Training Module for In
Service Clinical Training of
Senior/Junior Specialists

Prepared by :-

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# Training Module for In Service Clinical Training of Senior/Junior Specialists

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Training Module for In Service Clinical Training of Senior/Junior Specialists

General objective of Training:

The concept of health care can not be successfully implemented without the support of diagnostic services. Such services must include facilities for diagnostic radiology. Apart from their general inadequacy, the existing radiodiagnostic facilities in developing countries seldom meet the real needs of the majority of population. Accordingly, a few years ago WHO initiated the development of a ‘Basic radiological system’ (BRS) to provide better radiological coverage for population at present under served. Diagnostic services may help to decide whether the patient can continue treatment at primary center or whether he/she must be referred to higher centre and when the transfer should take place. Most such imaging will be by USG or radiography (X-Rays). In pursuit of the WHO's goal of health for all, many of these examinations will be performed at the first referral level, where patients will be seen, referred from primary care or in need of emergency treatment. Our country does not have sufficient radiologists or Sonologists to provide skilled techniques and interpretation, and imaging may be requested, interpreted and often performed by medical officers with little or no special training or experience. In doing so, it has tried to produce a module that will provide guidance on the use of diagnostic imaging by non-specialists.

The basic aim of the training is to improve the quality of diagnostic services at district and referral hospitals in Rajasthan. This training programme will develop skilled and competent doctors to diagnose various ailments at secondary level by ultrasonography and special radiological procedures. Not every disease or injury can be described in such a small module, more over conditions of frequent occurrence in our geographical area are included in this teaching module.

Ultrasound should be the preferred method of imaging wherever it can give useful clinical information. The module is a basic reference text to help with technique, recognition of normal and differential diagnosis. It indicates the clinical situations in which ultrasound scanning is likely to provide guidance for the care of the patient, and those in which scanning will not be reliable or helpful.

For a small hospital or clinic, radiography should remain the first choice of imaging technique, although ultrasound may be tempting, because the equipment is less expensive and apparently less complicated and there is no risk of ionizing radiation. However, Ultrasound can not image the lungs, fractures or most skeletal abnormalities. Its limitations must be recognized.

Ultrasound is very operator dependent. In its report, a WHO scientific group stated “The difficulties in making an accurate diagnosis from ultrasound images are such that the purchase of Ultrasound equipment without making provision for the training of an
operator is contrary to good health care practice and is unlikely to be cost effective."

Proper training and experience are required, preferably with teachers who are highly skilled and who have practised ultrasound for many years. The purpose of this teaching module is to achieve even a minimum level of expertise in our busy ultrasound department.
## Training Module for in service Clinical Training of Senior/Junior Specialists

### SESSION-WISE SCHEDULE (For 6 days)

#### SESSIONS

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**No. of Participants 2 per batch**
Day-1

SESSION – I

Ultrasound General Principles

Objectives:

- Introduction about general Ultrasound Physics
- How the ultrasound waves are generated and produces sonographic images.

Method of Teaching

- Lecture method for understanding the topic in detail.
- Teaching aids: Black board & chalks.
- OHP Presentation.

Contents: Text

The sonographic image begins with mechanical Oscillations of a crystal that has been excited by electrical pulses (piezoelectric effect). These oscillations are emitted as sound waves from the crystals just as sound waves are emitted from loudspeaker membrane, though the frequencies used in sonography are not audible to the human ear. Depending on the desired application the sonographic frequencies ranges from 2.0 to approximately 15MHz. Several crystals are assembled to form a transducer from which sound wave propagate through the tissues, to be reflected and returned as echoes, to the transducer. The returning echoes are in reverse, converted by the crystals into electrical pulses that are then used to compute the sonographic image.

The sound waves are reflected at the interfaces between media of different acoustic density (i.e. different sound propagation). The reflection of the sound waves is proportionate to the difference in acoustic density. A moderate difference will reflect and return a portion of sound beam to the transducer, with the remaining sound waves to be transmitted and propagated further into deeper tissue layers. If the difference in acoustic density increases, the intensity of reflected sound also increases and that of the transmitted sound decreases proportionately.

If the acoustic densities are vastly different, the sound beam is completely reflected and total acoustic shadowing results (Total reflection). Acoustic shadowing is observed behind bone (ribs), stone (in kidneys or Gall bladder) and air (intestinal gas). Echoes are not elicited if no differences in acoustic density are encountered eg. homogenous fluids (blood, bile, urine and cyst content but also ascites or pleural effusion) are seen as echo free (black) structures.
An echo reflected repeatedly back and forth before it returns to the transducer has a travel time that is no longer proportionate to the distance of its origin. The processor incorrectly assigns these as reverberation echoes to a deeper level.

References:

- Christenson’s Physics of Diagnostic Radiology
- P.E.S. Palmer, Manual of diagnostic ultrasound, 1995 (WHO)

Exercise/Evaluation

- Question & Answer session
- Quiz for assessment.
Day-1

SESSION-II

Live demonstration and functioning of Ultrasound Unit

Objectives:

- To provide basic information regarding various parts of Ultrasound machine.
- Basic information regarding Functioning of Ultrasound equipment
- How to use and handle the machine carefully.

Method of Teaching

- Lecture method for understanding the various parts of ultrasound machine and their proper functioning.
- O.H.P. Presentation
- Live demonstration on Ultrasound equipment / unit.

Ultrasound Machine: TOSHIBA (Just vision 400) with multifrequency probe with convex curved array transducer

Contents:

(i) Begin with a new patient
(ii) Enter name (ID)
(iii) Menu Selection eq. abdomen, Obs/Gyne etc.
(iv) Selection of transducer
(v) Gain
(vi) Depth gain compensation.
(vii) Track ball for positioning the dot or range markers
(viii) Freeze
(ix) Measurements.
(x) Annotation
(xi) Image recording.
References:

- P.E.S. Palmer, Manual of diagnostic Ultrasound, 1995 (WHO)
Day-1

SESSION-III

Ultrasound equipment and Selection of appropriate transducer

Objective –

- to provide information regarding various types of ultrasound transducers and selection of appropriate transducer for various parts of body.

Method of Teaching

- Lecture method
- OHP Presentation
- Blackboard and chalk.

Contents : Text and illustrations

Sonographic units used today can be operated with different types of transducers. Transducers are generally stored in storage shelf.

The Linear array transducer – emits sound waves parallel to each other and produces a rectangular image. The width of the image and the number of scan lines are constant at all tissue levels. An advantage of the linear array transducers is good nearfield resolution. They are primarily used with high frequencies (5-7.5MHz) for evaluating soft tissues and the thyroid gland. The disadvantage of these transducers is their large contact surface leading to artifacts when applied to a curved body contour due to air gaps between the skin and transducer. In general linear array transducers are not suitable for visualising organs in the thorax or upper abdomen.

A sector transducer produces a fan-like image that is narrow near the transducer and increases in width with deeper penetration. This diverging propagation of sound can be achieved by moving the piezo electric elements mechanically. This is less expensive solution but has the inherent risk of wear and tear. The electronic version (Phased array) is more expensive but has become established primarily in cardiology with frequencies of 2.0 – 3.0 MHz. The interference of the sound-reflecting ribs can be avoided by applying the transducer to the inter-coastal space and by taking advantage of the beam’s divergency to a 60° or 90° sector with increasing depth. The disadvantages of these types of transducer are poor near field resolution, a decreasing number of scan lines with depth (spatial resolution) and handling difficulties.

Curved or Convex array transducers are predominantly used in abdominal sonography with frequencies from 2.5 MHz (obese patients) to 5.0 MHz (slim patients), with the mean value around 3.5 – 3.75 MHz. As a compromise of both preceding types, it offers a
wide near and far zone and is handled easier than a sector scan. However, the density of the scan lines decreases with increasing distance from the transducer. When scanning the upper abdominal organs, the transducer has to be carefully manipulated to avoid acoustic shadowing of the lower limbs.

References:

- P.E.S. Palmer, Manual of diagnostic Ultrasound, 1995 (WHO)

Exercise/Evaluation -

- Question & Answer Session
- Assessment of Practical Skills Acquired During Session
Day-1

SESSION IV

Various artifacts on ultrasound imaging

Objectives:

- to provide information regarding various types artifacts on ultrasound imaging
- Significance of these artifacts that can be misleading or mistaken for some important findings that may affect proper diagnosis.

Method of Teaching –

- Lecture Method for understanding the necessity of topic in detail.
- OHP Presentation
- By live demonstration of various artifact on Ultrasound machine.

