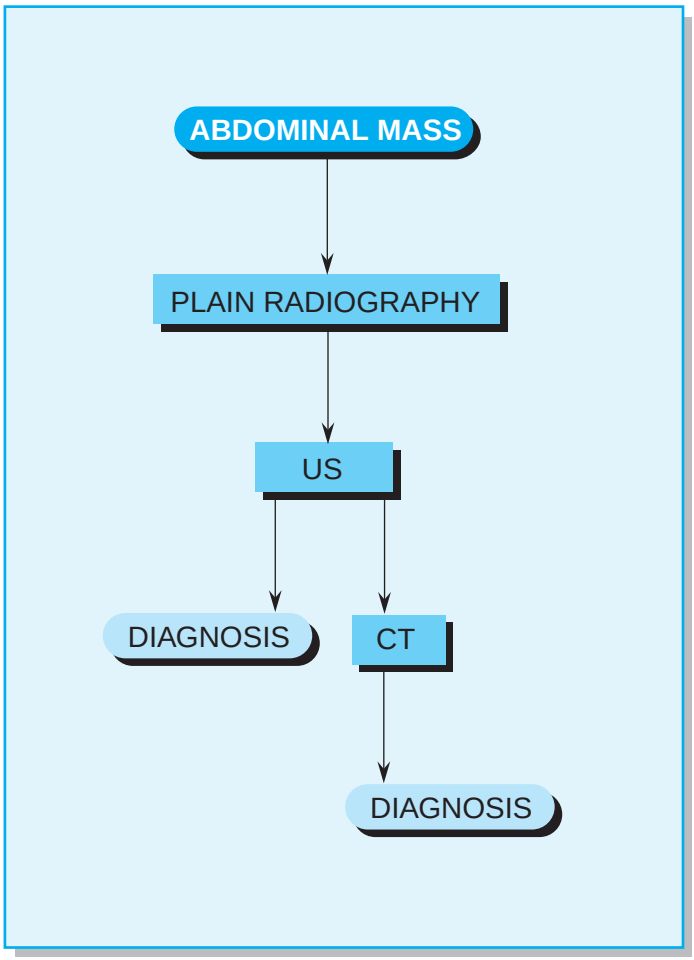
Useful to identify the site and organ of origin as well as to characterize the mass. The extent of the mass may also be determined.

COMPUTED TOMOGRAPHY (CT)

In most instances, CT is the definitive imaging modality for the assessment of abdominal masses and staging of tumours.

Superior in the assessment of bowel masses and retroperitoneal pathology, e.g. para-aortic lymphadenopathy and pancreatic masses.

May also be useful for performing biopsies and other interventions.


ABDOMINAL MASS
PLAIN RADIOGRAPHY
US
DIAGNOSIS
CT
DIAGNOSIS

SUSPECTED ABDOMINAL ABSCESS OR COLLECTION

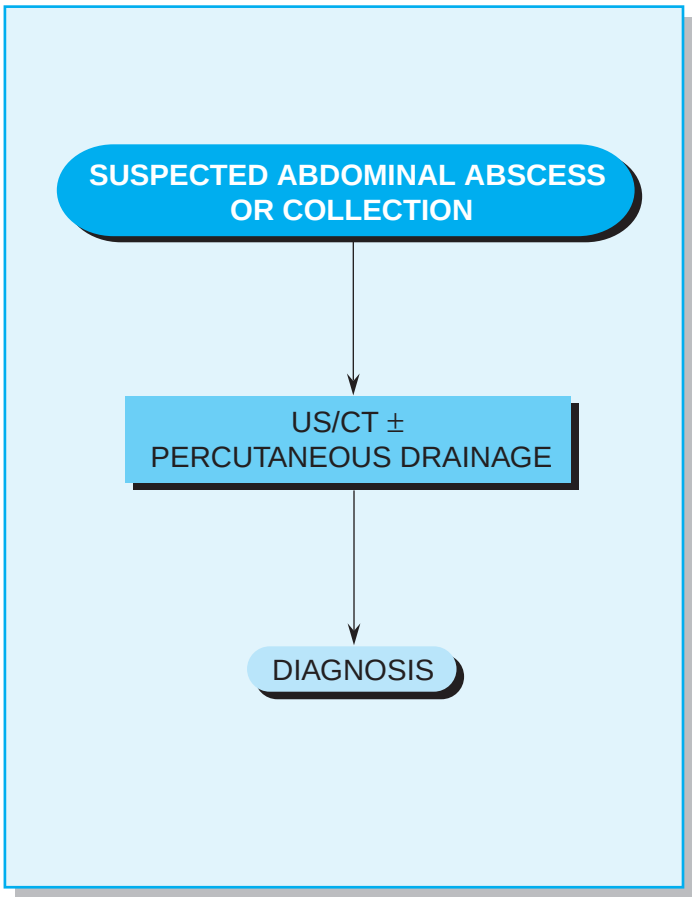
Intra-abdominal sepsis , suspected on clinical grounds does not often present with a palpable mass. The location and presence of an intra-abdominal abscess may be clinically uncertain as the patients are usually ill and difficult to examine.

ULTRASONOGRAPHY (US)

Initial imaging modality and can be done as a portable examination. Percutaneous aspiration or drainage of collections is feasible under ultrasonography guidance as a bedside procedure in patients in the critical care unit.

COMPUTED TOMOGRAPHY (CT)

More appropriate in patients where ultrasound is not possible due to presence of extensive dressing or bandages on the abdominal wall or if US is technically difficult. Under CT localization, the depth and extent of a collection can be accurately determined prior to percutaneous aspiration or drainage.


SUSPECTED ABDOMINAL ABSCESS OR COLLECTION
US/CT ± PERCUTANEOUS DRAINAGE
DIAGNOSIS

INTESTINAL OBSTRUCTION

PLAIN RADIOGRAPHY

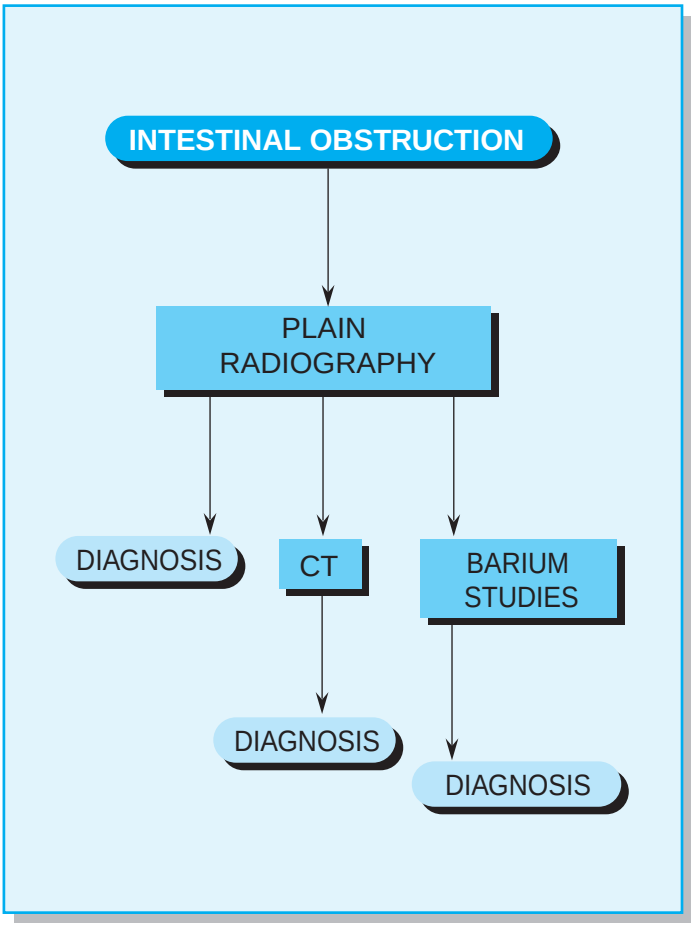
The plain abdominal radiograph is an appropriate initial step for imaging evaluation of patients with intestinal obstruction. This would help determine the presence of small or large bowel obstruction.

BARIUM STUDIES

Contrast studies are seldom indicated in intestinal obstruction. If the plain radiographs are equivocal regarding the presence of obstruction or if the assessment of the degree of obstruction and etiology is warranted, barium meal follow through/small bowel enema or Gastrografin® studies may be carried out.

COMPUTED TOMOGRAPHY (CT)

Sometimes carried out to evaluate bowel obstruction.


INTESTINAL OBSTRUCTION
PLAIN RADIOGRAPHY
DIAGNOSIS
CT
BARIUM STUDIES
DIAGNOSIS
DIAGNOSIS

GASTROINTESTINAL HAEMORRHAGE

Haematemesis is best assessed with upper endoscopy. Malaena and PR bleeding is a more difficult problem. If available, a colonoscopy should be performed promptly for PR bleeding after excluding haemorrhoids as a cause.

BARIUM STUDIES

Where endoscopy is technically difficult, barium studies of the upper GIT is helpful.

Small bowel enema (enteroclysis) offers a better anatomic display of the small bowel than a barium follow through study. It is indicated if small bowel tumours is suspected as the source of haemorrhage. It is also useful in the detection of a Meckel's diverticulum.

Barium enema is the examination to assess large bowel pathology.