Contents: Text

Cognizance of the physical properties of sound that can mimic pathologic findings is mandatory for the correct interpretation of a sonographic image. The most important artifacts include so called **distal shadowing**. An acoustic shadow appears as a zone of reduced echogenicity (hypoechoic or an echoic black) and is found behind a strongly reflecting structures such as calcium – containing bone. Thus the visualisation of soft tissue structures in the upper abdomen is impeded by overlying ribs and those of lower pelvis by the pubis symphysis. This effect, however can be exploited to reveal calcific gall stones, renal stones and atherosclerotic plaques. Similar shadowing can be caused by air in the lungs or intestinal tracts. Evaluating structures behind air-containing bowel loops is often precluded by acoustic shadowing or echogenic comet tail artifacts.

The **air artifacts** interfere primarily with the evaluation of retroperitoneal organs (like pancreas, kidneys, lymph nodes etc.) behind air containing stomach or bowel. Another characteristic finding is the so called edge shadowing behind cysts, principally occurring behind all round cavities that are tangentially hit by ultrasound waves. Edge shadowing is caused by scattering and refraction and can be seen behind the gallbladder.

**Relative distal acoustic enhancement** is found wherever sound waves travel for some distance through homogenous fluid. Because of decreased reflection in fluid, the sound wave attenuate less and are of higher amplitude distally in comparison with adjacent sound waves. This produces increased echogenicity that is seen as a bright band behind the gall bladder, behind the urinary bladder, or even behind major vessel such as the aorta. The acoustic enhancement, however can be applied to distinguish renal or hepatic cysts from hypoechoic tumours.
Not all echoes that originate at an acoustic interface return to the transducer without further reflection. If several strongly reflecting boundaries are encountered, the sound waves can be reflected back and forth before they eventually return as echo to the transducer. The resultant delay in registering these echoes leads to **reverberation echoes**. These reverberation echoes project as several parallel lines. The electronic version (far the transducer) of the urinary bladder or gall bladder.

**Section Thickness artifacts** – are caused when the boundary between the wall of a cyst, gall bladder, or urinary bladder and the containing fluid is not perpendicular to the interrogating sound beam. The echoes within the returning beam include echoes from liquid as well as from solid structures and are averaged by the processor. Consequently, the boundary between solid tissue and fluid is seen as a low echogenic and indistinct structure. Section thickness artifacts can occasionally mimic sludge or layered material (Concrements, blood clots) in the urinary bladder.

Strongly reflecting interfaces can cause a scattered reflection of the echoes, spuriously displacing the acoustic interface laterally as a so called **arch artifact**. For instance, the duodenal wall occasionally projects in the lumen of the neighboring gall bladder, or an air – containing bowel loop can be seen within the urinary bladder, Finally **mirror artifacts** are primarily produced by the diaphragm and Visceral pleura, causing intrahepatic structures to be seen as a mirage on the pulmonary side of the diaphragm.

**References:**

- Text Book of Radiophysics by Christensons.

**Exercise/Evaluation -**

- Question and Answer Session.
Day-2

SESSION - V

Normal anatomy and live demonstration of Upper abdominal viscera with their normal measurements.

Objectives:

- To provide information regarding normal anatomy and ultrasound appearances of various upper abdominal organs in normal human being

Method of Teaching

- Lecture Method
- OHP Presentation
- Diagrams and Charts
- Live demonstration of various upper abdominal organs and their measurements on ultrasound machine.

Contents: Text

Before examining Liver, the patient is asked to take a deep breath and hold it so that liver and porta hepatis moves inferiorly from acoustic shadow of lungs and ribs.

Liver is the largest organ weighing 1.5kg lies in the upper abdomen. The porta lies approximately transversely through it pass the portal vein, hepatic artery and the bile duct. The vein always lies posterior to the artery and the duct lying laterally and deviating further to the right as it pass down to enter the duodenum.

The right branch of portal vein passes transversely within the liver substance for a few centimeter before dividing into anterior and posterior branches. While the left branches curves anteriorly giving branches to the parts of the liver it transverse.

Three main hepatic veins drains the liver, they empty into upper part of IVC. Liver is divided into segments based on its vasculature. The supply vessels separates the right from the left part of liver along a line joining GB fossa inferiorly with the fossa for the IVC superiorly, this virtual line passes through the porta. Middle hepatievein lies in this plane.

Caudate lobe is considered as a finger like extension from the upper posterior part of the right lobe. It lies immediately posteriorly to the left lobe, the two being separated by a fissure in which the ligaments venosum is buried.
Ultrasound appearance of Liver :-

In longitudinal sections through the left lobe, the liver has a triangle shape with a rounded upper surface and a sharp inferior surface, its margins are clearly defined by the reflective capsule. The parenchymal echoes are mid-grey and consist of a uniform, sponge-like pattern interrupted by vessels. Sections on the right show the same basis shape but the liver, here is larger, especially the upper portion, while the various impressions produced by the contiguous organs are apparent. In transverse sections the wedge shape of liver is seen, tapering to the left. The caudate lobe is seen as an extension of the right lobe in transverse sections and as an almond-shaped structure posterior to the left lobe in longitudinal views. The position of the ligamentum teres is marked by an intensely reflective focus in transverse section.

The portal vein branches can be traced from the porta the right passes more or less transversely for a few centimetres before dividing into main anterior and posterior branches. The left portal vein curves anteriorly as well as crossing to the left, before giving of superior and inferior branches to various segment it traverses. Section high in the liver show the larger hepatic veins as they converge towards the upper venacava. Within the liver parenchyma the normal bile ducts are too small to be demonstrated except under good imaging conditions. However, the left and right main ducts measures a few millimeter in inner diameter and one expects to visualise them as well as the larger common hepatic and bile ducts. The diameter of the lumen of the bile duct increases slightly with age, as is the case also with the pancreatic duct. The conventional position to measure the bile duct lumen is within the porta at the level of the right portal vein where the duct is cut across, at this level the hepatic artery can usually also be demonstrated, probably actually the right hepatic artery.

* Dimensions of the Normal liver

**Midclavicular**

- Longitudinal - 10.5 ± 1.5 cm
- Anterior Posterior - 8.1 ± 1.9 cm

**Midline**

- Longitudinal = 8.3 ± 1.7 cm
- Anterior Posterior - 5.7 ± 1.5 cm
- Portal Vein - <13mm
- CBD - <6mm
- (after Cholecystectomy - <9mm)

**Pancreas**

The pancreas lies transversely across the abdomen in anterior pararenal space, extending from concavity of duodeum to splenic hilum.

The echogenicity of the pancreas changes with increasing age. In young and slim patient pancreas is hypoechoic in comparison with the surrounding tissue including hepatic parenchyma. The deposition of fat in older, causes the parenchyma to increase the echogenicity (i.e. brighter).

* Normal diameter
  
  | Head (AP) | <3cm |
  | Body & tail (AP) | <2.5 cm |

The normal anteroposterior diameters of the pancreas are somewhat variable and should be <3cm for its head and less than 2.5cm for its body and tail region. The pancreatic duct dialates with age but in subjects <60 yrs of age its maximum diameter should be no more than 3mm.

**Gall Bladder**

In fasting state has an echofree lumen and is surrounded by a smooth, moderately reflective wall. The gall bladder should be examined with patient in at least two different positions if small mobile stone and small polyp are to be carefully diagnosed. The normal gall bladder wall can measured upto 3mm in thickness. In non fasting state Gall Bladder is seen contracted and thick walled.

**Spleen**

The Spleen should also be evaluated as part of complete upper abdominal examination. The examination is carried out with the patient in supine or decubitus position with left arm raised in order to spread the intercostal spaces. The transducer is placed parallel to the ribs in tenth or eleventh inter coastal spaces in left mid auxillary line. The echo pattern of a spleen is very homogenous and similar in reflectivity to liver but more reflective than normal renal cortex. The architecture of the spleen is characterised by a radiating pattern of segmental arteries and veins.

**Kidneys**

Normal kidneys can usually be identified without difficulty because difference between renal reflectivity and surrounding fat. The kidneys are generally best examined in lateral decubitus position in both LS and TS. The outer margin of cortex is well defined due to renal capsule but inner margin of parenchyma adjacent to the echoes from sinus fat is less well-defined.

Normal cortex has a reflectivity less than that of the adjacent than normal liver and spleen if the renal cortex is brighter than liver / spleen it strongly suggests the presence of renal parenchymal disease

The medullary pyramids are less reflective than the cortex.

* Normal sizes of kidneys

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<th>Men</th>
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<td>Lt. kidney</td>
<td>11.0 (9.9-12.1)</td>
<td>11.5 (10.4 – 12.6)</td>
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<tr>
<td>Rt. Kidney</td>
<td>10.7 (9.5 – 12)</td>
<td>11.2 (10.1 – 12.4)</td>
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<td>Parenchymal width</td>
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**Adrenals:**

Right adrenal gland is triangular or pyramidal in shape while the left adrenal gland is more crescentic in shape and more cranial than right. The adrenal gland is echopoor on ultrasound. The medula is regularly seen as a thin reflective structure in centre of cortex. The glands are 3-6 cm in overall length and 2-3cm in width but only 2-6 mm in thickness. The position of the adrenals as described dictates an intercoastal approach using an acoustic window of liver on right and spleen on the left.

**Stomach and Bowel loops**

Abdominal sonography at best shows three of the five mural layers. The transducer is placed over the left upper quadrant of the abdomen. In non-fasting patient, mural layers of the gastric antrum can be seen behind the liver and directly in front of the pancreas. Air shadowing precludes a reliable evaluation. Depending on its state of contraction, the gastric wall should measure 3-5 mm. Because of air in the intestinal lumen, the sonographic evaluation of small bowel loops is often limited or not possible at all. However, the intraluminal air frequently decreases when it is surrounded by inflammatory wall thickening or can be reduced by graded compression applied to the transducer. High frequency transducers can add information in selected cases if used, for instance, intra operatively to exclude mesenteric lymphadenopathy. Tender appendix show no peristalsis, has no compressibility and measures >6mm in diameter.
The ascending colon can be seen in lateral sagittal section. In most cases, air in the colon precluded visualization of its lumen. It is often easiest to identify the descending colon in the left flank. Overlapping small bowel usually obscures the rectosigmoid and the rectum is difficult to visualise even with full bladder. In women this may be imaged more clearly with transvaginal scanning. The splenic flexure is often partially hidden under the coastal margin. The normal colonic wall thickness is up to 3mm.

References:


Exercise/Evaluation -

- Quiz for assessment
- Assessment of Practical Skills Acquired during Session
- Film Session
Day-2

SESSION-VI

Normal Anatomy and live demonstration of lower abdominal viscerae with their normal measurement in male subject.

Objective :

- To provide information regarding normal anatomy and Ultrasound appearance of lower abdominal organs in male subject.

Method of Teaching –

- Lecture Method
- Color diagrams and charts
- OHP Presentation
- Live Demonstration of various lower abdominal organs on ultrasound machine.

Contents : Text

Urinary Bladder

The urinary bladder is systematically screened in suprapubic transverse and sagittal sections. When it is full, usually achieved after the intake of a large amount of fluid.

The transverse section shows the normal bladder in the shape of a rounded rectangle behind the rectus muscles and in front of and above the rectum. The longitudinal section delineates the bladder more as a triangle with the prostate gland seen below the bladder.

Post void residual urine should be calculated by measuring the maximum. Transverse and sagittal diameters of the bladder after the patient has voided, by using the simplified volume formula.

Volume – A x B x C x $\frac{1}{2}$

Normal wall thickness in fully distended bladder <4mm.
in partially filled bladder <8mm.
Normal post void residual urine <100ml

The healthy bladder is never entirely echofree. Often, reverberation artifacts of the anterior abdominal wall are seen in the bladder anteriorly or section thickness artifacts
posteriorly, sinulative intraluminal matter. An incidental finding, a forceful jet of urine can be propelled from the Ureteral ostium into the bladder lumen. This jet phenomenon is physiologic.

**Prostate** – The normal prostate gland is shaped like a pyramid and lies posterioinferior to the bladder. The base of the prostate lies adjacent to the bladder and apex adjacent to the membranous urethra.

Normal measurements are

\[ 3 \times 3 \times 5 \text{ cm.} \]

\[ \text{or volume } 25 \text{ ml} \]

The prostate is divided into three zones which are better evaluated in transrectal ultrasonography. The peripheral zone occupies the posterior lateral and apical part of gland. It has a homogenous echotexture. The central zone represents the central gland extending from the bladder neck to the verumontanum. It is less reflective than the peripheral zone with a heterogenous echotexture. The transitional zone. Surrounds the Urethra and emerges sonographically with the central zone. The collapsed can be seen as a highly echogenic urethra coursing through through the prostate.

**Seminal vesicles** – The seminal vesicles are seen as paired, relatively hypoechoic structures cephalad to the base of the prostate. They are up to 1 cm. in width, but occasionally they may be very large. Clear separation between the posterior prostate and anterior seminal vesicle is seen, the vas deferens through this interspace.

**Testis**– The testis is an ovoid organ. Measuring approximately 5x3.5x3cm. It is surrounded by a dense fibrous capsule. The tunica albuginea. It is comprised of 200-300 lobules separated by thin septae. Seminiferous tubulus from each lobule converges into large collecting tubules and form the rete testis adjacent to the mediastinum. Efferent ductulus from the reta testis exit the testis over its candal half to form the epididymis. The epididymis lies closely applied to the testis in the long axis with two expansions – the head at the upper pole and the tail at the lower pole.

Sonographically, the testis is seen as an organ of homogenous echotexture with medium amplitude reflectivity surrounded by an echogenic capsule. The mediastinum is seen as a thin echogenic band. On the same side as the epididymis with fine hypoechoic strands of septa radiating from it into the testicular parenchyma. The epididymis is of varying reflectivity with the head being isoechoic or hyperechoic to adjacent testis and measuring approximately 10-12mm in diameter while the main length is hypoechoic measuring less than 4mm in diameter. The tail, appendix of epididymis, and appendix testis are most often identified sonographically as separate structures when a hydrocele is present.
The testis is normally bathed in a few millimeteres of fluid present in the tunica vaginalis which itself can only be seen when thickened by disease. Vas 4 spermatic cord are difficult to identified.

References:

- Diagnostic radiology by Dr. Manorama Berry. 2nd edition.

Exercise/Evaluation

- Question Answer Session
- Film Session
- Assessment of Practical Skill Acquired during Session.
Day-2

SESSION VII

Normal anatomy and live demonstration of lower abdominal viscera with their normal measurements in female subject.

Objective:

- to provide information regarding normal anatomy, measurement and ultrasound appearance of pelvic organs in female subject.

Method & Teaching

- Lecture
- Charts and diagrams
- By live demonstration of various pelvic organs and their measurements on ultrasound machine.

Contents

The pelvic viscera are cradled in the musculoskeleton frame work. Anteriorly the bladder lies on the levatorani muscles the urethra passing through a foremen between them. The ureters having entered the pelvic by crossing medial to the common iliac artery & vein, curve inferiorly around the pelvic side walls and then pass medially to enter the bladder base.

The uterus lies immediately posterior to the bladder its anterior surface lying in contact with bladder base and its posterior wall. Gaps between the left & Rt Levatorani muscles in the midline transmit the vagina and anus.

Uterus: The uterus a pear shaped muscular structure is divided cervix inferiorly and body and domed fundus superiorly uterus returns low level of echoes some what high than those from pelvic musculature. The endometrium on the other land gives high level of echoes. Between endometrium and myometrium a fine echo-poor line the transitional zone is usually visible

The uterine artery is usually empty is seen only as a strong central interface, A trace of endometrial fluid can be seen at the time of ovulation.

Normal measurement of Uterus

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>6 cm</td>
</tr>
<tr>
<td>Anteroposteriorly</td>
<td>4 cm</td>
</tr>
<tr>
<td>Transversely</td>
<td>5 cm</td>
</tr>
</tbody>
</table>
in prepubertal child all dimension are smaller but the cervix is disproportionately larger occupying one half of the uterus. The uterus never completely regress after marked hypertrophy during pregnancy so that parous uterus may reach the size up to 7 cm.

The degree of filling of bladder alter the lie of uterus. When bladder is empty uterus is angled forward. When bladder is full uterus is straightened.

Extending laterally from the cornua of the fundus of the uterus are the paired uterine tubes, these fine tortuous structure with a lumen of about a milimeter is diameter.

**Endometrium**

The appearance of endometrium also varies throughout the menstrual cycle acting as an indicator of estogenic and prosgestogenic stimulation. In proliferative phase the endometrial thickness increases but still it is hypoechoic. In secretory phase endometrium continue to thicken and becomes more reflective. Towards the end of cycle the endometrial thickness reaches upto 10mm.

**Ovaries** –

The ovaries are typically oval structures measuring some 4x2x1cm. For the measurement of ovarian size any cysts >1cm should be excluded.

The normal volume is upto 14ml at puberty and then progressively decreases to about 2.5ml at menopause.

Classically they lie against the pelvic wall muscle in close proximity to iliac vessels.