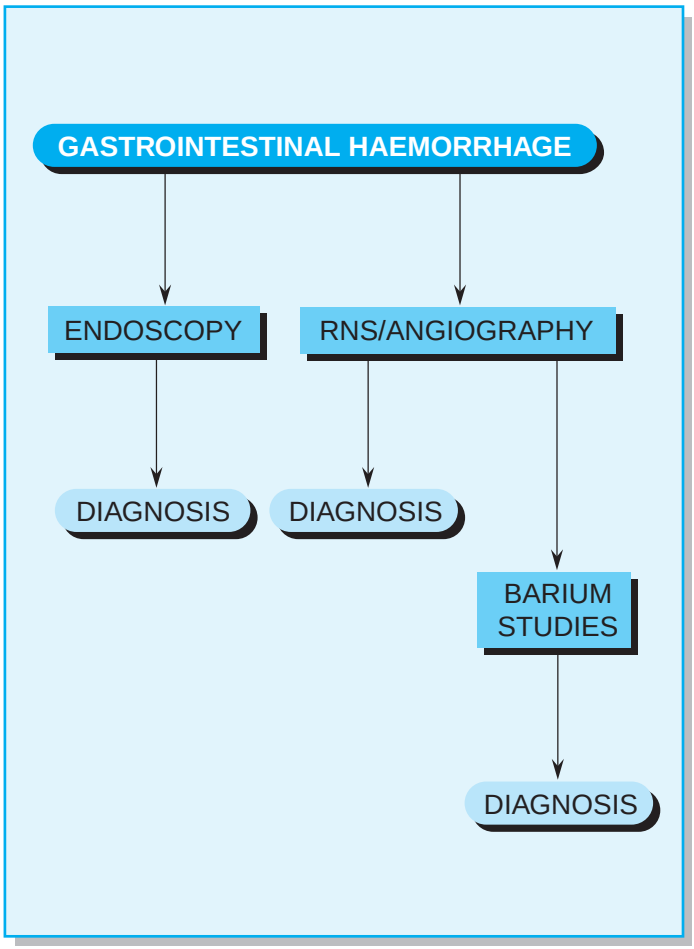
RADIONUCLIDE SCINTIGRAPHY (RNS)

Where available, a radionuclide-labelled red blood cell study is useful to detect the source of haemorrhage. However, this examination should be performed urgently at the time of active bleeding to enable localization of the site of haemorrhage.

May also be helpful where peptic ulceration in a Meckel's diverticulum is suspected in young patients.

MESENTERIC ANGIOGRAPHY

Performed to detect the exact site and cause of haemorrhage. This can be followed by therapeutic embolization in centres where there are experts in interventional radiology.


GASTROINTESTINAL HAEMORRHAGE
ENDOSCOPY
RNS/ANGIOGRAPHY
DIAGNOSIS
DIAGNOSIS
BARIUM STUDIES
DIAGNOSIS

BLUNT ABDOMINAL TRAUMA

There is absolutely no indication for further imaging in a haemodynamically unstable patient. Active resuscitation and immediate surgery is the first line of management. In haemodynamically stable patients, futher imaging is indicated .

PLAIN RADIOGRAPHY

A plain abdominal radiograph may reveal skeletal injuries and presence of free intraperitoneal air.

ULTRASONOGRAPHY (US)

Initial rapid imaging technique to evaluate the abdomen and pelvis. It is much less accurate than CT in cases of abdominal trauma.

COMPUTED TOMOGRAPHY (CT)

A contrast enhanced CT is the definitive imaging modality in the evaluation of abdominal and pelvic trauma.

INTRAVENOUS UROGRAPHY (IVU)

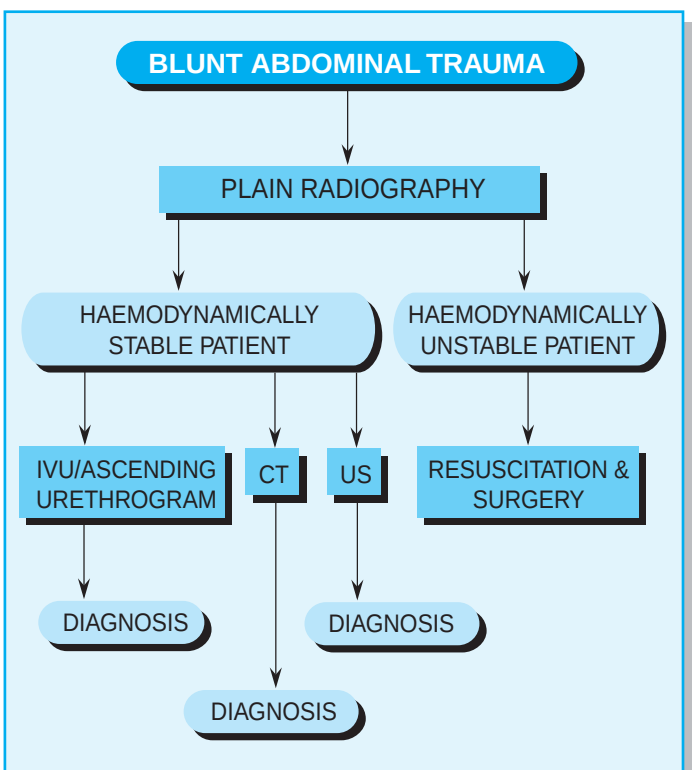
Where CT is not available, an IVU is indicated in patients with haematuria, major trauma to the renal or pelvic areas and for preoperative confirmation of a functioning contralateral kidney in patients who may need a nephrectomy.

ASCENDING URETHROGRAPHY AND CYSTOGRAPHY

This is indicated in patients who sustained pelvic injuries and suspected urethral injury.

ANGIOGRAPHY

An angiogram is indicated in suspected vascular trauma or where there is ongoing blood loss provided that immediate surgery is not indicated in unstable patients. Subsequent embolization may be carried out.



JAUNDICE

History, physical examination and serum biochemistry will yield the diagnostic category in most cases, i.e. whether it is obstructive. Imaging is indicated mainly to confirm and assess the site and cause of biliary obstruction.

ULTRASONOGRAPHY (US)

Able to determine presence of ductal dilatation, the level and the cause of obstruction.

COMPUTED TOMOGRAPHY (CT)

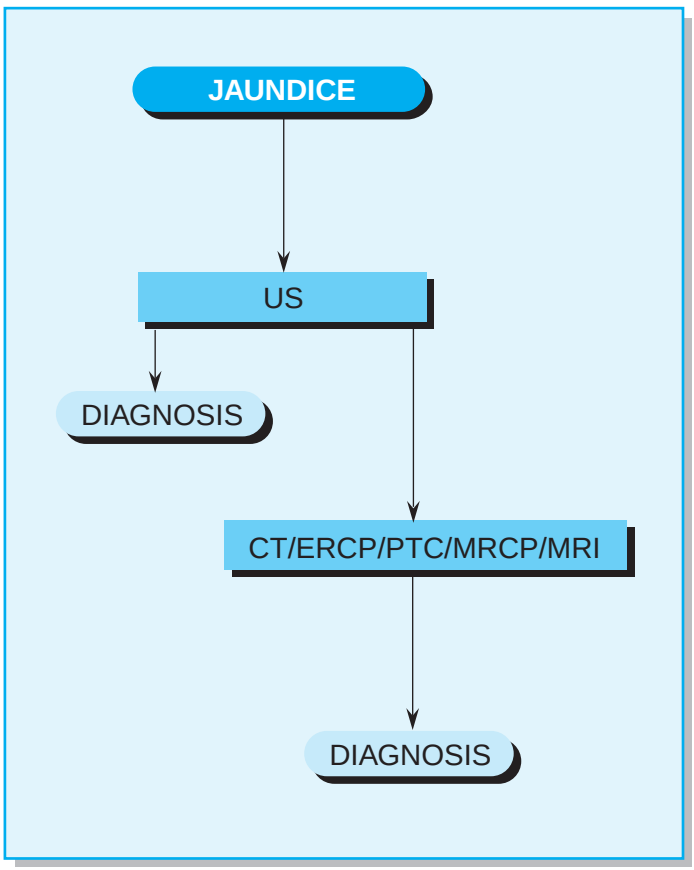
Indicated if ultrasonography is unsatisfactory in demonstrating the level or cause of obstruction, e.g. obscuration by overlying bowel gas. It is an excellent tool to image extrinsic causes of obstruction, e.g. compression of the main bile ducts by lymph nodes and for further assessment of pancreatic lesions that could be the cause for obstruction.

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY (ERCP) AND PERCUTANEOUS TRANSHEPATIC CHOLANGIOGRAPHY (PTC)

Both ERCP or PTC are useful as a definitive assessment of the site and cause of obstruction, as a 'road map' of the biliary tree is needed prior to surgical, endoscopic or radiological intervention. PTC may be more reliable to demonstrate the cause of obstruction in the proximal biliary tree and ERCP for obstruction in the distal biliary tree. However, ERCP is less invasive, thus making it the imaging modality of choice .

MRI/MAGNETIC RESONANCE CHOLANGIO-PANCREATOGRAPHY (MRCP)

Where available, MRCP may be the initial modality to assess the presence and level of biliary dilatation. It may also be followed by MRI to better define and characterize the cause of biliary obstruction.



GENITOURINARY SYSTEM

- Haematuria
- Indeterminate Renal Mass
- Recurrent UTI in Adults
- Urinary Tract Trauma
- Renal Failure – Acute or Chronic
- Renal Failure – Post Transplant
- Prostate Enlargement
- Scrotal Pain
- Adrenal Mass
- Renal Colic
- Acute Pyelonephritis

HAEMATURIA

A complete history, physical examination, urine analysis and appropriate serological tests is a prerequisite for imaging. Cystoscopy will almost always be necessary in the investigation of haematuria.

PLAIN RADIOGRAPHY

KUB is usually done prior to or as part of the IVU. Chest radiography may be carried out for pulmonary metastases/ infarct or tuberculosis.

INTRAVENOUS UROGRAPHY (IVU)

If imaging is indicated, IVU is used in the assessment of the pelvicalyceal systems, ureters and bladder.