The ovaries are uniform in texture at the beginning of the cycle but soon thereafter the developing follicles can be observed within them. One of them increases in size and reaches 20 to 25mm at mid cycle.

The corpus luteum that develops from follicle forms a mass of about a centimeter in diameter. Its irregular wall and low level of internal echoes may be a cause for concern. The scarred corpus Luteum form corpora albicans which is not apparent on ultrasound. Apart from their variable positions the ovaries are not subject to anomalies but anomalies in uterus is quite common, include duplication of uterus, cervix and occasionally even also of vagina.

**References:**


**Exercise/Evaluation**

- Question and Answer session
- Assessment of Practical Skills Acquired during Session
Day-3

SESSION VIII

Normal Anatomy & Imaging of Retroperitoneum

Objective:

- To provide information regarding normal anatomy and ultrasound appearance of various structures situated in retroperitoneum.

Method of Teaching

- Live demonstration of various retroperitoneal structures by ultrasound machine.
- Lecturers
- Diagrams and charts

Contents: Text

Aorta

It is found paravertebrally on the left and dorsal to the liver. It appears hypoechoic (dark) or anechoic (black)

Normal luminal diameter of aorta at suprarenal region is <2.5cm, >3cm is pathological.

IVC:

It is found paravertebrally on the right side. It opens in right atrium. The diameter of the inferior vena cava should not exceed 2.0 cm or, in young athletes, 2.5 cm. The confluence of the external and internal iliac vein is a frequent site for regional nodal enlargement. The vein is a frequent site for regional nodal enlargement. The iliac artery is anterior to the vein.

Lymph nodes:

Enlarged lymph nodes are characteristically visualised as ovoid to lobulated space-occupying lesions with a hypoechoic pattern. Lymph nodes must be differentiated from fluid filled bowel loops by absent peristatis and from veins by lack of compressibility. Normal size of abdominal lymph nodes is 7-10mm.
References:


Exercise/Evaluation

- Question and Answer session.
- Film Session
- Assessment of Practical Skills Acquired during Session
Ultrasound evaluation of common pathologies related to the upper abdominal organs.

Objective:
- To provide information about common pathologies of liver, gall bladder, biliary apparatus, pancreas adrenal gland and kidneys.

Method of Teaching:
- Lecture method
- Charts and diagrams
- Live demonstration of various Pathologies on Ultrasound machine.
- Correlation with clinical and other relevant investigations.

Contents: Text

Common pathologies of liver fatty Liver or hepatic steatosis

It produces a diffuse increase in echogenicity of the liver. This increased echogenicity is best appreciated in comparison with the renal echogenicity. The focal fatty changes predominantly occur around the gall bladder fossa or anterior to portal vein. These areas are more echogenic sharply demarcated and assume geographic configuration with no mass effect.

Hepatic cyst can be congenital or acquired. The criteria to distinguish a cyst from a lesion of low echogenicity are as follows – echo free contents, spherical shape, smooth outline, distal acoustic enhancement and edge effect. Hepatic Hemangiomas are homogenously echogenic (bright) in comparison to the remaining hepatic tissue, have a smooth outline and lack an echogenic rim. A draining, but not dilated, hepatic vein can be characteristically found in their immediate vicinity. Hepatic abscesses can produce a rather variable sonomorphology, including an anechoic centre due to liquefaction, heterogeneous foci surrounded by a rim of decreased echogenicity, and echogenic lesions. Occasionally, an infectious process can produce air bubbles into the biliary ducts. Various sonological criteria for hepatic cirrhosis are. Absence of thin, hyper echoic capsular line, paucity of peripheral hepatic vessels, obtuse angulation of the hepatic veins >45°, accentuated echogenic wall of the portal vein, abrupt caliber changes of the branches of the portal vein, regenerating nodules with displacement of adjacent vessels, nodular liver contour, contracted liver and signs of portal hypertension. The Hepato cellular carcinoma can be isoechoic in relation to the remaining hepatic parenchyma and
might only be detected by the convex displacement of adjacent hepatic veins. Metastosis exhibits a surrounding hypoechoic halo or rim.

**Pathologies of Gall Bladder** – Diagnosis of Gallstone is established if an echogenic structure with distal shadowing seen in gall bladder. lumen, if it can be dislodged from the gall bladder wall by moving and turning the patient, in contradistinction to a polyp. Cholecystitis is invariably caused by stones, early cholelcytitis only comes the gall bladder to be tender, but inflammatory edema of the gall bladder wall soon develops and the wall becomes thickened and multilayerd.

**Pathologies of kidney** – Renal cyst are echofree and produce distal acoustic enhancement. Cyst can be separated into peripheral cysts along renal surface, parenchymal cysts, or peripelvic cysts with latter to be differentiated from an obstructed and dilated renal pelvis polycystic renal disease presents with innumerable cyst that progressively increase in size. Various inflammatory conditions present with similar sonographic findings these are edema causes an enlargement and interstitial infiltration, an increased. parenchymal echogenicity with accentuated demarcation of the parenchyma relative to the hypoechoic pyramids. Hydronephrotic kidney appears as dilated calyceal system and fullness of renal pelvis. Renal stones should be differentiated from normal sinus echoes, criteria for stones are echogenic shadow with distal shadowing in more than one plane. Renal tumours may appear as complicated cyst isoechoic to renal parenchyma with bulging of renal contour and stretching of pelvicalyceal system. Angiomyolipoma is as echogenic as the central sinus echo and clearly demarcated.

**Adrenal glands** – Sonography plays important role in the detection of adrenal metastasis and large adrenal adenoma and adrenal hemorrhage. Metastases are usually seen as hypoechoic lesion between the upper renal pole and spleen or inferior hepatic surface.

**Pathologies of Spleen**- Many conditions are associated with enlargement of spleen. Splenomegaly is diagnosed, when length is >11cm. A spleen harboring multiple echogenic foci has been called the “star-sky spleen”. Splenic abscesses and metastases, which are rare, can have a rather varied sonomorphology depending on their duration and underlying cause. Splenic infarcts can be observed in splenomegaly with compromised vascular supply.

**Pathologies of pancreas** - Fibrofatty changes appear as echogenic pancreas in older and obese patient. Acute pancreatitis if the first degree can initially be devoid of any sonomorphologic changes. The edema found in more advanced stages causes marked hypoechoicnecity increased thickness, and indistinctness of pancreas. Chronic pancreatitis is characterized by a heterogenous fibrosis, calcific deposits and an undulated, irregular, outline of pancreas with irregular dilated or beaded main pancreatic duct.
References-


Exercise/Evaluation

- Question-Answer Session
- Assessment of Practical Skills Acquired during Session
- Film Session
Day-3

SESSION – X

Ultrasound evaluation of common pathologies related to lower abdominal organs in male patient.

Objective

• Informative regarding common pathologies of Urinary bladder. Prostate, seminal vesicles, testis and their ultrasound interpretation.

Method of Teaching

• By live demonstration of common pathologies of urinary bladder, Prostate, seminal vesicles and lesk on ultrasound machine.
• Lecture method
• Black board and chalk
• Correlation with clinical findings and other relevant investigations.

Contents- Text

It is important to scan for – Urinary Bladder Pathologies

1. Various causes of bladder wall thickness and trabeculation.
2. Asymmetry of urinary bladder
3. Cystic masses within the bladder (urelerocele or diverticulum)
4. Solid masses within bladder or at the base of bladder.

Prostate Gland.

The enlarged prostate gland elevates the bladder floor. Advanced prostatic hypertrophy and stenose the urethra, causing hypertrophy of bladder wall that becomes visible as a thick rim around the bladder. The carcinoma of prostate gland usually arises in the periphery of the gland, can infiltrate the bladder wall and extends as a lobulated wall into the lumen of bladder.

if both testicles are not found in the scrotum after the age of 3 months, the question of localising the undesended or ectopia testicles must be address.

Orchitis or epididymitis is usually accompanied by edematous thickening of the testicles or epididymiis.

A homogenous an echoic fluid collection invariable represent a hydrocele.
Most, but not all, testicular tumor cause a heterogenous parenchyma pattern. A well differentiated seminoma can be homogenous.

References:

- P.E.S. Palmer, Manual of diagnostic Ultrasound, 1995 (WHO)

Exercise/Evaluation

- Question-Answer Session
- Assessment of Practical Skills Acquired during Session
Day-4

SESSION-XI

Ultrasound evaluation of common pathologies related to lower abdominal organs in female patient.

Objective:

- Provide information regarding common pathologies of uterus, Urinary bladder, and both ovaries.

Method of Teaching –

- By live demonstration of common pathologies of urinary bladder, uterus and both ovaries on ultrasound machine.
- By Lecture method
- Colour diagrams and charts
- Correlation with clinical findings and other relevant investigations.

Contents: Text

The normal uterus is demarcated by an echogenic serosa and exhibits a homogenously hypoechoic myometrium. The most common benign uterine tumours, the fibroids (myomas), arise from the smooth musculature and appears hypo to isoechoic on ultrasound imaging. The submucosal fibroids close to the uterine cavity can easily mistaken for endometrial polyp. In menopause, hormone replacement therapy with estrogen leads to endometrial hyperplasia which can eventually transform into adenocarcinoma. Malignant criteria include conspicuous endometrial thickness exceeding 15 or 18mm, heterogenous echogenicity and irregular outlines.

A hypoechoic collection of blood in the uterine cavity (hematometra) can be caused by post inflammatory adhesions at the cervical os and by a cervical tumour.

Serial ultrasound examination allow close monitoring of follicular maturation and the time of ovulation. Follicular dysfunction includes premature lutenization of the follicle and continued growth without ovulation to a follicle cyst. The diagnosis of a follicle cyst should be considered if the diameter is larger than 3 cm. An ovarian cyst with a diameter exceeding 5 cm is suspicious of tumorous growth especially it septations, wall thickening or solid internal echoes are present. About 5% of women have polycystic ovarian syndrome (PCOS) caused by inhibited follicular maturation. Its most common cause is adrenal androgen excess. Ovary contains several small cysts, predominantly arranged peripherilly where they form a “Pearl on string”, appearance with tissue of increase echogenicity.
Reference:


Exercise/Evaluation

- Question-Answer Session
- Assessment of Practical Skills Acquired during Session.
Day-4

SESSION-XII

Ultrasound Evaluation of Acute Abdomen - nontraumatic cases

Objectives

- To provide information regarding the earliest possible diagnosis of causes of acute abdomen.

Method of Teaching

- Live Demonstrations of various pathologies of acute abdomen by US machine.
- Lecture method
- Correlation with radiographic, clinical and other investigations.

Contents: Text

Acute Hepatitis – Liver is normal in size with homogenous parenchyma. Liver edema makes portal triads usually prominent (periportal cuffing).

Acute Cholecystitis – Primary signs of Acute cholecystitis include, gallstones, focally tender gall bladder (Sonographic Murphy’s sign), impacted gallstone secondary signs include – gallbladder dilatation, sludge & diffuse wall thickening.

Billiary colic – Calculi may be seen in bile duct with proximal dilatation of bile duct.

Acute Pancreatitis – Pancreas becomes enlarged hypoechoic and non homogenous related to edema of pancreas. Fluid collections may be found in pancreas and peripancreatic tissues, intraperitoneal fluid collections both in greater sac and lesser sac can be seen.

Renal colic – Renal calculi are seen as reflective foci with acoustic shadowing posteriorly.

Ureteric calculi – Ultrasound is extremely helpful in visualising calculi in upper and retrovesical portion of ureter behind a filled urinary bladder.

Acute Appendicitis – It is the most common cause of acute abdomen. Sonographic criteria for positive diagnosis include visualisation of appendix as blind ended, non compressible a peristatic tube arising form tip of Cecum and having a diameter of greater than or equal to 6mm.

Mechanical Bowel obstruction – In most patients bowel loops are dilated and gas filled and gas related artifacts leads to unsatisfactory examination. In a minority of cases
sparsity of gas and presence of dilated fluid filled bowel loops provide optimal situation for ultrasonography

Aortic aneurysm rupture – Ultrasound is of great value in diagnosing a leaking abdominal aortic aneurysm and its associated hematoma.

Ruptured Ectopic Pregnancy – signs of ruptured ectopic pregnancy on USG are adrenal mass, pelvic fluid or hematoma, decidual reaction but no intrauterine gestational sac in presence of positive pregnancy test.

Torsion of Ovarian Cyst – torsion of ovarian cyst can be suspected on basis of a complex ovarian cyst and presence of pelvic fluid. However, findings are non-specific and require further evaluation by colour Doppler.

References

- Carol M. Rumak. Diagnostic Ultrasound Ilnd edition
- Dr. Manorama Berry - Diagnostic Radiology, 2nd edition

Exercise/Evaluation

- Question-Answer session
- Assessment of Practical Skills Acquired during Session
Day-4

SESSION XIII

Ultrasound Evaluation of Acute Abdomen – Traumatic Cases

Objectives

- to provide knowledge about initial evaluation of patients with trauma to abdomen and diagnosing hemoperitoneum and solid visceral injuries.

Method of Teaching

- Live demonstration of various ultrasound findings of trauma to abdomen on ultrasound machine

Contents:

ultrasonography is used as a complementary imaging modality in initial evaluation of abdominal trauma. It is operator dependant and limited by excessive bowel gas. In a technically successful examination, haemoperitoneum can be accurately diagnosed. The fluid is visualized as lerticular colecction in subpheric space, triangular in Morrison's pouch and ovoid in pelvis. Solid organ injury can be recognised by subcapsular or intraparenchymal haematomas.

Liver- Subcapsular hematomas present as echofree or complex area located between capsule of liver and underlying liver parenchyma.

Extracapsular hematomas present as echo free or complex area adjacent to liver outside the capsule. Hematomas may be seen within the liver parenchyma also.

Spleen – An echo free or complex echo area at periphery of spleen associated with general or localized spleenomegaly suggests a subcapsular hematoma. An intrasplenic echo free or complex, irregular mass suggests an acute hematoma. If there is free intraperitoneal or subpheric fluid and an irregular spleenic outline, a spleenic tear or injury is likely.

Kidney – In acute stage, real ultrasound may show intrarenal or perirenal echo free areas as a result of presence of blood (hematoma or extravasated urine)

When blood has clotted and formed thrombus, area will show as bright echoes or a mixture of echo and echo free areas.

Urinary Bladder – Bladder injury results in extra or intraperitoneal rupture or a combination of both, Sonography is usually not helpful in assessment of these injuries.

Scrotum & testis – Following injury, the testis may be enlarged or remain normal in size. When there is excess fluid in scrotum, testis should be scanned at many different angles
to exclude rupture. The injured testis may show complex echogenicity especially when there is an internal hematoma or subsequent abscess. Blood will appear as fluid within the scrotum often with complex echogenicity due to blood clots.

Bowel Perforation – In cases of bowel perforation free intraperitoneal fluid is seen. USG can show pneumoperitoneum, free air appearing as an echogenic line between anterior abdominal wall and anterior surface of liver with posterior ring down or reverberation artifacts.

References:

- P.E.S. Palmer, Manual of diagnostic Ultrasound, 1995 (WHO)
- Carol M. Rumak. Diagnostic Ultrasound IInd edition
- Dr. Manorama Berry - Diagnostic radiology, 2nd edition.

Exercise/Evaluation

- Question-Answer Session
- Assessment of Practical Skills Acquired during Session
Day-5

SESSION-XIV

Diagnosis of early Intrauterine pregnancy by ultrasonography

Objectives:

- To provide information regarding confirmation of early intrauterine pregnancy by ultrasonography
- Diagnosis of multifetal pregnancy by ultrasonography
- to exclude ectopic pregnancy by ultrasonography

Method of Teaching

- Live demonstration of early pregnancy on ultrasound equipment.
- Lecture method
- OHP presentation

Contents: Text

One of the most important applications of sonography in early pregnancy is to the confirm the presence of an intrauterine pregnancy. An elevated $\beta$-HCG in the maternal serum or urine is an indication of pregnancy and sonography can confirm it. The transvaginal probe is best for this application since it can detect an intrauterine gestational sac within the choriodecidual mass as early as 4-5 weeks much earlier than with abdominal ultrasonography. Furthermore sonography can identify multiple pregnancy and can exclude ectopic pregnancy. On TVS an unruptured ectopic pregnancy typically appears as rounded complex adenexal mass in close proximity to, but separate from, uterus and ovaries. With rupture and/or tubal abortion, intraperitoneal fluid is present.

Fetal cardiac activity can be detected from 6th gestational week. At this time normal rate is about 180 to 190 beats per minute.

References:

- Carol M. Rumak. Diagnostic Ultrasound IInd edition
Exercise/Evaluation

- Question-Answer session
- Assessment of Practical Skills Acquired during Session.
Day-5

SESSION-XV

(Biometry in First, Second and Third trimester) by Ultrasonography

Objectives:

- To evaluate various parameters in I, II, III trimester.
- To assess fetal growth, gestational age, fetal weight and expected date of delivery (EDD).
- To detect early changes of Intrauterine growth retardation.