ULTRASONOGRAPHY (US)

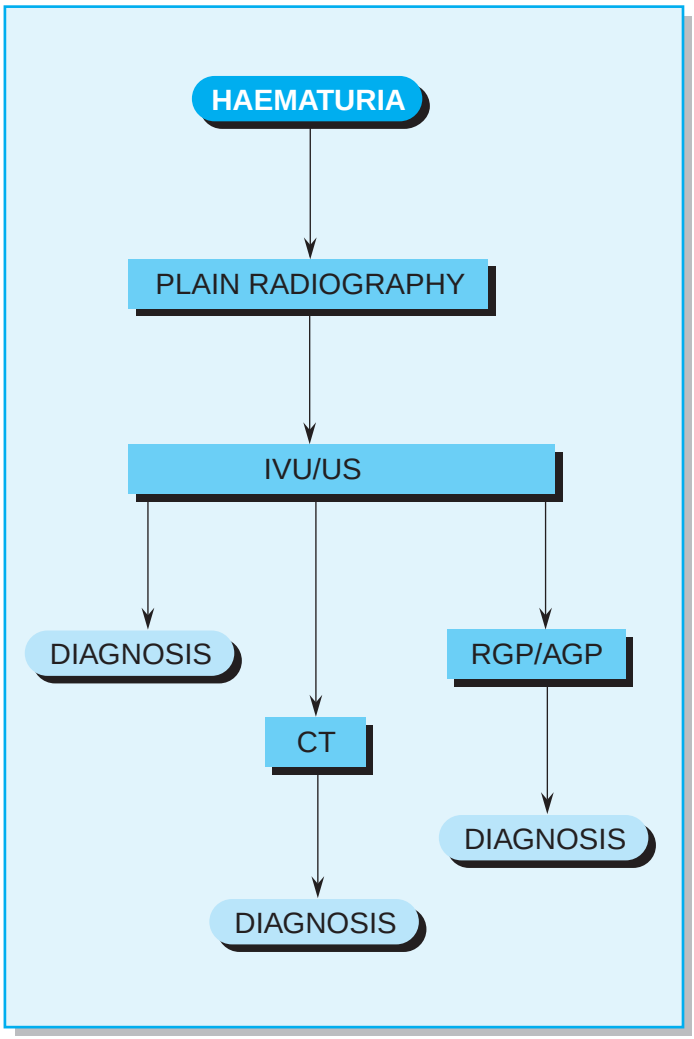
Often used in combination with IVU for the evaluation of renal masses, calculi and bladder tumours.

RETROGRADE/ANTEGRADE PYELOGRAPHY (RGP/AGP)

If calyces are suboptimally seen on IVU, a RGP/AGP may be required.

COMPUTED TOMOGRAPHY (CT)

Able to define the extent of tumours better for purposes of treatment planning and follow-up.


HAEMATURIA
PLAIN RADIOGRAPHY
IVU/US
DIAGNOSIS
CT
RGP/AGP
DIAGNOSIS
DIAGNOSIS

INDETERMINATE RENAL MASS

A complete history, physical examination, urine analysis and appropriate serological tests is a prerequisite for imaging.

INTRAVENOUS UROGRAPHY (IVU)

This will allow the evaluation of kidneys, pelvicalyceal systems and ureters.

ULTRASONOGRAPHY (US)

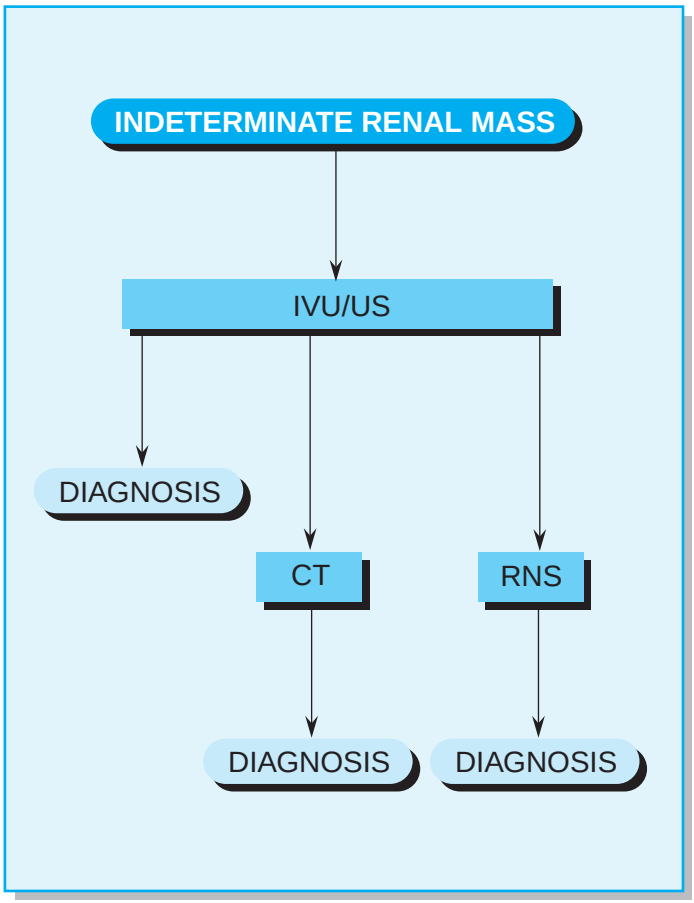
Allows differentiation of single cyst from other mass as diagnosis of hydronephrosis. US may be used to guide interventional techniques, e.g. cyst puncture, FNAC.

COMPUTED TOMOGRAPHY (CT)

Used to further evaluate renal mass other than single continual cysts. CT may be used to guide biopsies and other interventional techniques.

RADIONUCLIDE SCINTIGRAPHY (RNS)

Useful to confirm the presence of normal functioning parenchyma, e.g. column of Bertin or foetal lobulation, which may simulate a solid mass in an IVU (pseudo tumour).


INDETERMINATE RENAL MASS
IVU/US
DIAGNOSIS
CT
RNS
DIAGNOSIS
DIAGNOSIS

RECURRENT UTI IN ADULTS

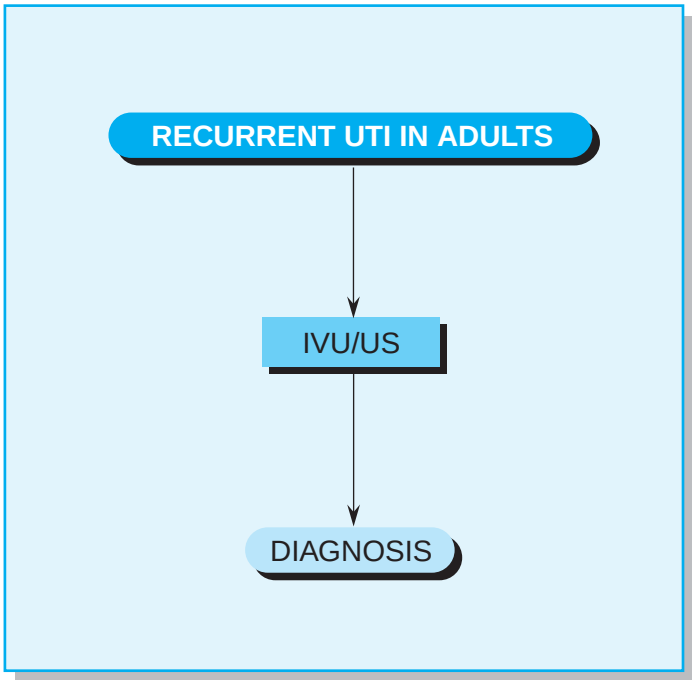
Recurrent lower urinary tract infection in adult females may not require imaging.

INTRAVENOUS UROGRAPHY (IVU)

If imaging is indicated clinically, an IVU is the screening examination of choice. An IVU is used for the assessment of renal function, scarring or obstruction.

ULTRASONOGRAPHY (US)

Used for the assessment of a non-functioning kidney with probable obstruction.


RECURRENT UTI IN ADULTS
IVU/US
DIAGNOSIS

URINARY TRACT TRAUMA

PLAIN RADIOGRAPHY

This may demonstrate the presence of associated bony injury.

INTRAVENOUS UROGRAPHY (IVU)

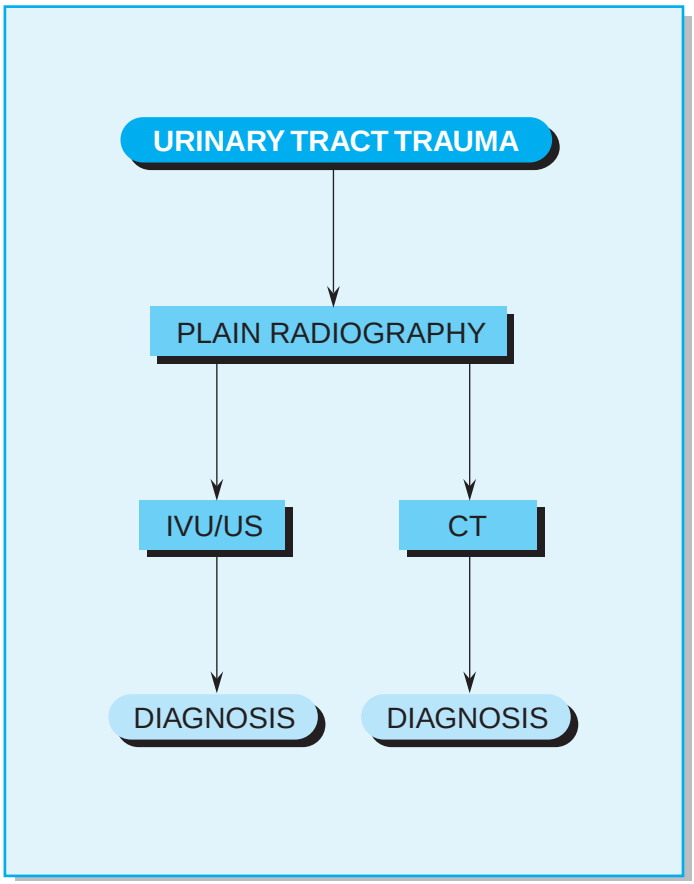
The patients are screened with the IVU for the assessment of renal function and exclusion of obstruction or rupture. Indicated in the follow-up of these patients, for the detection of delayed complications, i.e. scarring and obstruction.

ULTRASONOGRAPHY (US)

May be used to assess renal trauma and follow-up of these patients.

COMPUTED TOMOGRAPHY (CT)

If the patient is stable, CT is performed to evaluate perirenal, retroperitoneal and pelvic haematoma/urinoma, vascular or other injuries.