Method of teaching –

- Live demonstration and measurement of various parameters on Ultrasound machine
- Live demonstration of early changes of IUGR on Ultrasound machine.
- Lectures
- OHP Presentation.

Contents : Text

Biometry is primarily used to establish gestational age, to assess IUGR and it also assists in diagnosing anomalies.

Gestational sac diameter (GSD)

Anechoic chorionic activity becomes surrounded by an echogenic rim and is detectable after 14th day of conception. Gestational sac should be detectable if serum β-HCG is 750-1000 U/l otherwise ectopic pregnancy must be excluded.

Yolk sac is seen as echogenic ring at about 5th gestational week. Intrauterine you sac excludes an ectopic pregnancy.

Crown Rump length (CRL)– An embryo is detectable at a gestational age of 6 weeks and 3 days and has a CRL of 5 mm. As soon as embryo is visible (CRL) replaces the GSD in determining gestational age upto 12th week.

If an embryo is not detectable in the gestational sac after mean age of 6.5 weeks or g. sac of size >30mm or no yolk sac with a sac >20mm, this finding may indicate a blighted ovum.
Biparietal diameter – (BPD) Beginning with 12th week, BPD becomes more accurate than measuring CRL. It is important to select an orientation parallel to midline echo of the falx which is interrupted in anterior third by cavum septum pellucidi. Cerebellum or orbits should not be in the imaging plane. In the same plane, head circumference and occipito frontal diameter can be measured.

Femoral length (FL). The ossified femoral diaphysis can be easily measured. The upper leg should be as close to the probe as possible and oriented lengthwise.

Abdominal circumference (AC) – It should be used to establish the appropriateness of head/body proportionately and as an approximation of fetal weight. The reference plane is at the level of the liver possibly with visualization of dorsal third of umbilical and portal veins.

References:

- Carol M. Rumak. Diagnostic Ultrasound IInd edition

Exercise/Evaluation

- Question-Answer session
- Assessment of Practical Skills Acquired during Session.
Day-5

SESSION: XVI

Placental localisation and diagnosis of fetal malformation by ultrasonography.

Objectives:

- to provide information regarding diagnosis of low lying placenta, placenta preavia and early detection of congenital anomalies.

Method of Teaching

- Live Demonstration on ultrasound equipment
- Lectures
- OHP representation.

Contents : Text

Placenta Location – The normal placenta is located near the fundus of uterus along anterior or posterior wall. Placental location should not be definitively assessed before end of II trimester the placenta praevia of early pregnancy can ascend to normal position.

The placenta is said to be low lying if distance of placenta to internal os is <5cm. Placenta praevia is divided into three categories, total placenta previa – which covers the entire internal os, partial placenta previa which covers a portion of internal os and marginal placenta previa which extends near the internal os.

In multiple pregnancy, placentations of multiple gestations should be determined. The gestations can have a common placenta or their own placenta

Diagnosis of fetal malformations:

The fetal Brain

Hydrocephalus is most common cranial abnormality. After the 20th gestational week, the ratio of ventricles to hemispheric diameter (ventricular index) is used for assessing the ventricles with a ratio of 0.5 considered indicative of hydrocephalus. The transverse measurement at the level of atria of lateral ventricle more than 10mm suggests ventriculomegaly. Distance between medial atrial wall and choroid is normally 1 to 2 mm Measurements of 3mm or greater is seen in hydrocephalus.

The cerebellum is seen on transverse section through posterior cranial fossa. Absence of dorsal indentation causes the cerebellum to look like a banana (banana sign) and
indicates cerebellar displacement towards spinal canal suggesting neural tube defect. Also calvarium loses its oval form and resembles a sliced lemon (lemon sign) with projections of parietal bone bilaterally.

Spina bifida – The spine is visualized in sagittal and coronal plane, and then each vertebra is viewed in transverse plane. The transverse section shows three ossification centres of each segment as a triangle of closely adjacent structures. In spina bifida both posterior ossification centres are splayed laterally and spinal canal is open dorsally.

Hydrops Fetalis – It is defined as abnormal accumulation of serous fluid in at least two body cavities or tissues. The fetus may show unexpected ascites, pleural or pericardial effusions or subcutaneous edema at routine sonographic assessment or patient may be referred because of clinical suspicion of polyhydramnios. Placenta oedema is variable and usually late sign of hydrops.

Nucal Translucency – It is measured as maximal thickness between skin and soft tissues overlying cervical spine. Increased thickness (>3mm) is associated with trisomy 21, 18, 13, triploidy and Turner’s syndrome.

Facial bones – Transverse and coronal sections of face are evaluated for hypotelorism or hypertelorism. A lip – palate cleft is generally lateral and can be best appreciated as a gap in echogenic upper lip on coronal section.

Cardiovascular system – Position of heart is determined. It should be one third to right and two thirds to left. The four-chamber view should identify both atria and ventricles and exclude any ventricular septal defect or atrial septal defect Aortic arch and its branches should be visualized in sagittal section.

GIT – Duodenal atresia or stenosis is seen as double bubble sign (stomach and duodenum proximal to stenosis are fluid filled and appear as bubbles). Physiological herniation of ant. abdominal wall is seen until 11th week and should not be mistaken for omphalo coele.

Urinary Tract – After 15th week, renal malformation are indirectly revealed by digohydramnios or anhydramnios or empty urinary bladder.

Renal anomalies may include unilateral or bilateral renal agenesis and upper urinary tract dilatation (hydreneprosis) which may be obstructive or non-obstructive. Autosomal dominant polycystic kidney disease appear prenatally as numerous visible renal cysts. In autosomal recessive polycystic kidney disease, there is bilateral reniform enlargement of kidneys with increased renal echogenicity.

Skeletale system – In second & third trimester hands and feet are checked and syndactyly, polydactyly can be seen Clubfoot anomaly can be seen. Achondroplasia is recognised in III trimester as shortened tubular bones and disproportionately large head.
References:

- Carol M. Rumak. Diagnostic Ultrasound IInd edition

Exercise/Evaluation

- Question-Answer session
- Assessment of Practical Skills Acquired during Session.
Day-6

SESSION XVII

Radiological Session

Chest X-Ray Interpretation.

Objectives:

- to provide information regarding interpretation of normal X-ray chest.
- Information regarding selection of various views for various pathologies in chest.
- Information regarding interpretation of common pathologies of chest.

Method of Teaching

- Demonstration of normal and pathological chest X-Ray on view box.
- Demonstration of various X-Ray Views for various pathologies in chest
- OHP Presentation
- Lecture method

Contents: Text

Chest Interpretation

Following systemic method in inspecting chest X-ray is adopted.

1. Check that the film is correctly centred, and taken in full inspiration. A film taken in expiration can cause confusion, it may stimulate disease.

2. Check that bony skeleton (ribs, clavicles, scapula etc.) is normal.

3. Check that the diaphragm is normal in position right side of the diaphragm is usually 2.5cms higher than left.

4. Check Costophrenic angles in both PA and lateral films.

5. Check the superior mediastinum for widening or the presence of abnormal masses.

6. Check the heart and great vessels for abnormalities

7. (a) All the markings in normal lung are vascular Check that they are normal in size and pattern (Lung pattern).
(b) Check the both hilar region. The left hilum is normally higher than right.

A normal Chest-X-Ray does not exclude developing pulmonary disease especially in children. Abnormalities visible in a chest X-Ray may take longer to develop than clinical abnormalities.

Choice of Views for various pathologies of Chest

PA (Postero-anterior) or Antero-posterior (AP) view is usually sufficient.

If abnormality is seen, a lateral view should be taken.

Apical (lordotic) views are used only when the PA film shows a possible abnormality in the apical area of either lung.

Decubitus views are taken when there is strong clinical suspicion of pleural fluid.

Oblique views for bony abnormalities.

Expiratory view for pneumothorax.

References:

- P.E.S. Palmer, W.P. Cock Shott, Manual of Radiographic interpretation for General Practitioners, 2002 (WHO)

Exercise/Evaluation

- Question-Answer Session

- Assessment of Practical Skills Acquired by Film Session
Day-6

SESSION – XVIII

Radiological session

Introduction about special radiological procedure eq. Barium studies or IVP

Objectives:
  • to provide information regarding interpretation of normal barium studies on IITV.
  • to provide information regarding interpretation of normal excretory urography studies.
  • information regarding interpretation of common pathologies of GIT and genito Urinary system.
  • introduction about Intravenous contrast media used in excretory urography and their advance reaction.

Method of Teaching
  • Live demonstration of various barium studies on IITV.
  • Demonstration of various films of excretory urography on view box.
  • Demonstration of various general pathologies on IITV and view Box.

Contents : Text

Barium studies that are useful in routine diagnostic radiology are barium swallow.

Barium meal, Barium meal follow through and Barium enema studies.

These studies are performed by giving barium suspension of different concentration in different quantities per orally or per rectally (in case of Barium enema study).

These barium studies are useful in diagnosis of various diseases of GIT like oesophageal carcinoma, hiatus hernia, Gastric cancers, Gastric and duodenal ulcers and colon carcinomas, strictures of small and large bowel etc.

Excretory urography studies are performed by injecting iodinated contrast intravenously and films taken in 5, 15 or 30 mins and as required.

Excretory Urography studies are useful in evaluation of renal and ureteric calculus, vesical calculus, renal masses, and various pathologies of urinary bladder.
Urographic contrast media may occasionally cause reactions. Most media may occasionally cause reactions. Most reactions are mild, a feeling of heat and a strange taste in mouth. Sometimes there is mild urticaria, itching and nausea, if the reaction is serious patient may suffer from vascular collapse, respiratory distress, laryngeal edema or even cardiac arrest. Urgent cardiopulmonary resuscitation is required in such cases.

References

- P.E.S. Palmer, W.P. Cock Shott, Manual of Radiographic interpretation for General Practitioners, 2002 (WHO)

Exercise/Evaluation

- Question-Answer Session
- Assessment of Practical Skills Acquired by Film Session
Day-6

SESSION-XIX

Radiological session

Introduction about Radiation protection and its hazards

Objective:

- To provide information regarding Radiation (the risk of harm from X-rays). Information regarding methods of radiation protection.

Method of Teaching

- By Lecture method
- Demonstration of various equipment used for radiation protection.

Contents: Text

X-ray are only dangerous if we are careless. We can not feel or see them but repeated exposure to X-rays, even those that are scattered off the patient or the X-ray equipment, and even in small doses, can cause permanent damage to the health of X-Ray operator or anyone else. We must never make an X-Ray exposure when we are anywhere near X-Ray tube. We must always be behind the control panel. We must not allow any one except the patient to be in the X-Ray room, unless the patient needs to be supported or a child needs to be held.

Following rules for X-Ray protection are adopted.

(a) Stand behind the control panel when the X-Ray exposure is made.

(b) Make sure that lead aprons and lead gloves are worn.

(c) If possible, do not allow anyone else in X-Ray room.

When supplied, wear film badge always and have it checked regularly.

Never take an X-Ray unless ordered by a Doctor or other qualified medical person.

There is no danger if we are careful.

References:

- P.E.S. Palmer, W.P. Cock Shott, Manual of Radiographic interpretation for General Practitioners, 2002 (WHO)

Exercise/Evaluation

- Question-Answer Session
Training Module for In Service Clinical Training of Senior/Junior Specialists

Post Evaluation Exercise

Q.1. Ultrasound is a sound Wave with a Frequency greater than:
   (a) 200 cycles/sec.  (b) 300 cycles/sec.  (c) 500 cycles/sec.  (d) 20,000 cycles/sec.

Q.2. Medical Sonography employs frequencies in the range of:-
   (a) 1-20 MHz  (b) 20-40 MHz  (c) 40-60 MHz  (d) 60 MHz

Q.3. Ultrasound Waves are generated by:-
   (a) Tungsten  (b) Barium lead sulphate
   (c) Piezo electric Crystal  (d) europium activated barium Fluroholide

Q.4. Velocity of Ultrasound Waves in human soft tissue
   (a) 331 m/sec  (b) 1450 m/sec  (c) 1540 m/sec  (d) 4020 m/sec.

Q.5. Display the great variation of the amplitudes of the echoes arising from tissues as varying shades of gray on a television monitor, is called:
   (a) A mode  (b) B mode  (c) TM mode  (d) Gray Scale Mode

Q.6. Ultrasound transducer predominantly used for abdominal sonography is-
   (a) Linear array transducer  (b) Sector transducer  (c) Convex curved array transducer

Q.7. If several strongly reflecting boundaries are encountered in ultrasound path, then multiple repeat echoes are generated, this is called-
   (a) Reverberation artifact  (b) Section thickness artifact  (c) Air artifact  (d) minor artifact

Q.8. The normal luminal diameter of Portal vein is-
   (a) < 5cm  (b) < 13cm  (c) < 18cm  (d) < 20cm

Q.9. The normal Anterioposterior diameter of head of Pancreas is
   (a) < 6cm  (b) < 8cm  (c) < 3cm  (d) < 15cm

Q.10. In fasting state, the normal gall bladder wall, can be measured upto
   (a) 15mm  (b) 10mm  (c) 20mm  (d) 3mm

Q.11. Kidneys are generally best shown by ultrasound in
   (a) supine position  (b) prone position  (c) Lateral decubitus position

Q.12. The normal renal parenchymal width ranging from-
   (a) 1.3 - 2.5cm  (b) 5 - 7 cm  (c) 8 - 10 cm  (d) 10 - 12cm

Q.13. The normal adrenal gland measures approximately
   (a) 8-10cm in length  (b) 3-6cm in length  (c) 10-12cm in length  (d) 16-18cm in length
Q.14. The normal wall thickness of a fully distended urinary bladder is
(a) <8mm  (b) <4mm  (c) <10mm  (d) <15mm

Q.15. The normal volume of ovaries measures upto-
(a) 20 ml  (b) 30ml  (c) 14ml  (d) 25ml

Q.16. The normal luminal diameter of aorta at suprarenal region is-
(a) < 2.5cm  (b) < 4cm  (c) < 6cm  (d) < 8cm

Q.17. Spleen is best visualised in
(a) supine position  (b) prone position  (c) left lateral decubitus  (d) Right lateral decubitus with patient taking deep breath.

Q.18. Most reliable sonographic findings of portal hypertension is-
(a) Dilatation of porta hepatis  (b) Demonstration of porto canal collaterals at porta hepatis  (c) Recanalisation of umbilical vein  (d) Splenomegaly

Q.19. Ultrasonic "Murphy's sign" is positive in -
(a) Acute Cholecystitis  (b) Chronic cholecystitis  (c) Carcinoma of gall bladder  (d) GB polyp.

Q.20. All of the following are major signs of acute cholecystitis except
(a) Stones in gall bladder  (b) edema of gall bladder wall  (c) peri cholecystic fluid  (d) Gas in gall bladder wall.

Q.21. Sonographic findings in Acute Pancreatitis are all, except
(a) Diffuse pancreatic enlargement  (b) generalised increase is pancreatic reflectivity  (c) Peripancreatic fluid collections  (d) dilatation of CBD

Q.22. Most useful screening modality in patients with Jaundice is -
(a) endoscopic ultrasound  (b) abdominal ultrasonography  (c) CT scan  (d) MRI

Q.23. Klatskin's tumor is known as
(a) Renal cell carcinoma  (b) Melanoma  (c) Hilar cholangiocarcinoma  (d) Hepatocellular carcinoma

Q.24. Collection of blood in uterine cavity is known as -
(a) Pyometra  (b) Hacmatomatra  (c) Hemoperitoneum  (d) Pyoperitoneum

Q.25. Most common type of urinary bladder tumor is-
(a) Squamous cell carcinoma (b) adenocarcinoma
(c) Transitional cell carcinoma (d) biomosarcoma.

Q.26. In endometrial hyperplasia, the thickness of endometrium measures
(a) > 5mm (b) > 10mm (c) > 2mm (d) 8 mm

Q.27. All of the following are correct for uterine fibroids, except;
(a) Menorrhagia is most common presenting feature.
(b) Majority of them arise in uterine body region.
(c) They may produce acoustic shadowing
(d) Malignant potential is very high.

Q.28. The pregnancy is most accurately dated by measurement of-
(a) BPD at 18 Wks (b) CRL at 10 Wks
(c) Gestation sac dimensions at 6 Wks (d) FL at 18 Wks

Q.29. Blighted ovum is called when-
(a) Gestational Sac at least 10mm, with no fetal parts seen.
(b) Gestational Sac at least 25mm, with fetal parts seen.
(c) Gestational Sac at least 25mm, without any fetal parts seen.
(d) Gestational Sac at least 10mm, with fetal parts seen.