URINARY TRACT TRAUMA
PLAIN RADIOGRAPHY
IVU/US
CT
DIAGNOSIS
DIAGNOSIS

Renal Failure – Acute or Chronic

The aim of imaging in renal failure is to look for reversible causes of failure.

PLAIN RADIOGRAPHY

Simple means to assess renal size, contour and calculi if ultrasonography is not available or unsuccessful.

ULTRASONOGRAPHY (US)

Used to exclude obstruction and assist in intervention (nephrostomy). It can also show renal size, outline, parenchymal echogencitiy, hydronephrosis, renal cystic disease, perinephric collections as well as calculi. If the kidneys are small and echogenic, then the disease is most likely to be a chronic parenchymal disease.

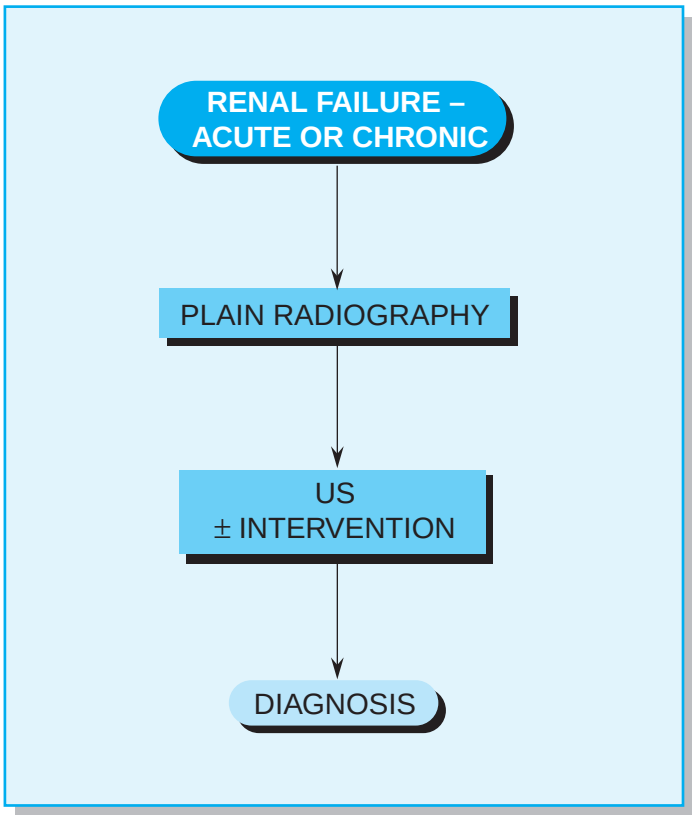
Percutaneous nephrostomy can be performed as a temporary means of urinary diversion in those with obstruction.

INTRAVENOUS UROGRAPHY (IVU)

Due to the poor excretion of contrast medium IVU should be reserved for selected cases. In addition, there is a potential risk of further renal impairment.

ANTEGRADE PYELOGRAPHY (AGP)

AGP via the nephrostomy is used to assess the underlying cause and level of obstruction.


RENAL FAILURE –
ACUTE OR CHRONIC
PLAIN RADIOGRAPHY
US
± INTERVENTION
DIAGNOSIS

RENAL FAILURE – POST TRANSPLANT

Radionuclide scan and ultrasonography are the examinations indicated in patients with impaired function following renal transplantation.

ULTRASONOGRAPHY (US)

US with Doppler is useful in several circumstances in renal transplant failure. A baseline study should be performed a few days after the transplant. It is helpful for fluid collections and obstruction. There are also specific US features in acute rejection. If indicated, biopsy and intervention of the transplant kidney may be performed under US control.

RADIONUCLIDE SCINTIGRAPHY (RNS)

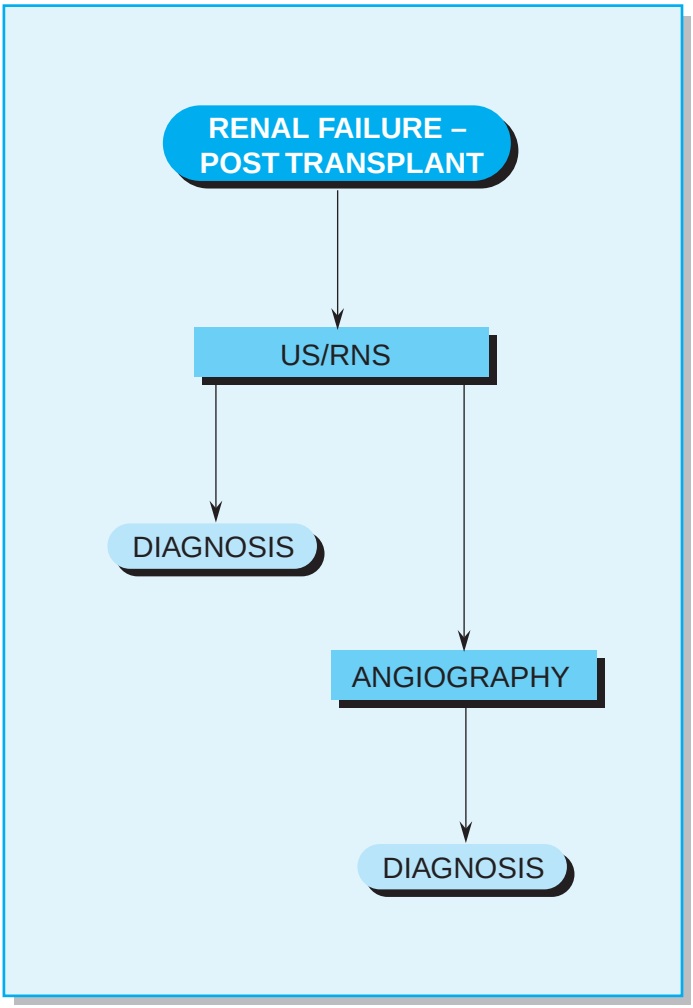
Allows quantitative assessment of perfusion, intrarenal transit time and excretion, offering early detection of rejection, acute tubular necrosis and vascular occlusion. It may also identify other complications, e.g. obstruction and fluid collections.

MICTURATING CYSTOURETHROGRAM (MCU)

Occasionally, dilatation may be associated with vesicoureteric reflux rather than obstruction and a MCU is required to differentiate between these two entities.

ANGIOGRAPHY & VENOGRAPHY

Usually done to confirm the presence of vascular compromise detected by the US/RNS.


RENAL FAILURE – POST TRANSPLANT
US/RNS
DIAGNOSIS
ANGIOGRAPHY
DIAGNOSIS

PROSTATE ENLARGEMENT

Initial assessment usually includes per rectal examination and serum prostate specific antigen (PSA) assay.

INTRAVENOUS UROGRAPHY (IVU)

Used to assess prostatomegaly, the degree of bladder neck obstruction (residual volume) and to confirm the normality of the upper tract.

ULTRASONOGRAPHY (US)

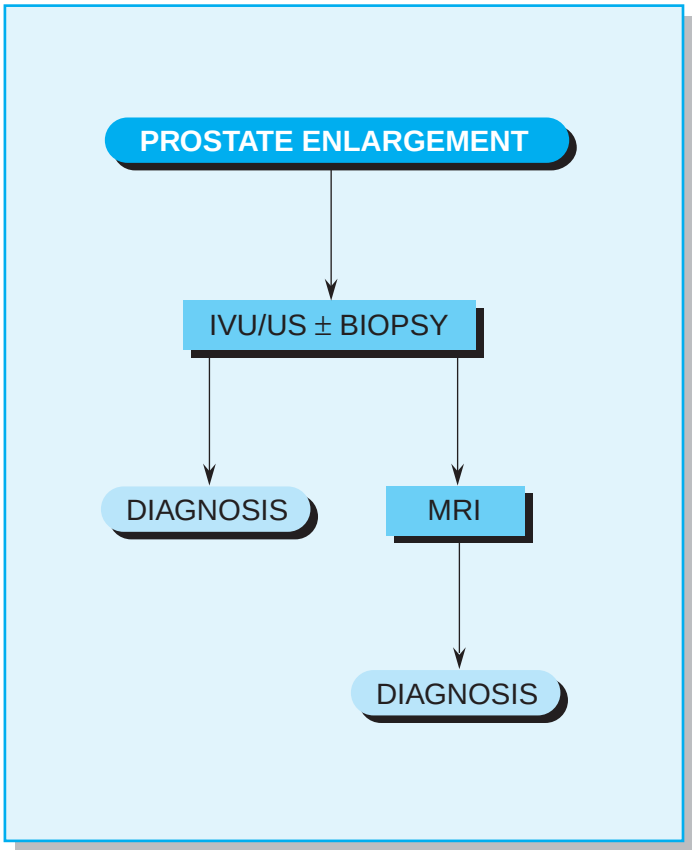
Trans-abdominal US can provide similar information as the IVU.

TRANSRECTAL ULTRASONOGRAPHY (TRUS)

Performed to assess glandular architecture and guide biopsy and if the per rectal examination is positive or suspicious, and/or the PSA is elevated. Biplane TRUS allows an assessment of the prostatic anatomy/architecture, prostatic capsule and seminal vesicles. TRUS guided biopsy of the suspicious areas will greatly improve accuracy and safety.

MAGNETIC RESONANCE IMAGING (MRI)

Current means of staging prostatic tumour.


PROSTATE ENLARGEMENT
IVU/US ± BIOPSY
DIAGNOSIS
MRI
DIAGNOSIS

SCROTAL PAIN

In a young adult, torsion of the testis and epididymo-orchitis provides a difficult clinical diagnosis.

Imaging may also differentiate cystic from solid scrotal masses and intra- from extra-testicular lesions. The majority of intra-testicular masses are malignant, while the majority of extra-testicular lesions are inflammatory, traumatic or benign tumours.

ULTRASONOGRAPHY (US)

Used to localize a scrotal swelling to the testis and / or the epididymis and to distinguish a varicocoele from a hydrocoele.

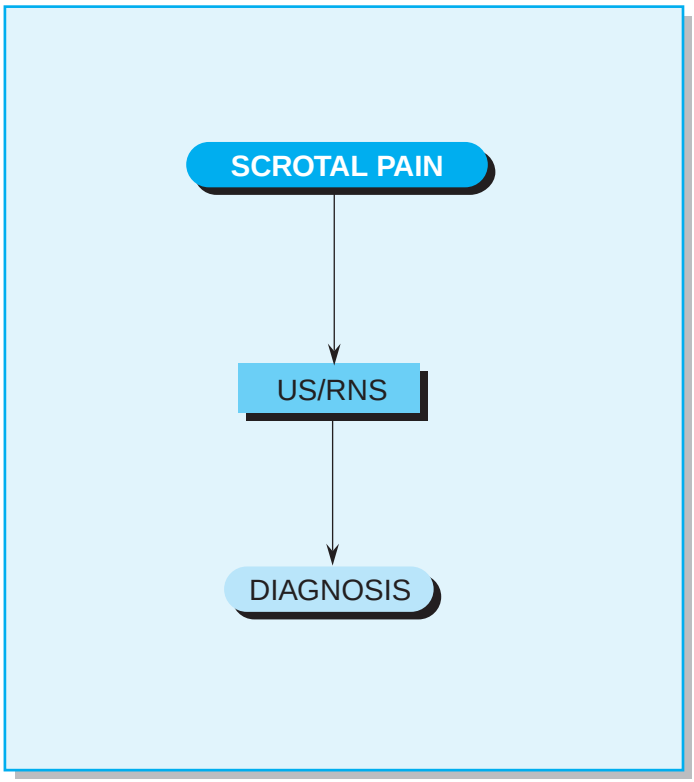
Colour Doppler US can reliably diagnose torsion.

RADIONUCLIDE SCINTIGRAPHY (RNS)

Has a high sensitivity and specificity in assessing torsion and may be performed, if available.

COMPUTED TOMOGRAPHY (CT)

Used for the staging of testicular tumours.


SCROTAL PAIN
US/RNS
DIAGNOSIS

ADRENAL MASS

An adrenal mass is usually discovered in patients following a CT or US either incidentally or as an assessment of endocrine disease or malignancy. The majority of 'incidentalomas' are benign and are adenomas. Metastasis to the adrenal without manifestation of the primary disease are rare.

ULTRASONOGRAPHY (US)

US can obtain images in any plane and in some instances, may be better in defining the origin of an abnormal mass compared to CT.

May also be used for biopsy.

COMPUTED TOMOGRAPHY (CT)

The single most effective imaging modality. It can characterize the nature (cyst or myelolipomas), location and monitor adrenal enlargement (either unilateral or bilateral, focal or diffuse).

Contrast enhanced CT must be used with caution in patients with suspected phaeochromocytoma as this can cause a hypertensive crisis.

FNAB of an adrenal mass and cytological analysis of the aspirate is indicated to exclude malignancy, when a positive diagnosis will alter treatment. However, this may be more difficult in benign disease.

MAGNETIC RESONANCE IMAGING (MRI)

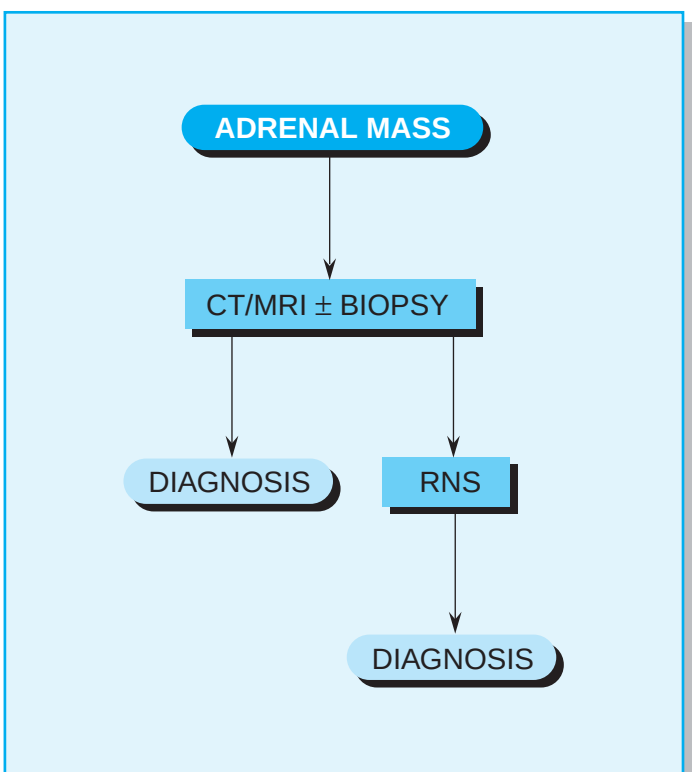
In equivocal cases, MRI is very useful in differentiating between adenomas and other tumours.

RADIONUCLIDE SCINTIGRAPHY (RNS)

May be used to detect the presence of active cortical and medullary tumours.

VENOUS SAMPLING AND ANGIOGRAPHY

Indicated for localization of small functioning adrenal tumours. As in CT, adequate pharmacological premedication, monitoring and resuscitation equipment should be available during the study on phaeochromocytoma.



RENAL COLIC

Calculi tend to lodge at three common locations within the ureter, i.e. pelviureteric junction, as it crosses the pelvic brim over the iliac vessels and at the vesicoureteric junction. The size of the calculus will determine the passage into the bladder with calculi of more than 1 cm are unlikely to pass.

PLAIN RADIOGRAPHY

A KUB may help with the demonstration of calculi, calcification or gas. It can either be done separately or as a preliminary radiograph of the IVU.

ULTRASONOGRAPHY (US)

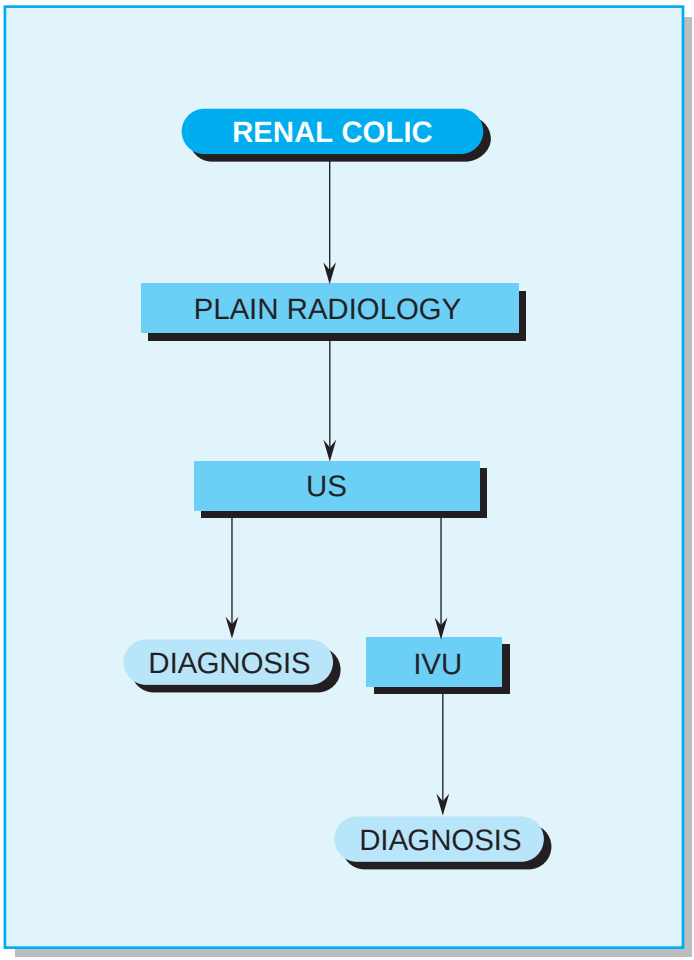
An easy method of looking at the upper collecting system for the presence of calculi, hydronephrosis, masses within the upper collecting system as well as the bladder. However, early obstructive changes may be absent.

INTRAVENOUS UROGRAPHY (IVU)

To demonstrate the presence and cause of obstruction. In addition, it provides an excellent overview of the structure of the urinary tract. Also provides all the information necessary to plan treatment.

COMPUTED TOMOGRAPHY (CT)

In selected cases, CT may have a role in the diagnosis of renal tract calculi.


RENAL COLIC
PLAIN RADIOLOGY
US
DIAGNOSIS
IVU
DIAGNOSIS

ACUTE PYELONEPHRITIS

The imaging protocol used will depend on the status of the patients. In uncomplicated patients, there is little role for imaging. However, in those patients with diabetes/ immunosuppression and complications (e.g. history of stones, previous surgery, etc.) imaging has an important role in both diagnosis and management of these patients.

PLAIN RADIOGRAPHY

Although a KUB is insufficient information to help with the management but it may demonstrate the presence of calculi or gas.