Q.30. All of the following are correct for ectopic pregnancy, except.
(a) 95-97% occurs in fallopian tube.
(b) β hcg is significantly higher in ectopic pregnancy
(c) Patient presenting with pain, vaginal bleeding, and adnexal mass.
(d) IUCD causes increase incidence of ectopic pregnancy.
**Answer Sheet**

<p>| | | | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>d</td>
<td>11.</td>
<td>c</td>
<td>21.</td>
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<td>2.</td>
<td>a</td>
<td>12.</td>
<td>a</td>
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<td>3.</td>
<td>c</td>
<td>13.</td>
<td>b</td>
<td>23.</td>
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<tr>
<td>4.</td>
<td>c</td>
<td>14.</td>
<td>b</td>
<td>24.</td>
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<td>5.</td>
<td>d</td>
<td>15.</td>
<td>c</td>
<td>25.</td>
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<td>6.</td>
<td>c</td>
<td>16.</td>
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<td>26.</td>
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<td>7.</td>
<td>a</td>
<td>17.</td>
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<td>8.</td>
<td>b</td>
<td>18.</td>
<td>c</td>
<td>28.</td>
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<td>9.</td>
<td>c</td>
<td>19.</td>
<td>a</td>
<td>29.</td>
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<td>10.</td>
<td>d</td>
<td>20.</td>
<td>c</td>
<td>30.</td>
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</tbody>
</table>
* Normal Measurements

The normal values listed here are subject to individual variations and should be considered only as guidelines. Different values apply for children. These representative values were taken from the literature and apply only to measurements in the stated standard sections. For vessels, the inner diameter of the vascular lumen is given, without consideration of the vascular wall.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Abdominal aorta luminal diameter</td>
<td></td>
</tr>
<tr>
<td>&lt; 2.5 cm (cranial portion)</td>
<td></td>
</tr>
<tr>
<td>&lt; 2.0 cm (caudal portion)</td>
<td></td>
</tr>
<tr>
<td>2.5-3.0 cm = ectasia</td>
<td></td>
</tr>
<tr>
<td>&gt; 3.0 cm = aneurysm</td>
<td></td>
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<tr>
<td>Adrenal glands maximal size:</td>
<td></td>
</tr>
<tr>
<td>&lt; 5.0 cm (Length)</td>
<td></td>
</tr>
<tr>
<td>&lt; 1.0 cm (width of an individual limb)</td>
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<tr>
<td>Biliary ducts</td>
<td></td>
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<tr>
<td>bile duct:</td>
<td></td>
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<tr>
<td>&lt; 0.6 cm (if gallbladder is present)</td>
<td></td>
</tr>
<tr>
<td>&lt; 0.9 cm (status post cholecystectomy)</td>
<td></td>
</tr>
<tr>
<td>intrahepatic bile ducts</td>
<td></td>
</tr>
<tr>
<td>&lt; 0.4 cm</td>
<td></td>
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<tr>
<td>Cervical subcutaneous tissue width (in prenatal measurements):</td>
<td></td>
</tr>
<tr>
<td>&lt; 3.0 mm (if more : &quot;nuchal edema&quot; or &quot;posterior cervical edema&quot;)</td>
<td></td>
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<tr>
<td>Endometrium width (both layers):</td>
<td></td>
</tr>
<tr>
<td>&lt; 15.0 mm (premenopausal)</td>
<td></td>
</tr>
<tr>
<td>&lt; 8.0 mm (postmenopausal)</td>
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<tr>
<td>Gallbladder</td>
<td></td>
</tr>
<tr>
<td>Wall thickness:</td>
<td></td>
</tr>
<tr>
<td>&lt; 0.4 cm (postprandial upto 0.7 cm)</td>
<td></td>
</tr>
<tr>
<td>Maximal diameter:</td>
<td></td>
</tr>
<tr>
<td>&lt; 11.0 cm longitudinal (preprandial)</td>
<td></td>
</tr>
<tr>
<td>&lt; 4.0 cm. transverse (preprandial)</td>
<td></td>
</tr>
<tr>
<td>Hepatic veins</td>
<td></td>
</tr>
<tr>
<td>luminal width:</td>
<td></td>
</tr>
<tr>
<td>&lt; 0.6 cm (distal to the last confluence before the inferior vena cava)</td>
<td></td>
</tr>
<tr>
<td>&gt;0.6 cm → right cardiac insufficiency</td>
<td></td>
</tr>
<tr>
<td>Inferior vena cava luminal width:</td>
<td></td>
</tr>
<tr>
<td>&lt; 2.0 cm (&lt; 2.5 cm in young athletes) (with collapse during forced expiration!)</td>
<td></td>
</tr>
<tr>
<td>&gt; 2.5 cm without expiration collapse → suspicious</td>
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<td>--------------------------</td>
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<tr>
<td>of right cardiac insufficiency</td>
<td></td>
</tr>
<tr>
<td>IUCD - fundus distance</td>
<td>&lt; 20.0 mm (if increased: dislodged)</td>
</tr>
<tr>
<td>Organ</td>
<td>Measurements</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Kidneys</td>
<td>Maximal size: 10.0 - 12.0 cm (lengthwise), 4.0 - 6.0 cm (transverse)</td>
</tr>
<tr>
<td></td>
<td>Parenchymal width: 1.3 - 2.5 cm</td>
</tr>
<tr>
<td></td>
<td>Respiratory morbidity: 3.0 - 7.0 cm</td>
</tr>
<tr>
<td>Liver</td>
<td>Size in right MCL: &lt; 13.0 cm (craniocaudal), &lt; 15.0 cm (depending on body habitus)</td>
</tr>
<tr>
<td></td>
<td>Marginal angle: &lt; 30° (left hepatic lobe, lateral), &lt; 45° (right hepatic lobe, caudal)</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>Maximal diameter: &lt; 1.0 cm (short axis diameter)</td>
</tr>
<tr>
<td>Ovaries</td>
<td>Volume: 5.5 - 10.0 cm(^3) (each ovary pre-menopausal), 2.5-3.5 cm(^3) (each ovary post-menopausal)</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Size of the head: &lt; 3.0 cm, size of the body: &lt; 2.5 cm, size of the tail: &lt; 2.5 cm</td>
</tr>
<tr>
<td></td>
<td>Luminal diameter of the duct: &lt; 0.2 cm</td>
</tr>
<tr>
<td>Portal vein</td>
<td>Luminal width: &lt; 1.3 cm, &gt; 1.5 cm (\Rightarrow) portal hypertension</td>
</tr>
<tr>
<td>Prostate gland</td>
<td>Size: &lt; 5.0 cm (transverse), &lt; 3.0 cm (craniocaudal), &lt; 3.0 cm (anteroposterior, sagittal)</td>
</tr>
<tr>
<td></td>
<td>Volume: &lt; 25 ml</td>
</tr>
<tr>
<td>Spleen</td>
<td>Maximal size: &lt; 11.0 cm (length), &lt; 7.0 cm (width), &lt; 4.0 cm (depth, measured between splenic hilum and surface)</td>
</tr>
<tr>
<td>Organ</td>
<td>Measurement</td>
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<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>Splenic vein</td>
<td>luminal width:</td>
</tr>
<tr>
<td></td>
<td>&lt; 1.0 cm</td>
</tr>
<tr>
<td></td>
<td>&gt; 1.2 cm (\rightarrow) portal hypertension or splenomegaly</td>
</tr>
<tr>
<td>Superior mesenteric artery</td>
<td>luminal diameter:</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.5 cm</td>
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<tr>
<td>Thyroid gland</td>
<td>size:</td>
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<tr>
<td></td>
<td>4.0 - 7.0 cm (craniocaudal)</td>
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<tr>
<td></td>
<td>1.0 - 3.0 cm (transverse)</td>
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<tr>
<td></td>
<td>1.0-2.0 cm (sagittal)</td>
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<tr>
<td></td>
<td>volume (both lobes combined):</td>
</tr>
<tr>
<td></td>
<td>&lt; 20 ml (women)</td>
</tr>
<tr>
<td></td>
<td>&lt; 25 ml (men)</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>wall thickness:</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.4 (if bladder is full)</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.8 cm (after voiding)</td>
</tr>
<tr>
<td></td>
<td>postvoid residual:</td>
</tr>
<tr>
<td></td>
<td>&lt; 100 ml</td>
</tr>
<tr>
<td></td>
<td>volume:</td>
</tr>
<tr>
<td></td>
<td>&lt; 550ml (women)</td>
</tr>
<tr>
<td></td>
<td>&lt; 750 ml (men)</td>
</tr>
<tr>
<td>Uterus</td>
<td>maximal size</td>
</tr>
<tr>
<td></td>
<td>5.0-8.0 cm longitudinal (nullipara)</td>
</tr>
<tr>
<td></td>
<td>1.5-3.0 cm width</td>
</tr>
<tr>
<td>Volume calculation</td>
<td>0.5 x A x B x C</td>
</tr>
<tr>
<td>Yolk sac</td>
<td>diameter</td>
</tr>
<tr>
<td></td>
<td>3.0-7.0 mm</td>
</tr>
</tbody>
</table>