ULTRASONOGRAPHY (US)

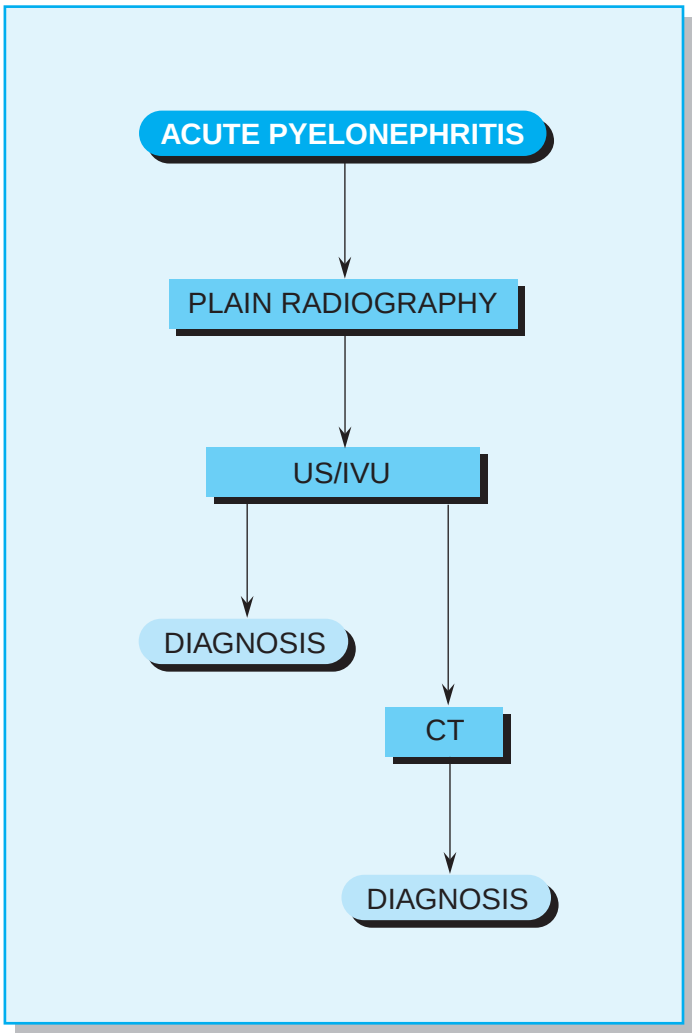
Easy method of looking at the upper collecting system for the presence of calculi, hydronephrosis, masses (abscesses, perinephric collections) within the upper collecting system. However may miss early obstructive and subtle parenchymal changes.

INTRAVENOUS UROGRAPHY (IVU)

In the patient with history of urinary tract, it may demonstrate the presence and cause of obstruction. In addition, it provides an excellent overview of the morphology of the urinary tract. IVU does not demonstrate renal parenchymal abnormalities. If the patient does not respond to antibiotics then an IVU may be helpful.

COMPUTED TOMOGRAPHY (CT)

To diagnose complicated pyelonephritis. This will provide excellent demonstration of renal abnormalities e.g. abscesses, perinephric collections. May have a role in follow-up.


ACUTE PYELONEPHRITIS
PLAIN RADIOGRAPHY
US/IVU
DIAGNOSIS
CT
DIAGNOSIS

FEMALE REPRODUCTIVE SYSTEM

- First Trimester Bleeding
- Second and Third Trimester Bleeding
- Ectopic Pregnancy
- Intrauterine Growth Retardation (IUGR)
- Pelvic/Adnexal Mass
- Abnormal Vaginal Bleeding
- Infertility

First Trimester Bleeding

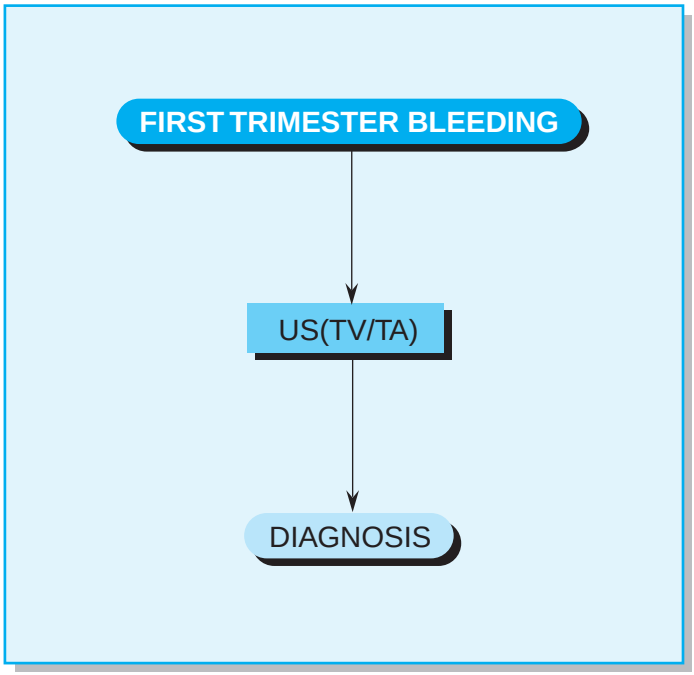
Per vaginal bleeding occurs in approximately 20-25% of patients. In the majority (50%) the bleeding is self-limiting.

HUMAN CHORIONIC GONADOTROPIN (HCG) ASSAY

β-HCG serum levels should be tested qualitatively by radioimmunoassay and correlated with the ultrasonographic findings. In a normal intrauterine pregnancy with a β-HCG level of about 1800 mIU/ml, an intrauterine sac should be demonstrated on a transabdominal (TA) US. Whereas on transvaginal (TV) US, β-HCG level for sac detection is 1000 mIU/ml.

ULTRASONOGRAPHY (US)

Ultrasound examination, especially a transvaginal (TV) US is the most appropriate tool of examination in these patients. It may determine the cause of bleeding.


FIRST TRIMESTER BLEEDING
US(TV/TA)
DIAGNOSIS

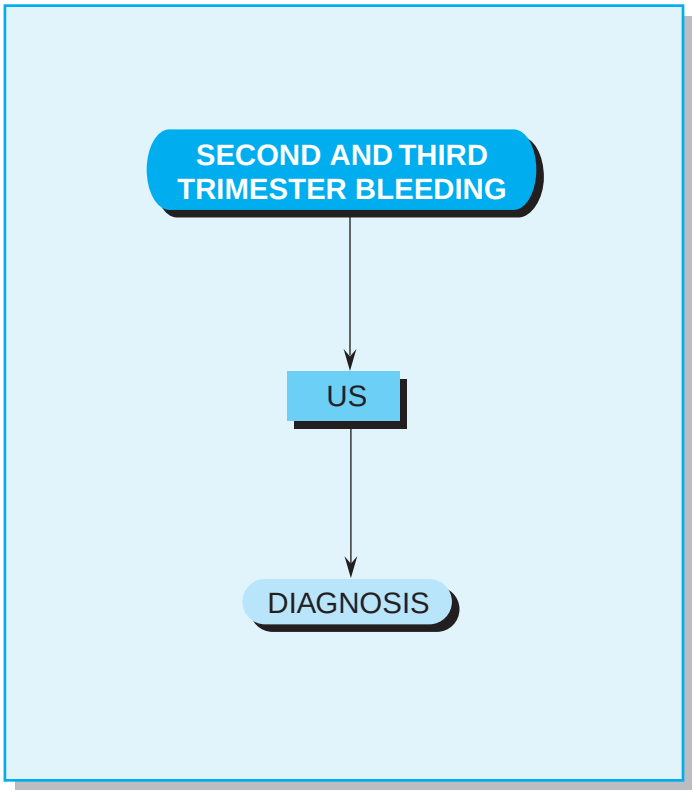
SECOND AND THIRD TRIMESTER BLEEDING

The causes of vaginal bleeding in the second and third trimester include placenta praevia, placental abruption and premature delivery. In some cases, the cause is unknown.

ULTRASONOGRAPHY (US)

Placenta praevia in the second trimester may not persist to term because of the growth of the lower uterine segment. Trans-abdominal (TA) US with a full bladder can exclude placenta praevia if the placenta is shown to lie away from the internal os.

TA US is also used to diagnose placental abruptional although a normal examination does not exclude it.


SECOND AND THIRD TRIMESTER BLEEDING
US
DIAGNOSIS

ECTOPIC PREGNANCY

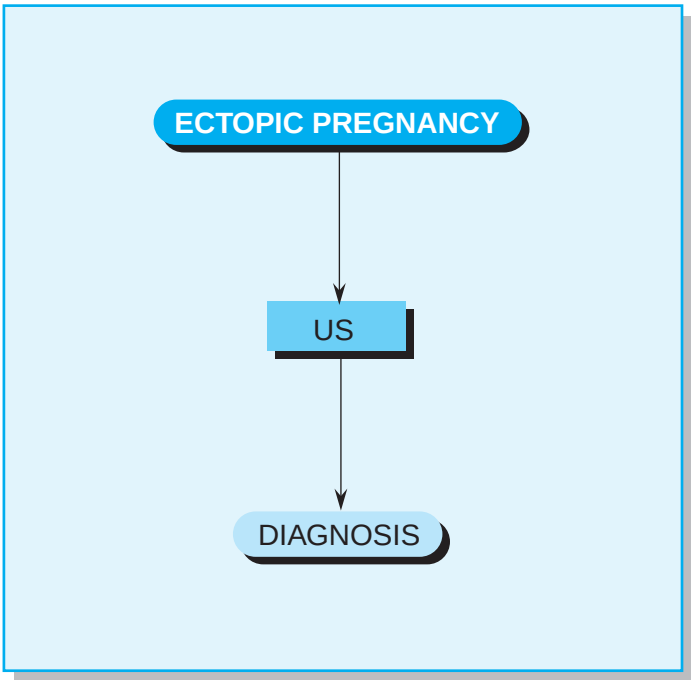
The triad of lower abdominal pain, amenorrhea and vaginal bleeding is seen in almost 80-90% of patients.

Laparoscopy has the highest predictive value for diagnosing ectopic pregnancy as a single test and provides a correct diagnosis in more than 90%.

ULTRASONOGRAPHY (US)

TV or TA ultrasound examination used in conjunction with UPT, β-hCG and laparoscopy may be integrated into a diagnostic algorithm to diagnose ectopic pregnancy.

Identification of an intrauterine gestational sac almost always excludes an ectopic pregnancy. Serum β-hcG levels of more than 6500 mIu/ml and demonstration of an absent gestational sac in the ulterus with or without the presence of an adrexal mass on an ultrasound examination are the characteristics of an ectopic pregnancy.


ECTOPIC PREGNANCY
US
DIAGNOSIS

INTRAUTERINE GROWTH RETARDATION (IUGR)

IUGR is a complication of pregnancy and an important cause of perinatal mortality. The etiology includes maternal, placental and primary foetal abnormalities.

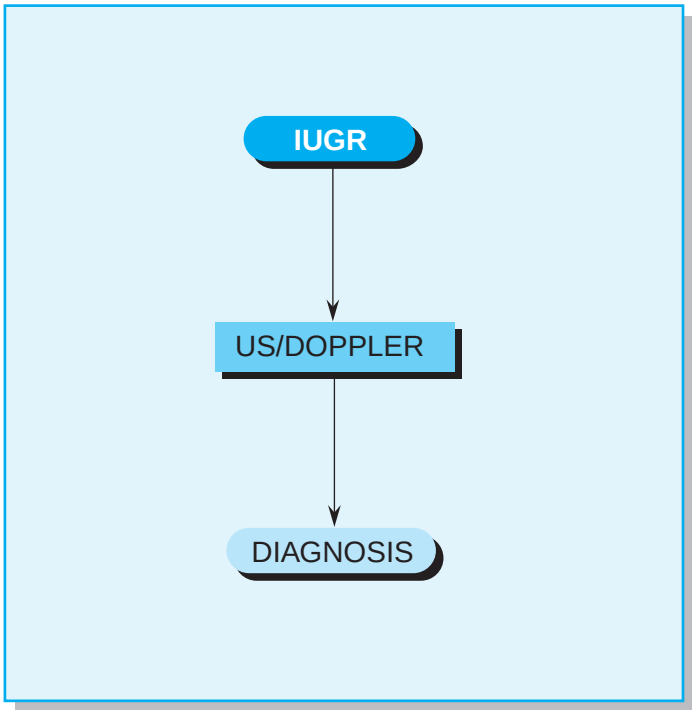
Clinical examination and ultrasound evaluation should be done before twenty weeks' gestation in cases judged to be at risk for IUGR.

ULTRASONOGRAPHY (US)

US examination utilizing representative graphs of biparietal diameter (BPD), abdominal circumference (80% accurate), femur length and head circumference are compared at regular intervals to assess the growth of the foetus. Placental maturity and liquor volume are also assessed at the same time. Symmetrical IUGR are mainly due to chromosomal abnormalities, infections or congenital malformation whereas asymmetrical IUGR are secondary to placental insufficiency from hypertension, diabetes or idiopathic.

DOPPLER ULTRASOUND

Doppler velocity waveform analysis of placental and foetal circulation is now used mainly for the assessment of IUGR.


IUGR
US/DOPPLER
DIAGNOSIS

PELVIC / ADNEXAL MASS

In the absence of pregnancy, a mass found clinically in the adnexa or pelvis should raise the possibility of a benign or malignant tumour arising from the pelvic organs.

ULTRASONOGRAPHY (US)

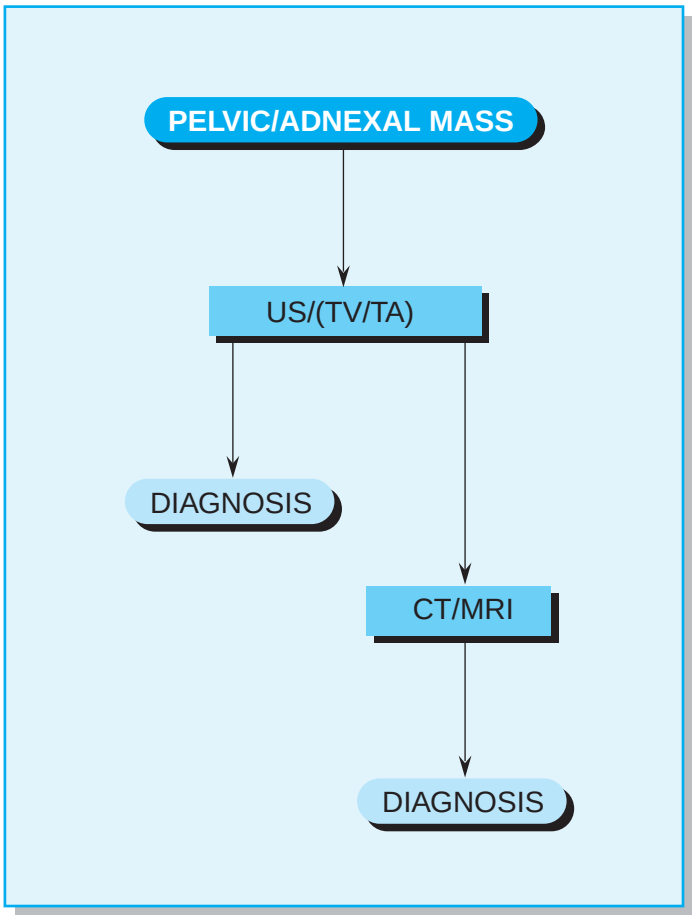
Initial imaging modality to identify normal pelvic organs, localize and characterize any mass lesion found. It may also demonstrate the presence of hydronephrosis, ascites, pleural effusion and show metastases in the liver, peritoneum or lymph nodes.

COMPUTED TOMOGRAPHY (CT)

This is the modality of choice for staging and follow-up.

MAGNETIC RESONANCE IMAGING (MRI)

This is mainly used to answer specific problem that has risen after a CT examination.


PELVIC/ADNEXAL MASS
US/(TV/TA)
DIAGNOSIS
CT/MRI
DIAGNOSIS

ABNORMAL VAGINAL BLEEDING

May happen due to hormonal imbalance (dysfunctional uterine bleed), polyps, myomas, endometrial hyperplasia and cancers of the cervix or endometrium. In post-menopausal women, the most likely cause is atrophic endometrium or endomerial carcinoma.

ULTRASONOGRAPHY (US)

Initial modality for evaluation of abnormal vaginal bleeding.

HYSTEROSONOGRAPHY

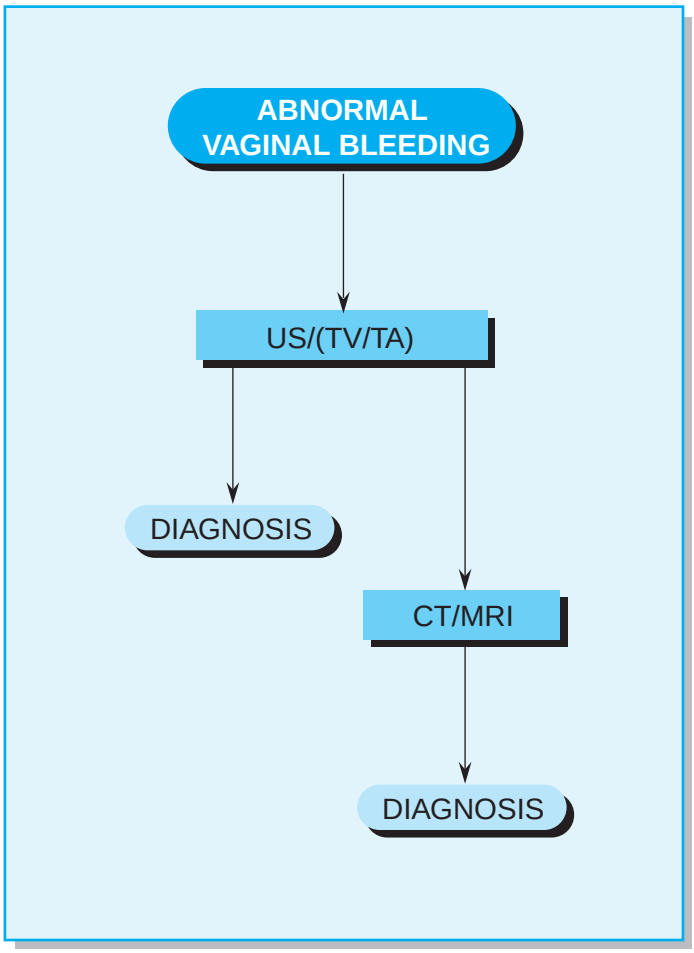
Used for measuring the endometrial thickness or to look for focal cavitary masses.

COMPUTED TOMOGRAPHY (CT)

This is the modality of choice for staging and follow-up of endometrial carcinoma.

MAGNETIC RESONANCE IMAGING (MRI)

Not warranted unless there is evidence of a cervical or endomerial tumour causing the abnormal vaginal bleeding. MRI can accurately stage the extent of tumour involvement of the uterus.


ABNORMAL VAGINAL BLEEDING
US/(TV/TA)
DIAGNOSIS
CT/MRI
DIAGNOSIS

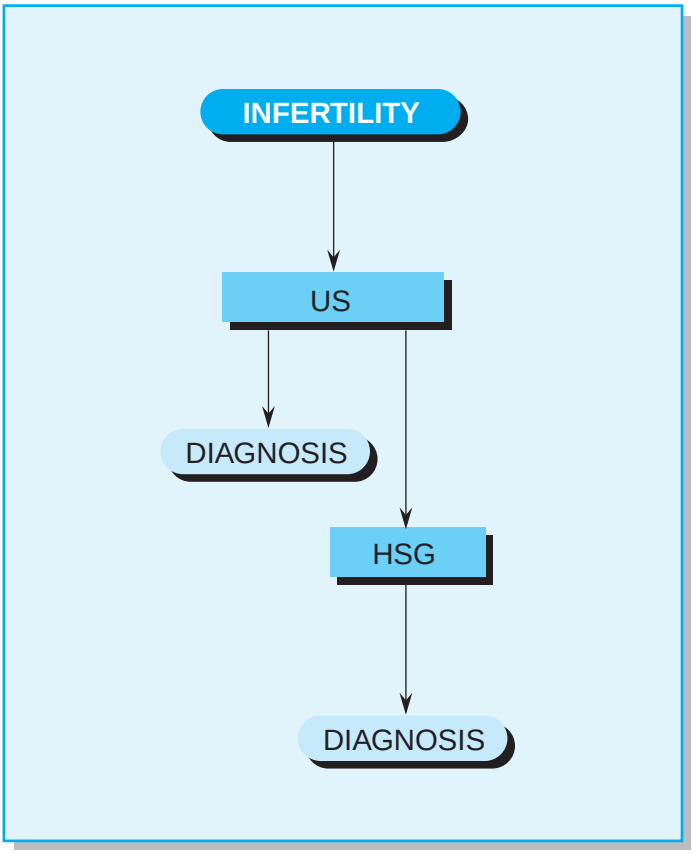
INFERTILITY

ULTRASONOGRAPHY (US)

Pelvic US is the initial modality for evaluation of uterine, ovarian abnormalities or endometriosis. Scrotal ultrasonography is mainly to look for evidence of varicocele.

HYSTEROSALPINGOGRAPHY (HSG)

To look for abnormalities of the uterine cavity and patency of fallopian tubes.


INFERTILITY
US
DIAGNOSIS
HSG
DIAGNOSIS

BREAST DISEASE

- Breast Mass
- Nipple Discharge
- Screening Mammography

BREAST MASS

MAMMOGRAPHY

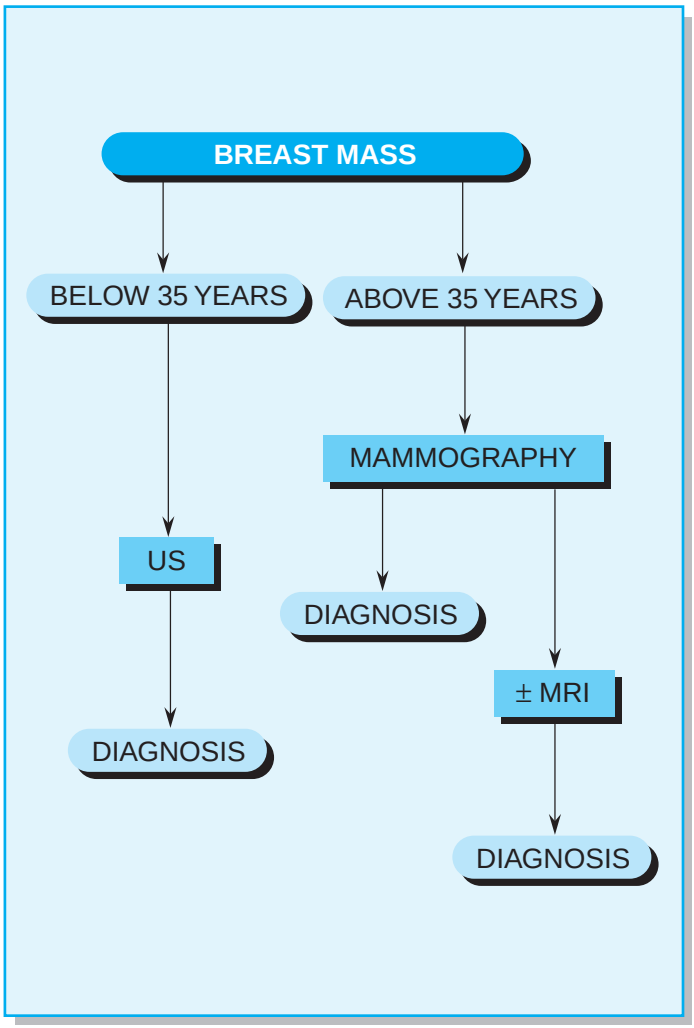
Most effective primary modality of imaging and screening the breast for women above 35 years. Mammography is highly sensitive in showing microcalcification and its characteristics compared to any other imaging modality. Fine needle aspiration cytology or biopsy (FNAB/FNAC) or hookwire localization can be performed under mammographic stereotactic guidance.

ULTRASONOGRAPHY (US)

Initial imaging modality of choice for women below 35 years and in all pregnant women. A diagnostic mammography is done on a particular breast if lesions with suspicious or malignant features are found. US can differentiate between a solid and a cystic and is able to a certain extent characterize any solid lesions to be benign or malignant. US complements mammography for patients who have a dense glandular parenchymal pattern (where 10–15% of masses can be missed). Presently, being used in guiding needles for FNAC/FNAB or hookwire localization.

MAGNETIC RESONANCE IMAGING (MRI)

MRI at present has a role especially in screening young patients with a strong family history of breast cancer or to look for multifocal cancer especially in dense breast.


BREAST MASS
BELOW 35 YEARS
ABOVE 35 YEARS
US
DIAGNOSIS
MAMMOGRAPHY
DIAGNOSIS
± MRI
DIAGNOSIS

NIPPLE DISCHARGE

Milk-stained or greenish nipple discharge although worrying does not require imaging. However, blood-stained or serous nipple discharge from a single or multiple ducts merits further imaging.

MAMMOGRAPHY

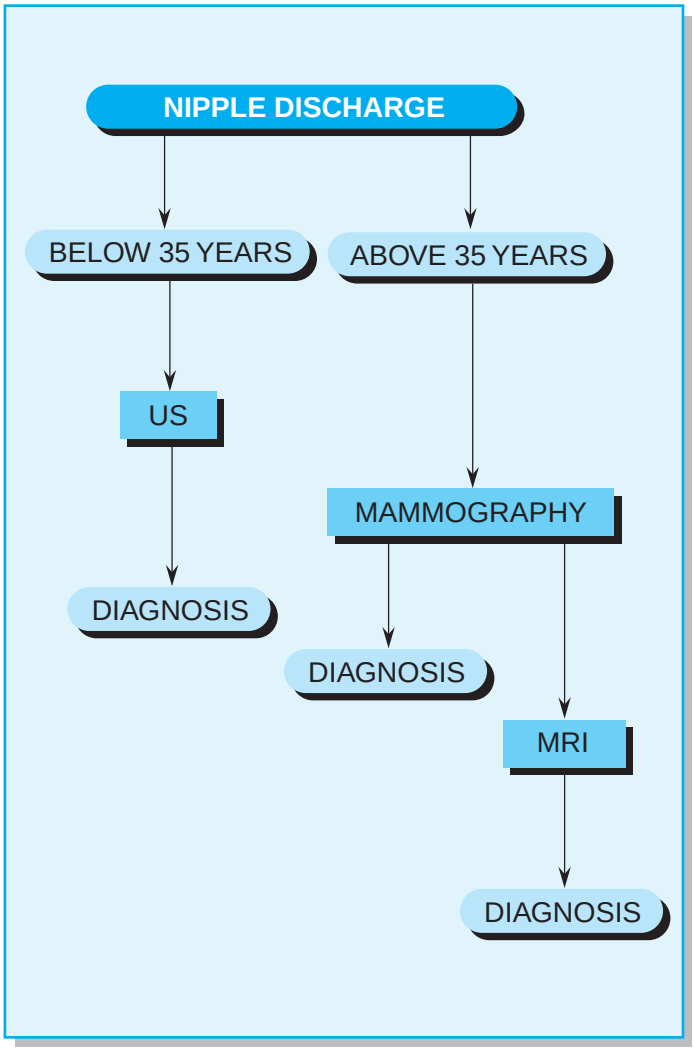
This is the initial investigation for women above 35 years.

ULTRASONOGRAPHY (US)

For women below 35 years, US is the first choice of investigation.

DUCTOGRAPHY

In cases of blood or serous discharge from a single duct a ductogram is advocated and if abnormal, a microductectomy will be recommended. Otherwise yearly mammograms are carried out in these patients.


NIPPLE DISCHARGE
BELOW 35 YEARS
ABOVE 35 YEARS
US
MAMMOGRAPHY
DIAGNOSIS
DIAGNOSIS
MRI
DIAGNOSIS

SCREENING MAMMOGRAPHY

Screening should begin at the age of 50 to 65 years since there is unequivocal evidence from randomized controlled studies in United States and Europe that have shown the detection of early small cancers has decreased mortality and morbidity. Screening mammography is advised every two-three yearly intervals.

MAMMOGRAPHY

Screening women at 40 to 49 years routinely is not currently indicated. Benefit to the population of this age group is limited. The outcome of randomized trials is awaited.

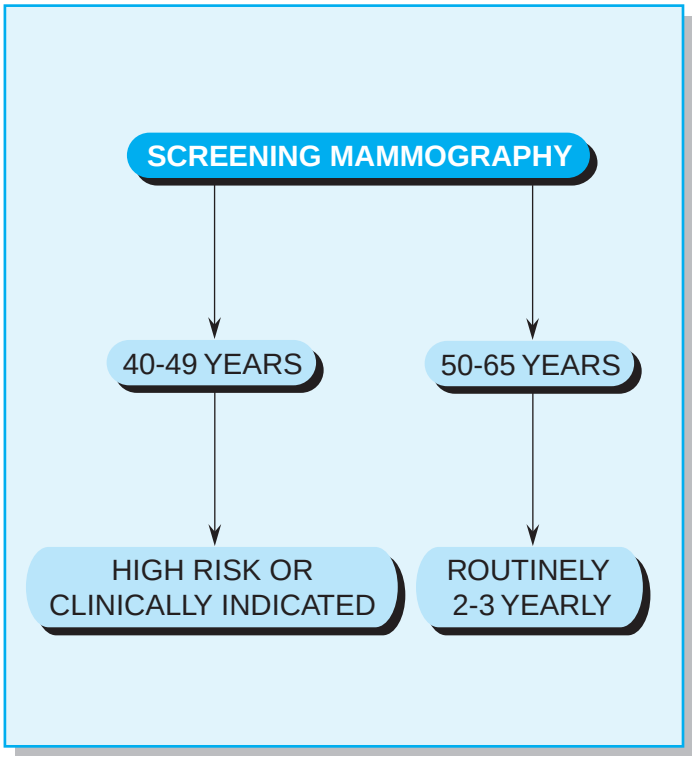
Screening for women above 40 years is not indicated since cancer is uncommon below 35 years and the sensitivity of mammography in detecting malignancy can be reduced in younger dense breasts.

Although mammography is the best method for detecting early breast cancer, it is not 100% sensitive and a negative study cannot exclude breast cancer.

Note: A single view mammogram gives an average glandular dose of about 1.2mSv. The lifetime risk of induction of cancer from such examination in women below 50 years is about 1:100,000. For women of ages 30-39 this risk is approximately doubled.

MAGNETIC RESONANCE IMAGING (MRI)

Currently has a role in screening young patients or those with dense breast seen on mammogram as well as those with a strong family history of breast cancer.


SCREENING MAMMOGRAPHY
40-49 YEARS
50-65 YEARS
HIGH RISK OR CLINICALLY INDICATED
ROUTINELY 2-3 YEARLY

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